NSTAR Business Solutions Program Evaluation: Noteworthy Approaches and Findings From a C&I Retrofit Program Evaluation

Noteworthy Approaches & Findings From C&I Retrofit Program Evaluation

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ABSTRACT

Typically, reporting on the approach and results of an impact evaluation of an entrenched C&I retrofit program would not be noteworthy, and there would likely be nothing other than typical results to report. However, the comprehensive approach taken by a local utility and their evaluation consultants in conducting the impact evaluation of their Business Solutions Program has proven that an effective program implementation team working in concert with evaluation practitioners, can simplify the evaluation process, improve the effectiveness of the tracking system, and, in the end, ensure excellent realization rates.

This paper describes in detail the approach undertaken in this evaluation, explaining the interactions between all parties, and the effectiveness of the process between program evaluation and implementation managers, and high-value findings of the evaluation study.

All the parties involved in the evaluation process worked in close association to ensure an enhanced understanding of each sampled project, and paved the way for improved energy savings analyses and gross realization rates that related better with tracking system data. During the evaluations many technical observations were made that could be critical in the redevelopment and enhancement of the implementation process. The findings from the evaluations were used to make recommendations, which could be readily applied to the ongoing program implementation process to yield a continued improvement in realization rates.

INTRODUCTION

The Business Solutions Program is the retrofit project energy efficiency program offered by the NSTAR Electric. It is designed to provide the commercial, industrial, and institutional customers with financial and technical assistance to facilitate the installation of energy saving equipment in existing buildings.

The impact evaluation study under consideration was conducted by the NSTAR in an effort to assess the effectiveness of its energy-efficiency programs and to compare the savings estimates projected prior to installation with the verified savings determined after the measure was installed. The findings from the evaluation also help the utility to characterize the measure technologies and refine the delivery of the energy efficiency programs. This paper discusses the interaction between the utility and all other involved parties and the overall approach undertaken to accomplish the project goal.

Effective communication between the various team players (consultants, utility evaluation staff, and program implementation staff) were critical to the success of the project. The monitoring and verification (M&V) vendor and all applicable utility staff worked in close association during the course of this project in effort to improve the program. This involved discussions during the kickoff meeting, file review meetings, project status meetings and the final presentation. Atypical of many evaluations, the utility implementation staff was kept in the loop throughout the project. The recommendations from the evaluation study were carefully considered by the utility both during and following the project. As a result there are multiple on-going efforts and initiatives to improve the program. Some of these efforts are briefly discussed later in this paper.

The Business Solutions evaluation was accomplished with key tasks including: sample design and selection; on-site engineering data collection; technology assessment; project analysis; and standardized methods for addressing free-ridership and spillover. A sample of sites was statistically generated for onsite assessments and net-to-gross surveys. Loggers were deployed at the site for data collection for approximately two weeks and savings analysis was performed using the logged data. Based on the observations and results from the study, recommendations and suggestions were made to improve the program. While key elements of the approach, results and recommendations are discussed in this paper, we also spend considerable focus reviewing the interactions between the consultants and program implementation staff. This dynamic interaction process with NSTAR, which served to immediately educate and direct the implementation staff on evaluation findings, differentiated this study from many others. This approach, it is believed, will lead to a continual progression and improvement in achieved realization rates.

A UNIQUE APPROACH: IMPLEMENTATION STAFF INVOLVEMENT

Typically an impact evaluation project primarily involves the M&V vendor and utility evaluation project managers. The M&V vendor conducts the site visits and calculates the savings and presents them to the evaluation staff. Year after year a similar approach is used and there is nothing noteworthy to report other than the evaluated savings estimates for the program. During this evaluation project the utility and the M&V vendor adopted a unique approach, which involved significant and continual interaction with the program implementation staff. The various aspects of the project are discussed in details below.

Involvement of Implementation Staff Throughout The Process. At every stage of the project, the utility evaluation manager and the M&V vendor involved the utility implementation staff. The implementation staff is the group with the knowledge of practical issues encountered in the field and in day-to-day operation of the program. The objective behind their involvement in the process was to add the field and project expertise to the evaluation team, and in the process identifying deficiencies in the evaluation process.

The project was initiated with a kickoff meeting, which involved the monitoring & verification (M&V) vendor, evaluation managers, NUP consultants, implementation staff and the account executives (AEs). The meeting addressed the outline for a work plan, but primarily delved into technical issues encountered after a preliminary program database review, and development of a plan for the estimation of non-electric benefits (NEBs). It was decided that the site-specific reports would be provided to the program implementation staff for review within two weeks of retrieval of monitoring data. This would enable staff that were most familiar with the program and projects to add their insights to consultant assessments of projects, and to support enhancements of all analyses and reports. It is noted that the objective was never to just achieve better project realization rates, but to develop the most objective and accurate analyses and reports, thereby benefiting the evaluation and offering evaluation insights for continuing program efforts.

One Goal. The objective behind adopting a new interactive approach to the impact evaluations was to achieve greater precision in estimation of the savings and identify deficiencies, which would lead to the improvement of future impact evaluation programs. Several meetings were conducted with the implementation staff at various stages of the project. The meetings were helpful as it facilitated direct exchange of ideas and increased the communication between the involved parties. Having involved the implementation staff in these meetings, the M&V vendor gained knowledge about the practical difficulties faced by the implementation staff in the field.

Dynamic & Continuous Interactions With Implementation Staff. Unlike typical evaluations, the new dynamic approach called for the implementation staff to be involved at every step in the project as if they were a part of the impact evaluations team. The contribution of the implementation staff was significant in three tasks – the review of project files, the review of site savings calculations, and in identifying what worked and what went wrong during the site visits.

- **Review of project files:** The M&V vendor reviewed the project files to identify the appropriate site contact, estimate the missing summer and winter demand values to populate the tracking database, prepare a list of missing documents that would facilitate data collection during site visits and estimation of energy savings. The M&V vendor noted issues or additional data requirements for the sites and then discussed these details with evaluation and implementation staff. File review meetings were conducted which involved the implementation staff and the account executives. These meetings were especially helpful in obtaining missing site contact information from the account executives, as the account executives knew these sites, facility contacts, and many project administrative details. This helped in avoiding further delay in working with most relevant contacts for both the net-to-gross surveys and on-site interactions.

- **Review of savings calculations:** A different approach was adopted for site report reviews. The site savings calculations (reported in the site report) for each site were submitted to the evaluation and implementation managers about two weeks after data collection. The program manager worked closely with implementation staff in the reviews. The implementation staff viewed the site report from a practical aspect and provided the M&V vendor with their comments and suggestions. Subsequently changes were made to the savings analysis and the site reports were re-submitted. This helped ensure the accuracy of savings calculations and in the process allowed improvement in savings analysis methodology on a continuous basis. This also created an excellent learning platform for both the implementation staff and the M&V vendor.

- **What went wrong and what works:** As the implementation staff reviewed the site savings analysis for each site, there were continual discussions with the M&V vendor. These discussions were helpful in determining if the analysis approach the M&V vendor adopted was adequate to obtain accurate energy savings and takes into consideration the practicality of the measure implemented at the site. These discussions also helped identify certain approaches that did not work with specific measure types.

Other Implementation Staff Interactions. Unlike more typical evaluation efforts, the implementation staff interacted with all the parties involved in the project. During the kickoff meeting, a milestone was set to conduct a status review meeting around halfway through the project. The primary focus of this meeting was to address any issues that the M&V vendor or the utility staff identified during the project or were likely to encounter in the future as a result of the findings to-date. In addition various topics such as the site visit schedule, logger deployment strategies, net-to-gross telephone surveys and the reporting template, were discussed in the meeting. This meeting was particularly important because the analysis approach for various measures was discussed in detail. Based on the site visits that had been conducted prior to that meeting, the M&V vendor presented the strategies that worked well in the field along with the strategies that did no do so good in the field.

Involvement of Program Staff During Presentation. At the conclusion of the evaluation project, the process and results from the impact evaluations were presented to all the utility parties involved in the project. This included several staff from the evaluation department and a large number from the implementation department. The presentation was informal and mostly focused towards the findings and recommendations to improve the program. These recommendations to improve the program were discussed during the presentation and were the predominant focus, not the evaluation results. As a consequence of these discussions, efforts are active and ongoing to improve the program using evaluation based findings and insights.

EVALUATION PROCESS & PROGRAM RESULTS

The Business Solutions Program is designed to provide the commercial, industrial, and institutional customers with financial and technical assistance to facilitate the installation of energy saving equipment in existing buildings. There are two primary tracks for customers to participate in the Business Solutions Program: the Prescriptive Track and the Custom Track. The Prescriptive Track is a more simplified process that allows customers to select measures from a prescriptive list with predetermined incentive levels for lighting, motors, variable speed drives, and HVAC equipment. In the Custom Track, the utility determines the rebate using a custom-screening model, after the customer demonstrates the reduction in electrical usage due to each proposed measure. The Custom Track allows customers more freedom to propose energy efficiency measures that are specific to their circumstances and requirements.

For complex custom measures, a formal commissioning of measures is performed. This process includes confirming that all energy conservation measures and systems are designed, installed, calibrated, and operated throughout their lifetimes as they were intended. This verification is done to ensure that the Company receives the full savings for rebated measure installations and that the installation and startup operation of the measure conforms to its design intent. The implementation staff plays an important role in assessing the application documents for such custom projects.

NSTAR’s tracking database consists of comprehensive information on measures installed through the program for each participant. The tracking database indicated that during the program year a total of 209 participants completed projects with a total estimated program savings of approximately 46 million kWh. Forty-five percent (45%) of the estimated program energy savings were predicted for lighting measures, twenty-seven percent (27%) for HVAC related variable speed drive (VSD) measures and fifteen percent (15%) for the HVAC related energy management system (EMS) measures.

Impact Evaluation Approach & Methodology

Several steps were required to determine the overall program net impacts. A brief overview of the evaluation approach is discussed in this section. Initially a sample population was selected for on-site monitoring and verification. The project files for these selected sites were reviewed and a metering plan was generated. An on-site engineering assessment was conducted for each site to determine the gross savings. The gross realization rates for all the sampled sites were obtained by comparing the post-retrofit energy savings with the pre-retrofit energy savings estimates. These individual site level realization rates were combined to determine the collective population realization rate, which was then used to obtain the program-wide realization rate. The net effects telephone surveys were conducted to obtain the population free-ridership and spillover estimates. Free-ridership is the effect where the customer would have installed the exact same quantity and type of equipment at the same time in the absence of the energy efficiency program. If any of the above mentioned parameters change, the effect is known as partial free-ridership. When a program participant purchases additional equipment outside the program due to the program influence, the effect is known as participant spillover. If a non-participant purchases energy efficient equipment due to the influence of program, the effect is known as non-participant spillover. The net effect estimates were taken into account in determining the net energy savings, realization rate and relative precision.

Sample Plan Development. The primary goals for this task was to develop a sample that was representative of the program and to determine a fixed number of on-site inspections that offer 90% confidence level with +/-10% sampling error. A sample plan was statistically generated for the on-site and the telephone surveys. A total of thirty (30) participant sites were selected for on-site visits while fifty-three (53) participants in total were selected for telephone surveys. In addition, ten (10) non-participants were sampled for non-participant spillover surveys. The participants were segmented into four strata based on the tracking energy (kWh) savings estimates.

Engineering Assessment Methodology. The engineering assessment involved review of project files prior to the site visit followed by on-site data collection. A site specific report, "Site Report", was generated which extensively documented the site conditions, collected data, analysis methodology, findings and the results from the savings analysis.

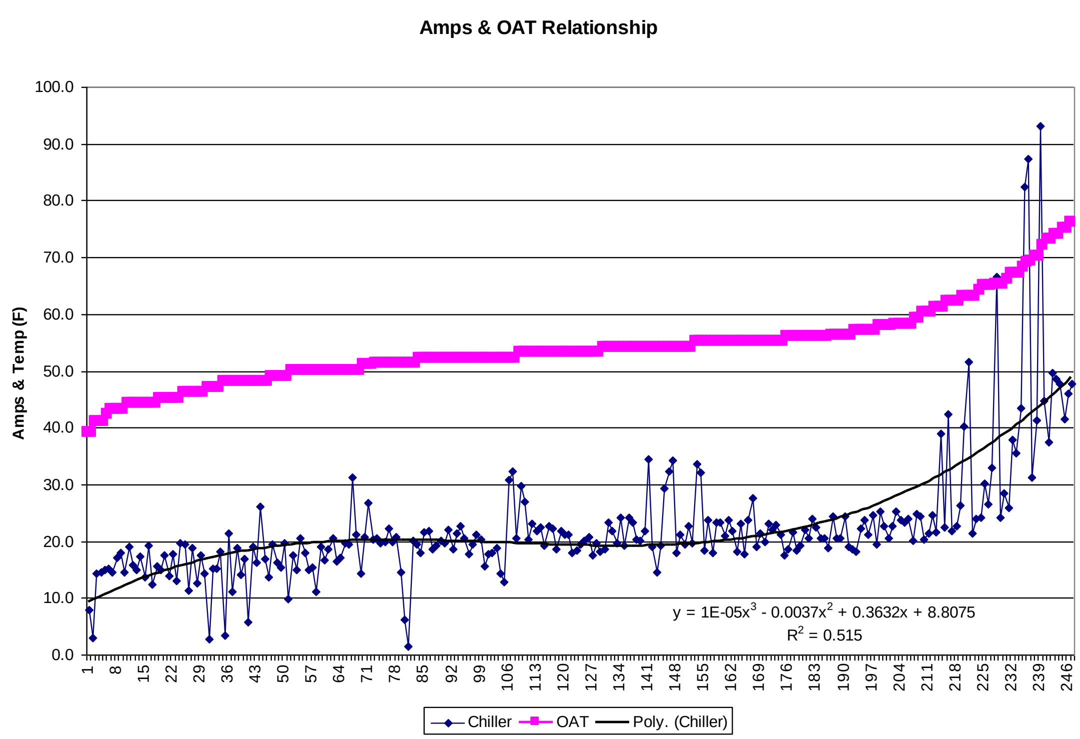
The project files were reviewed prior to the site visits to verify the information obtained from the tracking database by comparing it with that obtained from the project files. Through the file review process it was observed that the tracking database did not record the summer and winter demand impacts for the participants on a consistent basis. As a result, the project files for all the participants were reviewed and the demand savings values were populated in the tracking database. Project file reviews also facilitated the development of Site Plans prior to the site visit. A site plan outlined the facility contact information, implemented measures at the site, metering approach, savings analysis method, and possible non-electric benefits. The site plan was used as assessment guideline for each sampled site. Any variations in the approach were documented later in the site report.

For this evaluation, considerable attention was placed on including implementation staff in the technical aspects of the project. In this regard, all of the site plans were provided to the program manager and the implementation staff for review. Their comments were reviewed and incorporated in the site report. This reduced the time required for review of the site reports at a later stage, and enabled the consulting team to more cost effectively and efficiently handle the data collection, analysis, and site reporting efforts.

The participants were informed about the requirements, expectations and process of data collection prior to the site visit through letters. Following the letters, telephone calls were made to schedule the site visits. Both the on-site visit for engineering assessment and the telephone call for net effects were scheduled at the same time to reduce the amount of times the customer was contacted. Once the site was scheduled, a site visit was conducted. The primary task was to verify that the measure installations reported in the tracking database for each site were actually present and operational. The general approach was to verify 100% of the reported measure installation quantities wherever possible. Since the installation quantities varied widely, for sites with significant installed quantities (especially large lighting sites) approximately 10-20% of the total installed quantity was visually verified.

After verifying the installed equipment, a monitoring plan was generated on-site. The appropriate equipment was identified for logging and loggers were installed on them for a period of two weeks. Two basic types of loggers were installed during the evaluations, lighting and non-lighting loggers. A total of one hundred and fifty four (154) lighting loggers and forty-two (42) non-lighting loggers were installed. Prior to installation of non-lighting loggers, instantaneous amperage, voltage, kW and power factor measurements were taken to check if the circuit is balanced. HOBO data loggers and current transducers (CTs) were used to log the current draw of the equipment over time and to establish load profiles. The monitored data was regressed to establish a correlation between the desired parameters. Figure 1 represents an example of regression analysis.

Figure 1. Data Plot for Weather Based Measure



For lighting measures, HOBO lighting on/off loggers were used to establish hourly usage profiles. The lighting logger deployment was primarily based on the observed space types during the site visit so that a representative estimate of the operating hours for the entire facility could be obtained. Figure 2 illustrates the lighting usage profile generated from the lighting logger.

Figure 2. Lighting Usage Profile from Lighting Loggers

Open Office_Logger 32																								
Hour	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
Monday	50%	8%	0%	0%	0%	0%	40%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	85%	50%	50%	50%	50%	0%
Tuesday	26%	50%	50%	83%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	97%	50%	69%	63%	58%	100%
Wednesday	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	85%	31%	0%	0%	0%	1%
Thursday	50%	50%	50%	50%	50%	50%	50%	88%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	71%	52%	50%	50%	50%	50%
Friday	9%	0%	0%	0%	0%	0%	38%	96%	100%	100%	100%	100%	100%	100%	100%	100%	99%	100%	100%	100%	100%	100%	100%	100%
Weekday Avg.	**47%**	**42%**	**40%**	**47%**	**50%**	**50%**	**66%**	**97%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**88%**	**57%**	**54%**	**53%**	**52%**	**50%**
Hour	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
Saturday	100%	55%	50%	50%	50%	50%	50%	50%	50%	50%	50%	74%	100%	94%	87%	100%	100%	87%	50%	50%	50%	67%	100%	100%
Sunday	100%	99%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	56%	100%	100%	99%	50%	50%	50%	50%	50%	50%	50%	50%
Weekend Avg.	**100%**	**77%**	**50%**	**50%**	**50%**	**50%**	**50%**	**50%**	**50%**	**50%**	**50%**	**62%**	**78%**	**97%**	**93%**	**100%**	**75%**	**68%**	**50%**	**50%**	**50%**	**58%**	**75%**	**75%**
Weekly Avg.	62%	52%	43%	48%	50%	50%	61%	83%	86%	86%	86%	89%	94%	99%	98%	100%	93%	91%	77%	55%	53%	54%	58%	57%
Operating Hours	6296																							

The monitored data was used to generate operating profiles using regression or weighting analysis, which could be used in savings analysis. For weather dependent systems such as HVAC equipment, BIN weather data was used to reflect the variability of seasonal system use. For non-weather sensitive measures the monitored data, in most cases, followed an occupancy pattern. The data was regressed to generate an operating profile that matched the occupancy pattern and then was extrapolated to obtain annual energy savings.

Again we note that the implementation staff was continuously involved in the site results review process. The site conditions and savings methodology were discussed with them and only when all parties were satisfied with the results, the site report was finalized.

Program Results

Since the utility performs impact evaluations on a regular basis, it is important to maintain uniformity and consistency in reporting the impact evaluation results from year to year. As a result NSTAR has a pre-defined format known as the “reporting template” which provides a detail breakdown of the energy savings showing the effect of various discrepancies observed during the site visit. The reporting template consisted of several adjustment factors with the objective of identifying and diagnosing the discrepancies between the estimated tracking savings and the final adjusted gross savings. The impact evaluation results are presented in Table 1. Reporting parameters B through G indicate the discrepancies while I through K present the net effects results.

Table 1. Reporting Template

Reporting Parameter	Energy		Summer Demand		Winter Demand	
	kWh	Factor	Summer kW	Factor	Winter kW	Factor
A - Gross Savings (Tracking)	46,137,134	N/A	452	N/A	452	N/A
B - Documentation Adjustment	103,476	0.2%	8,112	1794.7%	6,376	1410.6%
C - Technology Adjustment	(66,062)	-0.1%	92	20.4%	92	20.4%
D - Quantity Adjustment	(1,525,818)	-3.3%	(279)	-61.7%	(411)	-90.9%
E - Operational Adjustment	1,522,656	3.3%	N/A	N/A	N/A	N/A
F - Coincident Adjustment	N/A	N/A	(1,236)	-273.4%	(366)	-81.1%
G - Interactive Adjustment	1,080,868	2.3%	462	102.2%	(4)	-1.0%
H - Adjusted Gross Savings	**47,252,255**	**102.4%**	**7,603**	**1682.1%**	**6,138**	**1358.0%**
I - Participant Spillover Adj.	4,793,663	10.1%	842	11.1%	707	11.5%
J - Non-Participant Spillover Adj.	1,285,590	2.7%	204	2.7%	163	2.7%
K - Free Ridership Adjustment	(13,087,657)	-27.7%	(2,100)	-27.6%	(1,692)	-27.6%
L - Net Savings	**40,243,852**	**85.2%**	**6,549**	**86.1%**	**5,316**	**86.6%**
M - Net Realization Rate	**87.2%**		**1448.9%**		**1176.2%**	
N - Measure Lifetime	**15**					
O - Precision, 90% Confidence	**+/-15.2%**					

It was also hoped that measuring and categorizing these discrepancies would point to program improvements. These adjustment factors are briefly described below.

- **Documentation Adjustment:** This accounts for errors or omissions in the paperwork observed in the project file. This adjustment gave the implementation staff a general overview of the amount of savings lost due to documentation error, a issue that was immediately addressed in order to improve tracking of savings.

- **Technology Adjustment:** This accounts for discrepancies in savings due to the difference in the technologies identified in the project file (paperwork) and that observed in the field. Especially for large lighting project sites, technology substitution was observed on a regular basis. This adjustment provided the field staff with an estimate of the impact of technology substitution in the field. This issue was also immediately addressed by program implementation staff, who realized that better post-installation inspections would improve final results reported in the tracking system.

- **Quantity Adjustment:** This accounts for the discrepancies in savings due to the difference in the quantity of equipment identified in the paperwork and that observed in the field.

- **Operational Adjustment:** This accounts for the discrepancies in savings due to the difference between the operating hours documented in the paperwork for a measure and the actual operating hours logged using logging equipment. The tracking savings are based on assumptions as to how the system will operate in the future. On the other hand the evaluation results are based on actual measured data. In almost all the cases, the system operating characteristics were different from the tracking estimates. This adjustment factor provided the implementation staff with the variation in operating characteristics due to actual site conditions in comparison to the assumption made during tracking savings analysis.

- **Coincidental Adjustment:** This accounts for the discrepancies in demand savings due to the difference between the operating characteristics obtained from the paperwork and the actual operating characteristics observed on-site. The measured data provided enough information to accurately calculate the summer and winter demand savings. The coincidental adjustment factor provided the implementation staff with an idea of the difference in pre-measurement estimates and the actual measured data.

- **Interactive Adjustment:** This accounts for the heating penalty and/or cooling savings realized due to reduction in demand (kW). Interactive savings were not captured in the tracking database and hence this adjustment factor gave the utility staff an estimate of its impact on the overall savings.

In addition to the realizations rates and net effects, NSTAR was interested in determining what benefits beyond the calculated demand and energy savings were attributable to the energy efficiency projects implemented through the program. These are termed as non-electric benefits (NEBs). The focus on NEBs assessment was entirely on customer perceptions of the NEBs that they believe have been realized from energy efficiency projects implemented through program participation. Qualitative information was gathered through telephone surveys to determine the NEBs. A survey instrument was developed that obtained the following information regarding each energy efficiency measure installed.

1) Does the participant perceive there to be any NEBs associated with the measure?
2) Does the participant perceive there to be a dollar value associated with these NEBs?
3) Does the participant perceive any dollar value associated with NEBs to be significant?
4) Can the participant quantify the dollar value of perceived NEBs?
5) Does the participant feel that NEBs quantification is valuable and would help in the decision making process for measure implementation?

The NEBs surveys were administered on telephone and the field engineer verified the results during the site visit.

Trends & Findings

During the evaluations, several trends were observed based on the logged data. The typical equipment observed through the program was lighting fixtures, lighting controls, variable speed drives, and energy management system. The most prominent observations are discussed in this section.

- **Weather dependency of VSD measure:** The data obtained from logging the variable speed drives indicated that the variable speed drives installed on the air-handling unit fans were independent of the weather conditions. The logging pattern indicated that the building occupancy governed the fan VSD operation. In contrast to the VSD measure discussed above, the VSD measures involving chillers, chilled water pumps, condenser water pumps and refrigeration were found to be weather dependent. The implementation staff have begun to use this information to more accurately characterize the energy savings for prescriptive VSD measures.

- **Customer interest in non-electric benefits:** The non-electric benefits (NEBs) survey conducted by telephone revealed that the customers were aware of the benefits from installation of the measure(s) but did not have any quantitative value to it. They expressed their interest in the quantification of the NEBs and see the results from the impact evaluations to get a feel of actual non-electric savings.

- **Repetitive non-electric benefits perceived by participants:** The NEBs survey also revealed the repetitive common non-electric factors perceived to be helpful by the participants. A brief description of these factors follows. For lighting measures, the customers reported significant savings in operating and maintenance (O&M) costs, improvement in the lighting quality, and increased safety especially in the parking garages. In case of energy management systems, the customers reported better system controllability and perceived comfort levels.

- **Consistency in observed non-electric benefits:** The NEBs were assessed through telephone surveys prior to the site visit. The engineer conducting the site visit carried the NEBs results with him/her and tried to verify the results through on-site observations. The NEBs data obtained via telephone survey was consistent with the findings verified during the site visit. It is important to note that determining the knowledgeable contact is key to obtaining useful and accurate data in surveys administered through telephone.

- **Assessment of new technologies:** Impact evaluations provide a great platform to assess the validity of new technologies. During the course of the impact evaluation study, NSTAR was interested in obtaining results for a specific energy management system, targeted and designed for hotels, to determine if it was a viable system and would qualify for incentives. The results obtained from the evaluations found the system to be credible and thus eligible for program incentives. Incorporating this research type effort in the impact evaluation was greatly supported by program implementation staff, which were keenly aware of the need to better understand the merits and weaknesses of the technology. In addition to the above referenced hotel EMS system, a hi-tech networked lighting system was evaluated through the program and was found to be a viable measure.

New Approaches for Implementation

The information obtained from the impact evaluations provided valuable information, which could help improve the NSTAR energy-efficiency program delivery. The data was used to make suggestions and recommendations with the intent of improving procedures for tracking data that would provide value to the program and further facilitate the savings estimation. It should be noted that these recommendations are a result of the observations made during the course of the project and the continuous discussions and meeting schedules with the evaluation and implementation staff.

- **Maintain a complete tracking database:** During the file review process it was found that the tracking database maintained by the utility was not always sufficiently comprehensive. The summer and winter demand savings were not recorded for a majority of the implemented measures. A small percentage of lighting measures were found to consist of the demand savings information in the tracking database. However, the demand savings values were available from the project files. A recommendation was made to systematically input the summer and winter peak demand impact values in the tracking database to facilitate the evaluations in the future. This will reduce the time required for subsequent file review efforts.

- **Capture interactive savings in tracking estimates:** The tracking database did not generally capture the interactive savings component of the measures such as cooling savings, savings from reduced compressor operation, etc. These interactive savings are assessed during impact evaluations and hence a recommendation was made to the utility to track the interactive savings.

Including the interactive effects into the savings analysis will increase the accuracy of the savings estimates and also yield better realization rates during future impact evaluations.

- **Increase commissioning requirements:** During the impact evaluations multiple projects were identified, which were not commissioned properly. If the measure is not properly commissioned, the equipment does not operate as expected and hence the savings may not be realized. Recommendation was made to increase the commissioning requirements for measures, especially measures involving VSDs and EMS, to ensure proper equipment operation and achieve the projected energy savings. Steps have already been taken towards enforcing stricter commissioning requirements.

- **Maintain adequate pre-retrofit system data:** Projects with VSD measures were found to lack adequate pre-retrofit system information such as measured full load data. In cases where the pre-retrofit system data was missing, the savings calculations were based on loading and power assumptions. Hence, whenever possible it is helpful to have measured full load data for the pre-retrofit system that can be used later for VSD analysis in order to facilitate the analyses and obtain as accurate results as possible.

- **Revise demand savings algorithm for prescriptive measures:** The savings estimate for prescriptive VSD measures were based on the impact tool developed by the utility. It was observed that the demand savings obtained from field measurements were consistently lower than specified by the impact tool. This difference in the tracking and field verified demand savings could be attributed to the actual field measured equipment loading. Given the variable nature of system loads, the VSDs may operate at higher loads during peak hours resulting in lower average demand savings over those peak hours. During the evaluations, the utility was considering implementing a new demand savings definition that considers maximum loads during the peak hours. This method of calculation for the demand savings is expected to narrow down the difference between the tracking and field measured demand savings during future impact evaluations.

- **Maintain comprehensive inventory for the installed measure:** Numerous small sites involving lighting measures failed to provide good information on retrofitted lighting fixture locations. This posed a problem in identifying the fixtures especially in facilities that had participated in programs more than once. Capturing fixture locations and including this in the physical files would be helpful to the implementation staff for post-installation inspections, as well as for evaluation purposes.

- **Capture as-built data for large sites:** For large sites involving lighting measures, lighting technology substitutions were commonly observed, but not captured in the physical files. Suggestion was made to update the physical files after implementing the measure to capture the as-built data. It was observed that in certain lighting retrofit projects, lighting fixture counts were obtained from building plans. This is a logical practice for large projects, but caution must be exercised since building plans may not be accurate due to numerous changes during actual construction. At one site it was determined that the customer purchased, and the utility issued rebates, retrofit kits that ended up in a storage room. This occurred because counts were taken from inaccurate drawings. Hence, to obtain accurate energy savings, whenever possible the fixture counts should be field-verified or should be based on as-built drawings. Maintaining the as-built data for the sites will help the implementation staff in post-installation inspections and also facilitate improved future evaluations.

NEW EFFORTS TO IMPROVE PROGRAM

Recommendations discussed above were made based on the observations and findings from the project to improve the energy-efficiency program implementation in the future. NSTAR considered the recommendations and as a result numerous efforts have been initiated to progressively improve the energy efficiency program. A couple of interesting examples follow:

Development of a Sophisticated EMS Tool for Internal Staff. The first project was undertaken to increase the implementation of EMS by simplifying the screening process and by training the account executives and customers to identify potential EMS projects. Separate guidelines documents were prepared for the utility energy-efficiency field staff and the control system vendors and engineering services firms. The guidelines document created for the utility field staff outlines the energy management systems and provides them with easy to follow steps to develop a successful EMS project. The document is intended to simplify the application process for the internal staff, as all the EMS measures will be considered under the custom track of the energy-efficiency program. The guidelines document created for the vendors and the design firms' outlines the utility program requirements with respect to the energy management system installations and further simplifies the application process. The document provides a detailed checklist of information or documentation required by the application.

In addition to these guideline documents, a simplified EMS software tool is being created for typical space types with a predefined set of installed equipments and control strategies. The objective of this tool is to implement more EMS projects for these typical space types without incurring the cost associated with involvement of design firms and controls vendors. The tool will provide the account executives with the flexibility to screen a potential EMS project in relatively less time, with higher accuracy and using far fewer resources.

Commissioning. During the evaluation process, it was observed that several large projects were not commissioned properly, were not operating as expected, and anticipated savings were not being achieved. Thus, a recommendation was made to make commissioning a requirement for all the projects. This recommendation is now being progressively adopted. The goals of this initiative is to make sure that estimated savings will be achieved and that customers do get the energy and cost savings they had anticipated when they elected to install the premium system in consideration.

CONCLUSION

This paper had the objective of demonstrating that new and noteworthy achievements would be realized if program implementation staff did have the opportunity to participate in the day-to-day planning for evaluation work. Throughout the evaluation project, implementation management was provided with the opportunity to review and contribute to aspects of the site data collection, monitoring, and analysis efforts. As indicated throughout this paper, this definitively opened the door to an enhanced evaluation and a progressively improving program.