EVALUATION OF THE 2009 ENERGY CONSCIOUS BLUEPRINT PROGRAM

Final Results

August 4, 2011

Global Energy Partners Project Director
P. Ignelzi

Principal Investigators
J. Murphy
K. Parmenter
J. Prijyanonda
B. Ryan
A. Sanchez
C. Williamson

Global Energy Partners™
An EnerNOC Company

Global Energy Partners
500 Ygnacio Valley Road, Suite 450
Walnut Creek, CA 94596

P: 925.482.2000
F: 925.284.3147
E: gephq@gepllc.com

CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

Global Energy Partners (Global) conducted this impact and process evaluation study for the Connecticut Energy Efficiency Board (EEB). It is an evaluation of the Energy Conscious Blueprint (ECB) program that is managed and operated by The United Illuminating Company (UI) and Connecticut Light and Power (CL&P) (collectively referred to as the Companies) on behalf of the Connecticut Energy Efficiency Fund. The scope of the current evaluation covers commercial and industrial (C&I) participants in the ECB program who completed projects and were paid incentives in the 2009 program year (PY 2009).

Throughout this document, we refer to the savings that the Companies recorded in their data tracking systems and provided to Global for review as "Company-reported savings." In other studies, these are sometimes referred to as ex-ante savings, pre-installation savings, expected savings, claimed savings, tracking savings, or unverified savings. We refer to the savings results from Global's independent review of the Company-reported savings as "realized savings," "adjusted gross savings" or simply "adjusted savings."[1] In other studies, these adjusted savings are sometimes also referred to as ex-post savings or verified savings.

Highlights of the Evaluation

- The Energy Conscious Blueprint Program (ECB) is a mature program with a well-established infrastructure for delivering the program services and tracking project activities. The program staff members at the Companies are fully knowledgeable about the program, the participants, and maintenance of the data on program activities.
- The results of our impact evaluation show that overall, across all measure types, the program achieved a 101% realization rate on the Company-reported annual kWh savings (Table ES-1). We did find considerable variation in the rate across the major measure categories and across projects within the categories.

Table ES-1 Realization Rates and Adjusted Program Savings Results Compared to Company-Reported Savings

Savings Type	Company-Reported Savings	Adjusted Gross Savings	Realization Rate
Annual kWh Savings	47,004,439	47,516,042	101%
Summer Peak kW Savings	9,497	8,578	91%
Winter Peak kW Savings	4,749	5,194	110%

- The results of our review of both the 2009 and 2011 Program Savings Document (PSD) manuals indicate that the methods are generally appropriate and consistent with prescriptive savings methodologies used elsewhere. They also seem easy to use. The greatest drawback is that, since the ECB is largely a custom program, a substantial number of the measures installed under the program are not addressed in the PSD. A second problem is that, despite its apparent ease of use, it appears that the formulas were not always used or used correctly in the calculation of the Company-reported savings.

[1] The inclusion of "gross" is only to underscore that unless explicitly noted otherwise (as they are in section 3.5 of this report), the savings do not include any net attribution factors (free-ridership or spillover) that might reflect motivation for the customer installations made under the program.

- Our major concern about the program is that the program documentation, while extensive for some projects and well-organized where it existed, fell short of being adequate to truly understand the installed measures and calculation of the Company-reported savings. In particular: 1) the nomenclature used to describe the measures was confusing and inconsistent, both within the Company and across the two Company tracking systems; 2) savings calculations and/or assumptions were missing for quite a number of projects; and 3) the complete lack of floor plans, despite this being a new construction program, made it difficult or impossible to identify program-installed measures accurately in a number of cases. Having said this, the data that were there appeared accurate and did not undermine confidence that the measures were installed as claimed.
- The contractors who participated in the program find that it helps them to successfully promote installation of more efficient equipment. They use the expected savings and rebate-subsidized payback to help them sell higher efficiency equipment. At the same time, these contractors feel that the Company staff could be more helpful by being more responsive to contractor inquiries during the project design and by giving them more accurate information about how the incentive is calculated so they can include the correct amount in their bids.
- Global believes that the program could be even more effective with the introduction of systematic marketing and education. It appears that, aside from information on the Company websites, the ECB program is not actively promoted; staff expects contractors and customers to bring projects themselves. While the Companies do offer training sessions, even the contractors who have been active in the programs seem relatively unaware of them. Nice brochures about the program are available, but, apparently, are not seen or recalled by customers or contractors.

Description of Energy Conscious Blueprint Program

The ECB program is an ongoing program designed to improve the energy efficiency of equipment purchases in C&I projects involving new construction, major renovation, tenant fit-outs, and equipment replacement/additions. Since these purchases are necessary parts of the projects, the ECB aims to influence equipment decisions during the design stage, thereby capturing opportunities to improve energy efficiency that might otherwise be lost. The program is comprehensive, providing technical assistance and financial incentives to customers and their design and equipment contractors (trade allies) to increase the energy efficiency and performance of lighting systems; heating, ventilation and air conditioning (HVAC) systems; motors; industrial processes; and other energy use components of C&I buildings.

The ECB program is an established program at a crossroad. In 2010, an effort was initiated by the EEB and the Companies to review and revise the direction of the program. The resulting “re-visioning” of the ECB gives the program a more forward-looking focus that emphasizes working more collaboratively with customers and their service trade allies to encourage ongoing efficiency improvements in all parts of their operations, beyond existing code and standard minimums. The ultimate goal is to transform the market with beyond-code building design and equipment purchase practices. The program in 2009 supported installation of a broad array of measures in C&I facilities, addressing all major end uses of electricity as well as gas measures. The Companies grouped measures into several measure categories, which were examined as five major measure categories in this evaluation:

- Cooling
- Heating
- Lighting
- Process
- Other—includes energy management systems (EMSs), refrigeration, motors and variable frequency drives (VFDs) not directly associated with the four major end uses, envelope

improvements, and other not-otherwise classified measures such as compressors, transformers, and some custom projects

Many PY 2009 projects included installation of equipment in multiple measure categories. Thus, while the population consists of 519 project sites, counting projects by measure type shows 721 measure sites.

Table ES-2 presents the distribution of project and measures installed. It shows that Cooling measures were most commonly installed (35% of total) and electric Heating measures least (7%). Aside from the Heating measure projects, the reported kWh savings are quite evenly split among the measures in each of the other categories, ranging from 22% to 26% of the Company-reported annual kWh savings. However, the kW savings are somewhat less evenly split.

Table ES-2 Energy Conscious Blueprint 2009 Projects and Company-Reported Savings

Major Measure Type	Number of Projects (by Measure)		Annual kWh Savings		Summer kW Savings	Winter kW Savings
Cooling	**252**	35%	**12,039,867**	26%	**3,652**	**305**
Heating	**47**	7%	**1,468,142**	3%	**330**	**119**
Lighting	**158**	22%	**12,309,286**	26%	**2,489**	**1,904**
Process	**110**	15%	**10,370,207**	22%	**1,208**	**1,103**
Other	**154**	21%	**10,816,937**	23%	**1,818**	**1,317**
Energy Mgt System	23		2,250,731		326	212
Envelope	4		671,953		259	18
Motors	69		1,952,788		242	203
Refrigeration	5		125,523		1	253
Other VFDs (UI)	16		1,302,920		70	32
Other	37		4,513,022		921	599
Totals	**721***	100%	**47,004,439**	100%	**9,497**	**4,749**

*These 721 measure sites were actually 519 individual project sites.

In reviewing the Company tracking system data, a number of other characteristics are noted, as follows:

- As shown later in Table 1-2, while projects were completed at a broad variety of facilities, more than half the projects (52%) happened at Manufacturing and Office facilities. At the other end of the spectrum, Hotels and Motels made up 3% of the participants. This gives some indication of customers who are currently more and less attracted to the program.
- While Offices make up 20% of the projects, they only make up 10% of the total program savings. Most of the Office projects were for Cooling measures. This suggests that, while Office customers are active, they install fewer measures and/or lower-impact measures.
- 402 of the 519 unique projects are for a single measure only. This provides a basis for reviewing the program's effectiveness in efforts to encourage customers to take a more comprehensive approach to improving energy efficiency as part of construction and remodel projects. It also underscores the relevance of the focus on improving comprehensiveness outlined in the program re-visioning.
- Global also notes that, while Lighting measures were included in fully three-quarters of the multi-measure projects, they accounted for fewer than 20% of projects in which only one

measure was installed. This is consistent with relatively well-established programs. New programs tend to be dominated by lighting-only projects.

The above observations regarding the make-up of the participants and measures installed provide something of a benchmark for the program, as of 2009. A characterization of the market could put these observations in better context for suggesting outreach efforts.

Purposes of the Study

The objective of this study was to evaluate the energy impacts and processes of the ECB program in PY 2009, with the ultimate goal of providing recommendations to improve the program's estimation of savings and effectiveness in future years. This evaluation had the following key purposes:

- Provide independent estimates of the program's annual energy (kWh) savings, seasonal peak demand (kW) savings, and hourly load shape impacts, and compare the results to the Companies' reported savings
- Assess program processes and activities and make recommendations to improve their effectiveness
- Recommend improvements to the Companies' most recent PSD (2011 PSD)[2] to enable more accurate projection of savings in future program years

Estimation of Realized Energy Impacts. Realized or adjusted energy impacts, sometimes called verified or ex-post savings, are savings calculated using information collected about actual installations after they are made. Compared with ex-ante or Company-reported savings estimates used to calculate customer incentive payments (which are generally based on the PSD in effect at the time and assumed conditions), realized savings are estimated based on conditions observed post-installation and take into account estimates of baseline equipment that would have been installed absent the program. For the ECB program, the baseline was the relevant building code in effect at the time the project was initiated within the program. As noted above, in this evaluation these impacts are reported as adjusted gross savings because they include adjustments to the Company-reported savings. The differences between Company-reported and adjusted savings can be due to a variety of factors, including the quantity, size, and efficiency specifications of measures actually installed; their actual hours of use; the actual square footage affected; the interactive effects on the energy use of other existing equipment; etc. The metric of the **adjusted gross savings** as a percent of Company-reported savings is the **realization rate**. The realized energy impacts estimated for this study include annual kWh savings, seasonal kW savings, and hourly load shapes of savings. Program-level adjusted savings and realization rates are presented for the measures, grouped into five major measure categories: Cooling, Lighting, Process, Heating, and Other.

Analysis of the Effectiveness of the Program. Many features of a program and its procedures affect the success of the program. The focus of this part of the evaluation was to assess how well the program is progressing toward achievement of the objectives the Companies have set for it. This assessment characterizes the key program objectives, the activities designed to bring them to fruition, and the challenges currently hindering their achievement. In this assessment, the objectives in effect in 2009 are updated to reflect the re-visioning of the program that set a new direction for the program going forward. The assessment culminates in a set of recommendations aimed at furthering achievement of the program's objectives.

Recommendations to Improve the PSD and Accuracy of Future Savings Estimates. The Companies developed the PSD and update it regularly to estimate savings from measures offered under their programs. The version in effect during program year 2009 was the 2009 PSD.[3] As part of this evaluation, Global was asked to review the savings calculations in the 2009 PSD to

[2] *UI and CL&P Program Savings Document for 2011 Program Year*, The United Illuminating Company, New Haven, CT and Connecticut Light & Power Company, Hartford, CT: Sep 2010.

[3] *UI and CL&P Program Savings Document for 2009 Program Year*, The United Illuminating Company, New Haven, CT and Connecticut Light & Power Company, Hartford, CT: Oct 2008.

see if they were appropriate and being applied consistently in the Company-reported savings estimates. In addition, Global reviewed the 2011 PSD to see if changes had been made that would have improved the savings calculations relative to the 2009 version.

Review of the 2009 and 2011 PSDs showed that the calculation methodologies for some measures that are not explicitly addressed in the PSD could realistically be added; for other measures, the PSD might not have been used entirely correctly to estimate Company-reported savings. As a result, Global expanded the review to focus more broadly on documentation, assumptions, and calculations as well as to provide recommendations that would assist the Companies in improving the pre-installation estimates of measure savings.

Methods Used in the Evaluation

The two main categories of methods used to address the purposes of the evaluation were data collection and data analysis. Within each main category, there were several specific methods. The study required considerable data collection—from the Companies, the participants, and the community that provides services to the Companies' customers (also known as trade allies). Because the program includes measures for all end uses and for a diverse set of facilities, a variety of methods were used in the analysis as well. Table ES-3 maps the specific methods to the study's purposes.

Table ES-3 Methods Used to Address the Evaluation Purposes

METHODS	DATA COLLECTION					DATA ANALYSIS				
PURPOSES	Program & Project Documentation	Customer Site Visits	Equipment Measurement	In-depth Interviews	On-line Surveys	Documentation & PSD Review	Building Simulation Modeling	Engineering Review	Statistical Analysis	Logic Model
Estimation of realized energy impacts	√	√	√			√	√	√	√	
Analysis of program procedures and recommendations to improve effectiveness	√	√		√	√	√				√
Recommendations to improve the PSD and accuracy of future savings estimates	√		√			√	√	√		

Data Collection. Data collection was essential for understanding the program, verifying equipment installations, measuring energy use characteristics of installed equipment, and helping to formulate enhancements to program processes. Global carried out five types of data collection:

- Program and project documentation
- Customer site visits
- Equipment measurement
- In-depth interviews

- On-line surveys

The program and project documentation were essential for understanding what was installed at each site and for developing recommendations for improving energy savings estimates, documentation, and education in future years. The customer site visits allowed us to speak with building personnel familiar with the program and the rebated equipment, verify equipment installations, and measure the equipment's energy use and operational characteristics. The in-depth interviews with program managers and trade allies, plus the on-line survey of program participants, helped us gather critical data to understand the experiences all parties had with the program.

Data Analysis. Once the data were collected, Global used several data analysis techniques to estimate the realized energy savings and to evaluate the various metrics of program effectiveness. To quantify the realized energy savings, Global reviewed the program documentation and employed building simulation modeling, engineering review, and statistical analysis to confirm or adjust per-unit savings and, ultimately, to quantify program-level energy impacts. To assess effectiveness of the program processes, Global first developed a program logic model to show how current processes contribute to the attainment of the program goals and identify intervention points for program re-visioning and improvement. Global also reviewed the program documentation, plotted the on-line participant survey results, and synthesized the findings with the qualitative results from the interviews with trade allies. The five main data analysis methods were as follows:

- Documentation and PSD review
- Building simulation modeling
- Engineering review
- Statistical analysis
- Logic model

Results and Findings

The following subsections summarize the key results and findings associated with the evaluation's three key purposes.

Estimation of Realized Energy Impacts

For annual energy savings, summer peak demand savings, and winter peak demand savings, respectively, Table ES-4 through Table ES-6 compare the Company-reported savings (ex-ante impacts) with the adjusted gross savings (ex-post impacts) estimated during this evaluation. The tables also include the corresponding realization rates (the ratio of adjusted savings to Company-reported savings).[4] The Company-reported annual savings include savings for all customers that participated in Program Year 2009 for each measure. Global made one modification to the measures, reclassifying one site that was confirmed during the on-site visit to be a Process project, but had been listed as a Cooling measure in the Company tracking database. For this reason, the Company-reported savings in Cooling and Process do not match the original totals for Cooling and Process savings as reported by the Companies. In addition, the Company-reported savings include savings for four sites at which measures were installed and verified but are currently unoccupied. The adjusted gross savings include these savings set to 0, since the unoccupied buildings do not have program-related savings.[5]

[4] A realization rate below one reflects finding that the savings achieved by customers are likely to be less than the Company-reported estimates while a rate above one indicates that customer savings likely exceed the Company-reported estimates.

[5] However, in order to more appropriately reflect the nature of the relationship between the Company-reported savings and the adjusted gross savings, the realization rates are calculated based on only those facilities that are occupied and in business. This difference only shows up in the third decimal place for lighting and the fourth decimal place for cooling.

Table ES-4 Adjusted Annual kWh Program Savings Compared to Company-Reported Savings

Major Measure Group	Company-Reported Annual Savings	Adjusted Gross Annual Savings	kWh Realization Rate
Cooling	11,874,541	9,096,355	77%
Lighting	12,309,286	12,004,169	98%
Heating	1,468,142	1,967,388	134%
Process	10,535,533	11,655,316	112%
Other	10,816,937	12,792,813	118%
Total	**47,004,439**	**47,516,042**	**101%**

Table ES-5 Adjusted Summer Peak Program Savings Compared to Company-Reported Savings

Major Measure Group	Company-Reported Summer Peak Savings	Adjusted Gross Summer Peak Savings	Summer Peak kW Realization Rate
Cooling	3,626	2,589	72%
Lighting	2,489	1,798	72%
Heating	330	164	50%
Process	1,235	2,404	199%
Other	1,818	1,622	89%
Total	**9,497**	**8,578**	**91%**

Table ES-6 Adjusted Winter Peak Program Savings Compared to Company-Reported Savings

Major Measure Group	Company-Reported Winter Peak Savings	Adjusted Gross Winter Peak Savings	Winter Peak kW Realization Rate
Cooling	279	656	235%
Lighting	1,904	1,655	87%
Heating	119	201	169%
Process	1,130	1,166	106%
Other	1,317	1,516	115%
Total	**4,749**	**5,194**	**110%**

Chapter 3 describes the adjusted savings results in details. The paragraphs below summarize key findings.

For Cooling, adjusted annual energy savings are 77% of Company-reported savings, adjusted summer peak demand savings are 72% of Company-reported savings, and adjusted winter peak demand savings are 235% of Company-reported savings. The disparate realization rates for Cooling are attributable to a multitude of factors. Apart from the effects of the Process site that was classified as a Cooling site and the unoccupied buildings discussed above, the major factor contributing to the disparate realization rates is a difference in the methodologies used to estimate or model occupancy and operational patterns. Global could identify differences in operating hour assumptions for some types of cooling equipment (e.g., rooftop units). However, for chillers and some other types of equipment, the methodologies and assumptions the Companies used to derive the claimed savings are not included in the PSD or the project documentation, so Global can only hypothesize that operational-type assumptions are the contributing factor. In general, the team did not observe a discrepancy between the equipment types and efficiencies installed and the equipment described in the program documentation; indeed, on-site verification showed that the vast majority of equipment was installed as specified.

For Lighting, adjusted annual energy savings are 98% of Company-reported savings, adjusted summer peak demand savings are 72% of Company-reported savings, and adjusted winter peak demand savings are 87% of Company-reported savings. While it is somewhat surprising that the summer peak demand savings are so different, while the kWh and winter peak savings are more similar to the company reported savings, we believe that this is due to several factors. Any differences between the expected operating hours and the actual operating hours could cause this situation. Also, the specific hours of the peak may not have been the same as what was assumed in the initial savings estimation. Lastly, there are almost certainly differences in the calculation of the interactive effect between lighting and cooling. The energy realization rate near 100% indicates that, averaged across all projects, the Company-reported savings estimates and the adjusted gross savings are fairly consistent. In general, the methodology used by the Companies to develop claimed savings for Lighting is very transparent. As such, it is clear that the main factor contributing to the differing individual customer realization rates is a difference in operating hour assumptions. Overall, Global's on-site monitoring of Lighting equipment showed that the actual operating hours are slightly higher than assumed for the Company-reported savings. On an individual site basis, 18 of the 34 Lighting sites visited had greater operating hours than estimated, 13 had fewer operating hours, and three had operating hours within 10% of the Company-reported estimates. On-site verification showed that the Lighting equipment was installed as specified in 30 of the 34 sites visited.

For Heating, adjusted annual energy savings are 134% of Company-reported savings, adjusted summer peak demand savings are 50% of Company-reported savings, and adjusted winter peak demand savings are 169% of Company-reported savings. The major factor contributing to the disparate realization rates is a difference in the methodologies Global and the Companies used to estimate savings. For example, Global noticed discrepancies between operating hour assumptions in the PSD and what was observed on-site for some types of heating equipment (e.g., heat pumps). Despite some differences in operating hour assumptions, the PSD covered heating measures very well. In fact, the PSD contained methodologies for deriving savings for all Heating measures in the sample except for CO_2 controlled ventilation. Nevertheless, the PSD was not always followed. For some heating projects the project files do not specify how the Company calculated their reported savings, but the methodology was clearly different that that used in the PSD, because when Global calculated the savings according to the PSD, the resulting impacts were largely different. In general, the team did not observe a discrepancy between the Heating equipment types and efficiencies installed and the equipment described in the program documentation.

For Process, adjusted annual energy savings are 112% of Company-reported savings, adjusted summer peak demand savings are 199% of Company-reported savings, and adjusted winter peak demand savings are 106% of Company-reported savings. As these realization rates indicate, energy and winter peak demand estimates for savings from the Process measures are fairly close to those developed by the Companies. The dramatically higher realization rate for summer peak demand savings is due entirely to one site, where there were no summer demand savings claimed, yet Global found savings of 1,254 kW in all of the summer peak demand hours. This site is responsible for half of the total summer demand savings for all of the Process measures. When provided, the methodologies in the Companies' documentation were found to be sound. Most discrepancies in savings results are associated with slight differences in approach or operating hours, which is to be expected in any energy analysis. The Companies used an approach that meets the generic criteria set forth in the PSD; more importantly, their approach was consistent from project to project.

For Other, adjusted annual energy savings are 118% of Company-reported savings, adjusted summer peak demand savings are 89% of Company-reported savings, and adjusted winter peak demand savings are 115% of Company-reported savings. Global modeled the weather-sensitive Other measures using the DOE-2 based simulation tool. The weather-sensitive measures include energy efficient motors for HVAC fans and pumps, EMSs, and VFDs associated with HVAC systems. Global used engineering review to analyze the impacts of the non-weather sensitive Other measures such as Energy Star Transformers, refrigeration systems, and motors. Global also used data logging results for the non-weather sensitive measures, except for the case of transformers. Developing impact estimates for the non-weather sensitive Other measures represented the greatest challenge. For a variety of reasons, many of these measures lacked sufficient documentation and data to develop estimates with a high level of confidence.

The overall realization rates across all projects in the five end-use categories together are 101%, 91%, and 110% for annual energy savings, summer peak demand savings, and winter peak demand savings, respectively. These values suggest that, in general, the Companies' savings estimates are in good alignment with the adjusted energy savings and adjusted winter peak demand savings estimates. The somewhat lower realization rate for summer peak demand savings indicates that Company-reported estimates are higher relative to adjusted savings estimates made using on-site verification, metering, engineering review, and calibrated simulation modeling.

As specified in the project Workplan, Global applied net attribution factors previously estimated by PA Consulting to the adjusted gross savings. The net-to-gross rates reflect both free-ridership and spillover components of attribution estimated by PA Consulting. The two effects were combined to create net-to-gross (NTG) rates by major measure group. The NTG rates were applied to the adjusted gross savings (annual kWh) to develop the adjusted net program impacts shown in Table ES-7. The adjusted gross savings account for adjustments captured in the realization rate. That rate reflects the percentage of savings achieved or realized by the participants in the program, regardless of their reasons they installed their measures. Those savings are labeled "gross" to distinguish them from net savings, which reflect participants' motivation for the actions they took.

Table ES-7 Net-to-Gross (NTG) Rates and Resulting Net Program Impacts

Major Measure Group	Adjusted Gross Savings (annual kWh)	Free-Ridership Rate	Spillover Rate	Combined NTG Rate	Adjusted Net Savings (annual kWh)
CL&P projects					
Cooling	7,228,438	16.6%	0.2%	84%	6,042,974
Lighting	9,089,133	24.3%	1.3%	77%	6,998,633
Heating	1,832,442	8.3%	4.1%	96%	1,755,480
Process	7,417,909	15.3%	4.4%	89%	6,609,357
Other					
Motors	819,245	42.1%	0.7%	59%	480,077
Refrigeration	150,001	7.3%	54.9%	148%	221,402
All other	2,203,760	55.2%	7.1%	52%	1,143,752
UI projects					
Cooling—Unitary	1,128,801	45.2%	0.0%	55%	618,583
Cooling—Other	739,117	46.7%	7.4%	61%	448,644
Lighting	2,915,036	36.8%	0.7%	64%	1,862,708
Heating	134,946	13.5%	24.7%	111%	150,060
Process	4,237,407	3.9%	34.8%	131%	5,546,766
Other					
Custom	7,690,024	3.9%	34.8%	131%	10,066,241
Motors	372,781	41.0%	0.0%	59%	219,941
VFDs	1,557,002	24.7%	0.0%	75%	1,172,422
Total	**47,516,042**	**-**	**-**	**-**	**43,337,039**

Source for net-to-gross rates is "2007 Commercial and Industrial Programs Free-Ridership and Spillover Study: Executive Summaries" prepared by PA Consulting, October 28, 2008. Connecticut Light & Power: free-ridership (p. 7-2) and spillover (p. 7-5); United Illuminating Company free-ridership (p. 4-2) and spillover (p. 4-3).

The analysis included development of 8760 hour load shapes for Cooling, Lighting, Heating, and Process measure impacts. These are summarized in Figure 3-1 through Figure 3-4 and in the tables in Appendix E. The load shapes reflect the peak demand adjusted savings. These shapes vary considerably over the course of the year, as expected. Global did not provide savings load shapes for Other measures because the EEB did not request them, and since the varied nature of measures in that category would not have yielded meaningful load shapes.

Figure 3-1 through Figure 3-4 in the body of the report provide the typical day load shape impacts by month for Cooling, Lighting, Heating, and Process measures, respectively. In each of the figures, the impact values are the total kW savings by hour for a typical weekday and weekend day in each month for each measure.

The shapes indicate that the Cooling savings correspond to the workday, when the building is occupied and are, not surprisingly, much higher during the summer. There are some winter savings as well, however, since many of the Cooling measures improve the efficiency of the HVAC system year round.

The Lighting load shapes show higher savings in the summer as well. However this is primarily driven by the interaction effect with HVAC. During the summer, the lower heat output of more efficient lighting lowers the cooling demand. Conversely, during the winter, for electrically-heated buildings, the lower heat output increases heating load, reducing the savings. This also creates a noticeable drop in the savings as the heating systems go on at the start of each day. The lighting savings persist into the evening hours as well, when lights are still on in many facilities.

The heating savings shapes also correspond to the workday, and are, as expected, higher in the winter. There are still significant savings overnight during the winter months, as savings are realized when the systems continue to operate, though generally at a lower thermostat set point. As with cooling, some of the measures were not specific to only the heating operation of the HVAC systems, so there are savings from the heating measures during the summer as well.

The process measure savings load shapes show very little weather sensitivity, being fairly consistent throughout the year. The savings tend to track the occupancy of the facility, with a noticeable drop in savings over the lunch hour.

Review of Program Operations

A major task of this evaluation was to provide EEB and the Companies with an assessment of program operational practices as they contribute to or impede achievement of the program's key objectives. There are several areas where the ECB program is progressing well:

- Trade allies like the program and feel it is good for their businesses. Both trade allies and customers acknowledge the strong influence trade allies have on the customer purchasing decisions and program participation. They feel the program is fuel neutral. They also believe the program makes the inclusion of controls and other high performance measures more attractive to customers. Trade allies are very supportive of project commissioning.
- Participating customers are generally satisfied with the program and report that it mostly meets their savings expectations. They have often been involved in programs in the past. For many customers, involvement in the program increases their knowledge of the benefits of energy efficiency and has improved the way they maintain and use their equipment. The majority of participants said they would consider making similar energy efficiency improvements in the future.

The evaluation also identified several challenges to meeting the programs objectives:

- The vast majority of participants surveyed indicated that they got involved in the program before selecting their equipment, but far fewer seem to have been involved with it at the very outset of their projects. From the survey, it appears that half of the participants decide to participate after the design process is complete, suggesting that they are not made aware of the program early enough in the design process and/or they don't see and/or use the Company staff as a design resource.
- The program is not currently providing deep savings; that is, it is not capturing all or most opportunities through the initial contact. Moreover, while the program is capturing both electric and natural gas savings, it is not clear what the existing opportunities or market penetration of savings currently are for either fuel type.
- Most businesses, as a general rule, do not plan in advance for future energy efficiency upgrades. The majority of participants surveyed use payback period to help make energy efficiency purchasing decisions and require a minimum payback of 3 years or less.
- Trade allies and customers report that first cost remains a barrier to fuller implementation. Some trade allies also suggest that the changing incentive amounts and program rules cause them to avoid recommendation of a broader range of measures.

Global identifies potential improvements to help the program make further progress toward the achievement of its goals. These include changes to the incentive structure, program promotion and implementation, and data collection/documentation.

Recommendations for improving the incentive structure:

1. Provide cash incentives to trade allies for building designs that include a range of energy efficiency improvements, using a sliding scale for improvement above an established baseline.
2. Introduction of tiered incentives, such that measures that are less known or have longer paybacks are more highly incented. Consider whether both customers and trade allies may be eligible for the incentives.
3. Include bonus incentives that may apply to both customers and trade allies, for certification as LEED or Green Globe buildings.[6]

Recommendations for improving the program promotion and outreach:

1. Conduct a market characterization study to better identify additional electric measures that can provide significant savings as well as customer groups with greatest remaining potential for improving energy efficiency. Then develop measure-specific promotion and customer group-specific outreach strategies.
2. Strengthen relationships with trade allies, especially design contractors who are very involved at the earliest stages of projects and mechanical/electrical engineers and equipment contractors who are very influential in equipment selection. More actively promote and provide training and workshops to trade allies about the incentive and the program, the importance of getting to customers early in process, the benefits of high performance measures including controls, and provide guidance on design simulation modeling.
3. Provide specific training to customers that includes the value of project commissioning and the use of controls to improve occupant comfort and building energy efficiency.
4. Support customer efforts to set company energy goals, including working with them to create initial baselines as well as supplying (e.g. loan) data loggers as part of an energy information program that also includes energy goals and energy action plans.
5. Support joint events with DOE and others to increase company energy efficiency commitment levels.
6. Dedicate staff to conduct outreach with building architects and design engineers to understand the benefits of a long term energy efficiency strategy.
7. Promote the use of load management controls to customers in conjunction with available demand response and dynamic pricing programs.

Recommendations for improving program implementation:

1. Provide better support and a faster turn-around time during the design and bid process.
2. Develop a spreadsheet, software program, and/or online tools to help contractors accurately estimate the size and availability of incentives for specific measures.
3. Continue to increase the number of natural gas measures that are eligible for the program.

Recommendations for Improving Documentation and Future Savings Estimates

Recommendations for improving program data collection and documentation:

1. The Companies should use the same grouping of measures, and the same nomenclature for both the major measure categories and the individual measures themselves, in the electronic databases.
2. Record and clearly specify all of the measures installed and rebated under the program for each project. Whether as separate line entries or additional fields in the database, this

[6] This incentive is outlined in the "Energy Conscious Blueprint (ECB) Re-Visioning Strategy- *straw"* as a recommended improvement to the program.

should include standardized measure names plus notes that provide more detail on every one of the measures for each project.

3. Add identifying information about the location of equipment installations in all project files. At a minimum, provide identifiers such as the room name (e.g., conference room) or equipment number (e.g., RTU1).
4. Convert all paper information describing existing and new equipment, as well as savings and cost documents and project plans, to electronic files. The easiest, most commonly used, and least error-prone way to do this is to scan all the paper documents into a PDF file at the conclusion of each project and maintain an electronic library of project files.
5. Include the methodologies and assumptions used to calculate savings in the individual project files. When applicable, refer to the relevant sections in the PSD.
6. Follow the methodologies in the PSD for all prescriptive measures or clearly explain the rationale for using a different approach.

Recommendations for improving the 2011 PSD:

1. Develop, and include in the PSD, methodologies, assumptions, and formulas that are specific to the targeted population of customers in the ECB program (i.e., C&I new construction or major renovation).
2. Provide more information on how the savings are derived for custom measures, either in the PSD or in supporting documentation or software tools. This will enable a better understanding of the differences in the estimation methodologies between Company-reported and adjusted calculations and should help reveal causes of discrepancies.
3. For Lighting measures, consider a more accurate approach that involves assigning lighting groups to specific areas within the facility, then assigning operating hours to those specific areas based on the function of the particular space.
4. For Cooling and Heating measures, conduct a study to examine and possibly adjust cooling and heating full load hour assumptions for new construction projects.[7]
5. Include more specific guidance on the calculation of savings for efficient air compressors.

[7] Though Global noticed some problems with the PSD's cooling and heating full load hours, deriving a new set of full load hour data based on the metering results and then recommending that the Companies use this new set instead of the values in the PSD would be inappropriate. This is because Global would have to derive the figure for each building type, and the sample of metering data for each type of building is not large enough to properly define a new set of full load hours.

INTRODUCTION AND PROJECT OVERVIEW

This chapter introduces the project by describing the purposes of this evaluation of the Commercial and Industrial (C&I) Energy Conscious Blueprint (ECB) program operated by Connecticut Light & Power and United Illuminating (the Companies). It then presents an overview of the program to provide context for the subsequent evaluation of the program process and impact results.

1.1 PURPOSES OF THE STUDY

The objective of this study was to evaluate the energy impacts and processes of the ECB program in the 2009 program year (PY 2009), with the ultimate goal of providing recommendations to improve the program's estimation of savings and effectiveness in future years. This evaluation had the following key purposes:

- Provide independent estimates of the program's annual energy (kWh) savings, seasonal peak demand (kW) savings, and hourly load shape impacts, and compare the results to the Companies' reported savings
- Assess program processes and activities, then make recommendations to improve their effectiveness
- Recommend improvements to the Companies' most recent Program Savings Document (2011 PSD)[1] to enable more accurate projection of savings in future program years

1.1.1 Estimation of Realized Energy Impacts

Realized energy impacts, sometimes called verified or ex-post savings, are savings calculated using information collected about actual installations after they are made. Compared with ex-ante or pre-installation savings estimates used to calculate customer incentive payments, which are referred to throughout this document as Company-reported savings (generally based on the PSD in effect at the time, plus assumed conditions), realized savings are estimated based on conditions observed post-installation and take into account estimates of baseline equipment that would have been installed absent the program. For the ECB program, the baseline was the relevant building code in effect at the time the project was initiated within the program. In this evaluation, these impacts are reported as adjusted gross savings,[2] because they reflect adjustments to the Company-reported savings. The differences between Company-reported and adjusted gross savings can be due to a variety of factors, such as the quantity, size, and efficiency specifications of measures actually installed; their actual hours of use; the actual square footage affected; and the interactive effects on the energy use of other existing equipment. The metric of the adjusted savings as percent of Company-reported savings is known as the realization rate. The realized or adjusted impacts estimated for this study include:

- **Annual energy savings from all measures in the 2009 program year:** These are annual, weather-normalized kWh savings estimates developed based on a sample of verified and measured installations. They are compared with the Companies' reported savings.
- **Seasonal peak demand savings:** These are weather-normalized kW reductions that occur at peak hours on peak days in the summer and/or winter seasons, estimated for the same

[1] *UI and CL&P Program Savings Document for 2011 Program Year*, The United Illuminating Company, New Haven, CT and Connecticut Light & Power Company, Hartford, CT: Sep 2010.

[2] The inclusion of "gross" is only to underscore that unless explicitly noted otherwise (as they are in section 3.5 of this report), the savings do not include any net attribution factors (free-ridership or spillover) that might reflect motivation for the customer installations made under the program.

customer sample as the kWh savings, calculated using ISO New England's definition of the seasonal peak hours.

- **Hourly load shapes of savings:** These are 8760 hourly savings estimates, which map the pattern of savings by hour of the day throughout the year. The loads calculated for each hour of the year provide the basis for the annual kWh and peak kW savings reported.

Program-level annual kWh and seasonal peak kW adjusted savings and realization rates are also presented for the measures, grouped into five major measure categories: Cooling, Lighting, Process, Heating, and Other.

1.1.2 Analysis of the Effectiveness of the Program

Many features of a program and its procedures affect the success of the program. The focus of this part of the evaluation was to assess how well the program is progressing toward achieving the objectives the Companies and the EEB have set for it. This assessment characterizes the program in terms of key program objectives, the activities designed to bring them to fruition, and the challenges currently hindering their achievement. In this assessment, the objectives in effect in 2009 are updated to reflect the re-visioning of the program that set a new direction for the program going forward.

In reviewing the program's performance with regard to key program objectives, the assessment addresses:

- Traditional concerns (e.g., customer satisfaction, comprehensiveness of projects)
- Specific concerns (e.g., customer and trade ally awareness of current and pending building codes) raised by EEB and the Companies as they prepare to implement the re-visioning strategy
- Completeness and usefulness of the program tracking database

The assessment culminates in a set of recommendations aimed at furthering achievement of the program's objectives.

1.1.3 Recommendations to Improve the PSD and Accuracy of Future Savings Estimates

The Companies developed the PSD and update it regularly to estimate savings from measures offered under their programs. The version in effect during program year 2009 was the 2009 PSD.[3] As part of this evaluation, Global was asked to review the savings calculations in the 2009 PSD to see if they were appropriate and being applied consistently in the Company-reported savings estimates. In addition, Global reviewed the 2011 PSD to see if changes had been made that would have improved the savings calculations relative to the 2009 version.

Review of the 2009 and 2011 PSDs showed that the calculation methodologies for some measures are not explicitly addressed in the PSD; for other measures, the PSD might not have been used entirely correctly to estimate Company-reported savings. As a result, Global expanded the review to focus more broadly on documentation, assumptions, and calculations, and to provide recommendations that would assist the Companies in improving the pre-installation estimates of measure savings.

1.2 SUMMARY OF PROGRAM AND SCOPE OF PROJECT

The ECB program is an ongoing program designed to improve the energy efficiency of equipment purchases in C&I projects involving new construction, major renovation, tenant fit-outs, and equipment replacement/additions. Since these purchases are necessary parts of the projects, the ECB aims to influence equipment decisions during the design stage, thereby capturing opportunities to improve energy efficiency that might otherwise be lost. The program is comprehensive, providing technical assistance and financial incentives to customers and their design and equipment contractors (trade allies) to increase the energy efficiency and

[3] *UI and CL&P Program Savings Document for 2009 Program Year*, The United Illuminating Company, New Haven, CT and Connecticut Light & Power Company, Hartford, CT: Oct 2008.

performance of lighting systems; heating, ventilation and air conditioning (HVAC) systems; motors; industrial processes; and other energy use components of C&I buildings.

The ECB program is an established program at a crossroad. In 2010, an effort was undertaken by the Connecticut Energy Efficiency Board (EEB) and the Companies to review and revise the direction of the program. The resulting "re-visioning"[4] of the ECB gave the program a more forward-looking focus that emphasizes working more collaboratively with customers and their service trade allies to encourage ongoing efficiency improvements in all parts of their operations, beyond existing code and standard minimums. The ultimate goal is to transform the market with beyond-code building design and equipment purchase practices. Thus, while the focus of this study was to evaluate the performance of the 2009 program, it was conducted with the intent to provide recommendations that will help the program move in the newly-defined direction.

The scope of the current evaluation project covers participants in the ECB program during the 2009 implementation year. Because of various procurement processes and/or the complexity of the projects, participation in the program can span several years. For the purposes of this study, the 2009 ECB program is defined to consist of those projects that were completed and paid incentives in 2009, regardless of when the customers enrolled in the program. Only electric measures are included in this evaluation.

The program in 2009 supported installation of a broad array of measures in C&I facilities, addressing all major end uses of electricity as well as gas measures. The measures were aggregated into, and the realized energy impact results were developed for, five major measure categories used by the Companies:

- Cooling
- Heating
- Lighting
- Process
- Other—includes energy management systems (EMSs), refrigeration, motors and variable frequency drives (VFDs) not directly associated with the four major end uses, envelope improvements, and other not-otherwise classified measures such as compressors, transformers, and some custom projects

Review of the PY 2009 data maintained by the Companies revealed a number of characteristics about the projects and participants. The projects and the energy savings reported by the Companies are summarized in the following tables. Many projects included installation of equipment in multiple measure categories. Thus, while the population consists of 519 project sites, counting projects by measure type indicates 721 measure sites. The tables reflect the Companies' categorization of these measures into each of the major categories.

Table 1-1 shows the distribution of project and measures installed. It tells that Cooling measures were most commonly installed (35% of total) and heating measures least (7%). Recalling that only electric program measures are included here, the heating measure count most likely is more reflective of the small share of electric heat in facilities than unpopularity of the heating measures. Aside from the heating measure projects, the reported energy savings are quite evenly split among the measures in each of the other categories, ranging from 22-26% of the annual kWh savings. Within the Cooling category, large chiller measures collectively were recorded as showing the highest energy savings, but far more small rooftop units (RTU), unitary, and split systems were installed. Note that the Companies used somewhat different measure names and groups. (See Appendix F for a complete listing of measure names used by the Companies.) For example, one of the Companies grouped all custom projects, which may include some of the measures identified in the table, into an "other custom" subcategory. So the subcategory counts are indicative rather than exact. Also, measures in "other" subcategory

[4] "Energy Conscious Blueprint (ECB) Re-Visioning Strategy- *straw,"* and "2011 Program Changes Summary," provided by K. Oswald, July 2010.

within the Other category were not identified in the Companies' tracking systems; they comprise about 5% of the projects and account for 10% of the total reported kWh savings, since among them are several projects with very large reported savings. These large projects are among the ones this evaluation verified on site and reviewed in depth.

Table 1-1 Number of Projects and Energy Savings by Measure Category and Equipment Types

Measure Type	# of Projects	% of Projects	Annual kWh Savings	% of Savings	Summer kW Savings	Winter kW Savings
Cooling	**252**	**35%**	**12,039,867**	**26%**	**3,652**	**305**
RTU/Unitary/Split Systems	155		2,689,564		1,127	2
Chillers	26		5,249,414		1,358	20
VFDs for Pumps/Chillers/Fans	19		1,435,151		302	80
Other Custom (UI)	46		1,240,182		221	64
Other	43		1425556		645	141
Heating	**47**	**7%**	**1,468,142**	**3%**	**330**	**119**
Motors/Fans for Air Handling Units/Pumps	24		101,188		0	21
VFDs for Pumps	22		1,060,353		0	71
Other	19		306,601		330	26
Lighting	**158**	**22%**	**12,309,286**	**26%**	**2,489**	**1,904**
General Lighting	143		9,786,393		2,097	1,562
Lighting Controls	63		2,522,893		392	342
Process	**110**	**15%**	**10,370,207**	**22%**	**1,208**	**1,103**
Air Compressors	66		3,224,419		363	288
Air Dryers	29		348,004		30	30
Other Custom (UI)	26		5,755,178		590	567
Other	15		1,042,606		225	219
Other	**154**	**21%**	**10,816,937**	**23%**	**1,818**	**1,317**
Energy Mgt Systems	23		2,250,731		326	212
Envelope	4		671,953		259	18
Motors	69		1,952,788		242	203
Refrigeration	5		125,523		1	253
Other VFDs (UI)	16		1,302,920		70	32
Other	37		4,513,022		921	599
Total	**721***	**100%**	**47,004,439**	**100%**	**9,497**	**4,749**

*These 721 measure sites were actually 519 individual project sites.

Table 1-2 offers a look at the make-up of customers who participated in the PY 2009 program. While projects were completed at a broad variety of facilities, more than half the projects (52%) were completed at Manufacturing and Office facilities. While Offices made up 20% of the projects, they only made up 10% of the reported total program savings. Most of the Office projects were for Cooling measures. This provides something of a benchmark of customers who are currently more or less attracted to the program. A characterization of the market could put these observations in better context for suggesting outreach efforts.

A closer look into these data revealed that, of the 519 projects, 402 (77%) were for a single measure only. This provides a basis for reviewing the program's effectiveness in encouraging customers to take a more comprehensive approach to improving energy efficiency as part of construction and remodel projects. It also underscores the relevance of the focus on improving comprehensiveness outlined in the program re-visioning. The most common single-measure projects were for Cooling and for Process measures. Also note that, while Lighting measures were included in fully three-quarters of the multi-measure projects, they accounted for fewer than 20% of projects in which only one measure was installed. These observations provide a benchmark of practices in the past, against which efforts in future years can be compared.

Table 1-2 Program Participation by Customer Type and Measure Type—Number of Projects and Reported Annual kWh Savings

Facility Type	Cooling #	Heating #	Lighting #	Process #	Other #	Totals # Projects	Totals Annual kWh
Arts, Entertainment, & Recreation	14	3	9	1	9	21	1,777,841
Banking	13	1	1	0	2	13	1,136,601
Food/Restaurant	15	1	8	1	8	26	615,810
Health Care Related	26	12	11	4	12	40	7,411,917
Hotel/Motel	8	0	0	0	5	8	736,018
Manufacturing/ Industrial	29	3	32	93	25	166	14,937,950
Office	70	0	27	2	24	106	4,792,213
Religious Building	11	1	5	0	2	13	150,031
Retail	26	1	23	1	1	39	3,137,285
School	31	23	35	1	56	60	10,879,497
Other	9	2	7	7	10	27	1,429,276
Totals	**252**	**47**	**158**	**110**	**154**	**519**	**47,004,439**

METHODS

The intent of this chapter is to describe the methods Global used to fulfill the purposes of the study that were identified in Chapter 1. The two main categories of methods were data collection and data analysis. Within each main category, there were five specific methods. Table 2-1 maps the methods to the purposes. The following subsections summarize these methods.

Table 2-1 Mapping of Methods to Purposes of the Study

METHODS	DATA COLLECTION					DATA ANALYSIS				
PURPOSES	Program & Project Documentation	Customer Site Visits	Equipment Measurement	In-depth Interviews	On-line Surveys	Documentation & PSD Review	Building Simulation Modeling	Engineering Review	Statistical Analysis	Logic Model
Estimation of realized energy impacts	√	√	√			√	√	√	√	
Analysis of program procedures and recommendations to improve effectiveness	√	√		√	√	√				√
Recommendations to improve the PSD and accuracy of future savings estimates	√		√			√	√	√		

2.1 DATA COLLECTION

Data collection was a vital element of this study. Data collection involved obtaining program and project documentation from the Companies, visiting a sample of customer sites to speak with personnel familiar with the program, verifying equipment installations, and measuring the equipment's energy use and operational characteristics. It also involved interviewing program managers and trade allies as well as conducting a survey of program participants to understand their experiences with the program.

- **Program & project documentation:** Global used Company-maintained information about the program including brochures and webpages, extracts from the Companies' respective tracking systems, and additional paper and electronic documentation on each project in the analysis sample. The data were critically important to understanding what was installed at each site and to developing recommendations for improving energy savings estimates, documentation, and education in future years.
- **Customer site visits:** Global conducted site visits for a sample of the ECB program participants. The site visits were used to verify equipment, collect data for estimating energy impacts, and obtain additional information regarding participants' understanding of the program. The site visits were carried out in two phases. The first phase (Phase 1) took place during the period of

July through October 2010. The second phase (Phase 2) took place during the period of November 2010 through January 2011. The focus of Phase 1 was to collect data for Cooling and Lighting measures. In addition, data were collected for most process and some "other" measures during Phase 1. The focus of Phase 2 was to collect data for Heating measures, Cooling and "Other" measures with winter loads, and the remainder of the Process measures. A total of 100 customer sites, representing 146 measures, were included in the on-site sample.

- **Equipment measurement:** Global's field staff installed two types of data logging equipment at customer facilities during the on-site visits: light loggers and load loggers. In general, light loggers were used to measure light intensity and on/off patterns of lighting circuits containing energy efficient lighting and occupancy or daylight sensors. For load logging, current transformers (CTs) were used along with spot measurements of amps, volts, kW, and kilovolt-amps to measure equipment loads and operational patterns for cooling, heating, process, and "other" equipment. The data were recorded for use in estimating the realized energy impacts. See Appendix B for more details about on-site data collection procedures.
- **In-depth interviews:** Global conducted interviews with the Companies' program managers for use in understanding and assessing the program objectives, procedures, and activities and to ensure that concerns about the effectiveness of specific aspects of the program would be addressed in the evaluation. Interviews with 15 building design contractors, engineers, equipment contractors, and energy service companies (collectively the trade allies) were conducted to help determine the effects and effectiveness of program procedures and identify barriers to greater effectiveness.
- **On-line surveys:** Global surveyed program participants to obtain information used in assessing the effectiveness of the program. Surveys were conducted by providing respondents a link to the on-line questionnaire. A total of 54 responses were received, 34 from participants in the on-site measurement and verification sample and 20 from other participants for whom email addresses were available.

Appendix A describes the sample design process. Appendix B provides the details of the protocols followed for measurement and verification during site visits. Appendix C contains the interview guide. Appendix D presents the on-line participant survey questions and results.

2.2 DATA ANALYSIS

Once the data were collected, Global used several data analysis techniques to estimate the realized energy savings and to evaluate the various metrics of program effectiveness. To quantify the realized energy savings, Global reviewed the program documentation and then employed building simulation modeling, engineering review, and statistical analysis to confirm or adjust per-unit savings and, ultimately, to quantify program-level energy impacts. To assess effectiveness of the program processes, Global first developed a program logic model to show how current processes contribute to the attainment of the program goals and to identify intervention points for program re-visioning and improvement. Global also reviewed the program documentation, plotted the on-line participant survey results and synthesized the findings with the qualitative results from the interviews with trade allies. The five main data analysis methods were as follows:

- **Program logic model:** The logic model is a tool to show how current processes contribute to the attainment of the program goals and to identify intervention points for program re-visioning and improvement. It was used to assess the current status of progress toward goals, identify challenges to progress, and help develop recommendations to further progress.
- **Documentation & PSD review:** Documentation of each project site was reviewed, both to help understand the project and to fill gaps in the primary data collection. The PSD was examined to review the assumptions and formulas for measures installed under the program. The documentation and PSD provided some insight into the way the Company-reported savings were calculated.
- **Building simulation modeling:** Global's DOE-2 based simulation model was used in conjunction with on-site measurements, customer bills, and weather data to develop the realized

energy savings estimates for the weather-sensitive Cooling and Heating measure categories plus some weather-sensitive measures in the Other category. Appendix E describes the methodology followed to simulate buildings and analyze weather-sensitive measures.

- **Engineering review:** Engineering calculations were used to estimate the realized energy savings for the non-weather-sensitive measures. This includes Lighting measures, Process measures, and some measures in the Other category. Appendix E describes the engineering review approaches for each of the various types of measures.
- **Statistical analysis:** Statistical methods for sample design and expansion were used to ensure that the conclusions made based on the savings estimates had a rigorous statistical basis. The sample was randomly selected using a stratified design (see Appendix A for details on the sample design). The load shapes, the kWh savings, and the seasonal kW demand savings were estimated, along with confidence intervals, using a ratio estimate that integrated the predicted savings into the analysis to estimate the adjusted gross savings more accurately. Appendix E includes explanation of the methodology followed to expand the sample results to the population. Standard statistical estimation techniques were also used to report the results of the survey data collected as part of the process evaluation (see Appendix D for disposition of the survey responses).

CHAPTER | 3

REALIZED ENERGY IMPACTS

This chapter presents the results of the impact evaluation. It begins by summarizing the outcome of the site visits in terms of the number of sites successfully visited and Global's experiences with verification and measurement of equipment. Then, the adjustment factors used to determine the adjusted gross impacts are defined to set the stage for a detailed discussion of adjusted gross impact results for the sample. Next, the expanded adjusted gross impact results for the population are presented, followed by a discussion of net program impacts. The chapter ends by describing a series of monthly load shapes for each measure type.

3.1 RESULTS OF SITE VISITS

3.1.1 Sites Included in Realization Rate

The on-site data collection process for Phase 1 was highly successful. Of all the sites included in the sample, Global was able to carry out site visits at all but one of the recruited sites. The customer not visited had originally agreed to the site visit, but then declined to participate when it came time to schedule the appointment. This customer is a building owner who was concerned about disrupting the tenant who occupied the space. Many attempts were made to try to persuade the customer. Ultimately, there was not sufficient time to replace the customer with a back-up and to conduct the site visit and analysis in time for inclusion in the report.

In addition, for one of the sites visited, the building was found to be still under construction. As a result, the site visit staff was able to verify installation of the energy efficient equipment, but they were not able to conduct any equipment monitoring since the building is not yet operational. Because the operation of the site was not representative of customers in operation, this site was excluded from the population and the sample. Because of the timing of the visit to this site, Global was unable to select, recruit, and monitor a backup site.

There were three other unoccupied or out-of-business sites in the sample, for which backups were chosen. These three sites were also excluded from the population for the calculation of the realization rate. All together, results from 37 Cooling sites, 34 Lighting sites, 28 Heating sites, 19 process sites, and 25 Other sites were included in the calculation of the program-level adjusted savings and realization rate.

Appendix G contains the site reports for each site visited.

3.1.2 Verification

Global's team visually verified installation of the majority of program-qualifying equipment during the site visits. Every site that claimed installation of a measure, contained equipment associated with the measure. In general, verification of each piece of equipment associated with Cooling, Heating, Process, and Other measures was much easier than verification of each lighting fixture. However, in some instances, it took the team quite a bit of time to locate the correct equipment due to the lack of documentation regarding the placement of equipment and the fact that on-site personnel were not always familiar with the installations. In one case for an Other measure (Other12), the site visit team was unable to identify the program-installed pump motors and VFDs, even with help from site personnel and the Company's program representative, because there are hundreds of pumps and VFDs installed at the site. For Lighting, the sheer number of fixtures did not allow the team to confirm installation of every light fixture. However, visual inspection did confirm that installations were made and quantities were of the right order of magnitude. Global did not find any instances in which equipment recorded in the tracking systems was not installed.

In some cases, Global found that the specifications of the equipment noted in the Companies' tracking system did not match the equipment at the customer location. For example, at one site (Lighting04) the lamps installed throughout the facility were F28T8s, while the project documentation listed them as F25T8s. For two Cooling sites (Cooling11 and Cooling12), the cooling capacity of the rooftop cooling units did not match the specifications in the project documentation. For an Other site (Other19), the motor horsepower ratings observed on-site did not completely match those listed in the project files.

3.1.3 Measurement

For the most part, spot measurement and data logging of equipment was highly successfully. In a couple of cases, the facility personnel did not allow the Global team to attach logging equipment because of the critical nature of equipment. For example, at one hospital (Cooling22) the high voltage (4160 V) associated with the chillers posed a safety hazard for the team. The hospital was unwilling to shut down the chillers to allow the loggers to be safely installed because chiller operation was crucial to the hospital and shut-down and re-start would have affected the building's comfort. In addition, an airport (Lighting12) did not permit light logging due to TSA requirements against installing electronic devices in airports.

One overarching limitation of equipment measurement was the constraint to keep logging points to a minimum. Though practical as a means to control the cost of measurement and verification, such a restriction reduces the accuracy of measurement results. Global's general rule of thumb was to use an average of two logging points per measure per site. As such, characterization of equipment operation was challenging for large sites with large equipment inventories. Nevertheless, measurement and monitoring of equipment yield valuable insight into the actual operation of the installed equipment for use in calculating realized energy impacts.

3.2 GROSS IMPACT ADJUSTMENTS

For each measure in the site visit sample, Global calculated the difference between the Company-reported savings, as noted in their tracking systems, and the evaluated savings (adjusted gross impacts) to account for a variety of factors that affect the actual achieved savings.

The combined effects of the following factors are captured in the Adjustment for Actual Installed Conditions values in the tables below. Since multiple factors, such as adjustments to recorded baseline conditions and observed rather than reported efficiency levels, were used to create a picture of conditions at each site used by Global's energy simulation models, their effects were estimated simultaneously and as a single net effect. The factors captured in this adjustment are:

- Documentation adjustments–errors or discrepancies in project documentation, including adjustments to baseline assumptions
- Technology adjustments–discrepancies between the technology (equipment type, efficiency, system configuration, etc.) identified in the paperwork and that observed in the field
- Quantity adjustments–discrepancies between the quantity or size of the documented equipment versus the equipment observed in the field
- Operational adjustments–observed and/or metered differences in operating hours at the site compared to those in the tracking system estimate of savings (not applicable to demand savings).

Two other adjustments treated individually are as follows:

- Coincident Adjustment–accounts for any change in kW savings due to the difference between connected and coincident/diversified demand impacts (not applicable to energy savings).
- Interactive Adjustment–reflects any change in savings due to interaction between the installed measures and other (generally HVAC) systems among the sampled sites. (Appendix E explains the methodology Global used to determine the factors for the Interactive Adjustment.)

3.3 ADJUSTED GROSS IMPACTS FOR THE SAMPLE

This section describes the adjusted gross impact results for the sites included in the sample. The tables contained in the discussion below list, for each project, the sampling stratum (see Appendix A for details on the sample design), the Company-reported savings, the appropriate adjustments as described in Section 3.2, the final adjusted savings for the site, and the ratio of the adjusted savings to the Company-reported savings, which can be thought of as a site-specific realization rate. It is important to note that these customer-specific realization rates are included for information only. They were not used in the measure-level or program-level calculations directly.

3.3.1 Cooling

The Cooling sites included in the sample contain a broad diversity of cooling equipment and facility types. For example, equipment varies from chilled water pumps to rooftop units to chillers (see Appendix F), while facilities range from schools to hospitals to exercise centers. As a result, the annual Cooling impacts range from hundreds of kWh to millions of kWh, depending on the project. Table 3-1 through Table 3-3 present the adjusted gross impact results for annual kWh, summer peak kW, and winter peak kW, respectively. To summarize:

- Adjusted gross annual kWh savings range from 362 to 2,254,759.
- Adjusted gross summer peak kW savings range from 0 to 226.07.
- Adjusted gross winter peak kW savings range from 0 to 126.46.
- Energy site-specific realization rates range from 30% to 511%.

The large range in site-specific realization rates is attributable to many factors unique to each project. However, Global speculates that the main factor affecting the realization rate for the majority of sites is a difference in the assumptions and methodologies used in the Company-reported estimates of operational patterns and the operating patterns observed during site visits and subsequently incorporated in Global's DOE-2 simulation model. Since the model was calibrated using billing and metering data that were collected from the actual sites, the resulting adjusted savings are more likely to be valid and appropriate for the projects.

Differences in operating hours for some types of cooling equipment (e.g., rooftop units) are easy to verify because the Companies' methodologies are detailed in the PSD. However, for chillers and some other types of equipment, the methodologies and assumptions used to derive the claimed savings are not included in the PSD, so Global can only hypothesize that operational-type assumptions are the contributing factor.

Global did not observe a significant discrepancy between the equipment types and efficiencies installed and the equipment described in the program documentation; indeed, on-site verification showed that the vast majority of equipment was installed as specified. There were only a couple of instances in which the observed equipment capacities were different than those in the project documentation. Specifically, the cooling capacity of the rooftop units (RTUs) did not match what was observed at two sites, Cooling11 and Cooling12. In addition, for a few cases, the equipment specifications were missing or incorrect in the project files. For example, the efficiency of the RTUs was not provided for project Cooling04 and the type of economizer was not provided for projects Cooling27 and Cooling11.

In some cases, the information in the project documentation indicates that the claimed savings may be wrong. For example, for Cooling33, the split system did not get an incentive, so savings should not be counted. In another project, Cooling29, the new chiller's efficiency is lower than the ASHRAE minimum. In project Cooling20, the project documentation states that the wrong values for the baseline and new chiller efficiencies were used in the savings calculations.

Table 3-1 Company-Reported and Adjusted Annual kWh Savings – Cooling Sample

Sampled Projects	Sampling Stratum	Company-Reported Annual kWh Savings	Adjustment for Actual Installed Conditions	Adjusted Annual kWh Savings	Site-Specific kWh Realization Rate
Cooling01	1	394	(32)	362	0.9197
Cooling02	1	480	616	1,096	2.2838
Cooling03	1	838	(111)	727	0.8675
Cooling04	1	1,581	(559)	1,022	0.6462
Cooling05	1	6,659	(2,189)	4,470	0.6712
Cooling06	1	16,452	(6,316)	10,136	0.6161
Cooling07	2	40,508	11,024	51,532	1.2722
Cooling08	2	44,093	(1,309)	42,784	0.9703
Cooling09	2	44,664	5,261	49,925	1.1178
Cooling10	2	45,667	(6,016)	39,651	0.8683
Cooling11	2	56,100	(442)	55,658	0.9921
Cooling12	2	58,239	(13,961)	44,278	0.7603
Cooling13	2	72,364	(38,379)	33,985	0.4696
Cooling14	2	82,159	(49,087)	33,072	0.4025
Cooling15	2	89,036	(35,626)	53,410	0.5999
Cooling16	2	120,725	(52,891)	67,834	0.5619
Cooling17	2	121,806	10,375	132,181	1.0852
Cooling18	2	150,852	(1,223)	149,629	0.9919
Cooling19	2	221,649	(118,302)	103,347	0.4663
Cooling20	2	289,464	(161,859)	127,605	0.4408
Cooling21	2	388,333	(234,400)	153,933	0.3964
Cooling22	3	3,178,081	(923,322)	2,254,759	0.7095
Cooling23	4	3,173	(249)	2,924	0.9215
Cooling24	4	9,931	(6,016)	3,915	0.3942
Cooling25	4	10,029	41,169	51,198	5.1050
Cooling26	4	13,339	29,324	42,663	3.1984
Cooling27	4	16,379	(1,075)	15,304	0.9344
Cooling28	4	37,539	7,235	44,774	1.1927
Cooling29	4	41,931	(17,272)	24,659	0.5881
Cooling30	4	126,370	68,337	194,707	1.5408
Cooling31	4	177,137	68,579	245,716	1.3872
Cooling32	5	44,371	34,403	78,774	1.7753
Cooling33	5	71,427	(49,814)	21,613	0.3026
Cooling34	5	140,672	(16,659)	124,013	0.8816
Cooling35	5	332,597	9,387	341,984	1.0282
Cooling36	5	519,383	(277,740)	241,643	0.4653
Cooling37	5	1,131,210	(237,494)	893,716	0.7901

Table 3-2 Company-Reported and Adjusted Summer Peak kW Savings – Cooling Sample

Sampled Projects	Sampling Stratum	Company-Reported kW Savings	Adjustment for Actual Installation Conditions	Adjustment for Peak Coincidence	Adjusted kW Savings	Site-Specific kW Realization Rate
Cooling01	1	0.41	(0.03)	0.28	0.66	1.6003
Cooling02	1	0.51	0.65	0.71	1.88	3.6841
Cooling03	1	0.90	(0.12)	0.32	1.10	1.2222
Cooling04	1	1.90	(0.67)	0.86	2.08	1.0965
Cooling05	1	2.70	(0.89)	0.47	2.29	0.8464
Cooling06	1	5.80	(2.23)	1.28	4.85	0.8362
Cooling07	2	16.33	4.44	(3.20)	17.57	1.0762
Cooling08	2	32.00	(0.95)	(5.85)	25.20	0.7875
Cooling09	2	19.42	2.29	(0.09)	21.62	1.1131
Cooling10	2	17.17	(2.26)	1.46	16.37	0.9534
Cooling11	2	15.80	(0.12)	74.97	90.65	5.7373
Cooling12	2	22.07	(5.29)	(7.18)	9.60	0.4351
Cooling13	2	7.90	(4.19)	6.09	9.80	1.2405
Cooling14	2	(1.00)	0.60	31.40	31.00	31.0000
Cooling15	2	7.00	(2.80)	31.10	35.30	5.0429
Cooling16	2	58.52	(25.64)	6.99	39.87	0.6814
Cooling17	2	34.74	2.96	(0.40)	37.30	1.0737
Cooling18	2	69.00	(0.56)	(37.74)	30.70	0.4449
Cooling19	2	67.61	(36.08)	23.42	54.94	0.8126
Cooling20	2	73.78	(41.26)	(10.52)	22.00	0.2982
Cooling21	2	-	-	3.10	3.10	n/a
Cooling22	3	447.00	(129.87)	(91.06)	226.07	0.5058
Cooling23	4	4.37	(0.34)	(2.60)	1.43	0.3265
Cooling24	4	13.72	(8.31)	(0.59)	4.82	0.3511
Cooling25	4	5.15	21.14	(22.99)	3.30	0.6408
Cooling26	4	13.72	30.16	(5.62)	38.26	2.7885
Cooling27	4	20.30	(1.33)	1.69	20.66	1.0176
Cooling28	4	93.09	17.94	(111.03)	0	0.0000
Cooling29	4	9.98	(4.11)	(3.27)	2.60	0.2605
Cooling30	4	92.00	49.75	(79.55)	62.20	0.6761
Cooling31	4	34.73	13.45	(17.08)	31.10	0.8955
Cooling32	5	24.30	18.84	(20.54)	22.60	0.9300
Cooling33	5	36.89	(25.73)	21.94	33.10	0.8972
Cooling34	5	174.58	(20.67)	(106.61)	47.30	0.2709
Cooling35	5	90.59	2.56	(31.16)	61.99	0.6843
Cooling36	5	51.00	(27.27)	33.67	57.40	1.1255
Cooling37	5	26.60	(5.58)	191.89	212.90	8.0039

Table 3-3 Company-Reported and Adjusted Winter Peak kW Savings – Cooling Sample

Sampled Projects	Sampling Stratum	Company-Reported kW Savings	Adjustment for Actual Installation Conditions	Adjustment for Peak Coincidence	Adjusted kW Savings	Site-Specific kW Realization Rate
Cooling01	1	-	-	-	-	N/A
Cooling02	1	-	-	-	-	N/A
Cooling03	1	-	-	-	-	N/A
Cooling04	1	-	-	-	-	N/A
Cooling05	1	-	-	-	-	N/A
Cooling06	1	-	-	-	-	N/A
Cooling07	2	-	-	-	-	N/A
Cooling08	2	-	-	0.40	0.40	N/A
Cooling09	2	-	-	1.67	1.67	N/A
Cooling10	2	-	-	-	-	N/A
Cooling11	2	15.80	(0.12)	(15.68)	0	0.0000
Cooling12	2	-	-	-	-	N/A
Cooling13	2	-	-	8.56	8.56	N/A
Cooling14	2	-	-	0.60	0.60	N/A
Cooling15	2	-	-	1.70	1.70	N/A
Cooling16	2	-	-	13.31	13.31	N/A
Cooling17	2	-	-	-	-	N/A
Cooling18	2	-	-	10.10	10.10	N/A
Cooling19	2	-	-	-	-	N/A
Cooling20	2	-	-	2.60	2.60	N/A
Cooling21	2	-	-	2.02	2.02	N/A
Cooling22	3	-	-	14.66	14.66	N/A
Cooling23	4	-	-	-	-	N/A
Cooling24	4	-	-	-	-	N/A
Cooling25	4	-	-	14.50	14.50	N/A
Cooling26	4	-	-	12.56	12.56	N/A
Cooling27	4	-	-	0.34	0.34	N/A
Cooling28	4	-	-	-	-	N/A
Cooling29	4	4.00	(1.65)	(2.35)	0	0.0000
Cooling30	4	34.00	18.39	(17.79)	34.60	1.0176
Cooling31	4	11.46	4.44	11.00	26.90	2.3473
Cooling32	5	1.00	0.78	(1.78)	0	0.0000
Cooling33	5	-	-	-	-	N/A
Cooling34	5	-	-	24.90	24.90	N/A
Cooling35	5	-	-	88.83	88.83	N/A
Cooling36	5	-	-	11.50	11.50	N/A
Cooling37	5	26.60	(5.58)	105.45	126.46	4.7543

However, at many of the sites with big discrepancies, Global was not able to determine specifically how the Company-reported savings were calculated, so it was impossible to explain the differences.

In addition, Global observed that the DOE-2 simulation results for the VFD pumping measure tend to be higher than the PSD method. For example, the cooling measure for Cooling25 involves installing a VFD on the chilled water pump. For this project, the Company-reported savings matches what Global calculated using the PSD. However, it is quite different than what was calculated using the simulation model (realization rate of 511%). Global calibrated the simulation model using both the metered data from the site and the billing data. The calibration to the annual billing data came within 1.3% (percent difference between the model and the billing data), indicating a good match between the model and reality. From this, Global deduces the PSD method underestimates the operation hours for chilled water pumps.

Another project with a very high realization rate is Cooling26, which has a realization rate of 320%. The measure for this site involves water-source heat pumps. In this case, the Company's claimed savings are much lower than Global's calculation using the PSD method. Furthermore, Global's DOE-2 simulation model generated savings close to the PSD method. So, Global hypothesizes that the Company either did not apply the PSD formula correctly when calculating the claimed savings figure, or they used another method entirely.

As is common, the relationship between the Company-reported demand savings and the estimated savings from the evaluation is more variable, with more extreme realization rates. In many cases, the discrepancies correspond to differences in the energy savings. One project that bears mentioning is Cooling14, which had a Company-reported savings of -1 kW, meaning that the measure was predicted to increase demand by 1 kW. Global's analysis showed a reduction of 31 kW. There was not sufficient information to determine the reason for the claimed savings of negative 1 kW. Click the icon below to view the site visit report for the project:

Cooling 14.pdf

In another case, Cooling21, no demand savings were claimed, but analysis showed a demand reduction of 3.1 kW.

Some other observations from the Cooling analysis are listed below.

- Global determined the adjusted gross kWh savings to be higher than the Company-reported savings for 11 projects and lower for 26 projects.
- Global determined the adjusted gross summer peak kW savings to be higher than the Company-reported for 16 projects and lower for 21 projects.

3.3.2 Lighting

The Lighting sites included in the sample are diverse. They range from schools to manufacturing facilities to airports. The facilities contain various types of energy efficient lighting, such as compact fluorescent lamps (CFLs) and T8 fluorescent fixtures. Some have installed daylighting and occupancy controls. As a result, the annual lighting impacts range from thousands of kWh to hundreds of thousands of kWh, depending on the project. Table 3-4 through Table 3-6 present the adjusted gross impact results for annual kWh and summer peak kW. To summarize:

- Adjusted gross annual kWh savings range from 0 to 816,586.
- Adjusted gross summer peak kW savings range from 0 to 228.17.
- Adjusted gross winter peak kW savings range from -0.05 to 164.63.
- Energy site-specific realization rates range from 0% to 303%.

The zero energy realization value reflects the fact that one site (Lighting13) had reported savings, but the lighting project was not incentivized. Ignoring the zero value, the energy realization rate ranges from 19% (Lighting07) to 303% (Lighting19). The main reason for the low realization rate for the lowest sites was a typo in the documentation of energy savings and apparent misstatement of the number and combination of wattages of the fixtures actually installed. This is discussed in more detail below. The highest realization rate of 303% is due to a significantly greater observed impact of occupancy sensors on energy use than was estimated in the Company-reported calculations. Essentially, data logging showed that the occupancy sensors turned the lights off more frequently than anticipated.

As with Cooling, the large range in realization rates for Lighting between sites is attributable to many factors unique to each project. The main lighting parameters with the potential to affect the realization rates are fixture type and efficiency, fixture quantities, occupancy sensor locations, occupancy sensor quantities, and operating characteristics. However, for most of the sites, the difference between realized and reported savings is due primarily to operating characteristics. For example, for "high performance" lighting, the Company-reported savings were derived using the difference between the site's lighting power density and the ASHRAE 90.1 standard, multiplied by the building's floor area and operating hours as prescribed in the PSD. This approach yields reasonable estimates only if all lighting is turned on and off at the same time, under both baseline conditions and new conditions. In reality, this rarely happens. In some locations, only a fraction of the lighting is brought on initially, and more is added as the day progresses. In other cases, the lighting may be on for significantly longer hours than was assumed initially. It should be emphasized that given the limited pre-installation data available on operating patterns for most projects, determining ex-ante savings using the lighting power density method is an acceptable and widely used approach. However, the Companies could consider a more accurate approach that involves assigning lighting groups to specific areas within the facility and then assigning operating hours to those specific areas based on the function of the particular space.

In contrast, Global's adjusted savings estimates were made based on actual operating hours logged during site visits. The logging results were critical since Global needed to develop hourly load profiles, rather than just annual energy savings and peak demand reduction estimates. The logging results from each site (typically two sets) were used to develop operating patterns for all lighting groups in the facility. Every effort was made to match the operating patterns (e.g., lighting with occupancy sensors, or not, etc.) to the appropriate sets of lighting. In addition, a small portion of the lighting (usually about 5% of the total) was assumed to be left on all the time to represent emergency lighting, which is found in most buildings. The result is that Global observed the following:

- Higher operating hours for 18 sites
- Lower operating hours for 13 sites
- Operating hours within 10% of Company-reported estimates for the remaining three sites visited

Table 3-4 Company-Reported and Adjusted Annual kWh Savings – Lighting Sample

Sampled Projects	Sampling Stratum	Company-Reported Annual kWh Savings	Adjustment for Actual Installed Conditions	Adjustment of Interaction with Other Measures	Adjusted Annual kWh Savings	Site-Specific kWh Realization Rate
Lighting01	1	7,715	978	1,454	10,147	1.3152
Lighting02	1	11,647	1,411	1,697	14,755	1.2668
Lighting03	1	12,734	(4,144)	649	9,238	0.7255
Lighting04	1	23,936	(15,258)	(282)	8,397	0.3508
Lighting05	1	31,786	187	5,335	37,308	1.1737
Lighting06	1	51,315	(33,725)	(136)	17,454	0.3401
Lighting07	2	68,072	(54,944)	(82)	13,046	0.1916
Lighting08	2	117,942	53,186	14,317	185,445	1.5723
Lighting09	2	132,352	(83,135)	(1,170)	48,047	0.3630
Lighting10	2	198,156	2,181	22,020	222,357	1.1221
Lighting11	2	236,813	131,704	31,640	400,157	1.6898
Lighting12	2	240,785	(30,062)	16,207	226,929	0.9425
Lighting13	2	275,879	(275,879)	-	-	0.0000
Lighting14	2	304,694	54,762	27,882	387,338	1.2712
Lighting15	3	402,772	(107,864)	31,354	326,262	0.8100
Lighting16	3	488,547	222,138	76,834	787,518	1.6120
Lighting17	3	564,970	(330,748)	(837)	233,385	0.4131
Lighting18	4	12,015	(7,294)	(135)	4,587	0.3817
Lighting19	4	20,487	37,593	4,009	62,089	3.0306
Lighting20	4	47,801	4,534	(5,714)	46,621	0.9753
Lighting21	4	47,885	36,023	11,979	95,887	2.0025
Lighting22	4	59,241	57,950	(6,865)	110,326	1.8623
Lighting23	4	68,502	5,393	(3,314)	70,580	1.0303
Lighting24	4	80,191	66,496	8,104	154,792	1.9303
Lighting25	4	128,299	96,662	24,029	248,990	1.9407
Lighting26	4	138,219	(31,659)	13,482	120,041	0.8685
Lighting27	4	168,110	(77,501)	9,110	99,718	0.5932
Lighting28	4	316,247	(256,168)	7,719	67,798	0.2144
Lighting29	5	118,729	(63,795)	1,620	56,554	0.4763
Lighting30	5	165,479	(5,625)	23,297	183,152	1.1068
Lighting31	5	335,093	(7,143)	(18,844)	309,106	0.9224
Lighting32	5	353,725	154,999	40,884	549,608	1.5538
Lighting33	5	510,813	255,376	50,397	816,586	1.5986
Lighting34	5	545,464	148,547	53,701	747,711	1.3708

Table 3-5 Company-Reported and Adjusted Summer Peak kW Savings – Lighting Sample

Sampled Projects	Sampling Stratum	Company-Reported kW Savings	Adjustment for Actual Installation Conditions	Adjustment of Interaction with Other Measures	Adjustment for Peak Coincidence	Adjusted kW Savings	Site-Specific kW Realization Rate
Lighting01	1	2.16	0.27	0.41	(0.19)	2.65	1.2271
Lighting02	1	2.73	0.33	0.40	0.48	3.94	1.4436
Lighting03	1	2.61	(0.85)	0.13	(0.26)	1.63	0.6261
Lighting04	1	4.65	(2.96)	(0.05)	0.39	2.02	0.4349
Lighting05	1	5.95	0.04	1.00	5.85	12.83	2.1570
Lighting06	1	13.66	(8.98)	(0.04)	(2.96)	1.69	0.1236
Lighting07	2	9.24	(7.46)	(0.01)	0.12	1.89	0.2045
Lighting08	2	16.85	7.60	2.05	(2.91)	23.59	1.3997
Lighting09	2	22.06	(13.85)	(0.19)	8.14	16.15	0.7320
Lighting10	2	35.37	0.39	3.93	16.16	55.85	1.5789
Lighting11	2	46.51	25.86	6.21	(0.76)	77.82	1.6734
Lighting12	2	46.09	(5.75)	3.10	(0.08)	43.36	0.9408
Lighting13	2	68.64	(68.64)	-	-	-	0.0000
Lighting14	2	58.05	10.43	5.31	3.60	77.40	1.3333
Lighting15	3	66.61	(17.84)	5.19	32.36	86.32	1.2958
Lighting16	3	114.74	52.17	18.05	43.21	228.17	1.9885
Lighting17	3	53.47	(31.30)	(0.08)	0.78	22.87	0.4276
Lighting18	4	3.95	(2.40)	(0.04)	0.14	1.65	0.4177
Lighting19	4	4.68	8.59	0.92	(14.18)	0.00	0.0003
Lighting20	4	14.21	1.35	(1.70)	(13.83)	0.03	0.0019
Lighting21	4	10.95	8.24	2.74	(21.93)	-	0.0000
Lighting22	4	12.83	12.55	(1.49)	(23.87)	0.03	0.0021
Lighting23	4	17.50	1.38	(0.85)	(13.12)	4.91	0.2804
Lighting24	4	10.50	8.71	1.06	(3.39)	16.88	1.6071
Lighting25	4	42.00	31.64	7.87	(81.51)	-	0.0000
Lighting26	4	23.33	(5.34)	2.28	(20.26)	-	0.0000
Lighting27	4	32.55	(15.01)	1.76	(6.29)	13.02	0.4000
Lighting28	4	28.98	(23.47)	0.71	4.53	10.74	0.3708
Lighting29	5	14.52	(7.80)	0.20	(1.57)	5.34	0.3680
Lighting30	5	47.26	(1.61)	6.65	1.46	53.76	1.1376
Lighting31	5	122.24	(2.61)	(6.87)	28.93	141.69	1.1591
Lighting32	5	109.06	47.79	12.61	(169.45)	-	0.0000
Lighting33	5	207.30	103.64	20.45	(331.39)	-	0.0000
Lighting34	5	79.04	21.53	7.78	(108.35)	-	0.0000

Table 3-6 Company-Reported and Adjusted Winter Peak kW Savings – Lighting Sample

Sampled Projects	Sampling Stratum	Company-Reported kW Savings	Adjustment for Actual Installation Conditions	Adjustment for Interaction with Other Measures	Adjustment for Peak Coincidence	Adjusted kW Savings	Site-Specific kW Realization Rate
Lighting01	1	1.39	0.18	0.26	(0.11)	1.71	1.2327
Lighting02	1	1.90	0.23	0.28	(0.50)	1.91	1.0035
Lighting03	1	2.16	(0.70)	0.11	(0.69)	0.88	0.4046
Lighting04	1	3.33	(2.12)	(0.04)	(0.37)	0.80	0.2402
Lighting05	1	3.99	0.02	0.67	1.46	6.14	1.5401
Lighting06	1	10.28	(6.76)	(0.03)	6.93	10.43	1.0139
Lighting07	2	-	-	-	0.60	0.60	N/A
Lighting08	2	11.99	5.41	1.46	(4.69)	14.16	1.1810
Lighting09	2	14.16	(8.89)	(0.13)	(5.06)	0.08	0.0054
Lighting10	2	21.01	0.23	2.33	(9.90)	13.68	0.6510
Lighting11	2	36.54	20.32	4.88	(1.20)	60.54	1.6569
Lighting12	2	39.03	(4.87)	2.63	0.36	37.15	0.9518
Lighting13	2	53.93	(53.93)	-	-	-	0.0000
Lighting14	2	51.66	9.28	4.73	(3.58)	62.10	1.2020
Lighting15	3	33.48	(8.97)	2.61	(27.12)	-	0.0000
Lighting16	3	73.87	33.59	11.62	(119.08)	-	0.0000
Lighting17	3	-	-	-	6.93	6.93	N/A
Lighting18	4	3.25	(1.97)	(0.04)	(1.29)	(0.05)	-0.0141
Lighting19	4	3.85	7.06	0.75	5.24	16.91	4.3927
Lighting20	4	10.07	0.96	(1.20)	(4.85)	4.98	0.4941
Lighting21	4	9.02	6.79	2.26	5.19	23.25	2.5780
Lighting22	4	10.56	10.33	(1.22)	(3.01)	16.66	1.5773
Lighting23	4	17.50	1.38	(0.85)	(3.46)	14.57	0.8326
Lighting24	4	10.50	8.71	1.06	11.90	32.17	3.0634
Lighting25	4	42.00	31.64	7.87	(62.17)	19.34	0.4605
Lighting26	4	23.33	(5.34)	2.28	(2.28)	17.99	0.7710
Lighting27	4	25.25	(11.64)	1.37	16.19	31.16	1.2342
Lighting28	4	23.76	(19.25)	0.58	8.84	13.93	0.5865
Lighting29	5	13.66	(7.34)	0.19	(0.58)	5.92	0.4337
Lighting30	5	-	-	-	29.28	29.28	N/A
Lighting31	5	108.19	(2.31)	(6.08)	(99.80)	-	0.0000
Lighting32	5	109.06	47.79	12.61	(169.45)	-	0.0000
Lighting33	5	207.30	103.64	20.45	(166.76)	164.63	0.7942
Lighting34	5	66.95	18.23	6.59	63.10	154.87	2.3132

Some other observations from the Lighting analysis are listed below.

- **kWh and kW Savings**
  - Global determined the adjusted gross kWh savings to be higher than the Company-reported savings for 18 projects and lower for 16 projects.
  - Global determined the adjusted gross summer peak kW savings to be higher than the Company-reported for 12 projects and lower for 22 projects.

- **Discrepancies in project files**
  - Though the majority of files had lighting inventories, five project files did not (Lighting03, Lighting15, Lighting25, Lighting28, and Lighting30). Global worked with on-site staff to develop representative inventories for these sites. The energy realization rates for these sites range from 21% to 194%.
  - For 10 project files, the lighting savings reported in the project files did not match the claimed savings in the Company's tracking spreadsheet. For one of these, the difference was due to a typo (Lighting28). The claimed savings should have been much lower. The error was due to reporting 292,290 kWh for occupancy sensor savings instead of 29,229 kWh. When combined with the savings due to efficient lighting, the result was 53,186 kWh instead of the Company-reported 316,247 kWh. The correctly reported savings would have resulted in a much better match with Global's estimates. For another (Lighting13), the project documentation in the program files clearly indicates that the lighting did not qualify for the program, and therefore did not receive an incentive, because the installed Watt/sq ft value is higher than the compliance level. Nonetheless savings were mistakenly claimed (275,879 kWh should have been 0). For another (Lighting17), only the occupancy sensors qualified for and received an incentive, while the lights themselves did not; but the Company-reported savings counted both the lights and occupancy sensors. Without the lights, the Company-reported savings would have been very close to Global's independent estimate. For several other sites, there were no lighting savings indicated in the project "paper" files, so a comparison could not be made between the project files and the Company-reported savings in the tracking spreadsheet.
  - For four sites, the observed lighting was notably different than reported – two with different quantity (Lighting18 and Lighting22), one with different type (Lighting04), and one with different type and quantity (Lighting07). The range of realization rates for these sites is 19% to 186%.
- **HVAC adjustments**
  - The Companies appear to have used an HVAC adjustment in their savings estimates, at least some of the time. However, the adjustment was only clearly delineated in four of the project files. For two of these cases, Global was given the Company's lighting calculation spreadsheet (Lighting04 and Lighting05); for the other two, the interaction adjustment was listed as a line item without further elaboration in the project's paper file (Lighting13 and Lighting17).
  - The Companies' interaction factors were observed to range from 0.1343-0.1558 (for both energy and peak demand savings) for the sites with adjustments reported.
  - Calculation of the summer peak demand adjustment for two sites was not consistent with the PSD.
  - For customers with gas heat, the HVAC adjustment will be positive, since the lower heat output of the more efficient lighting reduces cooling load only, and has little effect on winter load. However, for those facilities that are all electric, there is an increase in electricity used for heat resulting from the lower heat output of the more efficient lighting. For all-electric facilities, this winter interaction increase is usually greater than the summer decrease, so the overall interaction effect reduces the savings from the Lighting program. Global identified the heating fuel for each Lighting program participant, and incorporated that into the calculation of the interaction effect.
  - Since the interaction adjustments in the Company-reported savings could not be verified for all sites, Global did not separate the Companies' interaction adjustment from their reported savings in Table 3-4 through Table 3-6. But, as the tables indicate, Global did separate its own Adjustment of Interaction with Other Measures from its Adjustment for Actual Installed Conditions.

3.3.3 Heating

The Heating sites included in the sample range from schools to health care centers to churches. The majority of heating equipment falls into four categories: 1) high efficiency motors on hot water pumps and ventilation fans; 2) VFDs on hot water pumps; 3) heat pumps in the heating mode; and 4) CO_2 controlled ventilation.

Table 3-7 through Table 3-9 present the adjusted gross impact results for the representative sample of Heating measures in terms of annual kWh, peak summer kW, and peak winter kW, respectively. To summarize:

- Adjusted gross annual kWh savings range from 271 to 181,924.
- Adjusted gross summer peak kW savings range from .07 to 104.28.
- Adjusted gross winter peak kW savings range from 0 to 21.26.
- Energy site-specific realization rates range from 25% to 417%.

The large range in energy site-specific realization rates across Heating sites (25% to 417%) is attributable to many factors unique to each project. Since Global did not observe any discrepancies between the heating equipment types and efficiencies installed and the equipment described in the program documentation, Global speculates that the main factor affecting the realization rate for the majority of sites is a difference in the assumptions and methodologies used in the Company-reported estimates of operational patterns and the operating patterns observed during site visits and subsequently incorporated in Global's DOE-2 simulation model.

For example, for the three projects with the lowest energy realization rates – Heating03 (25%), Heating04 (34%) and Heating05 (27%) – the adjusted savings are much lower than the values calculated using the PSD method, because the metered data collected at these sites revealed considerably lower annual hours of operation than the PSD uses. All of these are heat pump measures.

For the two projects with very high energy realization rates – Heating20 (417%) and Heating26 (402%) – it is difficult to explain why the figures are so high, because the project files do not specify how the Company calculated its reported savings. However, comparing the adjusted gross annual kWh savings to the savings derived using the method recommended in the PSD, the adjusted gross annual kWh savings come very close to those derived using the PSD method. It is possible that the Company assumed a much lower number of operating hours than Global observed in the field and used in the adjusted savings analysis, and much lower operating hours than assumed in the PSD. The measure for Heating20 consists of VFDs on hot water pumps and the measure for Heating26 is comprised of high efficiency motors on hot water pumps and VFDs.

The low-end of 0 kW for adjusted gross summer peak kW savings is consistent with the Company-reported results. However, Company-reported results show that only one of the heating measures in the sample (Heating09, which is the only CO_2 controlled ventilation measure in the heating sample) has a non-zero summer peak kW savings value, while Global's adjusted gross savings estimates show 16 projects with non-zero summer peak savings because of adjustments for peak coincidence.

Similarly, the low-end of 0 kW for adjusted gross winter peak kW savings is consistent with the Company-reported results. However, Global found that 11 projects had 0 kW adjusted winter peak kW savings, while Company-reported results showed six projects with 0 kW for winter peak savings.

Table 3-7 Company-Reported and Adjusted Annual kWh Savings – Heating Sample

Sampled Projects	Sampling Stratum	Company-Reported Annual kWh Savings	Adjustment for Actual Installed Conditions	Adjusted Annual kWh Savings	Site-Specific kWh Realization Rate
Heating01	1	293	91	384	1.3121
Heating02	1	721	133	854	1.1850
Heating03	1	1,084	(813)	271	0.2501
Heating04	1	1,279	(844)	435	0.3397
Heating05	1	1,750	(1,274)	476	0.2718
Heating06	1	19,067	5,015	24,082	1.2630
Heating07	1	25,147	(10,239)	14,908	0.5928
Heating08	1	46,383	5,033	51,416	1.1085
Heating09	3	101,933	(114)	101,819	0.9989
Heating10	3	102,890	23,330	126,220	1.2267
Heating11	4	383	203	586	1.5291
Heating12	4	776	244	1,020	1.3140
Heating13	4	1,017	206	1,223	1.2024
Heating14	4	5,252	7,015	12,267	2.3356
Heating15	4	6,950	14,906	21,856	3.1447
Heating16	4	19,306	8,883	28,189	1.4601
Heating17	4	20,908	(9,825)	11,083	0.5301
Heating18	4	23,052	(13,339)	9,713	0.4214
Heating19	4	25,987	(170)	25,817	0.9935
Heating20	4	33,146	105,017	138,163	4.1683
Heating21	4	37,315	(5,935)	31,380	0.8410
Heating22	4	51,413	16,937	68,350	1.3294
Heating23	4	52,745	(1,205)	51,540	0.9772
Heating24	4	55,277	24,884	80,161	1.4502
Heating25	5	12,091	(574)	11,517	0.9526
Heating26	5	23,196	70,023	93,219	4.0188
Heating27	5	100,586	38,509	139,095	1.3829
Heating28	5	135,194	46,730	181,924	1.3457

Table 3-8 Company-Reported and Adjusted Summer Peak kW Savings – Heating Sample

Sampled Projects	Sampling Stratum	Company-Reported kW Savings	Adjustment for Actual Installation Conditions	Adjustment for Peak Coincidence	Adjusted kW Savings	Site-Specific kW Realization Rate
Heating01	1	-	-	0.07	0.07	N/A
Heating02	1	-	-	-	-	N/A
Heating03	1	-	-	-	-	N/A
Heating04	1	-	-	-	-	N/A
Heating05	1	-	-	-	-	N/A
Heating06	1	-	-	3.25	3.25	N/A
Heating07	1	-	-	-	-	N/A
Heating08	1	-	-	0.61	0.61	N/A
Heating09	3	328.89	(0.37)	(224.24)	104.28	0.3171
Heating10	3	-	-	9.84	9.84	N/A
Heating11	4	-	-	0.04	0.04	N/A
Heating12	4	-	-	-	-	N/A
Heating13	4	-	-	0.09	0.09	N/A
Heating14	4	-	-	3.69	3.69	N/A
Heating15	4	-	-	-	-	N/A
Heating16	4	-	-	0.15	0.15	N/A
Heating17	4	-	-	-	-	N/A
Heating18	4	-	-	-	-	N/A
Heating19	4	-	-	0.39	0.39	N/A
Heating20	4	-	-	-	-	N/A
Heating21	4	-	-	-	-	N/A
Heating22	4	-	-	0.84	0.84	N/A
Heating23	4	-	-	0.89	0.89	N/A
Heating24	4	-	-	2.37	2.37	N/A
Heating25	5	-	-	-	-	N/A
Heating26	5	-	-	0.16	0.16	N/A
Heating27	5	-	-	0.21	0.21	N/A
Heating28	5	-	-	0.06	0.06	N/A

Table 3-9 Company-Reported and Adjusted Winter Peak kW Savings – Heating Sample

Sampled Projects	Sampling Stratum	Company-Reported kW Savings	Adjustment for Actual Installation Conditions	Adjustment for Peak Coincidence	Adjusted kW Savings	Site-Specific kW Realization Rate
Heating01	1	0.13	0.04	(0.05)	0.12	0.9177
Heating02	1	-	-	0.37	0.37	N/A
Heating03	1	-	-	-	-	N/A
Heating04	1	-	-	-	-	N/A
Heating05	1	-	-	-	-	N/A
Heating06	1	1.37	0.36	1.29	3.02	2.2080
Heating07	1	1.81	(0.74)	1.02	2.10	1.1584
Heating08	1	3.54	0.38	4.90	8.83	2.4933
Heating09	3	-	-	-	-	N/A
Heating10	3	7.72	1.75	(9.47)	0	0.0000
Heating11	4	0.23	0.12	(0.23)	0.12	0.5209
Heating12	4	0.12	0.04	(0.16)	0	0.0000
Heating13	4	0.17	0.03	0.04	0.25	1.4585
Heating14	4	1.68	2.24	(3.92)	0	0.0000
Heating15	4	1.37	2.94	(0.93)	3.38	2.4655
Heating16	4	1.48	0.68	2.49	4.65	3.1401
Heating17	4	13.73	(6.45)	5.27	12.55	0.9137
Heating18	4	11.55	(6.68)	(4.87)	0	0.0000
Heating19	4	1.95	(0.01)	(1.94)	0	0.0000
Heating20	4	7.00	22.18	(8.06)	21.12	3.0174
Heating21	4	2.68	(0.43)	2.54	4.79	1.7879
Heating22	4	3.85	1.27	(5.12)	0	0.0000
Heating23	4	4.04	(0.09)	6.28	10.23	2.5316
Heating24	4	5.02	2.26	5.38	12.66	2.5220
Heating25	5	1.00	(0.05)	(0.95)	0	0.0000
Heating26	5	0.08	0.24	0.01	0.33	4.1214
Heating27	5	7.44	2.85	10.97	21.26	2.8575
Heating28	5	-	-	1.16	1.16	N/A

3.3.4 Process

The Process sites in the sample varied from a packaging plant to an athletic complex to a high securing equipment testing facility. The process measures were site-specific, but the majority of sites (12 of the 19 sites) installed new air compressors through the ECB program. The other sites installed new air dryers (for the compressed air), new VFDs on process equipment, new process chillers, and meters to control exhaust fans.

Table 3-10 through Table 3-12 present the adjusted gross impact results for the representative sample of Process measures in terms of annual kWh, peak summer kW, and peak winter kW, respectively. Key findings are as follows:

- Adjusted gross annual kWh savings range from 7,232 to 2,633,770.
- Adjusted gross summer peak kW savings range from 0 to 1,254.00.
- Adjusted gross winter peak kW savings range from 0 to 138.12.
- Energy site-specific realization rates range from 64% to 161%.

In general, adjusted savings for the Process measures are close to those developed by the Companies. When provided, the methodologies in the Companies' documentation were found to be sound. Most discrepancies in savings results are associated with slight differences in approach or operating hours, which are to be expected in any energy analysis. The Companies used an approach that meets the generic criteria set forth in the PSD; more importantly, their approach was consistent from project to project.

Some of the low energy realization rates were for Process01 (64%) and Process05 (77%). In these cases, the energy usage patterns from data logging show lower usage than what was assumed in calculations of Company-reported savings.

Two observations are noted for projects with high energy realization rates. For Process04 (141%), data logging shows that the new cycling dryer cycles off far more often than what was assumed in the Company-reported savings, as compared with the non-cycling baseline dryer, resulting in greater annual savings. Similarly, for Process15 (161%), a variable-speed air compressor, the metering data show that the unit operates for about the same number of hours noted in the project file, but more often at a lower load tier than assumed, so the adjusted gross annual kWh savings is much higher than the Company-reported savings.

Table 3-10 Company-Reported and Adjusted Annual kWh Savings – Process Sample

Sampled Projects	Sampling Stratum	Company-Reported Annual kWh Savings	Adjustment for Actual Installed Conditions	Adjusted Annual kWh Savings	Site-Specific kWh Realization Rate
Process01	1	11,273	(4,041)	7,232	0.6415
Process02	1	25,391	(4,151)	21,240	0.8365
Process03	1	31,738	(376)	31,362	0.9881
Process04	2	55,462	22,480	77,942	1.4053
Process05	2	59,283	(13,376)	45,907	0.7744
Process06	2	60,447	(5,071)	55,376	0.9161
Process07	2	80,257	(13,171)	67,086	0.8359
Process08	2	92,903	(4,009)	88,894	0.9568
Process09	2	98,731	8,825	107,556	1.0894
Process10	2	100,024	(11,917)	88,107	0.8809
Process11	2	112,185	5,858	118,043	1.0522
Process12	2	156,040	3,666	159,706	1.0235
Process13	2	165,326	26,108	191,434	1.1579
Process14	2	171,834	1,667	173,501	1.0097
Process15	2	234,030	142,964	376,994	1.6109
Process16	2	290,755	50,417	341,172	1.1734
Process17	2	325,651	158,533	484,184	1.4868
Process18	3	1,426,420	421,165	1,847,585	1.2953
Process19	3	2,627,233	6,537	2,633,770	1.0025

Table 3-11 Company-Reported and Adjusted Summer Peak kW Savings – Process Sample

Sampled Projects	Sampling Stratum	Company-Reported kW Savings	Adjustment for Actual Installation Conditions	Adjustment for Peak Coincidence	Adjusted kW Savings	Site-Specific kW Realization Rate
Process01	1	(0.35)	0.13	3.12	2.89	-8.2638
Process02	1	1.73	(0.28)	3.83	5.28	3.0533
Process03	1	3.36	(0.04)	9.73	13.05	3.8834
Process04	2	1.97	0.80	5.59	8.36	4.2429
Process05	2	8.19	(1.85)	7.78	14.12	1.7242
Process06	2	0.54	(0.05)	3.09	3.58	6.6311
Process07	2	7.00	(1.15)	3.69	9.54	1.3624
Process08	2	1.00	(0.04)	(0.96)	0	0.0000
Process09	2	13.16	1.18	2.25	16.59	1.2605
Process10	2	4.75	(0.57)	4.52	8.70	1.8316
Process11	2	13.10	0.68	4.44	18.22	1.3910
Process12	2	23.26	0.55	(1.73)	22.08	0.9492
Process13	2	26.70	4.22	(6.65)	24.27	0.9089
Process14	2	2.20	0.02	22.54	24.76	11.2547
Process15	2	26.80	16.37	(6.48)	36.69	1.3690
Process16	2	60.10	10.42	(19.86)	50.67	0.8430
Process17	2	66.33	32.29	(98.61)	0	0.0000
Process18	3	404.00	119.29	(308.44)	214.85	0.5318
Process19	3	0	0	1,254.00	1,254.00	N/A

Table 3-12 Company-Reported and Adjusted Winter Peak kW Savings – Process Sample

Sampled Projects	Sampling Stratum	Company-Reported kW Savings	Adjustment for Actual Installation Conditions	Adjustment for Peak Coincidence	Adjusted kW Savings	Site-Specific kW Realization Rate
Process01	1	(0.35)	0.13	0.22	0	0.0000
Process02	1	1.73	(0.28)	1.16	2.61	1.5078
Process03	1	3.36	(0.04)	9.73	13.05	3.8834
Process04	2	1.97	0.80	3.87	6.64	3.3718
Process05	2	8.19	(1.85)	4.29	10.63	1.2983
Process06	2	0.54	(0.05)	0.10	0.60	1.1052
Process07	2	7.00	(1.15)	4.69	10.54	1.5059
Process08	2	1.00	(0.04)	(0.96)	0	0.0000
Process09	2	13.16	1.18	4.72	19.06	1.4481
Process10	2	4.75	(0.57)	4.52	8.70	1.8316
Process11	2	13.10	0.68	(4.67)	9.11	0.6955
Process12	2	23.26	0.55	(23.81)	-	0.0000
Process13	2	26.70	4.22	(7.42)	23.50	0.8801
Process14	2	2.20	0.02	13.22	15.44	7.0175
Process15	2	26.80	16.37	(15.12)	28.05	1.0465
Process16	2	60.10	10.42	(18.51)	52.01	0.8653
Process17	2	66.33	32.29	(15.94)	82.67	1.2465
Process18	3	404.00	119.29	(385.17)	138.12	0.3419
Process19	3	-	-	-	-	N/A

3.3.5 Other

The Other sites in the sample varied widely, from a wastewater treatment plant to educational facilities to a medical center. The Other measures also comprised a wide array of equipment types, such as EMSs, Energy Star transformers, energy efficient motors for pumps and fans, VFDs, and CO_2 controlled ventilation. Some of the measures applied to HVAC systems and, thus, were weather-sensitive. Others were process related. Due to the varied nature of the measures in the Other category, the category-level savings are less meaningful than for the other four measure categories; the savings estimates for Other were made primarily to enable the results for the whole program.

Table 3-13 through Table 3-15 present the adjusted gross impact results for the representative sample of Other measures in terms of annual kWh, peak summer kW, and peak winter kW, respectively. There are five sub-types of Other measures: Motors, VFDs, Refrigeration, EMS, and Other. To summarize:

- Adjusted gross annual kWh savings (excluding the zero savings site (Other09)) range from 2,377 [Motors] to 1,053,828 [Other].
- Adjusted gross summer peak kW savings (excluding site Other09) range from 0.59 [Motors] to 120.30 [Other].
- Adjusted gross winter peak kW savings (excluding site Other09) range from 0 [Other] to 120.30 [Other].
- Energy realization rates (excluding site Other09) range from 28% [VFD] to 1174% [VFD].
- Low energy realization rates:
    1. For Site Other09 (0%), the measure did not qualify for the program and was not paid any incentive, but savings were claimed in the program file. Global adjusted the savings to zero. Further investigation showed that this was an adjustment to installed measures of other types (lighting, heating), but was not documented in such a way as to allow for any independent review of the savings. For Other25 [VFD] (28%), it can be inferred that a mistake in the calculation of the Company-reported savings occurred since the reported savings for VFD measures is almost as large as the site's entire annual energy consumption (according to the billing data for the past 12 months).
- High energy realization rates:
    1. For Other01 [Motors] (732%), it is difficult to explain the discrepancy because the project files did not include specific information on how the Company calculated their reported savings. Adjustments result from analysis of metering data and equipment specifications found in the project files.
    2. Similarly for Other04 [VFD] (1174%), again it is difficult to explain the discrepancy because the project files did not include specific information on how the Company calculated their reported savings. The measure involved installing VFDs on chilled water and hot water pumps, plus VFDs on HVAC fans. Global suspects that the Company only included savings for the VFDs on the fans and not the VFDs on the pumps.
- Other issues: Other13 [Refrig] has a Company-reported annual kWh savings of 0, but annual kWh savings were found based on the analysis of metering data.

Global modeled the weather-sensitive Other measures using the DOE-2 based simulation tool. The weather-sensitive measures include energy efficient motors for HVAC fans and pumps, EMSs, and VFDs associated with HVAC systems. Global used engineering review to analyze the impacts of the non-weather sensitive Other measures.

Table 3-13 Company-Reported and Adjusted Annual kWh Savings – Other Sample

Sampled Projects	Sampling Stratum	Measure Category	Company-Reported Annual kWh Savings	Adjustment for Actual Installed Conditions	Adjusted Annual kWh Savings	Site-Specific kWh Realization Rate
Other01	1	Motors	353	2,230	2,583	7.3173
Other02	1	Motors	4,897	(491)	4,406	0.8997
Other03	1	Motors	5,067	164	5,231	1.0324
Other04	1	VFD	9,581	102,936	112,517	11.7438
Other05	2	Other	80,063	(1,708)	78,355	0.9787
Other06	2	EMS	91,029	2,825	93,854	1.0310
Other07	2	EMS	114,623	(6,644)	107,979	0.9420
Other08	2	EMS	131,718	(13,153)	118,565	0.9001
Other09	2	Other	216,896	(216,896)	0	0.0000
Other10	2	VFD	248,728	(10,334)	238,394	0.9585
Other11	2	Other	670,782	383,046	1,053,828	1.5710
Other12	3	Other	775,117	(328,075)	447,042	0.5767
Other13	4	Refrig	-	6,766	6,766	N/A
Other14	4	Other	6,157	16,479	22,636	3.6765
Other15	4	Motors	10,821	6,935	17,756	1.6409
Other16	4	Other	46,914	4,378	51,292	1.0933
Other17	5	Motors	2,029	348	2,377	1.1714
Other18	5	Motors	10,816	(4,544)	6,272	0.5799
Other19	5	Motors	19,230	(4,320)	14,910	0.7754
Other20	5	Motors	35,360	4,267	39,627	1.1207
Other21	5	Other	106,442	(9,501)	96,941	0.9107
Other22	5	Other	111,740	(65,831)	45,909	0.4109
Other23	5	Other	164,630	151,635	316,265	1.9211
Other24	5	Other	209,067	(31,243)	177,824	0.8506
Other25	5	VFD	610,310	(437,364)	172,946	0.2834

Table 3-14 Company-Reported and Adjusted Summer Peak kW Savings – Other Sample

Sampled Projects	Sampling Stratum	Measure Category	Company-Reported kW Savings	Adjustment for Actual Installation Conditions	Adjustment for Peak Coincidence	Adjusted kW Savings	Site-Specific kW Realization Rate
Other01	1	Motors	0.09	0.56	0.05	0.70	7.9320
Other02	1	Motors	0.56	(0.06)	0.10	0.60	1.0790
Other03	1	Motors	0.47	0.02	1.10	1.59	3.3461
Other04	1	VFD	0.89	9.52	1.15	11.55	13.0384
Other05	2	Other	8.33	(0.18)	13.20	21.35	2.5627
Other06	2	EMS	5.00	0.16	(0.46)	4.70	0.9400
Other07	2	EMS	7.50	(0.43)	(1.70)	5.37	0.7156
Other08	2	EMS	1.00	(0.10)	17.27	18.17	18.1667
Other09	2	Other	10.27	(10.27)	-	0	0.0000
Other10	2	VFD	4.03	(0.17)	5.81	9.67	2.4011
Other11	2	Other	44.49	25.41	50.40	120.30	2.7040
Other12	3	Other	30.21	(12.79)	35.61	53.03	1.7554
Other13	4	Refrig	0.06	0.63	-	0.69	11.5351
Other14	4	Other	0.90	2.41	(2.07)	1.23	1.3714
Other15	4	Motors	-	-	4.65	4.65	N/A
Other16	4	Other	60.95	5.69	(50.36)	16.28	0.2671
Other17	5	Motors	0.78	0.13	(0.32)	0.59	0.7552
Other18	5	Motors	3.39	(1.42)	1.35	3.31	0.9782
Other19	5	Motors	7.40	(1.66)	(4.10)	1.64	0.2218
Other20	5	Motors	13.70	1.65	(4.21)	11.14	0.8134
Other21	5	Other	13.20	(1.18)	(2.17)	9.85	0.7464
Other22	5	Other	153.07	(90.18)	(46.20)	16.69	0.1090
Other23	5	Other	74.06	68.21	(89.70)	52.57	0.7099
Other24	5	Other	26.28	(3.93)	3.24	25.59	0.9737
Other25	5	VFD	22.66	(16.24)	27.39	33.81	1.4923

Table 3-15 Company-Reported and Adjusted Winter Peak kW Savings – Other Sample

Sampled Projects	Sampling Stratum	Measure Category	Company-Reported kW Savings	Adjustment for Actual Installation Conditions	Adjustment for Peak Coincidence	Adjusted kW Savings	Site-Specific kW Realization Rate
Other01	1	Motors	0.09	0.56	0.05	0.70	7.9320
Other02	1	Motors	0.56	(0.06)	(0.04)	0.46	0.8231
Other03	1	Motors	-	-	0.57	0.57	N/A
Other04	1	VFD	0.72	7.79	5.89	14.40	19.8677
Other05	2	Other	8.33	(0.18)	14.05	22.20	2.6651
Other06	2	EMS	5.00	0.16	4.64	9.80	1.9600
Other07	2	EMS	7.50	(0.43)	4.13	11.20	1.4933
Other08	2	EMS	1.00	(0.10)	14.36	15.26	15.2571
Other09	2	Other	17.40	(17.40)	-	0	0.0000
Other10	2	VFD	-	-	32.32	32.32	N/A
Other11	2	Other	-	-	120.30	120.30	N/A
Other12	3	Other	30.21	(12.79)	33.74	51.17	1.6936
Other13	4	Refrig	-	0.39	-	0.39	N/A
Other14	4	Other	4.18	11.19	(9.94)	5.43	1.2983
Other15	4	Motors	-	-	5.05	5.05	N/A
Other16	4	Other	69.27	6.46	(75.73)	0	0.0000
Other17	5	Motors	0.78	0.13	(0.18)	0.73	0.9366
Other18	5	Motors	-	-	-	-	N/A
Other19	5	Motors	7.40	(1.66)	(4.02)	1.72	0.2327
Other20	5	Motors	13.70	1.65	(3.46)	11.89	0.8681
Other21	5	Other	13.20	(1.18)	(2.30)	9.73	0.7368
Other22	5	Other	-	-	-	-	N/A
Other23	5	Other	66.51	61.26	(99.67)	28.10	0.4224
Other24	5	Other	19.08	(2.85)	(5.15)	11.08	0.5808
Other25	5	VFD	-	-	-	-	N/A

Developing impact estimates for the non-weather sensitive Other measures represented the greatest challenge to Global's modelers. For a variety of reasons, many of these measures lacked sufficient documentation and data to develop estimates with a high level of confidence. The challenges encountered during the analysis of the Other measures can best be shown by an example.

Three of the ten Other measures (including Other21, Other23, and Other24) were new Energy Star transformers. There is no doubt that Energy Star transformers reduce overall power consumption by reducing transformer losses – and there can be hundreds of these devices in any given facility. However, the loss profile is largely a function of the transformer loading (i.e. how closely it operates to its capacity). In order to more accurately determine energy savings, transformer loadings must be measured for long periods (ideally, up to one year or more). This length of measurement was not within the scope of this effort; but, without this information, the actual energy savings are difficult to estimate. To circumvent this problem, Global assumed an average loading for the transformers of 25 to 30 percent (based on anecdotal information observed in the field by a variety of experts) to develop savings estimates. Yet, it should be noted that actual savings could differ by 30 to 60 percent or higher, depending on specific equipment installed and the amount of work done by the transformers.

Similarly, other files lacked important information to develop estimates. For instance, two of the sites (Other11 and Other12) included new pump motors, but the site visit staff were unable to determine their function (and thus operation), even with support from facility staff, because personnel changes had occurred since installation of the motors. So, Global made some educated guesses to develop appropriate baseline and new energy consumption estimates.

A few of the sites could be assessed with more accuracy. For example, two sites had new premium efficiency motors (Other01 and Other19), the efficiency gains for which can be readily estimated by taking the efficiency gain (over NEMA efficiency values) and multiplying by the motor horsepower and hours of use per year. This approach was used to develop reasonable estimates of savings from the premium efficiency motors. In these cases, specific motor loads (i.e. number of yearly hours of operation) were assumed based on the motor use.

Without more complete information on both the baseline information and the new measure, it is very challenging to develop estimates. The majority of the non-weather sensitive Other measures evaluated here were prescriptive; oftentimes in many rebate programs, rebates and savings associated with prescriptive measures are assumed based on studies of industry averages. Presumably, no additional information was required by the Companies as part of the rebate process.

3.4 ADJUSTED GROSS IMPACTS FOR THE PROGRAM

3.4.1 Program-Level Savings Estimates

Once the savings, seasonal peak demands, and load shapes were calculated for each sample point, these results were expanded to estimate the savings, seasonal peak demands, and load shapes for the PY 2009 program population. This was done by first calculating the average by stratum and measure type, and then by combining the stratum averages using weights that reflect the number of customers in each stratum in the population. Both the Company-reported savings and the adjusted gross savings estimates were calculated for the sample. The ratio of these two estimates was calculated as an estimate of the realization rate for savings. This ratio was then applied to the total Company-reported savings to provide a more precise estimate of the adjusted savings. The same estimation approach was used for the energy savings, the seasonal demand savings, and the load shapes.

Table 3-16 through Table 3-18 report the population-level adjusted gross savings estimated using the sample-site measurements for annual kWh, peak summer kW, and peak winter kW respectively. The results are based on the Company-reported and adjusted savings estimates calculated on the sample of projects, expanded to the population. The rates compare the savings estimated by Global using analysis of metered data with those reported by the Companies in the tracking databases, extrapolated to the full population of projects completed in 2009 as reported in the databases.

Table 3-16 Realization Rates and Adjusted Program Savings Compared to Company-Reported Savings (Annual kWh)

Major Measure Group	Company-Reported Annual Savings	Adjusted Gross Annual Savings	kWh Realization Rate
Cooling	11,874,541	9,096,355	77%
Lighting	12,309,286	12,004,169	98%
Heating	1,468,142	1,967,388	134%
Process	10,535,533	11,655,316	112%
Other	10,816,937	12,792,813	118%
Total	**47,004,439**	**47,516,042**	**101%**

Table 3-17 Realization Rates and Adjusted Program Savings Compared to Company-Reported Savings (Summer Peak kW)

Major Measure Group	Company-Reported Summer Peak Savings	Adjusted Gross Summer Peak Savings	Summer Peak kW Realization Rate
Cooling	3,625.58	2,589.06	72%
Lighting	2,488.84	1,798.12	72%
Heating	329.90	164.48	50%
Process	1,234.54	2,404.47	199%
Other	1,818.20	1,622.05	89%
Total	**9,497.06**	**8,578.19**	**91%**

Table 3-18 Realization Rates and Adjusted Program Savings Compared to Company-Reported Savings (Winter Peak kW)

Major Measure Group	Company-Reported Winter Peak Savings	Adjusted Gross Winter Peak Savings	Winter Peak kW Realization Rate
Cooling	278.71	655.54	235%
Lighting	1,904.09	1,655.25	87%
Heating	119.02	200.79	169%
Process	1,129.78	1,165.98	106%
Other	1,317.34	1,516.43	115%
Total	**4,748.92**	**5,194.00**	**110%**

The Company-reported annual savings include savings for all customers that participated in Program Year 2009 for each measure. Global made one modification to the measures, reclassifying one site that was confirmed during the on-site visit to be a Process project, but had been listed as a Cooling measure in the Company tracking database. For this reason, as shown in Table 3-16, the Company-reported annual savings in Cooling and Process do not match the original totals for Cooling and Process savings as reported by the Companies.

The Company-reported savings includes savings for 4 sites at which measures were installed and verified but are currently unoccupied. The adjusted gross savings includes these savings set to 0, since the unoccupied buildings do not have program-related savings. However, these zero values were not included in the calculation of the kWh realization rate because they do not reflect mis-estimation of the project savings; the program savings are lower than anticipated, but the loss is in no way systemic. The same exclusions apply to the seasonal demand results in Table 3-17 and Table 3-18. In order to more appropriately reflect the nature of the relationship between the Company-reported savings and the adjusted gross savings, the realization rates are calculated based on only those facilities that are occupied and in business.

Key impact analysis findings are as follows:

- The overall annual kWh savings realization rate across all measures is 101%.
- The overall summer peak kW savings realization rate across all measures is 91%.
- The overall winter peak kW savings realization rate across all measures is 110%.

3.4.2 Achieved Precision of the Sample

As with any statistical study, the sample for this evaluation study was designed to achieve a target level of precision based on the best information available during the planning and design phase. The target precision for kWh savings was a 10% error with 80% confidence (80/10) for Lighting and Cooling, 12% error with 80% confidence for Process, and 18% error with 80% confidence for Heating. There was no separate target precision for the Other group, except that as part of the program as a whole, it contributed to the total program precision. The target precision for the total program was 10% error at 90% confidence (90/10). Target precision levels were not set for seasonal demands. Now that Global has collected data, the achieved precision of the estimates can be calculated. The achieved precision for the adjusted savings estimates are shown in Table 3-19 below. The achieved precision by major measure groups are reported at the 80% confidence level. Even though the initial goal was to achieve a 10% error at 90% confidence to the total program, the precision here is reported at 80% confidence to be consistent with ISO-NE reporting requirements. Though not shown in the table, the 90% confidence level precision for the total program for energy savings was 9.3%.

Table 3-19 Achieved Precision of the Savings Estimates

Major Measure Group	Confidence Level for Precision	Adjusted Annual kWh Savings Relative Precision	Adjusted Summer Peak kW Savings Relative Precision	Adjusted Winter Peak kW Savings Relative Precision
Cooling	80%	6.8%	13.1%	20.2%
Lighting	80%	12.9%	19.1%	14.9%
Heating	80%	7.3%	9.0%	14.6%
Process	80%	4.7%	10.9%	28.5%
Other	80%	23.1%	20.5%	25.5%
Total Program	**80%**	**7.3%**	**7.5%**	**11.2%**

The target precision levels were met and surpassed for kWh savings for Cooling, Heating, and Process, but not for Lighting, which had 12.9% error instead of the target 10% error. The greater error for Lighting is driven primarily by the lower-than-expected statistical correlation between the Company-reported savings and the adjusted savings. This lower correlation is caused by the widely varying site-specific realization rates, which, as discussed with the lighting results above, are driven primarily by differences in operating characteristics.

As is typical, the precision of the seasonal demand estimates was not as good as the precision of the kWh savings estimates. This is because demand is more variable than energy, because of lower correlation between Company-reported savings and adjusted savings, and because the sample was stratified based on the tracking system energy savings not demand savings.

The precision for the kWh savings for the total program is 7.3% at 80% confidence, which corresponds to 9.3% error at 90% confidence, which is slightly more precise than the target of 90/10. The precision for the total program summer peak savings of 7.5% at 80% confidence is nearly as good as the precision for energy. While the precision level for the total program winter demand savings is not quite as good, at 11.2% at 80% confidence, this is still remarkably good, given the normal difficulty with estimating seasonal demand savings, driven by the higher variability of hourly demand, which is consistent with results obtained in similar studies.

3.5 NET PROGRAM IMPACTS

This impact evaluation focused on assessing the savings actually achieved by customers whose projects conducted under the program and which were completed in 2009, rather than on attribution of customer actions and savings. Another study, however, focused on the attribution issue. PA Associates estimated the extent to which ECB program participants would likely have installed the efficient measures even without the presence of the program, and also additional similar measures they take, without program incentives, as a result of their participation. Global was asked to rely on the PA study in lieu of making an independent estimate of free-ridership and spillover.

Drawing on this study, Global has applied two attribution factors to the adjusted gross impacts estimated in this evaluation.[1] The results are presented in Table 3-20. The attribution factors are defined by the study author, PA Consulting, as follows:

- **Free-Ridership Rate:** This is "the percentage of program participants deemed to be free riders. A free rider refers to a customer who received an incentive through an energy efficiency program who would have installed the same or a smaller quantity of the same high efficiency measure on their own within one year if the program had not been offered. For free riders, the program is assumed to have had no influence or only a slight influence on their equipment purchase decision. Consequently, none or only some of the energy savings of equipment purchased by this group of customers should be credited to the energy efficiency program."[2]
- **Spillover Rate:** This is the percent of "additional energy-efficient equipment installed by a customer due to program influences but without any financial or technical assistance from the program."[3] The authors estimated what they refer to as participant "like spillover" which focuses on "the situation where a customer installed equipment through the program in the past year and then installed additional equipment of the same type due to program influences. In contrast to free-ridership, spillover adds benefits to the program at no additional cost, increasing the program benefits and benefit-cost ratio."

The free-ridership and spillover rates were combined to create net-to-gross (NTG) rates that reflect the percent of gross savings that are attributable to, i.e., motivated by, the presence of the program. For this evaluation, the net attribution rates were calculated as follows:

NTG rate = 100% - (Free-ridership rate) + (Spillover rate)

The NTG rates were applied to the adjusted gross savings (annual kWh) to develop the adjusted net program impacts shown in the table. The adjusted gross savings themselves already account for adjustments captured in the gross realization rate. That rate reflects the percentage of savings achieved or realized by the participants in the program, regardless of their reasons they installed their measures. Those savings are labeled "gross" to distinguish them from net savings, which also reflect participants' motivation for the actions they took.

[1] "2007 Commercial and Industrial Programs Free-Ridership and Spillover Study: Executive Summaries," prepared by PA Consulting, October 28, 2008. Connecticut Light & Power: free-ridership (p. 7-2) and spillover (p. 7-5); United Illuminating Company free-ridership (p. 4-2) and spillover (p. 4-3).

[2] Op. cit., p. 1-2.

[3] Op. cit., p. 1-3.

Table 3-20 Net-to-Gross (NTG) Rates and Resulting Net Program Impacts

Major Measure Group	Adjusted Gross Savings (annual kWh)	Free-Ridership Rate	Spillover Rate	Combined NTG Rate	Adjusted Net Savings (annual kWh)
CL&P projects					
Cooling	7,228,438	16.6%	0.2%	84%	6,042,974
Lighting	9,089,133	24.3%	1.3%	77%	6,998,633
Heating	1,832,442	8.3%	4.1%	96%	1,755,480
Process	7,417,909	15.3%	4.4%	89%	6,609,357
Other					
Motors	819,245	42.1%	0.7%	59%	480,077
Refrigeration	150,001	7.3%	54.9%	148%	221,402
All other	2,203,760	55.2%	7.1%	52%	1,143,752
UI projects					
Cooling—Unitary	1,128,801	45.2%	0.0%	55%	618,583
Cooling—Other	739,117	46.7%	7.4%	61%	448,644
Lighting	2,915,036	36.8%	0.7%	64%	1,862,708
Heating	134,946	13.5%	24.7%	111%	150,060
Process	4,237,407	3.9%	34.8%	131%	5,546,766
Other					
Custom	7,690,024	3.9%	34.8%	131%	10,066,241
Motors	372,781	41.0%	0.0%	59%	219,941
VFDs	1,557,002	24.7%	0.0%	75%	1,172,422
Total	**47,516,042**	**-**	**-**	**-**	**43,337,039**

Source for net-to-gross ratios is "2007 Commercial and Industrial Programs Free-Ridership and Spillover Study: Executive Summaries" prepared by PA Consulting, October 28, 2008. Connecticut Light & Power: free-ridership (p. 7-2) and spillover (p. 7-5); United Illuminating Company free-ridership (p. 4-2) and spillover (p. 4-3).

Note: The free-ridership and spillover rates were estimated based on surveys conducted in 2007. Since that time, the categories used to group measure types has changed. In particular, the measure categories used by UI are different from those used during the 2009 program. Nonetheless, while the measure names do not match the ones used in this evaluation, Global was able to reasonably match up the old categories with the 2009 measures and apply an appropriate rate to those respective savings. Because there were not any Heating measures for UI in 2007, Global used the overall program-wide rates for the UI Heating savings

Note: Because the sample was not designed to estimate savings separately for the two types of Cooling, or the three types of Other, the Cooling and Other savings were prorated based on the proportion of energy reported savings from the company databases. This is a reasonable estimate of the split of the adjusted savings for Cooling and Other.

3.6 LOAD SHAPE IMPACTS

Full 8,760-hour load shapes for each sample point were simulated based on the same models and assumptions that were used to estimate the energy and demand savings. The shapes were then aggregated in the same way as the energy and demand savings to estimate total savings load shapes by measure.

The following four figures show the typical day load shape impacts by month for four of the major measure types. In each of the figures, the impact values are the total kW savings by hour for a typical weekday and weekend day, in each month for each measure. Figure 3-1 is for Cooling measures, Figure 3-2 is Lighting measures, Figure 3-3 is Heating measures, and Figure 3-4 is

Process measures. The set of numbers showing typical weekday and weekend load shape impacts are included in Appendix E.

The shapes indicate that the Cooling savings correspond to the workday, when the building is occupied. They are, not surprisingly, much higher during the summer. There are some winter savings as well, however, since many of the Cooling measures improve the efficiency of the HVAC system year round.

The Lighting load shapes show higher savings in the summer as well. However, this is primarily driven by the interaction effect with HVAC. During the summer, the lower heat output of more efficient lighting lowers the cooling demand. Conversely, during the winter, for electrically-heated buildings, the lower heat output increases heating load, reducing the savings. This also creates a noticeable drop in the savings as the heating systems go on at the start of each day. The lighting savings persist into the evening hours as well, when lights are still on in many facilities.

The Heating savings shapes also correspond to the workday, and are, as expected, higher in the winter. There are still significant savings overnight during the winter months, as savings are realized when the systems continue to operate, though generally at a lower thermostat set point. As with cooling, some of the measures were not specific to only the heating operation of the HVAC systems, so there are savings from the heating measures during the summer as well.

The Process measure savings load shapes show very little weather sensitivity, being fairly consistent throughout the year. The savings tend to track the occupancy of the facility, with a noticeable drop in savings over the lunch hour.

Figure 3-1 Monthly Savings Load Shapes for Cooling Measures

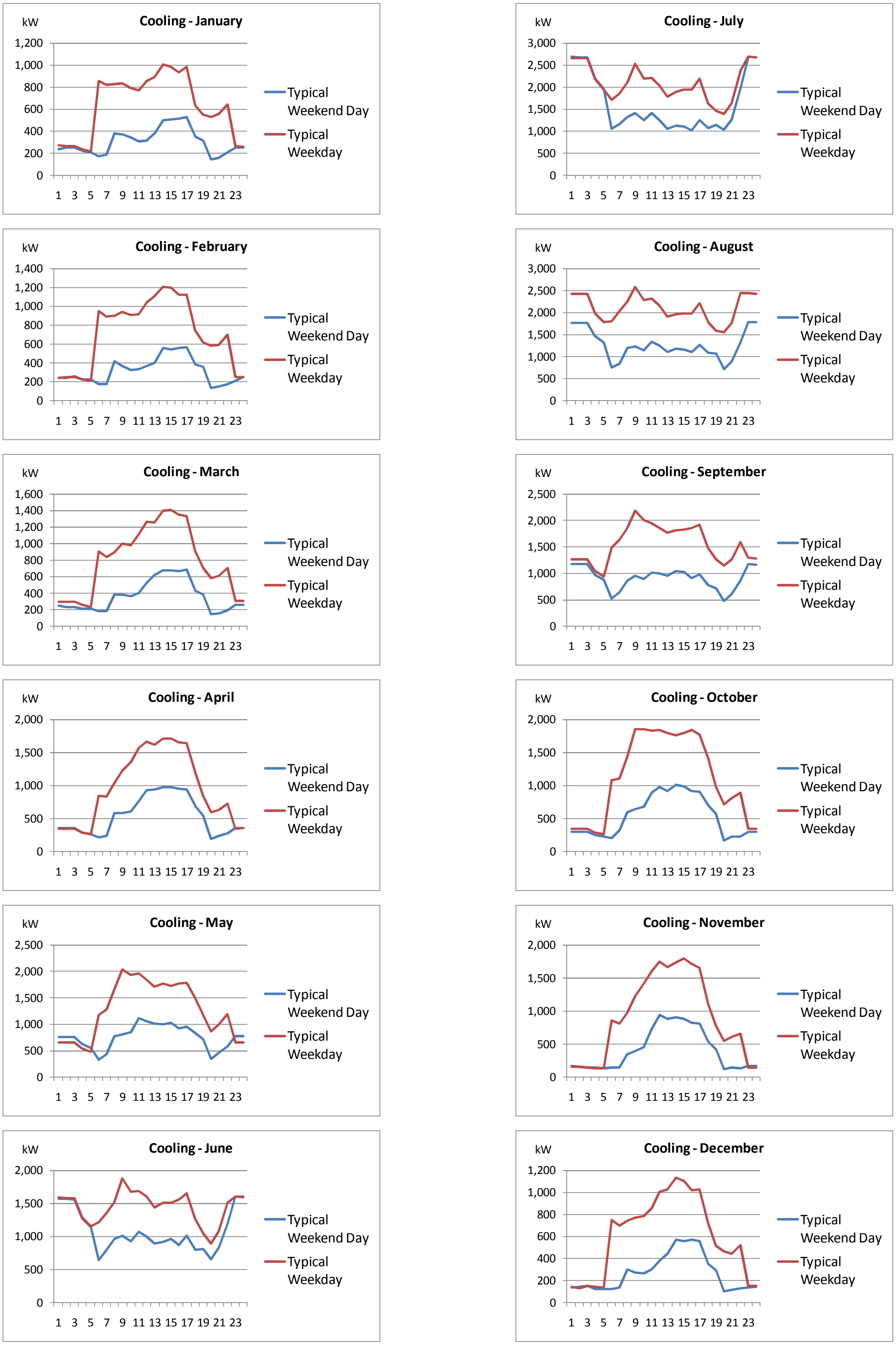


Figure 3-2 Monthly Savings Load Shapes for Lighting Measures

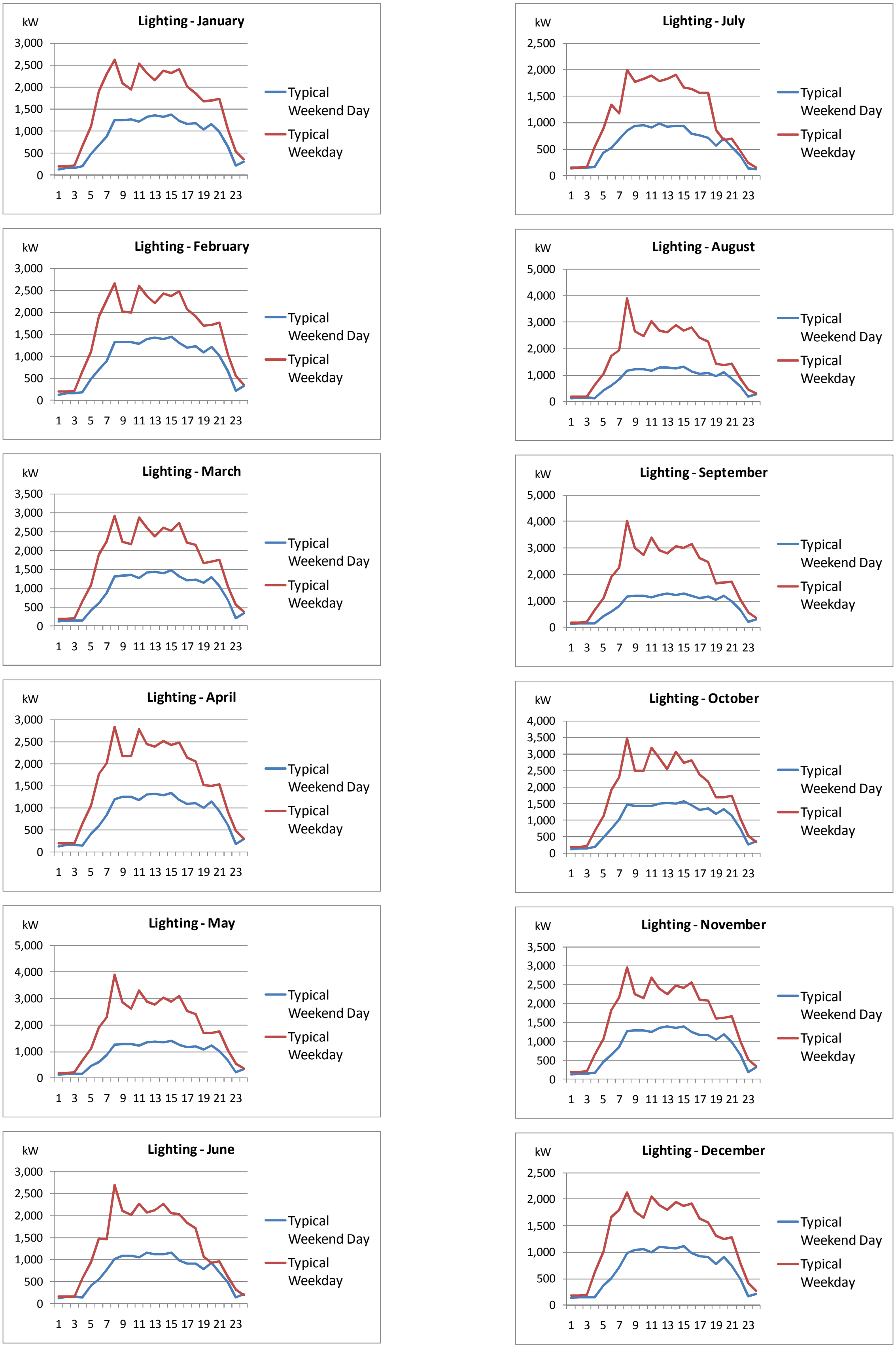


Figure 3-3 Monthly Savings Load Shapes for Heating Measures

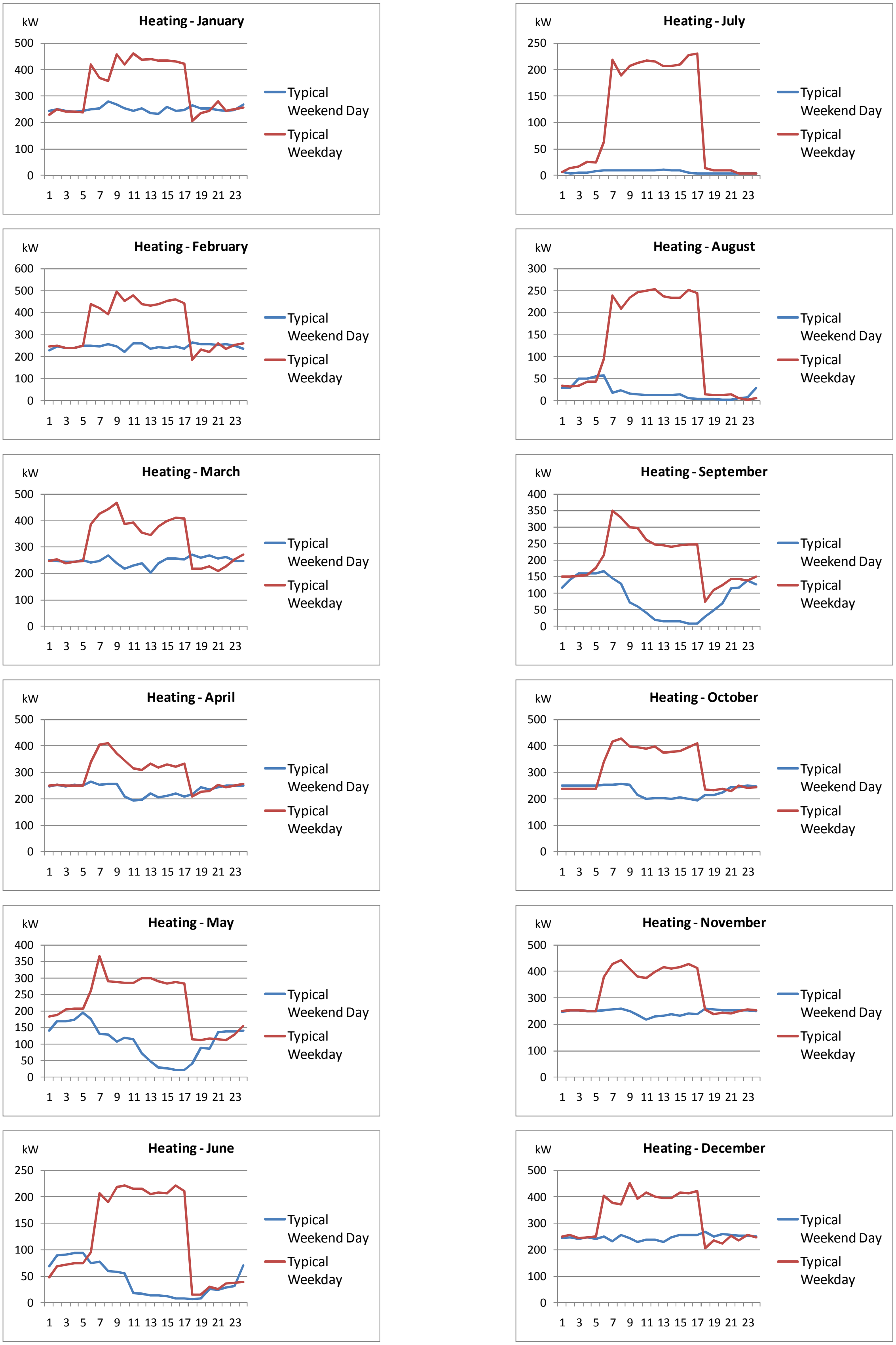
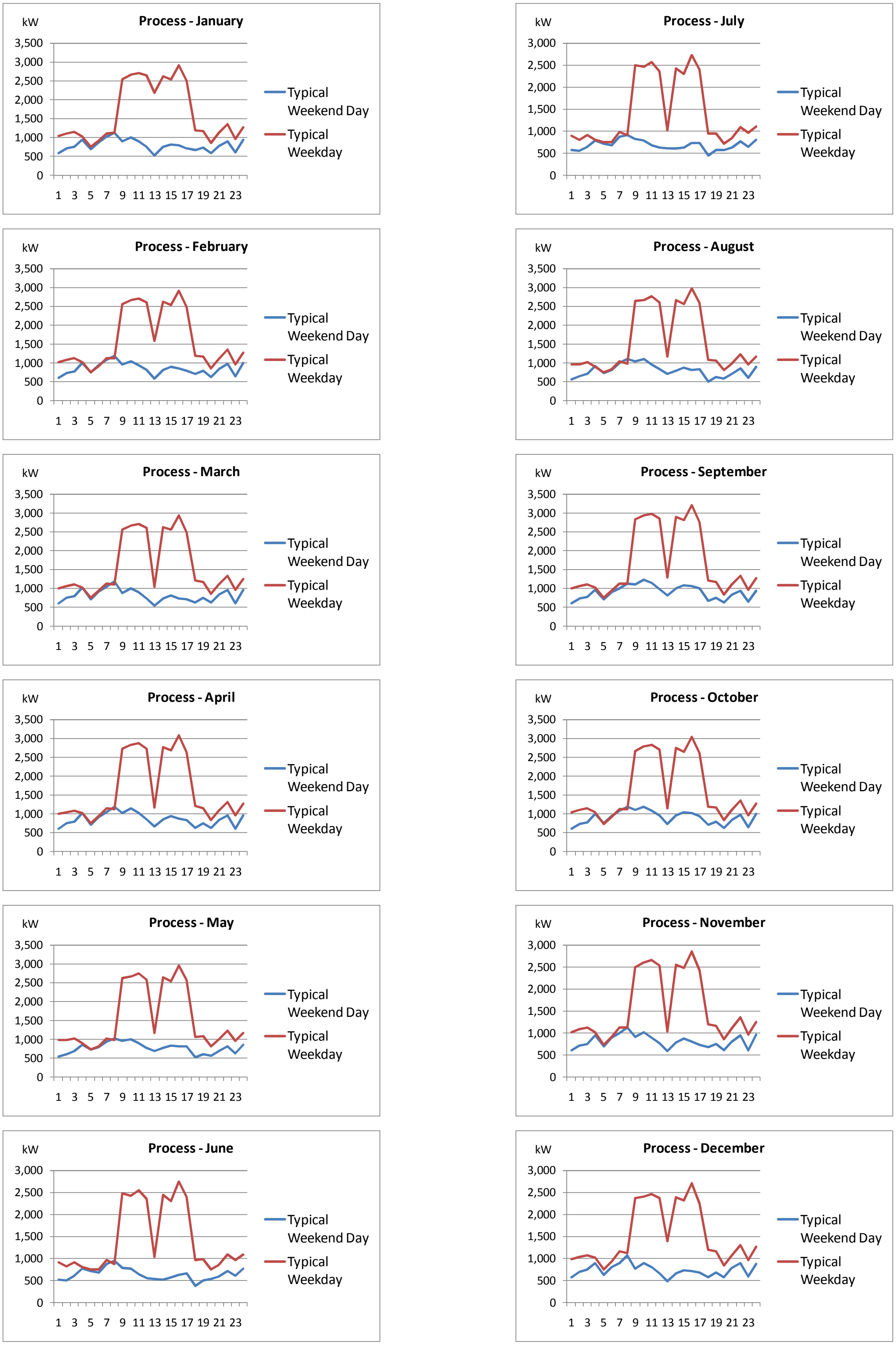


Figure 3-4 Monthly Savings Load Shapes for Process Measures



REVIEW OF PROGRAM OPERATIONS

A major purpose of this evaluation was to provide EEB and the Companies with an assessment of program operational practices as they contribute to or impede achievement of the Energy Conscious Blueprint program's key objectives. This chapter addresses that purpose. It also includes other findings of interest from the participant survey and interviews Global conducted with building design contractors, mechanical and electrical engineers, equipment contractors, and energy services companies (collectively the trade allies).

4.1 PROGRAM DESCRIPTION

As described in Chapter 1, the 2009 ECB program was designed to capture opportunities to improve energy efficiency for the following target market: C&I customer facilities anticipating new construction, major renovation, tenant fit-outs, equipment additions, or replacement of equipment that is no longer working or at the end of its life.

In 2010, an effort was undertaken by EEB and the Companies to review and revise the direction of the program. The resulting "re-visioning" of the ECB gave the program a more forward-looking focus that emphasizes working more collaboratively with customers and their trade allies to encourage ongoing efficiency improvements in all parts of their operations, beyond existing code and standard minimums. The ultimate goal is to transform the market with beyond-code building design and equipment purchase practices.

Several features of the program are important to note in assessing the current status, challenges, and opportunities for the ECB going forward. The program has two main tracks: contract incentives and rebates; individual projects may include both. The savings estimates, dollars per unit, and total incentive calculations are the same for both tracks, but the process for each track is different. Rebates are available for a limited set of measures and are applied for after installation, via submittal of a rebate application and requisite documentation. Contract incentives are applied for prior to initiation of a project; they can include prescriptive and custom measures. The programs are operated the same at each of the two companies, except for early in 2009, when CL&P temporarily capped project incentives at $20K.

Projects can enter the ECB program in a number of ways, including: directly from customers, from trade allies, and through utility staff outreach. Projects can involve trade allies in many capacities–from initial design, estimation of energy savings and program incentives, and consultation with Company engineers through installation, depending on the needs of the project.

4.2 CURRENT PROGRAM PRACTICES AND RECOMMENDATIONS FOR ACHIEVING PROGRAM OBJECTIVES

Interviews with program managers, the evaluation work plan, the Companies' 2009 Conservation and Load Management Plan,[1] and the ECB re-visioning strategy were used to develop a list of metrics critical to directing the course of the program going forward. Global assembled nine key program objectives that served as the framework for the evaluating the program's operations:

1. Increase awareness among customers and trade allies about the program. Customers and trade allies use the program and Company staff as a resource for building design.
2. Provide deep savings to customers capturing all or most opportunities through initial participation.

[1] "2009 Conservation and Load Management Plan", submitted jointly by CL&P and UI, Docket 08-10-03, October, 2008.

3. Encourage the installation of controls to increase energy savings and take advantage of load management opportunities.
4. Focus on all energy savings, both gas and electric.
5. Encourage customers to have their projects commissioned and promote LEED, Energy Star and other design standard certifications.
6. Supports businesses in making energy management an integral part of their business practices and corporate culture through strategic energy management and continuous energy improvement (CEI).
7. Increase customers' knowledge of the benefits of energy efficiency, resulting in changes in the way customers use and maintain equipment and helping customers realize expected bill savings from installed measures.
8. Support collection, storage, retrieval and analysis of data that will allow relevant information to be available when needed for program management, program evaluation and public information.
9. Maintain focus on achieving market transformation.

Interviews with trade allies familiar with the program, participant surveys, review of the program tracking systems and project documentation, and discussions with the program managers were used to determine the methods currently used to promote the objectives, the current status, and current challenges. The assessment of the Companies' practices culminates in a set of recommendations aimed at furthering progress toward the achievement of each program objective.

4.2.1 Program Objective 1

Increase awareness among customers and trade allies about the program. Customers and trade allies look to utility staff as a resource for building design.

This objective is discussed in greatest detail because it is fundamental to the success of the program going forward and it contains recommendations for most immediate action. The current methods in place to promote this objective:

- Company account executives provide information on program incentives, measures and potential savings to trade allies about the program through visits, trainings and meetings.
- Brochures with information about Company energy efficiency programs are delivered to customers.
- Program information is available on the Companies' websites.
- Incentives are available for design professionals for high performance building design that meet or exceed, LEED, Green Globes or High Performance standards.

4.2.1.1 Current Status

Regarding efforts to increase awareness, there does not appear to be any specific marketing devoted to promoting awareness of Company assistance specifically available for this target market, nor is the Energy Conscious Blueprint brand promoted. Global's review of the Companies' websites found that that the program information is thorough, easy to find, and includes information about measures, the incentive structure, success stories and contact information. However true this is, the participants surveyed suggest that this information is either not seen or not recalled by customers. Very few participants said that they had learned about the program from a brochure, bill insert, or ads in any local media; absolutely none named their utility website as the way they first learned about the program. The program managers offered that most of program participation is due to trade allies and participants contacting them. But that may understate their outreach efforts. The Company account representatives who have relationships with customers do seem to make them aware that help is available. Nearly half of the program participants surveyed (44%) reported finding out about the program from the Company reps or engineers; another 22% cited trade allies as their first source of information about the program. Most of surveyed participants (80%) said they had had prior experience with Company programs.

Trade allies also said they learned about the program from their personal interactions with the Companies. They tend to have a specific person at the Company that they contact about the program. Trade allies said that the Company does not have very much influence on what equipment and controls are selected and that main role of the Company staff is to assist the trade ally in determining the amount of the incentive. According to the Companies, incentives are available to design professionals for high performance building designs. It is important to note, however, that according to the participant survey half of the projects are not involved in the program during the design stage. The trade ally interviews also revealed that the cost and extra work required to obtain certification is a barrier. If having the certification is required to get the incentive, the customers may not see the value because it would only cover or reduce the cost of certification.

One measure of the Company's effectiveness in making customers and trade allies aware of the program is the point at which a project enters the program. Half of the PY 2009 participants surveyed said they decided to participate during the design process. Thirty-one percent decided during equipment selection. Participation after the project was completely designed and equipment was selected, generally considered program free ridership, was reported by 9%. A study conducted by PA Consulting for the 2007 ECB program[2] indicated free ridership rates upward of 15%. While this PY 2009 evaluation was not designed to assess free ridership and is not meant to replace the findings of the 2007 study, the fact that only 9% of surveyed customers said they participated after the project was completed and the equipment was selected suggests that the program may be getting more successful at reaching customers earlier in the design process. Despite this, fully half of the respondents' indication that they did not enter the program until after design decisions were made, shows they did not use the Company as a resource for their project design.

In terms of seeing the Companies as a resource for building design and equipment selection, results from the surveyed participants were mixed. Almost 60% rated equipment vendors as very important in equipment selection; more than half rated mechanical or electrical engineers as very important. But, a substantially lower 19% rated Company staff very important in selecting equipment. Most participants said they worked with equipment vendors and/or mechanical or electrical engineers on the project. Fewer participants said they worked with architects or general contractors. The majority of participants (63%) said they had worked with these trade allies in the past. This suggests that customers have ongoing relationships with trade allies. It provides more evidence that the Companies' relationship with trade allies is extremely important, both in terms of reaching potential participants and in developing customers' value of the Company as a resource.

In the interviews, trade allies gave mixed reviews of their interactions with Company staff. In some instances, trade allies said that a Company staff member had helped them maximize the incentive. But in a couple of other cases, they reported that the Company had been difficult to work with, had asked very detailed and complicated questions about bids "that you'd need a PHD to answer," and had taken too long to respond. The majority of participants (70% or more) rated the professionalism, knowledge, expertise, and support provided by Company staff a 4 or 5 on a 5-point satisfaction scale. This is relevant to the Companies' goal of being seen as a reliable resource for furthering energy efficiency in C&I facilities.

4.2.1.2 Current Challenges

Awareness of and attendance at program trainings and workshops is low among participating customers. Most trade allies interviewed are aware that workshops and trainings are offered by

[2] *2007 Commercial and Industrial Programs Free-Ridership and Spillover Study*, reports for United Illuminating Company and for Connecticut Light & Power prepared by PA Consulting, October 28, 2008.

the Company, and some said they attended the workshops/trainings. Fewer than half of participants surveyed were aware of Company-sponsored training and workshops. Fewer than a quarter have attended these events. This lack of awareness undermines the Companies' desire to be seen as resource for efficient building design information.

According to trade allies, the program is not branded as "the Energy Conscious Blueprint" program. Trade allies and customers are not generally aware of specific energy efficiency programs by name; many just know that there are incentives available for high efficiency equipment and controls. In some cases this lack of brand leads to both trade allies and customers thinking of the program as an equipment replacement program, despite the availability of Company print and on-line marketing materials that mention the program by name and emphasize building design.

While the vast majority of respondents started their participation in the program before they selected their equipment, half of them joined after the design planning stage, suggesting that customers do not see and/or use the Company staff as a design resource. Fully 20% of the respondents said they did not speak with a Company representative during the equipment selection stage, instead relying more heavily on other engineers and equipment vendors. This was despite the fact that almost half cited a Company rep or engineer as the original source of information about the program and that more than half had previously participated in other Company programs.

Trade allies believe that the company staff response to their requests for assistance is unduly slow; this, and a lack of clarity regarding the eligibility of or rebates available for specific measures, has led to their dissatisfaction with the Companies' handling of the program. This can largely be overcome by improving response time to trade ally requests.

4.2.1.3 Recommendations for Program Objective 1

Global believes the following changes in program design and marketing will result in a higher level of program awareness, increase the number of customers who get involved in the program at the design stage, and increase interest and attendance at trainings and workshops.

- Provide cash incentives to trade allies for building designs that include energy efficiency improvements on a sliding scale above an established baseline.
- Provide training and workshops to trade allies about the program and the incentives it provides, the importance of getting to customers early in process, and including guidance on how to select sub-contractors and access building design simulation modeling.
- Emphasize the importance and value of trade allies attending training during in-person meetings and include the value proposition (specifically how trade allies benefit from the training) in all written materials about the training.
- Provide better support and a faster turn-around time during the design and bid process.
- Conduct a market characterization study to assess the remaining potential of eligible customers, and determine program awareness among the general population of customers (not just participants).
- Take additional, different steps to make customers aware of ECB, such as mass market advertising, if brand recognition is important.

These changes are intended to encourage trade allies and customers to contact the Companies early in the design process. The Companies need to ensure that the trade allies/customers receive prompt service during the initial contact, and provide clear actionable instructions on how to maximize energy efficiency of the design at a cost and payback that is acceptable to customers. The design incentive should be set to overcome the barrier related to the time commitment required for trade allies to attend program trainings and do the extra work (e.g., simulation modeling) required to verify the savings.

4.2.2 Program Objective 2

Provide deep savings to customers; capturing all or most opportunities through initial participation.

The current methods in place to promote this objective:

- The program provides monetary incentives to participants to overcome payback barriers
- Provision of informational brochures to provide direct information to customers encouraging participation, but also to provide others who influence the decisions when the project is under development, the tools to 'sell' customers on a broader range of measures.
- Training sessions to provide information on incentives, measures and their potential savings, and 2-way feedback on how the program can reach customers.

4.2.2.1 Current Status

According to the Companies' tracking systems, 80% of the PY 2009 projects were single measure projects. At the same time, about the same percentage of participants surveyed said that they installed all design recommendations that were made. At first glance, this seems contradictory, though it may be explainable through the disconnect between reports by the trade allies who advise participants and what the participants reported. Generally, the trade allies reported that they provide comprehensive recommendations, but that some recommendations are difficult to sell to their customers. The trade allies also indicated that they are less likely to recommend measures for which they are unable to calculate the rebate with confidence. Thus, one possible scenario might be that trade allies may make one firm recommendation with estimated savings and incentive, then several, more casual, recommendations that don't include payback and incentive information. Customers may only perceive a single recommendation; they act on it and may think they have done everything they can. While there is no way to determine with any precision to what extent differences in understanding, errors, and/or 'gold star' behavior (knowing that a particular response paints the respondent in a positive light) are affecting the data, it is clear that the program is not currently providing deep savings.

A key consideration in facility improvement decisions is the payback period. Two-thirds of participants surveyed said they require a minimum payback of 3 years or less. According to one vendor, the average commercial building turns over every 3-4 years and customers are unwilling to spend capital on improvements unless they realize savings within that time frame. These results are consistent with those of other studies, which cite three years as a critical payback cutoff. A 2009 study noted that all types of business customers, from restaurants and banks to industrial plants, use simple payback to justify purchase decisions.[3]

4.2.2.2 Current Challenges

Trade allies and customers reported that first cost remains a barrier to fuller implementation. Some trade allies also suggested that the changing incentive amounts and program rules cause them to avoid recommendation of a broader range of measures. Trade allies reported that there is variability in and uncertainty regarding the availability of funds for the program; they often don't know when they submit a bid that the incentive will still be available when the customer decides to move forward with the project. This causes them to leave the incentive out of the bid, making the measure less attractive to customers, or to not include more-costly, high-performance measures in the project.

Most of the customers surveyed cited rebates as a primary reason they participated in the program and said they got involved in the program before or while choosing some of the equipment for their project. Their responses underscore the persistence of first cost as a barrier and suggest that the program incentives help address the barrier. But since almost 20% of the respondents said that they did not implement all of the energy saving recommendations made, it

[3] "Process Evaluation Insights on Program Implementation," prepared by Peters, Jane and M. McRae for CIEE Behavior and Energy Program, California Institute for Energy and Environment: February 2009.

seems that the deep savings aim of the program has not been fully achieved. Forty percent of the respondents said that they need to see a payback of three years or less to purchase more efficient equipment.

4.2.2.3 Recommendations for Program Objective 2

Global believes the following changes in program practices and design will result in increased frequency of achieving 'deep savings.'

- Introduction of tiered incentives, such that measures that are less known or have longer paybacks are more highly incented. Consider making both customers and trade allies eligible for the incentives.
- Provide bonus incentives that may apply both to customers and trade allies, for certification as LEED or Green Globe buildings[4].
- Develop spreadsheet, software and/or online tools to help contractors accurately estimate the size and availability of incentives.
- Data collection on the measures contractors recommended to participants in the original bid, as well as on the measures that were actually installed.

These changes are expected to motivate the trade allies to spend more time and effort to sell innovative or more costly measures and to provide customers with more incentive to consider inclusion of those measures in the project. The amount of the incentive should be set considering effect on payback for the 'stretch' measures and also to overcome barriers related to increased time commitments or effects on project completion timelines.

4.2.3 Program Objective 3

Encourage the installation of controls to increase energy savings and take advantage of load management opportunities.

Current program methods to promote this objective:

- The program provides monetary incentives to participants, to overcome payback barriers.
- Program staff meets regularly with various trade allies through visits, trainings and meetings. Through this interaction, trade allies become aware of the program, the availability of incentives, and the benefits of including controls. They are encouraged to include controls in their designs to increase the incentive and reduce the payback for customers.
- Marketing materials highlighting the use of controls to improve building performance.

4.2.3.1 Current Status

According to the program tracking database, 31% of all PY 2009 project sites included controls, while 26% included controls other than lighting (Table 4-1). Equipment contractors who participated in the program said they typically don't discuss controls with customers. But other trade allies and 72% of participating customers surveyed said that controls were recommended in the designs. Almost all of these participants said they installed the recommended controls. This disconnect between participants/trade allies and the program tracking data may have occurred because more involved participants (participants who installed a combination of measures and controls) were more likely to respond to the survey, or that participants are confused about the nature of controls. There is also evidence that controls were not accurately represented in the program tracking system. Global's review of the program tracking system found that the computerized reporting was often not consistent with the paper files. Specifically, measures listed on the paper files were not always included as separate line items in the tracking system. As a result, the tracking system may under-represent the number of controls installed.

[4] This incentive is outlined in the "Energy Conscious Blueprint (ECB) Re-Visioning Strategy- *straw"* as a recommended improvement to the program.

Table 4-1 Projects Including Controls by Utility

Utility	Lighting	VFD/VSD	Enthalpy	CO_2 Control	EMS
CL&P Projects					
Number	50	44	56	20	0
Percentage	16.4%	14.5%	18.4%	6.6%	0.0%
UI Projects					
Number	0	20	0	0	21
Percentage	0.0%	9.3%	0.0%	0.0%	9.8%
Total: Number of Projects	**50**	**64**	**56**	**20**	**21**
Total % of all projects	**9.6%**	**12.3%**	**10.8%**	**3.9%**	**4.0%**

Trade allies who said they often include controls in the program design reported that customers are receptive to controls if it makes economic sense. The trade allies feel that EMSs and other controls, when used correctly, are where customers can achieve the most savings.

Almost a quarter (23%) of participants who installed controls (or 10% of all participants), reported they installed load management controls. This maps well to the information in the program tracking database. If enthalpy and EMS controls are defined as load management controls, 15% of sites installed enthalpy controls; a figure within the margin of error for the survey results. According to the survey, the majority of participants who installed load management controls said they use them to reduce their peak demand. Trade allies said they sometimes install controls with load management capabilities, but they feel that few customers use the controls for load management. The main focus on controls is to save money by reducing energy use (e.g. occupancy sensors for lighting), not shifting load.

4.2.3.2 Current Challenges

Trade allies believe that customers require education on how to use the controls effectively. Even though trade allies often provide training during the installation, they are not sure that customers are getting the most out of their controls.

The majority of participants do not take advantage of load management, even when they have installed controls with load management capability.

One design contractor said that controls also have to be installed intelligently, and are often put in where customers do not have the education or the capability to use them appropriately. He has witnessed other trade allies installing controls in situations where they were not appropriate. In nursing homes, for example, the building is required to maintain a temperature of 70 degrees at all times. Installing HVAC controls in this situation is not useful, but in some cases trade allies have encouraged the installation of controls in nursing homes to increase the dollar amount of the sale.

The seemingly contradictory data from the participant surveys and the program tracking database make it difficult to ascertain how often controls are recommended to customers.

4.2.3.3 Recommendations for Program Objective 3

Global believes the following changes to the program design and marketing will increase the number of projects that include controls:

- Provide a "bonus" cash incentive to trade allies when they include improvements that create super savings, such as controls, in building designs.

- Educate trade allies on how inclusion of controls can increase savings and therefore increase the incentive payment.
- Provide training brochures, online resources, and workshops to customers on the use of controls in appropriate settings to improve occupant comfort and building energy efficiency.
- Communicate with both trade allies and customers about which control applications are appropriate and which are inappropriate because they would not lead to energy savings (e.g., temperature controls in nursing homes where they are required to maintain a constant indoor temperature year-round).
- Promote the use of load management controls in conjunction with available demand response and dynamic pricing programs.
- Include controls as a separate measure category in the program tracking database.

These changes are expected to encourage trade allies to consistently include controls in applicable projects, and to provide customers with more understanding about how they can benefit from the appropriate inclusion of controls. It will also provide more accurate data on the inclusion of controls for program staff.

4.2.4 Program Objective 4

Focus on all energy savings, both gas and electric.

Current program methods to promote this objective:

- The program provides monetary incentives to participants for natural gas and electric measures.
- Training sessions provide information on incentives, program-eligible gas and electric measures, and their potential savings.

4.2.4.1 Current Status

Trade allies report that the program is fuel neutral, and that both gas and electric measures qualify for incentives and are equally promoted. The marketing material consistently uses the term energy, rather than being fuel specific, and lists both electric and gas measures.

A study was conducted by KEMA and published in a final report dated May 7, 2009, titled "Connecticut Natural Gas Commercial and Industrial Energy-Efficiency Potential Study." The Natural Gas Potential Study ("MAP") conducted by KEMA, Inc. identified a number of gas end uses with high gas savings potential (e.g., commercial food service). As a result, prescriptive incentives and rebate forms were developed and deployed for Energy Star rated steam tables, fryers and convection ovens in 2010. In response to the Natural Gas Companies' presentation to vendors and contractors regarding the MAP study results, participants provided feedback indicating the desire to have more natural gas equipment rebates available. Additional rebates for low-intensity infrared heaters are currently under development and will be available in June, 2011.

4.2.4.2 Current Challenges

Information provided by Northeast Utilities indicates that the staff tracks both electric savings for CL&P and natural gas savings for Yankee Gas procured under the ECB program. According to this data, electric savings (and incentives paid) in PY 2009 were nine times as much as gas savings. This does not indicate whether the program operates as fuel neutral or not, because we do not know what actual gas savings opportunities existed. What it does show is that the program is capturing both electric and gas savings.

Focus on both gas and electric savings should not be equated with a goal of equal savings for both gas and electric for the program. There are many more uses of electricity (e.g., there are no gas lighting options); therefore it would be expected that there would be more electric measures and greater electric savings. Without knowing the relative opportunities between the fuels, it is not possible to know whether the program is succeeding in capturing electric and gas savings equally well.

4.2.4.3 Recommendations for Program Objective 4

Based solely on the input from the vendors, Global believes the program is currently meeting this objective of encouraging both gas and electric measures. The program re-visioning document cites plans to increase the number of natural gas measures. This is an excellent idea and will further ensure that the focus remains on both fuels.

The Companies conducted a market characterization study to assess natural gas opportunities in 2009. Global recommends they conduct a similar study to assess electric opportunities and remaining energy savings potential. The results can directly help with implementation of the program re-visioning by identifying measures it would be most effective to add and/or promote more heavily to achieve greater energy efficiency in the C&I market.

4.2.5 Program Objective 5

Encourage customers to have their projects commissioned and promote LEED, Energy Star and other design standard certifications.

Current program methods to promote this objective:

- Marketing materials that promote better operational proficiency, energy management strategies, retro-commissioning and LEED certification.

4.2.5.1 Current Status

Trade allies are strong proponents of project commissioning. Most said they have projects commissioned as a standard practice and it is well worth the money. But the participant survey results refute this claim. Only 35% of participants said their project was commissioned. Most of the participants who said their project was commissioned did not know how much it cost.

Only 20% of participants said they had the goal of achieving LEED certification and only 14 percent actually received LEED certification. Only 11% of participants said they received Energy Star certification. According to trade allies, there is some customer interest in having a LEED certified or Energy Star rated building.

According to the McGraw Hill Green Outlook 2011 report, green construction is growing rapidly in an otherwise depressed construction market. In the McGraw Hill report, building owners cited three business benefits as the main drivers for building green:

- Reduction in operating costs of 13.6%, on average, for new buildings and 8.5% for retrofits;
- Increase in building values of 10.9% for new buildings and 6.8% for retrofits; and
- Increase in return on investment (ROI) of 9.9% for new buildings and 19.2% for retrofits.

4.2.5.2 Current Challenges

There is conflicting data from trade allies and participants on the number of projects that are commissioned. It’s possible that participants do not understand the term project commissioning, and therefore did not provide accurate information. Trade allies who were interviewed often had completed several projects that received incentives; some were equipment replacement and some were integrated building designs. The trade allies tended to focus on the more elaborate design projects during the interview, which may explain some of the discrepancy.

Trade allies say the cost of certification is a definite barrier. According to trade allies, even if the building is eligible for certification, customers will often not spend the money to get the certification.

4.2.5.3 Recommendations for Program Objective 5

Global believes the following strategies will improve the Companies' progress toward this objective:

- Get strong data, such as benefits from "green" construction included in the McGraw Hill Green Outlook 2011 report, into the hands of building owners.
- Include information on the benefits of project commissioning during customer trainings and workshops.
- Track commissioning in the program tracking database.
- Provide a bonus incentive for LEED certification.

Over a period of time, these actions can be expected to increase customer interest and knowledge of the value of commissioning, allow program staff to accurately measure their progress towards this goal, and help to overcome the barrier of the cost of certification.

4.2.6 Program Objective 6

Support businesses in making energy management an integral part of their business practices and corporate culture through strategic energy management and Continuous Energy Improvement.

Current program methods to promote this objective:

- Provision of informational brochures, to provide direct information to customers increases knowledge of the benefits of energy efficiency improvements.
- Provision trade allies the same informational brochures, as tools to 'sell' customers on a broader range of measures.
- Training sessions, to provide information on incentives, measures and their potential savings, with 2-way feedback on how the program can reach customers.

4.2.6.1 Current Status

The majority of participants surveyed have been involved in utility programs prior to their involvement in the ECB program. This indicates that they continue to upgrade the energy efficiency of their buildings. Program managers provided further evidence, reporting that many participants are repeat customers. A small percentage of participants (19%) are aware of the term "continuous energy improvement" (CEI). Once defined, more than half of participants said they would be interested in learning more about CEI.

4.2.6.2 Current Challenges

Most businesses do not plan for future energy efficiency upgrades and the majority of participants require a minimum payback of 3 years or less. Not all capital improvements can meet this requirement without incentives. The challenge is to educate customers that CEI extends beyond capital improvements; it includes behavioral changes, such as shift changes, equipment optimization, and physical consolidation of production, that improve productivity as well as energy use.

4.2.6.3 Recommendations for Program Objective 6

Utilities across the country are actively developing CEI as a stand–alone program or integrated into other programs. These programs most typically focus on industrial customers. According to the recent Pike Research report, *Building Efficiency: 10 Trends to Watch in 2011 and Beyond*[5], prospective buyers and tenants are increasingly interested in the energy performance of buildings because they are looking for ways to control business costs. It will be key to get this

[5] "Building Efficiency: Ten Trends to Watch in 2011 and Beyond," Pike Research, 4Q 2010.

information to building owners so they realize that the performance of their building is an investment that can pay dividends when they are trying to sell or lease space.

Global believes the following actions will result in both building owners and tenants embracing CEI:

- Dedicate staff resources to customer awareness and understanding of CEI.
- Support efforts to set company energy goals, including working with customers to create initial baselines and benchmarks as well as defining other "SMART" aspects of their goals.
- Support joint events with DOE and others to increase company commitment levels.
- Supply (e.g. loan) data loggers as part of an energy information program which also includes energy goals and energy action plans.
- Make building owners aware of the re-sell/leasing value of high building performance. Less efficient space stays empty longer.[6]

Essentially, the value of this approach is that it provides lasting savings to the customer as well as the utility. Global believes these actions will result in a greater understanding of CEI among customers, and help them understand the range of benefits in taking a long term approach to energy efficiency.

4.2.7 Program Objective 7

Increase customers' knowledge of the benefits of energy efficiency, resulting in changes in the way customers use and maintain equipment and helping customers realize expected bill savings from installed measures.

Current program methods to promote this objective:

- Monetary incentives to participants, to overcome some of the incremental cost of high efficiency equipment.
- Provision of informational brochures, to provide direct information to customers to increase knowledge of the benefits of energy efficiency improvements, but also to provide trade allies the tools to 'sell' customers on a broader range of measures.
- Training sessions to provide information on incentives, measures and their potential savings, and 2-way feedback on how the program can reach customers.

4.2.7.1 Current Status

The Companies are doing a very good job of helping customers and trade allies understand the importance and value of energy efficiency. Survey respondents said they participated in the program mainly to save energy and save money. Concern for the environment and acquiring the latest equipment were secondary drivers of participation. Most participants said the program met their expectations and 63% rated their satisfaction with the resulting bill savings a 4 or 5 on a 5-point scale. Trade allies feel the savings achieved from the equipment and controls are in line with customer expectations.

Participation in the ECB program has had a positive impact on customer knowledge and behavior. The majority of participants surveyed said they are now more knowledgeable about energy efficient equipment. Forty-three percent of participants said that program participation has affected the way they maintain and use their equipment. These customers said they perform a higher standard of maintenance now because they understand that more maintenance equals better performance. They also said they activate the controls more now to use their equipment more efficiently. They also said they pay more attention to energy usage. The vast majority of participants surveyed (87%) said they would consider making similar energy efficiency improvements in the future.

[6] Ibid.

Marketing materials discuss specifics benefits achieved from specific technologies.

4.2.7.2 Current Challenges

Non-energy benefits are not promoted, tracked or evaluated for the program.

4.2.7.3 Recommendations for Program Objective 7

Global believes the program is currently meeting this goal, but could expand the program messaging to also promote the non-energy benefits of energy efficiency improvements.

4.2.8 Program Objective 8

Support collection, storage, retrieval and analysis of data that will allow relevant information to be available when needed for program management, program evaluation and public information.

Current program methods to promote this objective:

- Each Company maintains a program tracking system in the form of an electronic database.
- Each Company maintains some additional information about each project, mostly paper files.

4.2.8.1 Current Status

Electronic data collection and storage are done using different forms, collecting different information, and are stored in databases that are structured in different ways at the two Companies.

Additional program documentation and data are maintained in paper files. Paper files range from a single rebate form up to a complete description of the project, including floor plans. The vast majority of paper files contains little information on where equipment is located and often neglects to show how the expected savings were calculated. In addition, equipment inventories are not always provided in the paper files. For example, lighting inventories were missing for five of the projects in the sample. UI's program tracking system is somewhat more sophisticated, with a more transparent user interface and more uniform labels for measures. CL&P's paper files are much more complete and consistent.

4.2.8.2 Recommendations for Program Objective 8

Active pursuit of this objective will help the Companies conform with the guidelines outlined in the DPUC's recently issued final ruling on PY 2011 programs.[7] Specific findings from Global's review of the Companies' tracking systems and project documentation, along with reasons for the following recommendations for improvement, are discussed in Chapter 5. The recommendations for data tracking and maintenance are the following:

- The Companies should use the same grouping of measures and the same nomenclature for both the major measure categories and the individual measures themselves in the electronic databases.
- Include additional fields in the database to allow for entry of notes that provide more detail on the measures for each project without distracting from the basic measure information.
- Convert all paper information describing equipment inventories to an electronic database.
- Add identifying information about the location of equipment installations in all project files. At a minimum, provide identifiers such as the room name (e.g., conference room) or equipment number (e.g., RTU1).
- Include the methodologies and assumptions used to calculate savings in the individual project files. When applicable, refer to the relevant sections in the PSD.

[7] "DPUC Review of the Connecticut Energy Efficiency Fund's Conservation and Load Management Plan for 2011 -- Decision," Docket No. 10-10-03, issued January 6, 2011.

- Record and clearly specify all of the measures installed and rebated under the program for each project.

4.2.9 Program Objective 9

Maintain focus on achieving market transformation.

Current program methods to promote this objective:

- Provision of informational brochures, to provide direct information to customers encouraging integrated building design, high performance buildings, and optimal energy management, also to provide trade allies, who influence the decisions when the project is under development, the tools to 'sell' customers on integrated designs, and continuous improvement.
- Success stories posted on the Companies' website showing how participating customers have improved their energy efficiency and building performance.
- Participation in the NEEP annual summit that honors leaders in energy efficiency.

4.2.9.1 Current Status

According to trade allies the market is not yet transformed. They feel that the program incentive brings the payback period to an acceptable range and sells the equipment. They feel that without the incentive there would be less high efficiency equipment and controls sold. Results from the participant survey, however, show some evidence of market transformation. Forty-one percent said they would consider installing similar improvements in the future without assistance from the program.

The program provides an ongoing opportunity for the Companies to address different aspects of the market where potential remains. Plans to increase the number of gas measures in the program and more emphasis on on-going strategies, such as CEI, are helpful in leading the market to transformation.

4.2.9.2 Current Challenges

Market transformation is an elusive and very long term goal. Based on Global's experience with previous evaluations of new construction programs, the biggest influence on transforming the market is getting building architects and design engineers to change their design practices to incorporate efficient equipment. Design engineers and architects are traditionally resistant to changing their design practices, but once they do change them, they do not revert back to old practices.

4.2.9.3 Recommendations for Program Objective 9

Global believes the following changes in will help the Companies achieve market transformation in this target market over time:

- Dedicate staff to conduct outreach with building architects and design engineers to promote their understanding of the benefits of a long term energy efficiency strategy.
- Increase the promotion of CEI and integrated planning.
- Arm equipment and building contractors with better explanations of why efficiency improvements are a good business decision and have a wide range of benefits, including non-energy benefits.
- Promote the non-energy benefits of energy efficiency improvements directly to customers.
- Conduct a market characterization study to benchmark current penetration, design and purchase practices, and identify customer subgroups and particular types of trade allies lagging in the adoption of energy efficiency practices.

4.3 OTHER FINDINGS OF INTEREST FROM THE REVIEW

In addition to the nine objectives outlined above, the program managers also expressed concern about educating customers and trade allies about changes in building codes and standards, and promoting the use of VFDs. These two areas were also addressed in the participant survey and the trade ally interviews.

4.3.1 Changes in Building Codes and Standards

Trade allies said they are aware of code changes and keep up to date on changes. They feel this is part of their job. One way the Companies could help is to clarify how the code changes affect the availability of incentives.

Participants, on the other hand, said they need more training on codes and standards. Only 19% of those surveyed said they are very knowledgeable about changes to codes and standards, while 52% feel it is necessary for them to learn more. Furthermore, not a single participant surveyed said s/he was familiar with the Architecture 2030 challenge.

4.3.2 Installation of VFDs

More than half (56%) of the participants responding to the survey said their projects included VFDs. The majority of VFD projects discussed included by-pass switches (63%) and had electric motors replaced with high-efficiency models (87%). The program tracking data, however, does not support the customer-reported high proportion of projects including VFD's. Global's interpretation of the tracking system data indicates that only about 10% of projects included VFDs. The on-site verifications Global conducted, together with review of supplementary documentation, revealed that in some cases additional qualifying measures (not necessarily VFDs) were installed that were not included in the tracking systems. It is not clear whether this was an oversight, or if those measures were not rebated for some reason.

One contractor who sells VFDs said that he loves the program because it helps him meet his sales goals. Without the program, he thinks customers would not even consider the high efficiency models. VFDs are often a tough sell because, in this economy, companies are not buying capital equipment and when they are, they want to spend less money up-front. The program incentive offsets the cost difference for purchasing the higher efficiency equipment, so often with the energy savings his customers come out ahead in the end.

RECOMMENDATIONS FOR IMPROVING DOCUMENTATION AND FUTURE SAVINGS ESTIMATES

Global reviewed project documentation and the Program Savings Document with an eye toward improving future energy and demand savings calculations. This chapter describes specific recommendations for achieving this goal.

5.1 PROJECT DOCUMENTATION

Tracking and documenting program activities is not easy. It requires a considerable expenditure of time and resources to develop systems that allow program implementers to track project activities and document savings from installations sufficiently to allow their verification at a later date. To Global's knowledge, no utility or third party has a system that includes absolutely everything that evaluators would like to see in making a program assessment. A few may still have no systematized tracking system. Nonetheless, utilities must be able to adequately demonstrate that measures reflected in their reported savings estimates are all program-qualified and that these savings were reasonably estimated. Documentation is the key to that demonstration.

5.1.1 What's Working Well

Both Companies have made concerted efforts to document the ECB projects and their anticipated savings:

- Each Company has an electronic tracking system that identifies projects and measures installed, along with information about the project. From these, Global was able to identify the end-use application and estimated savings of each installed measure and to contact customers included in the analysis sample. UI's EnerNET electronic tracking system is particularly advanced and user-friendly.
- Each Company maintains some additional project information (mostly paper files) on each project. CL&P's project files are especially complete, containing more details on the equipment inventories, incentives given, and estimated savings.
- Each Company's staff was responsive in trying to locate information Global requested for use in verifying installations, metering the measures, reviewing the calculation of Company-reported savings, and making independent assessments of the measure savings. Some types of information were easier for the Companies to obtain than others. For example, UI was able to produce the necessary customer billing data almost immediately, which may be a result of having made efforts to integrate the tracking and other data systems there.

5.1.2 Current Challenges

In trying to use the documentation provided by the Companies, Global identified a number of shortcomings in the documentation. The items that Global believes are reasonable to address include the following:

- The two electronic database systems do not use the same typology for categorizing the measures. The lack of consistency across the 2009 program data may have led to specific measures being evaluated in one category for one Company and a different category for the other. For example, it appears that CL&P includes most VFD measures in the category of the end use affected, while UI puts them in their own category, without reference to the end use affected. Thus, most of the CL&P VFD measures were evaluated as Cooling, Heating, or Process measures, while the UI VFDs were included solely in the "Other" measure category.

This difference undoubtedly muddies the meaning of the results in the different measure categories. Though either categorization of VFD measures is appropriate if consistently applied by both Companies, Global prefers categorization by the end use affected since it portrays a clearer picture of the energy impacts at the end use level.

- The two systems do not describe specific measures in the same way and often are insufficiently clear about exactly what the measure is. One system uses a concise set of names in a drop down menu, which provides consistency but is incomplete; e.g., EBB-COOLING, CUSTOM. The other system has a description field that allows users to type in text freely. While this can be more descriptive, it allows considerable room for typos, and it undeniably led some identical measures to be described in different ways (see Appendix F). In addition, the meaning of the information in some fields in the electronic tracking systems is unclear.
- Paper files are accessible on a single project at a time basis, but are difficult to access for purposes that require summarization or analysis. The type and level of detail of information provided in the paper files are very inconsistent among the projects. For some projects, the paper files contain conflicting information. For example, they may have more than one equipment list, different incentive amounts, and different savings estimates. The discrepancies likely reflect changes in the project over time, but the documents are not always dated. As a result, it is sometimes difficult to tell which information is the most recent. The information in some of the paper files also conflicts with the data documented in the electronic tracking system. For example, three of the 34 Lighting projects in the sample (Lighting09, Lighting11, and Lighting28) showed different energy savings in the paper files than reported in the tracking system. For another two Lighting projects, no information on energy savings was provided in the paper files (Lighting03 and Lighting30).
- The documentation provided contains very little information on how the savings are calculated. In particular, the tracking system does not indicate the methodologies used to calculate the kWh and kW savings values (e.g., prescriptive, custom, reference to formula in PSD, etc.). In addition, the detailed project files rarely show how the values were calculated. The Companies may have additional spreadsheets for the projects showing details of savings calculations, but only two such sheets (for Lighting04 and Lighting05) were provided during the evaluation.
- In some cases important equipment specifications were missing or incorrect in the project files. For example, the efficiency of the RTUs was not provided for one project (Cooling04) and the type of economizer was not provided for two projects (Cooling11 and Cooling27). For a couple of others, the cooling capacity of the RTUs did not match what was observed at the sites (Cooling11 and Cooling12).
- In some cases, the information in the project documentation indicates that the Company-reported savings may be wrong. Examples of this include measures that did not qualify for the program, but for which savings were recorded in error; projects that show the wrong value for the baseline; and projects for which the efficiency ratings were incorrect.
- Despite this being mainly a new construction program, there is almost no indication in any of the project files about where in the facility a measure was installed. This sometimes made it difficult to identify which equipment at a site was the 2009 ECB installation, especially in cases where the facility manager had changed. Building construction or remodeling projects ordinarily have construction drawings. Yet, only a couple of project files contained such drawings. Having this information would facilitate Company or third-party verification, likely reducing evaluation costs and increasing confidence in the Company-reported installations.
- There were several instances in which the individual project files indicated installation of several related, but specific measures. However, the specific measures were not recorded separately in the tracking system. While the tracking system data did not mention these measures individually, the savings values tracked seem to include them in aggregate. Without the additional project files, the discrepancy between the Company-reported savings

and Global's adjusted gross savings could not have been reconciled and would have led to realization rates with higher variance. Use of the project files allowed Global to include savings for all of the specific measures. If only the tracking system had been used, it would have been difficult to understand the nature of the aggregate measure, so the resulting evaluated savings could have been lower. This was mostly observed for the UI electronic tracking files, since the electronic database contained less detail on the types of measures included in the projects.

- The ECB is positioned mainly as a program for C&I new construction. It seemed evident from both review of the project records and the on-site visits conducted by the Global team, however, that a very high proportion of the PY 2009 projects was straight equipment replacement. The Companies could find it instructive to track whether each project is a completely new facility/addition, a renovation/upgrade, or replacement. While it is not critical to the success of the program, having a better understanding of the pre-program conditions can help the Companies apply the most appropriate baseline efficiency in calculating savings for rebate and reporting purposes.

5.1.3 Recommendations for Improving Project Documentation

Global believes the following changes in program data collection and storage by the Companies will allow for easier access and higher quality in the data:

- The Companies should use the same grouping of measures and the same nomenclature for both the major measure categories and the individual measures themselves in the electronic databases.
- Record and clearly specify all of the measures installed and rebated under the program for each project, including controls, VFDs and project commissioning. Whether as separate line entries or additional fields in the database, this should include standard measure names plus notes that provide more detail on every one of the measures for each project. Other useful information to include would be 1) whether the project is a new construction/addition, renovation/upgrade, or equipment replacement and 2) measures contractors recommend to participants in the original bid, as well as the measures actually installed, so that the Companies can easily learn about remaining potential savings. Consider providing incentives, not necessarily financial, to contractors who provide written recommendations to customers and the Companies that can be included in the tracking system with other project information.
- Add identifying information in all project files about the location of equipment installations. At a minimum, provide identifiers such as the room name (e.g., conference room) or equipment number (e.g., RTU1).
- Convert all paper information describing existing and new equipment, as well as savings and cost documents and project plans, to electronic files. The easiest, most commonly used, and least error-prone way to do this is to scan all the paper documents into a PDF file at the conclusion of each project, then maintain an electronic library of project files.
- Include the methodologies and assumptions used to calculate savings in the individual project files. When applicable, refer to the relevant sections in the PSD.
- Follow the methodologies in the PSD for all prescriptive measures or clearly explain the rationale for using a different approach.

5.2 PROGRAM SAVINGS DOCUMENT (PSD)

The Companies developed the PSD and update it regularly to estimate savings from measures offered under their programs. The version in effect during program year 2009 was the 2009 PSD.[1] As part of this evaluation, Global was asked to review the savings calculations in the 2009

[1] *UI and CL&P Program Savings Document for 2009 Program Year*, The United Illuminating Company, New Haven, CT and Connecticut Light & Power Company, Hartford, CT: Oct 2008.

PSD to see if they were appropriate and being applied consistently in the Company-reported savings estimates. In addition, Global reviewed the 2011 PSD[2] to see if changes had been made that would have improved the savings calculations relative to the 2009 version.

5.2.1 What's Working Well

By its very nature, the PSD is not a perfect tool for quantifying energy and demand savings, nor is it intended to be. Its purpose is to estimate savings based on engineering algorithms, regional building and weather characteristics, and measured savings from replicable projects. The methods and look up tables are designed to yield reasonably approximate savings values for equipment installed in prototypical building types. Since it is improbable that actually equipment and building operation details are known prior to project implementation, the algorithms in the PSD are usually the most reasonable methods to apply. This inherent limitation is true for analogous documents across other utility programs.

With that said, Global found the methods generally to be very appropriate and consistent with prescriptive savings methodologies used elsewhere. In addition, the PSD was very easy to use for prescriptive measures.

5.2.2 Current Challenges

Review of the PSD showed four primary challenges:

- The ECB program is targeted at the new construction/major renovation segment, but is available to all customers. However, the required assumptions and inputs can be different for new construction compared to existing buildings, but the measures referenced in the PSD do not account for that difference. As such, applying the assumptions and inputs provided in the PSD to new construction participants of the ECB program may introduce additional errors into the Company-reported savings estimates. For example, since newly constructed buildings tend to be better insulated than existing buildings, assumptions for cooling and heating impacts may not be accurately represented by the ECB program.
- The calculation methodologies for some Cooling and Heating measures in the program are not explicitly addressed in the PSD because the measures do not lend themselves to a prescriptive approach; these are custom measures. Most notably, both central chillers and CO_2-controlled ventilation are custom measures; for these, neither the PSD nor the program documentation provides any indication about the methodologies or simulation tools used to estimate savings. While this is somewhat understandable since the savings due to these measures cannot be properly derived by using a simplified formula, this forces the Companies or trade allies to develop their own estimates, which were not documented (at least the documentation was not given to Global). Global found that many of the Company-reported savings estimates for measures of this type did not closely match the adjusted results. Documentation of the methods used to estimate savings is very important.
- Similar to above, many of the Process and Other measures are considered custom energy efficiency measures. The PSD provides only generic guidance on commercial and industrial custom measures. There is very little specific guidance as to the most appropriate method to calculate baseline and compliance efficiencies, as these methods depend on the process. Given this minimal guidance, Global relied on the operation data from the data loggers and engineering judgment to determine savings estimates. It is unlikely that future editions of the PSD can include more specific guidance on appropriate methods to estimate energy savings for most process-specific measures. However, one possible exception may be new air compressors. Many electric utilities incentivize the replacement of air compressors, and their energy efficiency benefits are well established.
- For some measures, the formulas in the PSD were not used entirely correctly, as evidenced by values in the tracking system differing from the PSD-derived results, which Global

[2] *UI and CL&P Program Savings Document for 2011 Program Year*, The United Illuminating Company, New Haven, CT and Connecticut Light & Power Company, Hartford, CT: Sep 2010.

calculated for comparison. For example, the HVAC interaction adjustment for summer peak demand was not calculated according to the PSD for at least two of the sites (Lighting04 and Lighting05); the program documentation used a factor of 0.146, while the PSD prescribed a factor of 0.3042.

- Comparison of the adjusted results – which were derived by Global with actual operating data – to the PSD-calculated savings implies that the operating assumptions in the PSD do not always hold true. This is particularly true for Rooftop Units, high performance lighting, and heat pumps in the heating mode (see following subsections for more details).

5.2.2.1 Rooftop Units (RTUs)

The PSD provides a formula for estimating the savings due to RTUs. One of the inputs to the formula is a list of full load hours by building type. The cooling full load hours contain embedded assumptions that are intended to capture all of the variables that determine the cooling load of a building for the entire year (e.g., the building construction, efficiencies of other building systems, operational hours, climate, etc.). Global did not use the full load hours from the PSD in the DOE-2 modeling and estimation of the adjusted savings estimates, but did calculate the RTU savings based on the PSD methodology in order to obtain a point of comparison for the adjusted figures.

Global noticed a trend in the modeling and analysis of RTU savings, where the Company-reported savings are higher than Global's adjusted savings. Global speculates that the full load hours provided in the PSD are generally high, which would yield higher savings when using the PSD methodology compared to the DOE-2 modeling approach that uses actual operating data. Part of the discrepancy may be related to the fact that the PSD does not specifically address new construction, as mentioned previously. It is reasonable to expect that operating hours for space conditioning equipment in older buildings would be higher than in new construction.

5.2.2.2 High Performance Lighting

For high performance lighting, the Company-reported savings were derived using the difference between the site's lighting power density and the ASHRAE 90.1 standard, multiplied by the building's floor area and operating hours as prescribed in the PSD. This approach yields reasonable estimates if all lighting is turned on and off at the same time, under both baseline conditions and new conditions. In reality, this rarely happens. In some locations, only a fraction of the lighting is brought on initially, and more is added as the day progresses. In other cases, the lighting may be on for significantly more or fewer hours than was assumed initially. It should be emphasized that given the limited pre-installation data available on operating patterns for most projects, determining savings using the lighting power density method is an acceptable method, and it is widely used.

On a site by site basis, Global's measurements of operating hours for lighting often differed from those prescribed in the PSD; some were higher, others were lower. However, on average for the program, the net effect was that the realization rate for Lighting is very close to unity.

5.2.2.3 Heat Pumps

During site visits, Global's data logging measurements revealed that operating hours for heat pumps during the winter for heating were considerably lower than assumed in the PSD. As a result, Global's adjusted savings for heat pump measures were lower than the Company-reported values.

5.2.3 Comments on the 2011 PSD

For the most part, there were no significant changes between the 2011 and the 2009 versions of the PSD. It appears that all formula, full-load operation hours, and peak coincidence factors remain the same. However, Global did note the following items which would have affected adjusted savings estimates of some measures, if Global had used the 2011 PSD:

- The 2011 PSD redefined the baseline efficiency levels of chillers, packaged cooling units, and packaged heat pump units. In some cases, the new baseline efficiency levels are slightly higher than what Global used as the baseline in the adjusted savings analyses. This would result in a lower savings figure if Global were to use the 2011 PSD baseline efficiencies (since there would be a smaller difference between the baseline and the installed equipment efficiencies).

  - **Chillers:** The 2011 PSD baseline efficiency levels are higher than the IECC 2003 and IECC 2006 building codes. Global used the IECC building codes as the baseline for non-government buildings.
  - **Packaged cooling and heat pump units:** The 2011 PSD baseline efficiency levels are higher than the IECC 2003, IECC 2006, as well as ASHRAE 90.1-2007 (for buildings constructed before Jan. 1, 2010). So essentially all of Global's savings estimates for packaged units would be lower if the 2011 PSD baseline efficiencies had been used.

- The 2011 PSD redefined the baseline efficiency levels of motors by dividing motors into two separate categories: Subtype I and Subtype II. It appears that most HVAC motors would fall under Subtype I. The 2011 PSD baseline efficiency levels for Subtype I are higher than the baseline efficiency levels defined in the IECC 2003, IECC 2006, as well as ASHRAE 90.1-2007 building codes. As such, Global's savings estimates for HVAC motors would be slightly lower if the 2011 PSD baseline efficiencies had been used.

However, it is important to note that all of the above discussion is essentially moot for this PY 2009 evaluation, since Global was directed to use the building codes in effect at the time the energy-efficiency project was contracted as the baseline.

5.2.4 Recommendations for Improving the PSD

The Companies currently have several studies in process that will inform and improve the accuracy of future savings estimates. Global believes the following changes in the PSD and supporting calculation tools will aid that effort:

- Develop, and include in the PSD, methodologies, assumptions, and formulas that are specific to the targeted population of customers in the ECB program (i.e., C&I new construction or major renovation).
- Provide more information on how the savings are derived for custom measures, either in the PSD or in supporting documentation or software tools. This will enable a better understanding of the differences in the estimation methodologies between Company-reported and adjusted savings calculations and should help reveal causes of discrepancies.
- For Lighting measures, consider a more accurate approach that involves assigning lighting groups to specific areas within the facility and then assigning operating hours to those specific areas based on the function of the particular space.
- For Cooling and Heating measures, conduct a study to examine and possibly adjust cooling and heating full load hour assumptions for new construction projects.[3]
- Consider including more specific guidance on appropriate methods to estimate energy savings of air compressors. Many electric utilities incentivize the replacement of air compressors, and their energy efficiency benefits are well established. For example, the current version of the *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs: Residential, Multi-Family, and Commercial/Industrial Measures* (October 15, 2010)[4] contains a methodology for estimating energy and peak demand savings for air compressor upgrades.

[3] Though Global noticed some problems with the PSD's HVAC full load hours, deriving a new set of full load hour data based on the metering results and then recommending that the Companies use this new set instead of the values in the PSD would be inappropriate. This is because Global would have to derive the figure for each building type, and the sample of metering data for each type of building is not large enough to properly define a new set of full load hours.

[4] This document is available for download at http://www.dps.state.ny.us/TechManualNYRevised10-15-10.pdf.

SAMPLE DESIGN

This appendix describes the process Global went through to design a statistically representative sample of the ECB program participants for 2009. The sample was designed to be as unbiased as possible and to achieve various levels of target accuracy for the major measure groups and for the program as a whole.

The first step was to define the population associated with the evaluation. The population was based on all electric measure ECB projects completed in 2009 by either CL&P or UI. It included both rebate and contract projects. The individual members of the population were the combination of customer and measure type. There were often multiple measures per measure type (say, three motors replaced); these were combined into one unit in the population. In addition, there were often multiple measure types for an individual project at a customer site; in these cases, there were multiple units in the population at the customer site, since each measure type was a separate unit in the population. So a customer that included, say, three Motor measures, a Cooling measure, and a Heating measure was considered to have three units in the population.

The population was defined by the records in the database files provided by the Companies. The Companies denoted or removed records that were included for accounting reasons related to things that are not specific measures (things like design incentives, reserve projects, gas measure projects, and the like); Global excluded those measure-sites from the population. Each unit in the population also had a predicted kWh savings and summer and winter predicted kW savings. These numbers were used as proxies for the estimated kWh and summer & winter kW savings that were calculated in the evaluation, to optimize the stratification and calculate the required sample sizes to achieve the target accuracy for each major measure group and the total program.

Once the databases were filtered to remove all extraneous records, the two Company databases were combined into one population database that served as the sampling frame. Each record was the combination of all the same measure type records for a specific customer. Each of the individual measure types was mapped into the major measure groups as well. Each record included the project number/customer identifier, the measure type, the major measure group, the start date of the project, and the three predicted energy savings (kWh, summer kW, and winter kW). This represented the sampling frame from which the sample was designed and drawn.

Based on conversations with the EEB Project Manager and on the project data provided by CL&P and UI, Global grouped the measures into five major measure categories:

- Cooling measures
- Heating measures
- Lighting measures
- Process measures
- Other measures, including
    - Motor
    - Envelope
    - Refrigeration
    - VAR (Variable Frequency Drive, or VFD)
    - EMS (Energy Management System)
    - Other

Global designed a sample for each major measure type in the same general manner, and then combined those sample designs into one large sample design to estimate the savings for the program.

In order to take advantage of cost and time savings associated with including multiple measures at a given site in the sample, Global chose to stratify based on the number of measures at each site as well as on the energy savings for individual measures. The measures at sites with one or two measure types were put in one group, while the sites with three or four major measure types were put in a separate group (there were no sites with all five major measure types). It is important to note that the population was still measure-types at sites, rather than sites. But, the population was divided into both of these two groups. By stratifying in this way, Global retained statistical validity, but was able to take advantage of monitoring multiple measure types at many (but not all) sites.

Each major measure type was originally split into five strata:

- Stratum 1 – lower savings measures at one- or two-measure type sites
- Stratum 2 – higher savings measures at one- or two-measure type sites
- Stratum 3 – the very highest savings measures at one- or two-measure type sites
- Stratum 4 – most of the measures at three- and four-measure sites
- Stratum 5 – measures that were at the very highest three- and four-measure sites

For heating, there were only a few measures at one- or two-measure sites, so Global combined strata 1 and 2 into stratum 1. For process, there was only one process measure that was part of a three- or four-measure site, so Global added that in with the rest of the process measures, and used only the first three strata for process. This resulted in a total of 22 strata instead of 25.

Global used a Delanius-Hodges minimum variance stratification approach to determine the optimal stratum breakpoints between stratum 1 and stratum 2 for each major measure type.

Global then calculated the required sample sizes by major measure type to achieve the following target accuracy levels on kWh savings for each major measure group:

- Cooling measures – 10% error with 80% confidence
- Heating measures – 18% error with 80% confidence
- Lighting measures – 10% error with 80% confidence
- Process measures – 12% error with 80% confidence
- Other measures – no specific accuracy target for Other by itself, but sample will achieve about 25% error with 80% confidence
- The target accuracy for the program as a whole was set at 10% error with the more stringent 90% confidence

Global then used Neyman allocation to allocate the sample points to the strata, for strata 1, 2, and 4 (strata 3 and 5 were census strata, with all cases included).

Global then selected the sample from the population, using the required sample sizes calculated as described above. For strata 1-3, this resulted in the sample. However, for stratum 4, it was not quite so simple. Because the multi-measure sites had different combinations of the major measure types, Global could not control which measure types the selected sites would include. So, Global selected 20 stratum 4 customers, which resulted in enough of each of the major measure types to cover what was needed. But, for everything except heating, Global had more than necessary. So, Global selected a random subsample of each measure from the 20 selected sites, which resulted in the necessary sample size for each measure for stratum 4. Global also did the same thing for "other" for stratum 5, since there was no specific accuracy target for the other major measure group. The resulting sample sizes by stratum are shown in Table A-1 on the following page.

Table A-1 Sample Sizes by Stratum

Major Measure Group	Stratum	Population	Sample Size	Single/Multi Measure Site	Sample/ Census
Cooling	1	180	6	Single	Sample
Cooling	2	36	15	Single	Sample
Cooling	3	1	1	Single	Census
Cooling	4	28	9	Multi	Sample
Cooling	5	7	7	Multi	Census
	Total:	**252**	**38**		
Heating	1	17	8	Single	Sample
Heating	3	2	2	Single	Census
Heating	4	24	15	Multi	Sample
Heating	5	4	4	Multi	Census
	Total:	**47**	**29**		
Lighting	1	97	6	Single	Sample
Lighting	2	23	9	Single	Sample
Lighting	3	3	3	Single	Census
Lighting	4	28	12	Multi	Sample
Lighting	5	7	7	Multi	Census
	Total:	**158**	**37**		
Other	1	72	4	Single	Sample
Other	2	28	7	Single	Sample
Other	3	1	1	Single	Census
Other	4	39	5	Multi	Sample
Other	5	14	10	Multi	Sample
	Total:	**154**	**27**		
Process	1	67	3	Single	Sample
Process	2	41	13	Single	Sample
Process	3	2	2	Single	Census
	Total:	**110**	**18**		
	Grand Total:	**721**	**149**		

The sample included 100 physical locations, with 80 single-measure sites and 20 multiple-measure sites.

For strata 1 and 2, Global chose the primary sample points and then also randomly selected an equal number of backup sample points. The backup sample points were only used to replace customers that were no longer in business. Making every effort to recruit the primary sample points helped reduce the possibility of sampling bias. Global did not choose backups for the two census strata (3 and 5) since all customers in those strata were included in the sample. Global also did not choose backups for the stratum 4 customers, since the use of a backup would most likely have changed the resulting sample size for the various measures.

Before data collection started, Global also validated the sample, using it to estimate the known energy savings totals. The resulting simulated accuracy was slightly better than the target accuracy in all cases except for heating. For heating, there were not sufficient stratum 4 customers available in the sample, so the accuracy was slightly lower than the design accuracy.

The accuracy target for the program as a whole was 10% error with 90% confidence. The sample design used, with the sample selected, achieved a bit better than this for the known company-reported energy totals – about 8.6% simulated accuracy at 90% confidence.

While the validation check is important as a verification of the sample design, it is still a prediction based on the best information available at the beginning of the study, before any on-site data are collected and analyzed. Once the data collection is complete, the actual achieved precision can be calculated. If the data are comparable to what was assumed in the sample design, the achieved precision levels should be about the same as the target precision levels used in the sample design. Table A-2 below shows the target precision levels and the actual achieved precision levels by measure and in total. The actual achieved precision levels are met or exceeded in all cases except for Lighting.

Table A-2 Achieved Precision of the Savings Estimates

Major Measure Group	Confidence Level for Precision	Target kWh Relative Precision	Adjusted Annual kWh Savings Relative Precision
Cooling	80%	10%	6.8%
Heating	80%	18%	7.3%
Lighting	80%	10%	12.9%
Process	80%	12%	4.7%
Other	80%	25%	23.1%
Total	**90%**	**10%**	**9.3%**

ON-SITE DATA COLLECTION

This appendix describes the methodology that Global and its subcontractor, Lime Energy, followed when collecting program impact data at the facilities of ECB program participants. The data collected during this process were used to develop customer load shapes and to estimate ECB program impacts for 2009.

DATA COLLECTION APPROACH

Preparing for the Site Visit

The analysis for development of load shapes and estimation of savings required data about the project equipment and the site. For some projects, these data were collected during the project development phase and were contained in a limited extent in the project "paper files," which were made available to Global by the Companies. Before the site visit, Global reviewed the information provided by the Companies on the specific site and measure(s) to be evaluated to extract as much information on the site and equipment characteristics as possible. The information was captured on a spreadsheet referred to as a metering information sheet (MIS). During the site visit, critical missing information was collected by site visit staff.

The MIS contained information about the facility, inventories of the equipment to be verified and monitored, and data logging recommendations. The MIS also provided information fields for the site visit staff to fill in during their facility walkthrough. Table B-1 lists the type of information in the MIS provided by Global and Table B-2 lists the data requested of the site visit staff. Each MIS was customized for the type of equipment included in the sample points for the site. The information provided by Global and requested of the site visit staff reflected the type of information needed for the subsequent analysis of gross impacts.

Site Visit

As Global recruited customers, the customers were contacted by site visit staff to schedule the site visits. Site visits were carried out by a lead energy engineer. In many cases the engineer was also accompanied by an electrician/technician. Most site visits were conducted by Lime Energy staff, but Global staff carried out a portion of the visits in order to maintain the project schedule.

Verification and Measurement

Upon arrival at the customer's facility, the site visit staff verified installation of the equipment in the sample and noted facility characteristics from a visual inspection of the facility or directly from facility operating personnel, whichever was most appropriate. Additionally, if the customer had not yet completed the on-line survey, the site visit staff requested that they do so.

The site visit staff collected two types of data that were subsequently used in the impact evaluation: 1) general data on facility and equipment characteristics, which were input into the MIS; and 2) equipment measurement data. The measurement data were in one of two forms, depending on whether load loggers or light loggers were used for monitoring.

Table B-1 Metering Information Sheet: Data Provided to the Site Visit Staff by Global

Customer Information ECB Project Number: Account Number: Customer Name: Site Address: Contact Name: Contact Phone: Contact Email: Special Instructions:	
Measures in Sample Measure #1 (Description, Type of Sample Point): Measure #2 (Description, Type of Sample Point): Etc.	
Equipment Details *(For each type of equipment in each measure)* Equipment ID / Location: Equipment Description: Size (tons, hp, etc.): Quantity: Model: Metering Recommendation	

Table B-2 Metering Information Sheet: Data Input by the Site Visit Staff While On-Site

Data Collection Status Date(s) of On-Site Visit: Status of On-Line Survey:	
General Building Information Primary Use of Building (offices, retail, etc.): Total Building Floor Area (square feet): Total Number of Floors in Building: Construction of Building (brick, concrete, etc.): Approx. % of Walls Covered by Windows/Glazing:	
Equipment in the Sample *(For each type of equipment in each measure)* Existence Verified? (Y/N): Typical Operating Hours: Metered? (Y/N): Description of Metered Sample: Number of Units Included in Metered Sample: Date Meters Installed: Date Meter Removed: If Not Metered, Why?: Other Notes/Problems/Issues:	

Installation of Load Logging Equipment

The site visit staff deployed load logging devices on the space conditioning, process, and “other” energy-efficient equipment in the sample. In some cases, it was also installed on lighting circuits associated with the lighting sample (see following subsection).

The load loggers were used in accordance with OSHA safety requirements. All current transformers (CTs) were installed with the directional arrows in the proper direction on the conductors and all voltage clamps were secured. The electrical box or panel into which the CTs and voltage clamps were placed was closed as much as possible and safety precautions were taken to warn others of the danger if the box could not be completely closed.

The load loggers were set with a sampling rate of at least 15 minutes and were left in place for a minimum of seven days, but most equipment was monitored for two weeks or more. While on-site, the site visit staff confirmed that the customer did not plan any unique or irregular operations during the measurement period, such as a maintenance shut down or any unusual operational changes that would distort the collected data.

The load loggers measured current (amps). The current was converted to instantaneous load (kW) and interval energy use (kWh) by use of spot measurements of power (Watts), voltage (volts), current (amps), and kilovolt-amps. The site visit staff made the spot measurements at the beginning and end of the data collection period and then averaged the results and determined the power factor (PF). The amps recorded by the data logger were multiplied by the volts, SQRT(3), and PF and divided by 1,000 to calculate the instantaneous electrical demand in units of kilowatts for each data point:

Instantaneous power (kW) = Amps X Volts X SQRT(3) X PF / 1,000

The data point kilowatt value was then multiplied by the data interval in hours to calculate the energy in units of kWh per data interval.

Installation of Light Logging Equipment

Light loggers measure the light intensity (lumens/sq ft) or on/off status of the lights to which they are attached as a function of time. The measured data reflect the operational patterns of the lighting. For loggers with the capability to measure light intensity, the data can also indicate whether or not the lights are dimmed. The site visit staff deployed light logging equipment at the majority of the customer facilities in the lighting sample. However, during early site visits, load monitoring equipment was installed on lighting circuits to measure the operational characteristics. After these early visits, light loggers were determined to be the easiest and more effective way to isolate the operation of specific lighting.

The on-site staff used a sampling rate of at least 15 minutes and a data collection period of at least seven days with the light loggers. While on-site, the site visit staff confirmed that the customer did not plan any unique or irregular operations during the monitoring period, such as a maintenance shut down or any unusual operational changes that would distort the collected data.

To determine the demand associated with lighting, the site visit staff visually inspected the lamps and ballasts and recorded the wattage. The energy use was calculated by multiplying the demand by the operating hours.

Measurement Methodologies

The measurement methodologies followed during this project are consistent with two options described in Section 5.2 of the ISO New England "Manual for Measurement and Verification of Demand Reduction Value from Demand Resources" (Manual M-MVDR): Option A and Option D. Option A allows for the spot measurement of relevant variables and then the continuous measurement of a proxy variable to determine load shapes. Option A was used for lighting and process equipment as well as for non-weather sensitive "other" measures. Option D employs calibrated computer simulation models of components of buildings or entire buildings to determine load shapes. The accuracy of the simulations is increased by calibrating the model to actual metered data from the equipment being evaluated and/or actual billing data from the site. Option D was used for space conditioning equipment and weather-sensitive "other" measures.

Retrieval of Data Logging Equipment

Obeying all OSHA safety requirements, the site visit staff retrieved the data logging equipment after an appropriate data collection period had elapsed. Upon retrieval, all required spot measurements were recorded on a field data sheet. Then, all logged data was downloaded to a laptop and field checked to verify that the data logging was successful. The site visit staff uploaded the monitoring data to a data repository website for Global to access.

DATA COLLECTION SCHEDULE

There were two phases for impact evaluation data collection. The first phase (Phase 1) took place during the period of July through October 2010. The second phase (Phase 2) took place during the period of November 2010 through January 2011. The measures at customer sites were monitored according to the approach below:

- **Measures with summer loads only:** Monitored during Phase 1, July through September
- **Lighting measures:** Monitored during Phase 1, July through October
- **Process and "other" measures with no weather-dependence:** Monitored during Phase 1 or Phase 2, July through January
- **Measures with winter loads only:** Monitored during Phase 2, November through January
- **Measures with different non-zero loads in summer and winter:** Monitored both during Phase 1 (July through September) and during Phase 2 (November through January)

During both phases, the site visit staff visited the facility to install data logging equipment and observe and record characteristics of the customer's facility. One to four weeks later, the site visit staff returned to the facility to remove the logging equipment from the premises. The logging equipment was in place at the customer's facility at least seven days, but no longer than four weeks. The typical data collection period was two weeks.

INTERVIEW GUIDE

TRADE ALLY INTERVIEWS – ENERGY CONSCIOUS BLUEPRINT PROGRAM

Background
What type of business is [Company Name]?

- Architect
- Engineer
- Contractor (general, facilitator)
- Design/Build contractor
- Other professional, specify: ___________________

How long has your company been in business?

What is your relationship with the utility? Do you typically contact the utility about new projects to determine if they can help with the design or offer incentives? Is there someone at the utility that you regularly work with?

Are you aware of the types of energy efficiency programs the utility is currently offering?

Program Awareness
How did you first hear about the Energy Conscious Blueprint Program?

Is this your first project that involved the ECB program? If not, how long have you worked on ECB projects?

Have you attended any utility sponsored training/workshops or brownbag events? If so, what type of information did you learn at the event (EE measures, the ECB program, codes and standards)?

How familiar are you with building codes and standards? How do you keep up with changes in codes and standards?

Program Participation
How did the customer become involved with the ECB program? In your experience is this typical?

Do you regularly recommend the program to customers? Do customers ask you about the program?

What is your overall satisfaction with the ECB program? What aspects do you specifically value about the program? What do you dislike?

Was there a utility contact for the project? What was his/her role? Was he/she knowledgeable, helpful, easy to work with, etc.? Did he/she recommend controls or equipment that you had not originally included in the design? Did they try to get the customers to incorporate both gas and electric measures?

What are the benefits to your company for participating in the ECB program? Do you think you make more money because of the program? Have a more satisfied customer? Get more repeat business?
Has your awareness of or involvement with the ECB program in any way changed your own practices, for projects outside the program? (e.g., for equipment vendors: had it made you more likely to promote high efficiency or controls for all you clients? for architects: has it influenced what you incorporate into your building designs? for contractors: has it affected your choice of building materials?)

Do you think participation in the ECB program increases the value of the project to the customer?

Once the customer is informed about the program what is the enrollment process?

Have you heard any feedback, either positive or negative, from customers about the enrollment process?

Are customers interested in getting an Energy Star rating for their buildings?

How interested are customers in obtaining the LEED standard for their building? Is that the driver behind many of your more energy efficient projects? How does LEED certification affect participation in the utility program?

What is your perception of the customer's satisfaction with participation in the ECB program? Would they have done the same measures without the program? Does the program make recommendations you make seem more credible?

Do you think the customer's expectations of savings are being met? How about equipment performance?

Equipment Installed
How knowledgeable would you say you are about various energy efficient equipment and controls? How has your participation in the program improved your understanding of the equipment and controls?

How do you typically stay informed about energy efficient equipment? What resources do you use?

Do you specifically promote EE equipment and controls to customers? Why or why not?

What do you see as the benefits of the EE equipment?

Do your projects typically involve integrated designs with energy management systems and controls for HVAC equipment, lighting, etc.? Do these controls include load management controls that allow the customer (or the utility) to shift their energy usage to off-peak times of the day or week? Were you encouraged to recommend/install controls by the utility?

Are customers receptive to including controls in the design? Why or why not?

What EE equipment tends to get installed the most? Why are they installed more than other types of EE equipment? How much does the program influence the installation of the equipment? Is there equipment that customers want to install but the program doesn't cover?

What EE equipment is the hardest sell? Why do you think that is?

Do you think there is more of a program focus on electric or gas equipment? Are customers interested in both electric and gas EE equipment?

Are your projects typically commissioned? Why or why not? How much does commissioning cost?

Do you think the customer's participation in the ECB program affects how they use/maintain the equipment?

What are the biggest barriers to installing EE equipment? (Try to get beyond cost, probe for the following:

- Lack of expertise to identify equipment
- Company purchasing requirements
- Ability to obtain financing
- Recommended equipment not available/ hard to get
- Contractors are not familiar enough with equipment
- We only replace equipment at time of failure
- Hard to believe we'll see the expected savings
- Other projects are higher priority
- Building owner will not approve/difficulty to get owner approval
- Bad economy/non-critical projects on hold
- Company moving/closing facility)

Do you think the ECB program specifically addresses any of these barriers?

Is there any evidence that the market for any EE equipment has been transformed? Is there EE equipment that most customers install without incentives, or promotion?

Future Plans

Do you plan to continue to be involved in the program in the future? Why or why not?

Are there any changes you would like to see in the program? (Probe for specific suggestions.)

PARTICIPANT SURVEY AND SURVEY RESULTS

FINAL DISPOSITION OF THE ON-LINE SURVEY SAMPLE

Sample	Sample Size	Duplicates	Onsite	Completes
UI onsite	35	3	11	10
CL&P Onsite	72	8	2	24
Email	92	0	7	20
Total	199	11	20	54

PARTICIPANT SURVEY RESPONSES

Q lighting	Have you already installed lighting?				
Answered	53				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Yes	5	1	5	9.43%	7.87%
No	48	2	96	90.57%	7.87%
Totals	53	3	101	100.00%	

Q1	What is your title/primary responsibility?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Owner/President/CEO	3	1	3	5.56%	6.11%
Vice President/VP of Operations	4	2	8	7.41%	6.99%
General Manager/Regional Manager	3	3	9	5.56%	6.11%
Facility/Operations Manager	24	4	96	44.44%	13.25%
Energy Manager/Engineer	7	5	35	12.96%	8.96%
Other	13	6	78	24.07%	11.40%
Totals	54	21	229	100.00%	

Q3	What type of project did you complete with the help of the Energy Conscious Blueprint program (select all that apply)?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Percent**	**Value**	**Stderr**	
Equipment replacement	32	59.26%	1	13.11%	
New construction of a building or addition	20	37.04%	2	12.88%	
Remodel of an existing building	13	24.07%	3	11.40%	
Other	2	3.70%	4	5.04%	
Totals	67	100.00%			

Q4	At what point in your project did you begin your participation in this program?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
During the planning, before any decisions were made about equipment selection	27	1	27	50.00%	13.34%
During equipment selection	17	2	34	31.48%	12.39%
After some but not all of the equipment was selected	2	3	6	3.70%	5.04%
After the project was completely designed and the equipment was selected, but not purchased or installed	5	4	20	9.26%	7.73%
Other	3	5	15	5.56%	6.11%
Totals	54	15	102	100.00%	

Q5	Have you been involved in other energy efficiency programs provided by your utility?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Yes	43	1	43	79.63%	10.74%
No	11	2	22	20.37%	10.74%
Totals	54	3	65	100.00%	

Q6	Did your company initiate involvement in these programs before, during or after your involvement in the Energy Conscious Blueprint program?				
Answered	43				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Before	24	1	24	55.81%	14.84%
During	8	2	16	18.60%	11.63%
After	2	3	6	4.65%	6.29%
All of the above	9	4	36	20.93%	12.16%
Totals	43	10	82	100.00%	

Q7	How did you first learn about the Energy Conscious Blueprint program?				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
I approached a contractor/vendor	5	1	5	9.26%	7.73%
I contacted my utility	5	2	10	9.26%	7.73%
I was informed by my utility account representative	24	3	72	44.44%	13.25%
I was informed by an engineer at my utility	1	4	4	1.85%	3.60%
I was informed by a contractor/vendor	11	5	55	20.37%	10.74%
I saw a program brochure	1	6	6	1.85%	3.60%
I saw an insert in my utility bill	0	7	0	0.00%	0.00%
I heard about the program from friends, family, co-workers	1	8	8	1.85%	3.60%
I saw/heard a TV, radio, or newspaper ad	0	9	0	0.00%	0.00%
My utility website	0	10	0	0.00%	0.00%
Totals	54	66	226	100.00%	

Q8	What were the primary reasons your company participated in the Energy Conscious Blueprint program? (Check all that apply)			
Choice	**Frequency**	**Percent**	**Value**	**Stderr**
To identify ways to save energy	43	79.63%	1	10.74%
To acquire the latest technology	17	31.48%	2	12.39%
To save money on electric bills	44	81.48%	3	10.36%
To help protect the environment	26	48.15%	4	13.33%
Previous experience with other efficiency programs	19	35.19%	5	12.74%
Because of rebates/incentives	38	70.37%	6	12.18%
To meet the LEED standard	6	11.11%	7	8.38%
Other	1	1.85%	8	3.60%
Totals	194	100.00%		

Q9a	{Contractor/Vendor/Architect/ Engineer} Influence over decision to participate?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
1 No influence at all	8	1	8	14.81%	9.48%
2	4	2	8	7.41%	6.99%
3	17	3	51	31.48%	12.39%
4	16	4	64	29.63%	12.18%
5 A great deal of influence	9	5	45	16.67%	9.94%
Totals	54	15	176	100.00%	

Q9c	{Utility engineer or account representative} Influence over decision to participate?				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
1 No influence at all	7	1	7	12.96%	8.96%
2	3	2	6	5.56%	6.11%
3	14	3	42	25.93%	11.69%
4	16	4	64	29.63%	12.18%
5 A great deal of influence	14	5	70	25.93%	11.69%
Totals	54	15	189	100.00%	

Q10	Are you aware of any technical trainings or workshops sponsored by United Illuminating/Connecticut Light & Power or by the Connecticut Energy Efficiency Fund about energy efficiency equipment?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Yes	25	1	25	46.30%	13.30%
No	29	2	58	53.70%	13.30%
Totals	54	3	83	100.00%	

Q11	Have you attended any of these trainings or workshops? If so, please specify the training or workshops you attended.				
Answered	25				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Yes	13	1	13	52.00%	19.58%
No	12	2	24	48.00%	19.58%
Totals	25	3	37	100.00%	

Q12	How knowledgeable would you say you are about compliance with building codes and standards?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
1 Not at all knowledgeable	2	1	2	3.70%	5.04%
2	13	2	26	24.07%	11.40%
3	17	3	51	31.48%	12.39%
4	12	4	48	22.22%	11.09%
5 Very knowledgeable	10	5	50	18.52%	10.36%
Totals	54	15	177	100.00%	

Q13	On a scale of 1 to 5, with 1 meaning "Not at all necessary" and 5 meaning "Extremely necessary" how necessary do you think it is for you to learn more about compliance with building codes and standards?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
1 Not at all necessary	1	1	1	1.85%	3.60%
2	9	2	18	16.67%	9.94%
3	16	3	48	29.63%	12.18%
4	17	4	68	31.48%	12.39%
5 Extremely necessary	11	5	55	20.37%	10.74%
Totals	54	15	190	100.00%	

Q14	Have you heard of the energy management approach known as Continuous Energy Improvement (CEI)?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Yes	10	1	10	18.52%	10.36%
No	44	2	88	81.48%	10.36%
Totals	54	3	98	100.00%	

Q15	On a scale of 1 to 5, how interested are you in learning more about Continuous Energy Improvement (CEI)?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
1 Not at all interested	3	1	3	5.56%	6.11%
2	4	2	8	7.41%	6.99%
3	18	3	54	33.33%	12.57%
4	17	4	68	31.48%	12.39%
5 Very interested	12	5	60	22.22%	11.09%
Totals	54	15	193	100.00%	

Q16	Have you heard of the Architecture 2030 challenge?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Percent**	**Value**	**Stderr**	
Yes	0	0.00%	1	0.00%	
No	54	100.00%	108		
Totals	54	100.00%			

Q17	Who helps make the decisions within your company about what equipment is purchased and installed? (Check all that apply)				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Percent**	**Value**	**Stderr**	
Owner/President/CEO	18	33.33%	1	12.57%	
Vice President/VP of Operations	22	40.74%	2	13.11%	
General Manager/Regional Manager	11	20.37%	3	10.74%	
Facility/Operations Manager	31	57.41%	4	13.19%	
Energy Manager/Engineer	10	18.52%	5	10.36%	
Purchasing manager	5	9.26%	6	7.73%	
Accountant	1	1.85%	7	3.60%	
Other	14	25.93%	8	11.69%	
Totals	112	100.00%			

Q17local	Are these decision makers local (e.g., he or she works in the building)?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Yes	46	1	46	85.19%	9.48%
No	8	2	16	14.81%	9.48%
Totals	54	3	62	100.00%	

Q18	Who makes the final decision? (coded open ended responses)			
Answered	54			
Skipped	0			
Choice	**Frequency**	**Percent**		
Respondent	3	5.56%		
Group Decision	6	11.11%		
Owner	7	12.97%		
V.P	7	12.97%		
President	4	7.40%		
Board of Directors	4	7.40%		
Facility Manager/Engineer	7	12.97%		
Varies	5	9.25%		
Other	11	20.37%		
Totals	54	100.00%		

Q19	What kind of financial criteria do new equipment purchases need to meet?			
Answered	54			
Skipped	0			
Choice	**Frequency**	**Percent**	**Value**	**Stderr**
A minimum payback period	31	57.41%	1	13.19%
A specific return on investment	26	48.15%	2	13.33%
Other	10	18.52%	3	10.36%
Totals	67	100.00%		

Q20	What is the minimum payback period your company requires?	
Answered	35	
Skipped	0	
Open Ended Response	**Frequency**	**Percent**
1 year	4	11.44%
2 years	6	17.14%
3 years	14	40.00%
4 years	1	2.85%
5 years	6	17.14%
6 years	2	5.71%
10 years	2	5.71%
Totals	35	100.00%

Q21	What is the minimum return on investment your company requires?	
Answered	26	
Skipped	0	
Open Ended Response	**Frequency**	**Percent**
3%	1	3.84%
5%	3	11.55%
8%	1	3.84%
10%	2	7.69%
25%	2	7.69%
30%	3	11.55%
40%	2	7.69%
50%	6	23.08%
92%	1	3.84%
95%	1	3.84%
100%	3	11.55%
200%	1	3.84%
Totals	26	100.00%

Q22	Thinking back to when you first learned about this program and talked to a utility representative, to what extent were the program requirements and process clearly explained, on a scale of 1 to 5 with a 1 meaning "not at all" and a 5 meaning "very much"?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
I did not speak with a utility representative	7	0	0	12.96%	8.96%
1 Not at all	1	1	1	1.85%	3.60%
2	5	2	10	9.26%	7.73%
3	10	3	30	18.52%	10.36%
4	18	4	72	33.33%	12.57%
5 Very much	13	5	65	24.07%	11.40%
Totals	54	15	178	100.00%	

Q23	Based on your understanding of the program, what did you expect? (coded open ended responses)			
Answered	53			
Skipped	1			
Choice	**Frequency**	**Percent**		
Incentive/rebate/savings	22	41.50%		
Information/feedback on equipment selection/design	18	33.97%		
Not sure/No expectations	4	7.55%		
Other	9	16.98%		
Totals	53	100.00%		

Q24	Please rate how well the program met your expectations?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
1 Not at all	1	1	1	1.85%	3.60%
2	0	2	0	0.00%	0.00%
3	13	3	39	24.07%	11.40%
4	24	4	96	44.44%	13.25%
5 Very much	16	5	80	29.63%	12.18%
Totals	54	15	216	100.00%	

Q25	Using a five-point scale, with 1 meaning "very difficult" and 5 meaning "very easy", how difficult or easy was it to finalize the Letter of Agreement?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
1 Very difficult	1	1	1	1.85%	3.60%
2	2	2	4	3.70%	5.04%
3	14	3	42	25.93%	11.69%
4	20	4	80	37.04%	12.88%
5 Very easy	17	5	85	31.48%	12.39%
Totals	54	15	212	100.00%	

Q26a	{The professionalism of the utility staff} On a scale of 1 to 5, with a 1 meaning "not at all satisfied" and a 5 meaning "very satisfied," how satisfied you were with respect to:				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
1 Not at all satisfied	0	1	0	0.00%	0.00%
2	1	2	2	1.85%	3.60%
3	5	3	15	9.26%	7.73%
4	11	4	44	20.37%	10.74%
5 Very satisfied	32	5	160	59.26%	13.11%
Not applicable/no staff interaction	5	6	30	9.26%	7.73%
Totals	54	21	251	100.00%	

Q26b	{The knowledge and expertise of the utility staff} On a scale of 1 to 5, with a 1 meaning "not at all satisfied" and a 5 meaning "very satisfied," how satisfied you were with respect to:				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
1 Not at all satisfied	0	1	0	0.00%	0.00%
2	1	2	2	1.85%	3.60%
3	7	3	21	12.96%	8.96%
4	13	4	52	24.07%	11.40%
5 Very satisfied	28	5	140	51.85%	13.33%
Not applicable/no staff interaction	5	6	30	9.26%	7.73%
Totals	54	21	245	100.00%	

Q26c	{The level of support provided by utility staff} On a scale of 1 to 5, with a 1 meaning "not at all satisfied" and a 5 meaning "very satisfied," how satisfied you were with respect to:				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
1 Not at all satisfied	1	1	1	1.85%	3.60%
2	0	2	0	0.00%	0.00%
3	9	3	27	16.67%	9.94%
4	13	4	52	24.07%	11.40%
5 Very satisfied	25	5	125	46.30%	13.30%
Not applicable/no staff interaction	6	6	36	11.11%	8.38%
Totals	54	21	241	100.00%	

Q26d	{The program overall} On a scale of 1 to 5, with a 1 meaning "not at all satisfied" and a 5 meaning "very satisfied," how satisfied you were with respect to:				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
1 Not at all satisfied	1	1	1	1.85%	3.60%
2	0	2	0	0.00%	0.00%
3	6	3	18	11.11%	8.38%
4	16	4	64	29.63%	12.18%
5 Very satisfied	28	5	140	51.85%	13.33%
Not applicable/no staff interaction	3	6	18	5.56%	6.11%
Totals	54	21	241	100.00%	

Q27a	{The design process (e.g., helping you decide which equipment and controls would suit your needs)} How helpful was the utility staff in the design process and the final result?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
1Not at all helpful	2	1	2	3.70%	5.04%
2	6	2	12	11.11%	8.38%
3	9	3	27	16.67%	9.94%
4	10	4	40	18.52%	10.36%
5Very helpful	13	5	65	24.07%	11.40%
Not applicable	14	6	84	25.93%	11.69%
Totals	54	21	230	100.00%	

Q28	On a scale from 1 to 5 with a one meaning "not at all" and a 5 meaning "very much," how much did your participation in the program improve your knowledge of the energy efficient technologies and/or processes that would benefit your business?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
1 Not at all	1	1	1	1.85%	3.60%
2	3	2	6	5.56%	6.11%
3	28	3	84	51.85%	13.33%
4	17	4	68	31.48%	12.39%
5 Very much	5	5	25	9.26%	7.73%
Totals	54	15	184	100.00%	

Q29a	{The ease of selecting equipment for this project that qualified for an incentive } On a scale of 1 to 5, with a 1 meaning "not at all satisfied" and a 5 meaning "very satisfied," indicate how satisfied you were with:				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
1 Not at all Satisfied	1	1	1	1.85%	3.60%
2	1	2	2	1.85%	3.60%
3	10	3	30	18.52%	10.36%
4	30	4	120	55.56%	13.25%
5 Very Satisfied	12	5	60	22.22%	11.09%
Totals	54	15	213	100.00%	

Q29c	{The utility bill savings resulting from the equipment you installed} On a scale of 1 to 5, with a 1 meaning "not at all satisfied" and a 5 meaning "very satisfied," indicate how satisfied you were with:				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
1 Not at all Satisfied	1	1	1	1.85%	3.60%
2	0	2	0	0.00%	0.00%
3	19	3	57	35.19%	12.74%
4	30	4	120	55.56%	13.25%
5 Very Satisfied	4	5	20	7.41%	6.99%
Totals	54	15	198	100.00%	

Q29d	{The final incentive amounts relative to your initial expectations} On a scale of 1 to 5, with a 1 meaning "not at all satisfied" and a 5 meaning "very satisfied," indicate how satisfied you were with:				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
1 Not at all Satisfied	2	1	2	3.70%	5.04%
2	2	2	4	3.70%	5.04%
3	10	3	30	18.52%	10.36%
4	27	4	108	50.00%	13.34%
5 Very Satisfied	13	5	65	24.07%	11.40%
Totals	54	15	209	100.00%	

Q30	Did your organization work with any the following professionals for the measures installed through the Energy Conscious Blueprint program? (Check all that apply)			
Answered	54			
Skipped	0			
Choice	**Frequency**	**Percent**	**Value**	**Stderr**
Architect	20	37.04%	1	12.88%
Building Designer	9	16.67%	2	9.94%
Equipment vendor	26	48.15%	3	13.33%
General Contractor	20	37.04%	4	12.88%
Mechanical or Electric Engineer	28	51.85%	5	13.33%
Other	2	3.70%	6	5.04%
Totals	105	100.00%		

Q31	Had you worked with any of these professionals before the Energy Conscious Blueprint program?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Yes	34	1	34	62.96%	12.88%
No	14	2	28	25.93%	11.69%
Don't know	6	3	18	11.11%	8.38%
Totals	54	6	80	100.00%	

Q32a	{Architect} How important was the input from each professional in deciding which specific equipment was eventually installed?				
Answered	20				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
1 Not at all important	0	1	0	0.00%	0.00%
2	3	2	6	15.00%	15.65%
3	10	3	30	50.00%	21.91%
4	5	4	20	25.00%	18.98%
5 Very important	2	5	10	10.00%	13.15%
Totals	20	15	66	100.00%	

Q32b	{Building Designer} How important was the input from each professional in deciding which specific equipment was eventually installed?				
Answered	9				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
1 Not at all important	0	1	0	0.00%	0.00%
2	0	2	0	0.00%	0.00%
3	3	3	9	33.33%	30.80%
4	5	4	20	55.56%	32.46%
5 Very important	1	5	5	11.11%	20.53%
Totals	9	15	34	100.00%	

Q32c	{Equipment Vendor} How important was the input from each professional in deciding which specific equipment was eventually installed?				
Answered	26				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
1 Not at all important	0	1	0	0.00%	0.00%
2	1	2	2	3.85%	7.39%
3	5	3	15	19.23%	15.15%
4	5	4	20	19.23%	15.15%
5 Very important	15	5	75	57.69%	18.99%
Totals	26	15	112	100.00%	

Q32d	{General contractor} How important was the input from each professional in deciding which specific equipment was eventually installed?				
Answered	20				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
1 Not at all important	1	1	1	5.00%	9.55%
2	3	2	6	15.00%	15.65%
3	4	3	12	20.00%	17.53%
4	7	4	28	35.00%	20.90%
5 Very important	5	5	25	25.00%	18.98%
Totals	20	15	72	100.00%	

Q32e	{Mechanical or Electrical Engineer} How important was the input from each professional in deciding which specific equipment was eventually installed?				
Answered	28				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
1 Not at all important	0	1	0	0.00%	0.00%
2	0	2	0	0.00%	0.00%
3	2	3	6	7.14%	9.54%
4	11	4	44	39.29%	18.09%
5 Very important	15	5	75	53.57%	18.47%
Totals	28	15	125	100.00%	

Q32f	{Other} How important was the input from each professional in deciding which specific equipment was eventually installed?				
Answered	2				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
1 Not at all important	0	1	0	0.00%	0.00%
2	0	2	0	0.00%	0.00%
3	0	3	0	0.00%	0.00%
4	2	4	8	100.00%	0.00%
5 Very important	0	5	0	0.00%	0.00%
Totals	2	15	8	100.00%	

Q33	How important was the input from the utility staff in deciding which specific equipment was eventually installed?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
1 Not at all important	2	1	2	3.70%	5.04%
2 Somewhat unimportant	5	2	10	9.26%	7.73%
3 Neither unimportant or important	10	3	30	18.52%	10.36%
4 Somewhat important	16	4	64	29.63%	12.18%
5 Very important	10	5	50	18.52%	10.36%
I did not speak with a utility representative	11	0	0	20.37%	10.74%
Totals	54	15	156	100.00%	

Q34	Did your company implement all of the design recommendations to improve the energy efficiency of your project?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Yes	44	1	44	81.48%	10.36%
No	10	2	20	18.52%	10.36%
Totals	54	3	64	100.00%	

Q35*	Were measures other than lighting recommended?				
Answered	5				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Yes	4	1	4	80.00%	35.06%
No	1	2	2	20.00%	35.06%
Totals	5	3	6	100.00%	
*Asked only of those respondents who only had lighting installed as part of the project.					

Q36	What other measures were recommended?			
Answered	4			
Skipped	0			
Choice	**Frequency**	**Percent**	**Value**	**Stderr**
Cooling	2	50.00%	1	49.00%
Heating	1	25.00%	2	42.44%
Process	2	50.00%	3	49.00%
Lighting controls	1	25.00%	4	42.44%
Other controls	0	0.00%	5	0.00%
Motors	3	75.00%	6	42.44%
Refrigeration	0	0.00%	7	0.00%
Variable speed drives	3	75.00%	8	42.44%
Energy management systems	3	75.00%	9	42.44%
Building envelope	1	25.00%	10	42.44%
Other	0	0.00%	11	0.00%
Totals	16	100.00%		

Q37	Why didn't you install measures other than lighting? (Check all that apply)			
Answered	1			
Skipped	0			
Choice	**Frequency**	**Percent**	**Value**	**Stderr**
Lack of expertise to identify equipment	0	0.00%	1	0.00%
Company purchasing constraints	1	100.00%	2	0.00%
Inability to obtain financing	0	0.00%	3	0.00%
Recommended equipment not available/ hard to get	0	0.00%	4	0.00%
Contractors are not familiar enough with equipment	0	0.00%	5	0.00%
We only replace equipment at time of failure	0	0.00%	6	0.00%
Hard to believe we'll see the expected savings	0	0.00%	7	0.00%
Other projects are higher priority	0	0.00%	8	0.00%
Building owner will not approve/difficulty to get owner approval	1	100.00%	9	0.00%
Bad economy/non-critical projects on hold	0	0.00%	10	0.00%
Recommended action was too expensive	0	0.00%	11	0.00%
Installing the recommendations would be too disruptive	0	0.00%	12	0.00%
Didn't understand recommendations/needed more information	0	0.00%	13	0.00%
Incentive wasn't large enough	1	100.00%	14	0.00%
Other	0	0.00%	15	0.00%
Totals	3	100.00%		

Q38	What prevented your company from implementing all of the design recommendations? (Check all that apply)?			
Answered	9			
Skipped	0			
Choice	**Frequency**	**Percent**	**Value**	**Stderr**
Lack of expertise to identify equipment	1	11.11%	1	20.53%
Company purchasing constraints	2	22.22%	2	27.16%
Inability to obtain financing	1	11.11%	3	20.53%
Recommended equipment not available/ hard to get	0	0.00%	4	0.00%
Contractors are not familiar enough with equipment	0	0.00%	5	0.00%
We only replace equipment at time of failure	0	0.00%	6	0.00%
Hard to believe we'll see the expected savings	1	11.11%	7	20.53%
Other projects are higher priority	4	44.44%	8	32.46%
Building owner will not approve/difficulty to get owner approval	0	0.00%	9	0.00%
Bad economy/non-critical projects on hold	1	11.11%	10	20.53%
Recommended action was too expensive	0	0.00%	11	0.00%
Installing the recommendations would be too disruptive	0	0.00%	12	0.00%
Didn't understand recommendations/needed more information	1	11.11%	13	20.53%
Incentive wasn't large enough	2	22.22%	14	27.16%
Other	2	22.22%	15	27.16%
Totals	15	100.00%		

Q39	Did the design recommendations involve integrated designs with energy management systems and controls for heating and cooling equipment and lighting that help improve the energy efficiency?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Yes	39	1	39	72.22%	11.95%
No	15	2	30	27.78%	11.95%
Totals	54	3	69	100.00%	

Q40	Who recommended the inclusion of controls?				
Answered	39				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Utility staff	2	1	2	5.13%	6.92%
Contractor/vendor	11	2	22	28.21%	14.12%
Architect/designer	4	3	12	10.26%	9.52%
Engineer	16	4	64	41.03%	15.44%
Other	3	5	15	7.69%	8.36%
Don't know	3	6	18	7.69%	8.36%
Totals	39	21	133	100.00%	

Q41	Did you install the recommended controls?				
Answered	39				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Yes	37	1	37	94.87%	6.92%
No	2	2	4	5.13%	6.92%
Totals	39	3	41	100.00%	

Q42	Did you incorporate controls that allow you to shift some of your energy usage to off-peak hours (times of day/week when energy is less expensive)?				
Answered	39				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Yes	9	1	9	23.08%	13.22%
No	21	2	42	53.85%	15.65%
Don’t know	9	3	27	23.08	13.22%
Totals	39	6	78	100.00%	

Q43	Do you use the controls to shift your energy usage to off-peak times of the day or week?				
Answered	9				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Yes	7	1	7	77.78%	27.16%
No	2	2	4	22.22%	27.16%
Totals	9	3	11	100.00%	

Q44	Was one of the goals of your project to have your building LEED certified?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Yes	11	1	11	20.37%	10.74%
No	43	2	86	79.63%	10.74%
Totals	54	3	97	100.00%	

Q45	Did you achieve LEED certification?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Yes	8	1	8	14.81%	9.48%
No	46	2	92	85.19%	9.48%
Totals	54	3	100	100.00%	

Q46	What level of LEED certification did you achieve?				
Answered	8				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Certified	1	1	1	12.50%	22.92%
Silver	2	2	4	25.00%	30.01%
Gold	2	3	6	25.00%	30.01%
Platinum	0	4	0	0.00%	0.00%
Don't know	3	5	15	37.50%	33.55%
Totals	8	15	26	100.00%	

Q47	Has your building obtained an ENERGY STAR rating?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Yes	6	1	6	11.11%	8.38%
No	48	2	96	88.89%	8.38%
Totals	54	3	102	100.00%	

Q48	What ENERGY STAR rating did you achieve? (coded open ended question)		
Answered	6		
Skipped	0		
Choice	**Frequency**	**Percent**	
Bronze	1	16.67%	
Silver	2	33.33%	
Don't know	3	50.00%	
Totals	6	100.00%	

Q49	Was the project commissioned?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Yes	19	1	19	35.19%	12.74%
No	35	2	70	64.81%	12.74%
Totals	54	3	89	100.00%	

Q50	What was the cost of commissioning? (If you do not know the cost please type 000 in the space provided)
Answered	19
Skipped	0
Min	0
Max	400000
Mean	41180
Stddev (Sample)	96455
Stddev (Populace)	93882

Q51	Did your project include a Variable Frequency Drive (VFD)?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Yes	30	1	30	55.56%	13.25%
No	24	2	48	44.44%	13.25%
Totals	54	3	78	100.00%	

Q52	Did you install a by-pass switch on the VFD?				
Answered	30				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Yes	19	1	19	63.33%	17.24%
No	11	2	22	36.67%	17.24%
Totals	30	3	41	100.00%	

Q53	Did you replace your electric motor with a high efficiency model during VFD installation?				
Answered	30				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Yes	26	1	26	86.67%	12.16%
No	4	2	8	13.33%	12.16%
Totals	30	3	34	100.00%	

Q54	Did the incentive cover the incremental installation costs of the higher efficiency equipment including commissioning, control point installation, building management system, programming and training?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Yes	16	1	16	29.63%	12.18%
No	38	2	76	70.37%	12.18%
Totals	54	3	92	100.00%	

Q55	Compared to before you participated in the Energy Conscious Blue Print program, would you say that your current awareness of energy-efficient equipment and practices is greater, or the same?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Greater than before	37	1	37	68.52%	12.39%
The same	17	2	34	31.48%	12.39%
Totals	54	3	71	100.00%	

Q56	Has your participation in the program affected the way that you maintain or use your equipment?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Yes	23	1	23	42.59%	13.19%
No	31	2	62	57.41%	13.19%
Totals	54	3	85	100.00%	

Q57	Would your organization consider installing similar energy efficiency improvements in the future in this or other facilities?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Yes	47	1	47	87.04%	8.96%
No	1	2	2	1.85%	3.60%
Don't know/Undecided	6	3	18	11.11%	8.38%
Totals	54	6	67	100.00%	

Q58	Would your organization consider installing similar improvements in the future without assistance from the utility?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Yes	22	1	22	40.74%	13.11%
No	15	2	30	27.78%	11.95%
Don't know	17	3	51	31.48%	12.39%
Totals	54	6	103	100.00%	

Q59	What is the primary business activity at this particular facility?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Office	6	1	6	11.11%	8.38%
Retail (non-food)	4	2	8	7.41%	6.99%
College/University	0	3	0	0.00%	0.00%
School	6	4	24	11.11%	8.38%
Grocery Store	0	5	0	0.00%	0.00%
Restaurant	2	6	12	3.70%	5.04%
Health Care	4	7	28	7.41%	6.99%
Hospital	2	8	16	3.70%	5.04%
Hotel or Motel	1	9	9	1.85%	3.60%
Warehouse/Distribution	0	10	0	0.00%	0.00%
Construction	1	11	11	1.85%	3.60%
Community Service/Church/Temple/ Municipality	2	12	24	3.70%	5.04%
Industrial Process/ Manufacturing/ Assembly	15	13	195	27.78%	11.95%
Condo Assoc./Apartment Mgr.	0	14	0	0.00%	0.00%
Other	11	15	165	20.37%	10.74%
Totals	54	120	498	100.00%	

Q60	Approximately how many full-time employees work at this location?
Answered	54
Skipped	0
Min	0
Max	55000
Mean	1660
Stddev (Sample)	7572
Stddev (Populace)	7502

Q61	How many days a week does your business typically operate?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Less than 5	0	1	0	0.00%	0.00%
5 days a week	23	2	46	42.59%	13.19%
6 days a week	11	3	33	20.37%	10.74%
7 days a week	20	4	80	37.04%	12.88%
Totals	54	10	159	100.00%	

Q62	How many hours per day does your business typically operate?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
24 hours a day	21	1	21	38.89%	13.00%
13 – 23 hours	5	2	10	9.26%	7.73%
12 hours a day	5	3	15	9.26%	7.73%
9 to 12 hours	18	4	72	33.33%	12.57%
8 hours a day	3	5	15	5.56%	6.11%
Less than 8 hours	2	6	12	3.70%	5.04%
Totals	54	21	145	100.00%	

Q63	Do you own or lease this facility?				
Answered	54				
Skipped	0				
Choice	**Frequency**	**Value**	**Total value**	**Percent**	**Stderr**
Own	43	1	43	79.63%	10.74%
Lease	11	2	22	20.37%	10.74%
Totals	54	3	65	100.00%	

IMPACT ANALYSIS

Global carried out the impact analysis by estimating the adjusted savings for sites in the sample using two general approaches: 1) building simulation modeling for weather sensitive measures; and 2) engineering review for non-weather sensitive measures. After the adjusted savings for each site in the sample were calculated, the sample was expanded to the population using a statistical ratio expansion as described below.

BUILDING SIMULATION MODELING

HVAC Impacts

The evaluation of HVAC impacts centered on deriving an estimate of the savings due to each measure in the sample by using Global's in-house building energy simulation model. Called "BEST" (acronym for "Building Energy Simulation Tool"), this model is a building energy analysis tool developed by Global that utilizes the DOE-2 simulation engine in an easy-to-use Windows environment. BEST allows users to select a prototype from a library of residential and commercial building types and perform building energy consumption simulations. Due to the DOE-2 algorithms, BEST is capable of accounting for climatic impacts on a building's HVAC energy consumption. Climatic data for the location in question must be supplied to BEST in a format that is specific to the DOE-2 simulation engine.

BEST also has advanced capabilities that allow a more experienced user to make more complex modifications to the base case building prototype, including adjustments to the square footage, number of floors, lighting levels, wall and window characteristics, shading conditions, and HVAC equipment configurations and efficiency levels. This is accomplished using a simple interface accessed directly from within BEST.

The user can make changes to modify the building prototype and model an individual or a package of standard energy-efficiency measures. These measures include efficient lighting (e.g. compact fluorescent lamps, low-loss ballasts, and 32-watt T-8 fluorescent lamps with electronic ballasts), high-efficiency HVAC equipment (e.g. air conditioners and chillers), and high-efficiency motors (e.g. ventilation fan motors and chilled water pump motors). By modeling a package of measures all at once, the user takes advantage of DOE-2's capability to account for thermal and energy interactions between measures and across multiple end uses.

The results from the building energy simulation are available to the user in several different output formats including:

- Annual electricity use by end use,
- Peak demand by end use, and
- Load shapes for 8,760 hours in the year by end use.

The BEST modeling of residential and commercial buildings in Connecticut requires the use of Connecticut-specific weather data. The required weather data parameters include dry- and wet-bulb temperatures, humidity, precipitation, cloud cover, and solar radiation. All this information must be compiled into a format that is specifically required by the DOE-2 simulation engine (called "BIN" format). For this project, Global recognized that two sets of weather data are needed: one for the coastal climate zone (e.g. Bridgeport, New Haven, etc.) and another for the inland climate zone (e.g. Hartford, Waterbury, etc.).

Global selected Bridgeport to represent the coastal climate zone and Hartford to represent the inland climate zone. For each of these two locations, Global collected two sets of weather data:

1) actual weather data, and 2) typical meteorological year (TMY) weather data. TMY represents a composite of average temperatures and other weather conditions for 8,760 hours in a typical year represented over a long historical time period (30 years). The actual weather data is needed to calibrate the BEST model to the metering data collected during the site visits and to the site's actual billing data for the same 12-month period. TMY data is needed to estimate the measures' savings potential under typical weather conditions. While Global obtained the actual weather data from the National Oceanic and Atmospheric Administration (NOAA) and compiled it into the BIN format required by DOE-2, TMY weather data is available at no cost to the public for the Bridgeport and Hartford locations.

The BEST modeling approach was used for all Cooling, Heating, and weather-sensitive "Other" measures. The following is a step-by-step description of the procedure used to estimate the energy and demand savings of these measures:

1. Gather needed information for BEST modeling: Modeling the weather-sensitive measures requires information about the building where the measures were installed as well as information about the new equipment installed under the program.
    a. Site-specific building information:
        i. Building type and operation schedule: this was obtained from observations and information obtained by site visit staff during the site visits.
        ii. Building floor area: this was mainly obtained from information gathered by site visit staff during their site visits. In cases where site visit staff was unable to obtain this information, Global obtained the building floor area from the site's incentive documentation provided by the Companies.
        iii. Other physical characteristics of the building such as number of floors, construction material, window to wall ratio, etc. were based on observations and information gathered by site visit staff. For the building characteristics and parameters that site visit staff was unable to gather (e.g. insulation levels, lighting densities, etc.), Global assumed these to be equal to the values specified by Connecticut's building energy-efficiency code that was in effect during the time of the site's signing of the agreement to participate in the program. For private entities, the 2003 International Energy Conservation Code (IECC) was used for sites that signed the agreement before August 1, 2009. The 2006 IECC was used for private-sector sites that signed the agreement on or after August 1, 2009. The ASHRAE Standard 90.1-2007 was used for all public and government sites.
    b. Information on the new equipment installed under the program was mainly obtained from the site's incentive documentation provided by the Companies. This information includes the type of equipment installed, the capacity of the equipment installed, and the efficiency of the equipment installed.
    c. The operation schedule of new equipment installed under the program was based on the metered data that site visit staff collected on-site. Global performed an analysis of the metered data and created daily graphs/plots of the metered data, where the operational schedule of the equipment can be observed. Global assumed that the baseline and the new equipment operate according to the same schedule.
2. Construct a building model in BEST using the information gathered in Step 1 above, then calibrate the model using metered data collected by site visit staff, the most recent electricity monthly billing data received from the Companies, and the actual weather data: This step results in a calibrated building model that represents the most current energy consumption conditions and patterns of the site.

3. Construct building models in BEST to create baseline and efficiency cases for each measure: The building models for both of these cases are based on the calibrated building model developed in Step 2 above. In the baseline case, the efficiency of the equipment being evaluated would be set equal to the value recommended by the appropriate building energy-efficiency code (2003 IECC, 2006 IECC, or ASHRAE Standard 90.1-2007 – see Step 1-a-iii above). For the efficiency case, the efficiency of the equipment being evaluated is equal to that documented in the site's incentive documentation provided to Global by the Companies.

4. Run BEST for the baseline and efficiency cases: The TMY weather data was used for these runs because savings should be estimated under typical climate conditions. Either Bridgeport or Hartford TMY data was selected, depending on the location of the site. BEST generated the following outputs for the baseline and the efficiency cases:

    a. The entire building's annual kWh consumption by end use (i.e. lighting, cooling, ventilation (fans), heating, auxiliary (pumps and cooling towers), plug loads, and domestic hot water).

    b. kW values for each of the 8,760 hours of the year by end use. This is the load shape by end use.

5. Energy savings analysis:

    a. The difference in annual kWh between the baseline and the efficiency cases is the annual energy savings.

    b. Similarly, the difference between the baseline and efficiency case load shapes is the savings load shape by measure.

6. Demand savings analysis: According to ISO New England, the "Demand Resource Seasonal Peak Hours are those hours in which the actual, Real-Time hourly load for Monday through Friday on non-holidays, during the months of June, July, August, December, and January, as determined by the ISO, is equal to or greater than 90% of the most recent 50/50 system peak load forecast, as determined by the ISO, for the applicable summer or winter season." Global used this definition of the seasonal peak hours to determine which hours of the 8,760 load shape data to use for determining the kW demand savings. The following describes the process that was used:

    a. Global obtained ISO New England's historical hourly demand data from their website for the period Oct. 1, 2009 to Sept. 30, 2010.

    b. Global obtained hourly temperature and dew point data (from NOAA) for Hartford and Bridgeport for the same period (Oct. 1, 2009 to Sept. 30, 2010). Using this information, Global calculated the Total Heat Index (THI) and Weighted Heat Index (WHI) for each hour during June to August 2010 (summer peak period) and Dec 2009 to Jan 2010 (winter peak period).

    c. Global performed a regression analysis to develop the correlation between the hourly THI, WHI, and the hourly demand data (from Step (a.) above). This regression analysis was completed separately for Hartford and Bridgeport.

    d. Global then used the correlations to determine the "trigger point" THI and WHI values that correspond to 90% of the most recent system peak load forecast as determined by the ISO New England. Again, this was completed separately for Hartford and Bridgeport.

    e. Finally, Global used the TMY hourly temperature data for Hartford and Bridgeport to calculate the hourly THI and WHI values for typical weather conditions (since the 8,760 hourly savings load shapes are generated using TMY weather data – see Steps 4 and 5 above). The "trigger point" THI and WHI values from Step (d.) above determine which hours were selected for calculation of the demand savings using the 8,760 savings load shapes. Table E-1 and Table E-2 below provide a list of the summer and winter seasonal peak hours that were selected as a result of this analysis.

f. The demand savings of a particular measure was taken to be the average across all the selected hours.

Table E-1 Summer Seasonal Peak Hours

Hartford		Bridgeport	
Date*	**Hour Ending**	**Date***	**Hour Ending**
July 10	14	Aug 1	14
July 10	15	Aug 1	15
July 11	14	Aug 1	16
July 11	15	Aug 1	17
July 11	16	Aug 13	14
July 12	14	Aug 13	15
July 22	15		
July 22	16		
July 22	17		
July 24	14		
July 24	15		
July 24	16		
July 24	17		
July 25	14		
July 25	15		
July 25	16		
July 25	17		
August 6	14		
August 6	15		
* Note: The dates are based on calendar year 2008 without a leap day, necessitated by the DOE-2 simulation model.			

Table E-2 Winter Seasonal Peak Hours

Hartford		Bridgeport	
Date*	**Hour Ending**	**Date***	**Hour Ending**
January 24	18	January 8	18
January 24	19	January 8	19
January 30	18	January 9	18
January 30	19	January 9	19
January 31	18	January 10	18
January 31	19	January 10	19
December 13	18	January 11	18
December 13	19	January 11	19
		January 15	18
		January 15	19
		January 16	18
		January 16	19
		January 17	18
		January 17	19
* Note: The dates are based on calendar year 2008 without a leap day, necessitated by the DOE-2 simulation model.			

HVAC/Lighting Interaction Adjustment

Adjustment factors were developed that can be applied to the annual lighting savings and lighting savings load shape to account for the HVAC interactive effects. These adjustment factors were developed such that there is a set of adjustment factors for all of the building prototypes within the BEST model that are applicable to the sample of sites with lighting measures. Specifically, these building prototypes are:

- Large office
- Small office
- Department store
- Strip mall retail
- School
- Hospital
- Restaurant

For the results included in this report, Global used the Small Office Prototype to represent all types of small facilities less than 100,000 square feet, and the Large Office prototype to represent all types of large facilities.

The following is the procedure that was used to develop the sets of adjustment factors for each building type:

1. Developed building prototypes that reflect the 2003 IECC energy-efficiency code: The BEST model contains a library of building prototypes that has been developed to reflect typical building characteristics in the New England region. This set of prototypes was developed as part of Global's previous work for a Company in the New England region. Global then updated all the prototype parameters for the seven building types listed above to reflect the 2003 IECC energy-efficiency code. The set of prototypes also includes two versions of each building: a gas-heated building and an electrically-heated building.
2. For each building prototype, Global performed two sets of BEST runs:
    a. The first set of runs was comprised of a building that has gas heating using Bridgeport weather data:
        i. Run #1 was the baseline building;
        ii. For run #2, Global reduced the lighting densities in the baseline building arbitrarily by 10%.
        iii. The difference of the two runs is the lighting and cooling savings due to the lighting density reduction. BEST also generated the 8,760 load shape by end use for both runs, and the difference of the two load shapes is the savings load shape.
    b. The second set of runs was comprised of a building that has electric heating using Bridgeport weather data:
        i. Run #1 is the baseline building;
        ii. For run #2, Global reduced the lighting densities in the baseline building arbitrarily by 10%.
        iii. The difference of the two runs is the lighting and cooling savings and heating increase due to the lighting density reduction. BEST also generated the 8,760 load shape by end use for both runs, and the difference of the two load shapes is the savings load shape.

3. The entire Step #2 above was repeated for Hartford weather data. At the end of this step, Global had created four sets of savings load shapes for each building prototype: one for each heating type (gas vs. electric heating) and location (Bridgeport vs. Hartford).
4. Global calculated the interactive effects adjustment factors by dividing the cooling savings and heating increases by the lighting savings in each hour of the 8,760 load shape. This exercise yielded adjustment factors that can be interpreted as "for every kWh saved in lighting, there is a corresponding X kWh savings in cooling and X kWh increase in heating."
5. Lastly, Global took each set of 8,760 adjustment factors and created average hourly adjustment factors by day type (weekdays vs. weekends) for each month of the year. These sets of adjustment factors were applied to the lighting savings load shapes for each site to obtain the net lighting savings that have been adjusted for HVAC interactive effects.

ENGINEERING REVIEW

Lighting Impacts

Global determined the lighting savings impacts by comparing installed lighting fixtures and operation with baseline lighting fixtures and operation. For energy efficient fixtures, the wattage reduction relative to the baseline was apparent from the project documentation and from field verification of installed lighting. However, developing 8,760 load shapes for the efficiency and baseline cases, in order to estimate annual kWh savings and peak demand reductions, required a systematic approach.

Lighting operation for the efficiency case was modeled on an hourly basis based on a combination of building type and data logging results. Weekly lighting loads were developed using the individual fixture types included in the facility's lighting retrofit. The individual lighting fixture types were assigned an "on/off sequence", where each hour of a typical 168 hour week the fixtures were assumed to be either "on" or "off". The determination as to whether the fixtures were on or off depended on the results obtained by conducting data logging of the different lighting circuits within the facility. The lighting circuits chosen were those intended to be the most representative of the lighting fixtures installed in the facility. Most facilities had several different combinations of fixtures types and operation patterns.

In those cases where occupancy or daylight sensors were used on a portion or all of the fixtures, the on/off sequence was adjusted so that only some fraction of the fixtures was on during any given one hour time period. The fraction used and the hours of operation were dependent on the results obtained from the data logging.

Once the typical work week lighting sequence was developed for each fixture/operation type, a year-long (8,760) sequence was constructed for each lighting type by completing 52 consecutive weeks and accounting for limited lighting during appropriate holidays. In the case of offices, government and retail, these included 8 different holidays. Schools were assumed to be in operation approximately 40 weeks per year. Hospitals were assumed to operate continuously with no holiday operation. Depending on the specific characteristics, some industrial operations were assumed to operate continuously, except for New Year's Day, Memorial Day, 4th of July, Labor Day, Thanksgiving Day, and Christmas Day. Under all circumstances, whenever any holiday fell on a Sunday, the holiday was observed on the following Monday. Further, New Year's Day was assumed to be the first Sunday of the year.

Global used the same procedure to develop yearly load shapes for the baseline lighting.

The 8,760 savings load shape was then obtained by subtracting the sum of the hourly values for the energy efficient case from the sum of the hourly values for the baseline case. Global determined the yearly energy savings (kWh) impacts by summing the hourly values in the savings load shape. The summer and winter peak demand impacts were calculated according to the ISO New England methodology, whereby the "Demand Resource Seasonal Peak Hours are those hours in which the actual, Real-Time hourly load for Monday through Friday on non-holidays, during the months of June, July, August, December, and January, as determined by the ISO, is equal to or greater than 90% of the most recent 50/50 system peak load forecast, as determined by the ISO, for the applicable summer or winter season."

In addition, Global determined the HVAC/lighting interaction adjustment factor as described in the previous section.

Process Impacts

Global modeled process impacts on an hourly basis based on data logging results and consideration of the specific process change. The process changes were site-specific, but 12 of the 19 sites assessed were for new air compressors. The other sites include new air dryers (for the compressed air), new VFDs on process equipment, new process chillers, and meters to control exhaust fans.

The modeling approach used to estimate savings from process measures was similar to the one used for the lighting. In the case of air compressors, a compressor energy use profile was developed based on the data provided in the project file. Energy use in an air compressor depends upon the system demand (i.e. compressed air needs in the facility). With all other things equal, a compressor with a VFD will consume less energy than a compressor without one, at any flow other than full load. Thus, a profile reflecting different power consumption profiles at different uses was needed. Global derived this information from the calculations included in the utility files, which were based on the specific compressor installed and a particular baseline compressor (also given in the files).

Once Global established the power use profile for both new and baseline cases, the data logging information was used to develop usage patterns. The site visit team set the data loggers to collect data at either 1 minute or 5 minute intervals over a one to four week period, so Global used this information to reflect the variation in use throughout the work week. Absolute values could not be used, because often the logged data represented only a portion of the energy used to compress plant air. However, it helped in establishing consistent usage patterns.

Global handled the other process assessments in a similar manner, but to reflect how energy was typically consumed in that process. For instance, one measure included installing carbon monoxide meters in a parking garage to control exhaust fans at a community center. In that case, the exhaust fan operation was largely dependent on number of visitors to the center, which varied throughout the day and week. Thus, fan operation was slower during periods of low occupancy (e.g. mid-mornings or overnight) and higher during periods of higher occupancy (mornings and evenings).

As with the lighting impacts development, Global computed energy consumption for the baseline and efficiency cases for every hour in a single week, beginning on Sunday at midnight and lasting through Saturday. The difference at each hour between baseline and efficiency case was computed to produce a week-long savings curve. The savings curve for the week was repeated to produce a year-long curve. Then, specific holidays were added. If the facility had a scheduled yearly outage where the process equipment was shut down (usually lasting a week or less), that was included too.

Global assumed New Year's Day to be the first Sunday of the year. Depending on the specific characteristics, some industrial operations were assumed to operate continuously, except for New Year's Day, Memorial Day, 4th of July, Labor Day, Thanksgiving Day, and Christmas Day. Under all circumstances, whenever any holiday fell on a Sunday, the holiday was observed on the following Monday.

Global determined the yearly energy savings (kWh) impacts by summing the hourly values in the savings load shape. The summer and winter peak demand impacts were calculated according to the ISO New England methodology, whereby the "Demand Resource Seasonal Peak Hours are those hours in which the actual, Real-Time hourly load for Monday through Friday on non-holidays, during the months of June, July, August, December, and January, as determined by the ISO, is equal to or greater than 90% of the most recent 50/50 system peak load forecast, as determined by the ISO, for the applicable summer or winter season."

"Other" Impacts

Developing impact estimates for the non-weather sensitive "Other" measures represented the greatest challenge to Global's modelers. For a variety of reasons, many of these measures lacked sufficient documentation and data to develop estimates with a high level of confidence. The challenges encountered during the analysis of the Other measures can best be exemplified by an example.

Three of the ten Other measures (including Other21, Other23, and Other24) were new Energy Star transformers. There is no doubt that Energy Star transformers reduce overall power consumption by reducing transformer losses – and there can hundreds of these devices in any given facility. However, the loss profile is largely a function of the transformer loading (i.e. how closely it operates to its capacity). In order to more accurately determine energy savings, transformer loadings must be measured for long periods (ideally, up to one year or more). This length of measurement was not within the scope of this effort; but, without this information, the actual energy savings are difficult to estimate. To circumvent this problem, Global assumed an average loading for the transformers of 25-30% based on anecdotal information observed in the field by a variety of experts to develop savings estimate. Yet, it should be noted that actual savings could differ by 30-60% or more, depending on specific equipment installed and the amount of work done by the transformers.

Similarly, other files lacked important information to develop estimates. For instance, two of the sites (Other11 and Other12) included new pump motors, but the site visit staff were unable to determine their function (and thus operation), even with support from facility staff because personnel changes had occurred since installation of the motors. So, Global made some educated guesses to develop appropriate baseline and new energy consumption estimates.

A few of the sites could be assessed with more accuracy. Two sites had new premium efficiency motors (Other01 and Other19), the efficiency gains for which can be readily estimated by taking the efficiency gain (over NEMA efficiency values) and multiplying by the motor horsepower and hours of use per year. This approach was used to develop reasonable estimates of savings from the premium efficiency motors. In these cases specific motor loads (i.e. number of yearly hours of operation) were assumed based on the motor use. Finally, one of the sites had an air compressor and the approach described in the section above on Process Impacts was used with confidence.

Without more complete information on both the baseline information and the new measure, it is very challenging to develop estimates. The majority of the Other measures evaluated here were prescriptive; in many rebate programs, rebates and savings associated with prescriptive measures are assumed based on studies of industry averages. Presumably, no additional information was required by the Companies as part of the rebate process.

SAMPLE EXPANSION TO POPULATION

After the adjusted savings for each site were calculated as described above, the stratified sample was expanded using a statistical ratio expansion. For each major measure type (Cooling, Heating, Lighting, Process, and Other), the estimated total adjusted savings were calculated as follows:

1. First, for each stratum in the sample, the mean (average) Company-reported savings and mean adjusted savings were calculated.
2. Then the weighted mean Company-reported savings and weighted mean adjusted savings were calculated, with the weights based on the population for that measure in

each stratum. For this step, because of the situation described in the body of the text, the weights were based on the population with the known unoccupied buildings excluded. Note that these two weighted means were both calculated based on the sample only.

3. Next, the ratio of the weighted mean adjusted savings to the weighted mean Company-reported savings was calculated. While the ratio expansion technique is a standard statistical method used in many applications, in this case, the ratio also represents the realization rate for the occupied buildings.
4. Lastly, this ratio was multiplied by the total actual Company-reported savings for the measure type to get the estimated total adjusted savings for each measure. Again here, that calculation used the total Company-reported savings with the known unoccupied buildings excluded.

After the above steps were done for each of the major measure types, the results for the five measure types were combined to get the estimated total adjusted savings for the entire program.

The results of these calculations are shown in Table 3-16, Table 3-17, and Table 3-18. However, as described in the body of the text, the column labeled "Company-reported savings" contains the total Company-adjusted savings with the known unoccupied buildings included. The adjusted savings and the realization rate, however, reflect the exclusion of the known unoccupied buildings.

The relative precision of the adjusted savings estimates for each major measure type was calculated based on standard formulas for a combined ratio estimate, and reported at the 80% confidence level. The relative precision of the total program adjusted savings was calculated based on a 90% confidence level.

LOAD SHAPE ESTIMATION

As part of the process for each measure described above, Global estimated baseline and actual load shapes for each customer. As with the kWh savings estimates, the hourly savings estimates are the difference between the baseline and the actual load on an hourly basis. This results in an 8,760-hour savings load shape for each customer. These hourly load shapes were then expanded to the population, in the same way as the adjusted savings described above, to create the measure-level total savings load shapes for the Cooling, Lighting, Heating, and Process groups. Graphs of the hourly load shapes for monthly typical days are included in Chapter 3. Table E-3 through Table E-18 show the hourly data for these monthly typical days as well as the ratio of each of the hourly values of the typical day load shape to the average hourly savings for the year. The 8,760-hour load shapes by measure type are also being provided separately in an Excel Spreadsheet.

Table E-3 Typical Weekday Total Cooling Savings Load Shapes (kW)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
01	271	247	299	352	659	1,588	2,665	2,428	1,268	346	153	143
02	269	244	293	352	658	1,585	2,659	2,425	1,265	343	152	130
03	267	260	299	352	657	1,577	2,649	2,421	1,261	342	149	151
04	233	225	256	293	541	1,284	2,173	1,987	1,037	292	131	145
05	218	208	231	268	483	1,157	1,946	1,780	939	269	128	137
06	853	949	900	842	1,179	1,208	1,714	1,805	1,483	1,079	861	750
07	818	888	835	835	1,272	1,351	1,857	2,034	1,635	1,106	807	701
08	827	896	896	1,040	1,664	1,523	2,106	2,254	1,864	1,434	980	743
09	834	937	995	1,223	2,033	1,875	2,527	2,584	2,179	1,851	1,224	773
10	791	904	976	1,352	1,933	1,676	2,202	2,283	2,008	1,853	1,413	782
11	769	920	1,111	1,565	1,962	1,692	2,216	2,321	1,951	1,835	1,600	854
12	857	1,037	1,267	1,667	1,850	1,604	2,032	2,153	1,861	1,839	1,753	1,005
13	889	1,103	1,259	1,613	1,712	1,442	1,792	1,907	1,763	1,793	1,666	1,029
14	1,005	1,210	1,398	1,715	1,774	1,505	1,886	1,958	1,812	1,760	1,733	1,133
15	981	1,202	1,407	1,717	1,725	1,506	1,945	1,972	1,831	1,795	1,789	1,107
16	938	1,120	1,349	1,657	1,763	1,554	1,938	1,975	1,854	1,838	1,712	1,022
17	986	1,125	1,329	1,639	1,779	1,656	2,192	2,204	1,914	1,766	1,656	1,029
18	636	744	906	1,199	1,480	1,257	1,632	1,788	1,478	1,416	1,105	720
19	550	618	710	848	1,170	1,042	1,459	1,587	1,264	976	774	516
20	532	583	578	602	864	892	1,388	1,552	1,147	718	551	467
21	559	590	608	630	997	1,088	1,643	1,765	1,258	812	608	445
22	645	703	704	724	1,185	1,508	2,365	2,448	1,595	893	657	524
23	266	252	305	351	663	1,610	2,690	2,447	1,288	345	149	151
24	259	255	302	354	659	1,599	2,681	2,431	1,277	344	151	149

Table E-4 Typical Weekday Total Cooling Savings Ratios

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
01	0.261	0.238	0.288	0.339	0.635	1.530	2.566	2.338	1.221	0.333	0.147	0.137
02	0.259	0.235	0.282	0.339	0.634	1.526	2.560	2.335	1.219	0.330	0.146	0.125
03	0.257	0.251	0.288	0.339	0.632	1.518	2.551	2.332	1.214	0.329	0.144	0.146
04	0.225	0.216	0.246	0.282	0.521	1.236	2.093	1.914	0.999	0.282	0.126	0.140
05	0.210	0.200	0.222	0.258	0.465	1.115	1.874	1.714	0.904	0.259	0.123	0.132
06	0.822	0.914	0.867	0.811	1.136	1.163	1.651	1.738	1.428	1.040	0.829	0.723
07	0.788	0.855	0.804	0.804	1.225	1.301	1.789	1.959	1.574	1.065	0.777	0.675
08	0.797	0.862	0.863	1.002	1.602	1.467	2.028	2.171	1.795	1.381	0.943	0.715
09	0.803	0.902	0.959	1.178	1.958	1.806	2.434	2.489	2.099	1.782	1.178	0.745
10	0.762	0.871	0.940	1.302	1.861	1.614	2.120	2.199	1.934	1.784	1.361	0.753
11	0.741	0.886	1.070	1.507	1.889	1.630	2.134	2.235	1.879	1.768	1.540	0.822
12	0.825	0.999	1.220	1.605	1.782	1.544	1.957	2.073	1.793	1.771	1.689	0.968
13	0.856	1.063	1.213	1.554	1.648	1.389	1.726	1.836	1.697	1.727	1.604	0.991
14	0.968	1.165	1.347	1.652	1.709	1.449	1.816	1.885	1.745	1.695	1.669	1.091
15	0.945	1.158	1.355	1.654	1.661	1.450	1.873	1.899	1.763	1.729	1.723	1.066
16	0.903	1.078	1.299	1.596	1.698	1.496	1.866	1.902	1.786	1.770	1.648	0.984
17	0.949	1.084	1.280	1.578	1.713	1.594	2.111	2.123	1.844	1.700	1.595	0.991
18	0.613	0.717	0.873	1.154	1.425	1.210	1.571	1.722	1.424	1.363	1.064	0.694
19	0.530	0.595	0.683	0.817	1.126	1.004	1.405	1.528	1.218	0.940	0.746	0.497
20	0.512	0.561	0.557	0.580	0.832	0.859	1.336	1.495	1.105	0.691	0.531	0.450
21	0.538	0.568	0.585	0.607	0.960	1.048	1.582	1.700	1.211	0.782	0.586	0.429
22	0.621	0.677	0.678	0.697	1.141	1.452	2.278	2.357	1.536	0.860	0.633	0.504
23	0.256	0.243	0.293	0.338	0.639	1.550	2.591	2.356	1.241	0.333	0.144	0.146
24	0.249	0.245	0.291	0.341	0.635	1.540	2.582	2.341	1.230	0.331	0.146	0.143

Table E-5 Typical Weekend Day Total Cooling Savings Load Shapes (kW)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
01	238	247	247	358	766	1,573	2,692	1,772	1,174	296	168	138
02	250	249	227	357	763	1,567	2,682	1,772	1,170	295	161	146
03	251	253	233	361	762	1,560	2,677	1,765	1,169	294	150	152
04	222	224	209	290	628	1,271	2,187	1,463	962	250	142	124
05	205	227	209	260	558	1,141	1,960	1,318	879	229	134	126
06	172	179	184	211	327	646	1,060	750	517	204	147	126
07	185	174	187	242	435	798	1,161	842	636	318	151	136
08	381	419	382	590	778	969	1,321	1,196	858	594	353	300
09	371	365	386	579	812	1,009	1,409	1,241	950	640	389	276
10	343	323	358	604	852	931	1,251	1,152	897	681	455	265
11	310	334	399	761	1,115	1,075	1,415	1,333	1,012	896	725	303
12	313	367	524	927	1,062	1,000	1,255	1,248	1,002	980	944	382
13	382	404	617	944	1,013	889	1,047	1,108	960	915	880	440
14	501	555	681	977	1,004	923	1,121	1,183	1,041	1,012	907	570
15	510	539	677	975	1,021	970	1,109	1,158	1,030	983	881	555
16	514	560	670	955	924	868	1,018	1,099	914	920	828	571
17	531	568	689	943	953	1,012	1,249	1,264	980	905	814	561
18	352	387	433	697	827	802	1,070	1,096	782	706	538	351
19	316	363	387	546	714	814	1,151	1,081	717	570	421	291
20	143	131	141	188	350	660	1,036	718	479	174	117	104
21	159	148	158	243	458	832	1,272	886	616	232	145	113
22	207	180	196	275	579	1,186	1,965	1,313	865	234	139	131
23	251	213	260	359	775	1,606	2,690	1,788	1,171	298	166	138
24	254	251	258	359	774	1,595	2,680	1,781	1,162	296	167	144

Table E-6 Typical Weekend Day Total Cooling Savings Ratios

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
01	0.229	0.238	0.238	0.344	0.738	1.515	2.593	1.706	1.130	0.285	0.162	0.133
02	0.241	0.240	0.219	0.343	0.735	1.509	2.583	1.706	1.127	0.284	0.155	0.141
03	0.242	0.244	0.225	0.347	0.734	1.502	2.578	1.700	1.125	0.283	0.145	0.147
04	0.214	0.216	0.201	0.280	0.605	1.224	2.106	1.409	0.926	0.241	0.137	0.119
05	0.198	0.218	0.202	0.251	0.538	1.099	1.888	1.269	0.847	0.221	0.129	0.121
06	0.166	0.172	0.177	0.203	0.315	0.622	1.021	0.722	0.498	0.197	0.141	0.121
07	0.178	0.168	0.180	0.233	0.419	0.769	1.118	0.811	0.613	0.306	0.145	0.131
08	0.367	0.404	0.368	0.568	0.749	0.934	1.272	1.152	0.827	0.572	0.340	0.289
09	0.357	0.351	0.372	0.557	0.782	0.971	1.357	1.195	0.915	0.616	0.375	0.266
10	0.331	0.311	0.345	0.582	0.820	0.896	1.205	1.109	0.864	0.656	0.438	0.255
11	0.298	0.321	0.384	0.733	1.074	1.035	1.363	1.283	0.975	0.862	0.699	0.291
12	0.302	0.353	0.505	0.893	1.023	0.963	1.208	1.202	0.965	0.943	0.909	0.367
13	0.368	0.389	0.594	0.909	0.975	0.856	1.008	1.067	0.925	0.882	0.848	0.424
14	0.483	0.535	0.656	0.941	0.967	0.888	1.079	1.139	1.002	0.974	0.874	0.549
15	0.491	0.520	0.652	0.939	0.983	0.934	1.068	1.115	0.992	0.946	0.848	0.535
16	0.495	0.539	0.645	0.920	0.890	0.836	0.981	1.059	0.880	0.886	0.797	0.549
17	0.511	0.547	0.663	0.908	0.918	0.974	1.203	1.218	0.944	0.871	0.784	0.540
18	0.339	0.373	0.417	0.671	0.797	0.773	1.030	1.056	0.753	0.680	0.518	0.338
19	0.305	0.349	0.373	0.526	0.687	0.784	1.108	1.041	0.691	0.549	0.406	0.281
20	0.138	0.127	0.136	0.182	0.337	0.635	0.998	0.691	0.461	0.167	0.113	0.100
21	0.153	0.142	0.152	0.234	0.441	0.802	1.225	0.853	0.593	0.223	0.140	0.109
22	0.199	0.173	0.189	0.265	0.557	1.142	1.893	1.265	0.833	0.225	0.134	0.126
23	0.242	0.205	0.250	0.345	0.747	1.546	2.590	1.722	1.127	0.287	0.160	0.133
24	0.244	0.242	0.249	0.346	0.746	1.536	2.581	1.715	1.119	0.285	0.161	0.139

Table E-7 Typical Weekday Total Heating Savings Load Shapes (kW)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
01	230	248	248	249	183	47	6	33	150	237	250	250
02	249	249	252	253	189	69	14	33	151	238	254	256
03	240	241	239	250	205	72	16	35	154	239	252	245
04	242	238	244	251	207	74	25	43	156	238	249	248
05	238	249	246	249	206	75	25	44	176	238	251	249
06	420	439	385	339	263	95	62	95	214	339	377	404
07	367	422	424	405	367	207	219	239	350	415	429	378
08	356	391	443	411	290	190	189	208	328	428	443	370
09	458	497	465	372	287	218	207	234	299	399	410	452
10	419	452	387	344	285	221	212	246	296	396	380	391
11	461	477	393	315	287	216	217	250	262	389	375	415
12	438	440	354	310	299	216	216	252	248	398	398	401
13	441	431	345	333	300	206	207	237	244	376	416	394
14	434	439	379	319	290	208	206	234	240	377	411	395
15	434	454	398	329	282	207	210	234	245	380	415	416
16	431	461	411	320	288	221	227	252	248	394	428	413
17	423	442	406	333	283	211	230	245	248	411	412	423
18	206	187	218	209	114	16	14	14	74	235	256	205
19	236	234	217	225	112	15	10	12	111	232	239	234
20	244	222	226	228	118	31	9	13	124	237	244	224
21	279	261	209	252	115	25	9	15	143	230	240	253
22	244	236	227	244	113	36	4	6	144	249	249	236
23	251	252	254	249	128	38	3	3	138	241	256	257
24	256	259	269	257	154	39	3	5	150	244	252	247

Table E-8 Typical Weekday Total Heating Savings Ratios

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
01	1.022	1.103	1.104	1.108	0.814	0.211	0.028	0.149	0.666	1.056	1.115	1.113
02	1.107	1.109	1.120	1.125	0.840	0.308	0.064	0.147	0.672	1.062	1.129	1.141
03	1.070	1.072	1.063	1.111	0.913	0.322	0.072	0.154	0.684	1.063	1.123	1.092
04	1.076	1.060	1.084	1.118	0.920	0.330	0.111	0.191	0.695	1.060	1.110	1.104
05	1.061	1.107	1.097	1.110	0.917	0.333	0.110	0.196	0.785	1.062	1.116	1.107
06	1.871	1.956	1.716	1.507	1.169	0.424	0.276	0.424	0.953	1.509	1.678	1.799
07	1.636	1.879	1.886	1.805	1.633	0.920	0.973	1.064	1.560	1.849	1.912	1.682
08	1.584	1.741	1.974	1.831	1.293	0.844	0.842	0.927	1.460	1.904	1.971	1.649
09	2.039	2.214	2.073	1.658	1.276	0.973	0.920	1.042	1.332	1.777	1.824	2.014
10	1.867	2.011	1.721	1.533	1.268	0.984	0.946	1.095	1.319	1.762	1.692	1.742
11	2.051	2.126	1.751	1.404	1.276	0.962	0.967	1.115	1.167	1.733	1.670	1.849
12	1.950	1.960	1.576	1.382	1.330	0.962	0.961	1.124	1.105	1.770	1.770	1.787
13	1.962	1.918	1.536	1.482	1.335	0.915	0.922	1.054	1.087	1.673	1.854	1.756
14	1.934	1.954	1.687	1.419	1.290	0.924	0.918	1.042	1.069	1.678	1.831	1.757
15	1.933	2.021	1.771	1.463	1.258	0.920	0.935	1.043	1.093	1.693	1.848	1.854
16	1.918	2.054	1.831	1.427	1.284	0.984	1.012	1.120	1.103	1.754	1.904	1.839
17	1.883	1.968	1.809	1.483	1.260	0.941	1.024	1.089	1.106	1.831	1.836	1.882
18	0.916	0.832	0.972	0.929	0.509	0.069	0.061	0.063	0.330	1.047	1.140	0.914
19	1.051	1.042	0.964	1.002	0.500	0.066	0.042	0.055	0.493	1.034	1.066	1.042
20	1.088	0.987	1.005	1.016	0.525	0.136	0.040	0.056	0.552	1.055	1.086	0.996
21	1.242	1.164	0.929	1.121	0.513	0.113	0.038	0.069	0.638	1.025	1.067	1.125
22	1.088	1.052	1.012	1.088	0.505	0.159	0.017	0.029	0.641	1.110	1.110	1.051
23	1.116	1.122	1.131	1.109	0.569	0.169	0.014	0.013	0.616	1.074	1.141	1.142
24	1.138	1.154	1.200	1.143	0.687	0.172	0.013	0.022	0.670	1.085	1.120	1.102

Table E-9 Typical Weekend Day Total Heating Savings Load Shapes (kW)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
01	243	230	250	246	140	69	7	28	116	250	247	243
02	249	245	248	253	170	90	3	28	142	250	252	248
03	244	240	244	248	169	91	6	50	160	250	252	241
04	241	241	245	253	174	93	5	50	160	250	251	248
05	244	249	250	250	195	94	8	55	160	251	251	240
06	251	249	242	264	177	75	9	57	167	252	254	249
07	254	246	248	252	131	78	9	18	146	252	256	231
08	279	256	269	256	129	60	9	24	129	255	258	257
09	268	247	239	257	107	59	9	16	72	252	250	243
10	253	223	217	208	120	56	10	14	60	215	237	229
11	243	261	228	194	115	17	9	14	41	201	218	237
12	254	261	239	197	72	17	10	13	19	204	230	237
13	236	236	202	221	48	14	10	13	15	203	233	229
14	233	242	238	205	29	13	10	13	14	199	237	246
15	259	241	257	211	27	12	9	14	14	206	233	256
16	245	247	256	221	23	7	5	6	7	198	242	256
17	247	237	253	210	21	7	3	4	9	195	238	255
18	264	263	272	218	42	7	3	3	28	214	259	268
19	252	256	260	245	88	7	3	3	49	215	255	250
20	254	258	267	234	85	25	3	3	71	222	252	259
21	248	252	255	243	135	24	3	3	114	244	253	256
22	244	256	262	249	137	29	3	5	118	244	252	254
23	248	251	248	250	138	32	3	8	139	249	252	253
24	267	237	247	251	141	70	3	29	126	248	250	249

Table E-10 Typical Weekend Day Total Heating Savings Ratios

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
01	1.080	1.024	1.112	1.094	0.623	0.307	0.030	0.125	0.517	1.113	1.099	1.081
02	1.111	1.092	1.106	1.128	0.757	0.400	0.013	0.127	0.630	1.111	1.122	1.103
03	1.088	1.067	1.087	1.106	0.751	0.405	0.025	0.221	0.714	1.114	1.123	1.071
04	1.075	1.071	1.093	1.126	0.776	0.416	0.024	0.221	0.712	1.115	1.117	1.106
05	1.084	1.107	1.114	1.112	0.868	0.419	0.034	0.245	0.712	1.119	1.118	1.068
06	1.116	1.110	1.079	1.177	0.786	0.332	0.042	0.253	0.745	1.124	1.132	1.108
07	1.132	1.096	1.103	1.120	0.583	0.347	0.039	0.079	0.650	1.123	1.140	1.029
08	1.244	1.140	1.198	1.138	0.576	0.265	0.042	0.107	0.573	1.137	1.149	1.142
09	1.194	1.099	1.066	1.145	0.477	0.261	0.041	0.072	0.320	1.120	1.115	1.081
10	1.126	0.994	0.967	0.924	0.534	0.248	0.042	0.062	0.266	0.956	1.053	1.021
11	1.083	1.163	1.015	0.862	0.513	0.078	0.042	0.061	0.182	0.893	0.973	1.057
12	1.130	1.163	1.064	0.878	0.321	0.076	0.042	0.060	0.084	0.908	1.025	1.056
13	1.051	1.051	0.902	0.986	0.215	0.063	0.046	0.059	0.069	0.903	1.036	1.020
14	1.039	1.079	1.062	0.912	0.131	0.058	0.043	0.060	0.065	0.885	1.054	1.094
15	1.153	1.074	1.145	0.940	0.122	0.054	0.040	0.063	0.062	0.915	1.037	1.139
16	1.090	1.100	1.138	0.982	0.101	0.032	0.022	0.025	0.033	0.883	1.076	1.142
17	1.101	1.057	1.125	0.934	0.093	0.032	0.015	0.016	0.038	0.867	1.061	1.133
18	1.174	1.170	1.210	0.971	0.187	0.031	0.015	0.016	0.125	0.954	1.152	1.194
19	1.121	1.141	1.157	1.089	0.390	0.032	0.015	0.015	0.219	0.957	1.136	1.115
20	1.131	1.151	1.191	1.042	0.379	0.112	0.013	0.013	0.314	0.988	1.123	1.151
21	1.106	1.122	1.136	1.082	0.600	0.109	0.013	0.012	0.505	1.086	1.127	1.142
22	1.085	1.141	1.167	1.107	0.611	0.129	0.013	0.024	0.524	1.087	1.121	1.132
23	1.105	1.116	1.103	1.113	0.613	0.140	0.013	0.035	0.617	1.108	1.121	1.126
24	1.190	1.053	1.101	1.117	0.628	0.311	0.012	0.129	0.561	1.103	1.111	1.111

Table E-11 Typical Weekday Total Lighting Savings Load Shapes (kW)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
01	230	248	248	249	183	47	6	33	150	237	250	250
02	249	249	252	253	189	69	14	33	151	238	254	256
03	240	241	239	250	205	72	16	35	154	239	252	245
04	242	238	244	251	207	74	25	43	156	238	249	248
05	238	249	246	249	206	75	25	44	176	238	251	249
06	420	439	385	339	263	95	62	95	214	339	377	404
07	367	422	424	405	367	207	219	239	350	415	429	378
08	356	391	443	411	290	190	189	208	328	428	443	370
09	458	497	465	372	287	218	207	234	299	399	410	452
10	419	452	387	344	285	221	212	246	296	396	380	391
11	461	477	393	315	287	216	217	250	262	389	375	415
12	438	440	354	310	299	216	216	252	248	398	398	401
13	441	431	345	333	300	206	207	237	244	376	416	394
14	434	439	379	319	290	208	206	234	240	377	411	395
15	434	454	398	329	282	207	210	234	245	380	415	416
16	431	461	411	320	288	221	227	252	248	394	428	413
17	423	442	406	333	283	211	230	245	248	411	412	423
18	206	187	218	209	114	16	14	14	74	235	256	205
19	236	234	217	225	112	15	10	12	111	232	239	234
20	244	222	226	228	118	31	9	13	124	237	244	224
21	279	261	209	252	115	25	9	15	143	230	240	253
22	244	236	227	244	113	36	4	6	144	249	249	236
23	251	252	254	249	128	38	3	3	138	241	256	257
24	256	259	269	257	154	39	3	5	150	244	252	247

Table E-12 Typical Weekday Total Lighting Savings Ratios

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
01	0.173	0.186	0.186	0.187	0.137	0.036	0.005	0.025	0.112	0.178	0.188	0.188
02	0.187	0.187	0.189	0.190	0.142	0.052	0.011	0.025	0.113	0.179	0.191	0.193
03	0.181	0.181	0.179	0.188	0.154	0.054	0.012	0.026	0.115	0.179	0.189	0.184
04	0.182	0.179	0.183	0.189	0.155	0.056	0.019	0.032	0.117	0.179	0.187	0.186
05	0.179	0.187	0.185	0.187	0.155	0.056	0.019	0.033	0.132	0.179	0.188	0.187
06	0.316	0.330	0.290	0.254	0.197	0.072	0.047	0.072	0.161	0.255	0.283	0.304
07	0.276	0.317	0.318	0.305	0.276	0.155	0.164	0.180	0.263	0.312	0.323	0.284
08	0.267	0.294	0.333	0.309	0.218	0.143	0.142	0.156	0.246	0.321	0.333	0.278
09	0.344	0.374	0.350	0.280	0.215	0.164	0.155	0.176	0.225	0.300	0.308	0.340
10	0.315	0.339	0.291	0.259	0.214	0.166	0.160	0.185	0.223	0.297	0.286	0.294
11	0.346	0.359	0.296	0.237	0.215	0.162	0.163	0.188	0.197	0.293	0.282	0.312
12	0.329	0.331	0.266	0.233	0.224	0.162	0.162	0.190	0.187	0.299	0.299	0.302
13	0.331	0.324	0.259	0.250	0.225	0.155	0.156	0.178	0.184	0.282	0.313	0.296
14	0.326	0.330	0.285	0.240	0.218	0.156	0.155	0.176	0.180	0.283	0.309	0.297
15	0.326	0.341	0.299	0.247	0.212	0.155	0.158	0.176	0.184	0.286	0.312	0.313
16	0.324	0.347	0.309	0.241	0.217	0.166	0.171	0.189	0.186	0.296	0.321	0.310
17	0.318	0.332	0.305	0.250	0.213	0.159	0.173	0.184	0.187	0.309	0.310	0.318
18	0.155	0.140	0.164	0.157	0.086	0.012	0.010	0.011	0.056	0.177	0.192	0.154
19	0.177	0.176	0.163	0.169	0.084	0.011	0.007	0.009	0.083	0.174	0.180	0.176
20	0.184	0.167	0.170	0.172	0.089	0.023	0.007	0.009	0.093	0.178	0.183	0.168
21	0.210	0.196	0.157	0.189	0.087	0.019	0.006	0.012	0.108	0.173	0.180	0.190
22	0.184	0.178	0.171	0.184	0.085	0.027	0.003	0.005	0.108	0.187	0.187	0.177
23	0.188	0.189	0.191	0.187	0.096	0.029	0.002	0.002	0.104	0.181	0.193	0.193
24	0.192	0.195	0.202	0.193	0.116	0.029	0.002	0.004	0.113	0.183	0.189	0.186

Table E-13 Typical Weekend Day Total Lighting Savings Load Shapes (kW)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
01	243	230	250	246	140	69	7	28	116	250	247	243
02	249	245	248	253	170	90	3	28	142	250	252	248
03	244	240	244	248	169	91	6	50	160	250	252	241
04	241	241	245	253	174	93	5	50	160	250	251	248
05	244	249	250	250	195	94	8	55	160	251	251	240
06	251	249	242	264	177	75	9	57	167	252	254	249
07	254	246	248	252	131	78	9	18	146	252	256	231
08	279	256	269	256	129	60	9	24	129	255	258	257
09	268	247	239	257	107	59	9	16	72	252	250	243
10	253	223	217	208	120	56	10	14	60	215	237	229
11	243	261	228	194	115	17	9	14	41	201	218	237
12	254	261	239	197	72	17	10	13	19	204	230	237
13	236	236	202	221	48	14	10	13	15	203	233	229
14	233	242	238	205	29	13	10	13	14	199	237	246
15	259	241	257	211	27	12	9	14	14	206	233	256
16	245	247	256	221	23	7	5	6	7	198	242	256
17	247	237	253	210	21	7	3	4	9	195	238	255
18	264	263	272	218	42	7	3	3	28	214	259	268
19	252	256	260	245	88	7	3	3	49	215	255	250
20	254	258	267	234	85	25	3	3	71	222	252	259
21	248	252	255	243	135	24	3	3	114	244	253	256
22	244	256	262	249	137	29	3	5	118	244	252	254
23	248	251	248	250	138	32	3	8	139	249	252	253
24	267	237	247	251	141	70	3	29	126	248	250	249

Table E-14 Typical Weekend Day Total Lighting Savings Ratios

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
01	0.182	0.173	0.188	0.185	0.105	0.052	0.005	0.021	0.087	0.188	0.185	0.183
02	0.188	0.184	0.187	0.190	0.128	0.068	0.002	0.021	0.106	0.188	0.189	0.186
03	0.184	0.180	0.184	0.187	0.127	0.068	0.004	0.037	0.121	0.188	0.190	0.181
04	0.181	0.181	0.184	0.190	0.131	0.070	0.004	0.037	0.120	0.188	0.189	0.187
05	0.183	0.187	0.188	0.188	0.146	0.071	0.006	0.041	0.120	0.189	0.189	0.180
06	0.188	0.187	0.182	0.199	0.133	0.056	0.007	0.043	0.126	0.190	0.191	0.187
07	0.191	0.185	0.186	0.189	0.098	0.059	0.007	0.013	0.110	0.190	0.192	0.174
08	0.210	0.193	0.202	0.192	0.097	0.045	0.007	0.018	0.097	0.192	0.194	0.193
09	0.202	0.185	0.180	0.193	0.081	0.044	0.007	0.012	0.054	0.189	0.188	0.183
10	0.190	0.168	0.163	0.156	0.090	0.042	0.007	0.010	0.045	0.161	0.178	0.172
11	0.183	0.196	0.171	0.145	0.087	0.013	0.007	0.010	0.031	0.151	0.164	0.178
12	0.191	0.196	0.180	0.148	0.054	0.013	0.007	0.010	0.014	0.153	0.173	0.178
13	0.177	0.177	0.152	0.166	0.036	0.011	0.008	0.010	0.012	0.152	0.175	0.172
14	0.175	0.182	0.179	0.154	0.022	0.010	0.007	0.010	0.011	0.149	0.178	0.185
15	0.195	0.181	0.193	0.159	0.021	0.009	0.007	0.011	0.011	0.154	0.175	0.192
16	0.184	0.186	0.192	0.166	0.017	0.005	0.004	0.004	0.006	0.149	0.182	0.193
17	0.186	0.178	0.190	0.158	0.016	0.005	0.002	0.003	0.006	0.146	0.179	0.191
18	0.198	0.197	0.204	0.164	0.032	0.005	0.002	0.003	0.021	0.161	0.194	0.202
19	0.189	0.193	0.195	0.184	0.066	0.005	0.002	0.003	0.037	0.162	0.192	0.188
20	0.191	0.194	0.201	0.176	0.064	0.019	0.002	0.002	0.053	0.167	0.190	0.194
21	0.187	0.189	0.192	0.183	0.101	0.018	0.002	0.002	0.085	0.183	0.190	0.193
22	0.183	0.193	0.197	0.187	0.103	0.022	0.002	0.004	0.088	0.183	0.189	0.191
23	0.186	0.188	0.186	0.188	0.103	0.024	0.002	0.006	0.104	0.187	0.189	0.190
24	0.201	0.178	0.186	0.189	0.106	0.053	0.002	0.022	0.095	0.186	0.188	0.187

Table E-15 Typical Weekday Total Process Savings Load Shapes (kW)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
01	230	248	248	249	183	47	6	33	150	237	250	250
02	249	249	252	253	189	69	14	33	151	238	254	256
03	240	241	239	250	205	72	16	35	154	239	252	245
04	242	238	244	251	207	74	25	43	156	238	249	248
05	238	249	246	249	206	75	25	44	176	238	251	249
06	420	439	385	339	263	95	62	95	214	339	377	404
07	367	422	424	405	367	207	219	239	350	415	429	378
08	356	391	443	411	290	190	189	208	328	428	443	370
09	458	497	465	372	287	218	207	234	299	399	410	452
10	419	452	387	344	285	221	212	246	296	396	380	391
11	461	477	393	315	287	216	217	250	262	389	375	415
12	438	440	354	310	299	216	216	252	248	398	398	401
13	441	431	345	333	300	206	207	237	244	376	416	394
14	434	439	379	319	290	208	206	234	240	377	411	395
15	434	454	398	329	282	207	210	234	245	380	415	416
16	431	461	411	320	288	221	227	252	248	394	428	413
17	423	442	406	333	283	211	230	245	248	411	412	423
18	206	187	218	209	114	16	14	14	74	235	256	205
19	236	234	217	225	112	15	10	12	111	232	239	234
20	244	222	226	228	118	31	9	13	124	237	244	224
21	279	261	209	252	115	25	9	15	143	230	240	253
22	244	236	227	244	113	36	4	6	144	249	249	236
23	251	252	254	249	128	38	3	3	138	241	256	257
24	256	259	269	257	154	39	3	5	150	244	252	247

Table E-16 Typical Weekday Total Process Savings Ratios

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
01	0.173	0.186	0.186	0.187	0.137	0.036	0.005	0.025	0.112	0.178	0.188	0.188
02	0.187	0.187	0.189	0.190	0.142	0.052	0.011	0.025	0.113	0.179	0.191	0.193
03	0.181	0.181	0.179	0.188	0.154	0.054	0.012	0.026	0.115	0.180	0.190	0.184
04	0.182	0.179	0.183	0.189	0.155	0.056	0.019	0.032	0.117	0.179	0.188	0.186
05	0.179	0.187	0.185	0.187	0.155	0.056	0.019	0.033	0.133	0.179	0.188	0.187
06	0.316	0.330	0.290	0.255	0.197	0.072	0.047	0.072	0.161	0.255	0.283	0.304
07	0.276	0.317	0.319	0.305	0.276	0.155	0.164	0.180	0.263	0.312	0.323	0.284
08	0.267	0.294	0.333	0.309	0.218	0.143	0.142	0.157	0.247	0.321	0.333	0.278
09	0.344	0.374	0.350	0.280	0.216	0.164	0.155	0.176	0.225	0.300	0.308	0.340
10	0.315	0.340	0.291	0.259	0.214	0.166	0.160	0.185	0.223	0.298	0.286	0.294
11	0.346	0.359	0.296	0.237	0.215	0.162	0.163	0.188	0.197	0.293	0.282	0.312
12	0.329	0.331	0.266	0.233	0.225	0.162	0.162	0.190	0.187	0.299	0.299	0.302
13	0.331	0.324	0.259	0.250	0.225	0.155	0.156	0.178	0.184	0.282	0.313	0.297
14	0.327	0.330	0.285	0.240	0.218	0.156	0.155	0.176	0.180	0.283	0.309	0.297
15	0.326	0.341	0.299	0.247	0.212	0.155	0.158	0.176	0.185	0.286	0.312	0.313
16	0.324	0.347	0.309	0.241	0.217	0.166	0.171	0.189	0.186	0.296	0.322	0.311
17	0.318	0.332	0.305	0.250	0.213	0.159	0.173	0.184	0.187	0.309	0.310	0.318
18	0.155	0.140	0.164	0.157	0.086	0.012	0.010	0.011	0.056	0.177	0.192	0.154
19	0.177	0.176	0.163	0.169	0.084	0.011	0.007	0.009	0.083	0.175	0.180	0.176
20	0.184	0.167	0.170	0.172	0.089	0.023	0.007	0.009	0.093	0.178	0.183	0.168
21	0.210	0.196	0.157	0.189	0.087	0.019	0.006	0.012	0.108	0.173	0.180	0.190
22	0.184	0.178	0.171	0.184	0.085	0.027	0.003	0.005	0.108	0.187	0.187	0.177
23	0.188	0.189	0.191	0.187	0.096	0.029	0.002	0.002	0.104	0.181	0.193	0.193
24	0.192	0.195	0.203	0.193	0.116	0.029	0.002	0.004	0.113	0.183	0.189	0.186

Table E-17 Typical Weekend Day Total Process Savings Load Shapes (kW)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
01	243	230	250	246	140	69	7	28	116	250	247	243
02	249	245	248	253	170	90	3	28	142	250	252	248
03	244	240	244	248	169	91	6	50	160	250	252	241
04	241	241	245	253	174	93	5	50	160	250	251	248
05	244	249	250	250	195	94	8	55	160	251	251	240
06	251	249	242	264	177	75	9	57	167	252	254	249
07	254	246	248	252	131	78	9	18	146	252	256	231
08	279	256	269	256	129	60	9	24	129	255	258	257
09	268	247	239	257	107	59	9	16	72	252	250	243
10	253	223	217	208	120	56	10	14	60	215	237	229
11	243	261	228	194	115	17	9	14	41	201	218	237
12	254	261	239	197	72	17	10	13	19	204	230	237
13	236	236	202	221	48	14	10	13	15	203	233	229
14	233	242	238	205	29	13	10	13	14	199	237	246
15	259	241	257	211	27	12	9	14	14	206	233	256
16	245	247	256	221	23	7	5	6	7	198	242	256
17	247	237	253	210	21	7	3	4	9	195	238	255
18	264	263	272	218	42	7	3	3	28	214	259	268
19	252	256	260	245	88	7	3	3	49	215	255	250
20	254	258	267	234	85	25	3	3	71	222	252	259
21	248	252	255	243	135	24	3	3	114	244	253	256
22	244	256	262	249	137	29	3	5	118	244	252	254
23	248	251	248	250	138	32	3	8	139	249	252	253
24	267	237	247	251	141	70	3	29	126	248	250	249

Table E-18 Typical Weekend Day Total Process Savings Ratios

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
01	0.182	0.173	0.188	0.185	0.105	0.052	0.005	0.021	0.087	0.188	0.186	0.183
02	0.188	0.184	0.187	0.191	0.128	0.068	0.002	0.021	0.106	0.188	0.189	0.186
03	0.184	0.180	0.184	0.187	0.127	0.068	0.004	0.037	0.121	0.188	0.190	0.181
04	0.181	0.181	0.185	0.190	0.131	0.070	0.004	0.037	0.120	0.188	0.189	0.187
05	0.183	0.187	0.188	0.188	0.147	0.071	0.006	0.041	0.120	0.189	0.189	0.180
06	0.188	0.187	0.182	0.199	0.133	0.056	0.007	0.043	0.126	0.190	0.191	0.187
07	0.191	0.185	0.186	0.189	0.098	0.059	0.007	0.013	0.110	0.190	0.192	0.174
08	0.210	0.193	0.202	0.192	0.097	0.045	0.007	0.018	0.097	0.192	0.194	0.193
09	0.202	0.186	0.180	0.193	0.081	0.044	0.007	0.012	0.054	0.189	0.188	0.183
10	0.190	0.168	0.163	0.156	0.090	0.042	0.007	0.010	0.045	0.161	0.178	0.172
11	0.183	0.196	0.171	0.145	0.087	0.013	0.007	0.010	0.031	0.151	0.164	0.179
12	0.191	0.196	0.180	0.148	0.054	0.013	0.007	0.010	0.014	0.153	0.173	0.178
13	0.177	0.178	0.152	0.166	0.036	0.011	0.008	0.010	0.012	0.153	0.175	0.172
14	0.175	0.182	0.179	0.154	0.022	0.010	0.007	0.010	0.011	0.149	0.178	0.185
15	0.195	0.181	0.193	0.159	0.021	0.009	0.007	0.011	0.011	0.155	0.175	0.192
16	0.184	0.186	0.192	0.166	0.017	0.005	0.004	0.004	0.006	0.149	0.182	0.193
17	0.186	0.178	0.190	0.158	0.016	0.005	0.002	0.003	0.006	0.146	0.179	0.191
18	0.198	0.198	0.204	0.164	0.032	0.005	0.002	0.003	0.021	0.161	0.194	0.202
19	0.189	0.193	0.195	0.184	0.066	0.005	0.002	0.003	0.037	0.162	0.192	0.188
20	0.191	0.194	0.201	0.176	0.064	0.019	0.002	0.002	0.053	0.167	0.190	0.194
21	0.187	0.189	0.192	0.183	0.101	0.018	0.002	0.002	0.085	0.183	0.190	0.193
22	0.183	0.193	0.197	0.187	0.103	0.022	0.002	0.004	0.088	0.184	0.189	0.191
23	0.187	0.188	0.186	0.188	0.103	0.024	0.002	0.006	0.104	0.187	0.189	0.190
24	0.201	0.178	0.186	0.189	0.106	0.053	0.002	0.022	0.095	0.186	0.188	0.188

MEASURE DESCRIPTIONS IN THE CL&P AND UI TRACKING SYSTEMS

This appendix shows the categorization and varied naming practices and spellings of measures found in the Company tracking systems for the 2009 Energy Conscious Blueprint program.

Table F-1 Measure Names Recorded for 2009 ECB Projects—United Illuminating Company

MAJOR MEASURE CATEGORIES **Measure Subcategories** Individual Measures	
COOLING	EBB-PROCESS, CUSTOM, VARIABLE SPEED DRIV
EBB-AC, SPLIT SYSTEMS, DUCTLESS	MEB-CUSTOM, PROCESS AND SYSTEMS
EBB-AC, UNITARY AND SPLIT SYSTEMS	MEB-PROCESS, CUSTOM
EBB-COOLING - CHILLERS, ASHRAE 90.1 - 20	
EBB-COOLING, CUSTOM	**OTHER**
EBB-COOLING, UNITARY AC & SPLIT SYSTEMS	**Energy Management Systems**
EBB-COOLING, WATER SOURCE HP	EBB-CUSTOM, ALL
EBB-CUSTOM, COOLING	EBB-CUSTOM, CUSTOM
EBB-HEAT PUMP, WATER, GROUND LOOP	EBB-ENERGY MANAGEMENT SYSTEM (EMS)
MEB-AC, UNITARY AND SPLIT SYSTEMS	MEB-ENERGY MANAGEMENT SYSTEM (EMS)
MEB-COOLING - CHILLERS, ASHRAE 90.1 - 20	**Envelope**
MEB-COOLING, CUSTOM	EBB-CUSTOM, HVAC
MEB-COOLING, UNITARY AC & SPLIT SYSTEMS	EBB-ENVELOPE, ASHRAE 90.1
	EBB-ENVELOPE, CUSTOM
HEATING	MEB-ENVELOPE, ASHRAE 90.1
EBB-CUSTOM, HEATING	**Motors**
EBB-HEATING, ASHRAE 90.1	EBB-CUSTOM, CUSTOM
EBB-HEATING, CUSTOM	EBB-CUSTOM, VARIABLE SPEED DRIVES
MEB-HEATING, ASHRAE 90.1	EBB-MOTOR, HVAC, <= 200 HP
MEB-HEATING, CUSTOM	EBB-MOTOR, STANDARD (<= 200 HP)
	EBB-VARIABLE FREQUENCY DRIVES
LIGHTING	MEB-CUSTOM, VARIABLE SPEED DRIVES
EBB-CUSTOM, ADDITIONAL LIGHTING	MEB-MOTOR, STANDARD (<= 200 HP)
EBB-LIGHTING, CUSTOM, ADDITIONAL	MEB-VARIABLE FREQUENCY DRIVES
EBB-LIGHTING, STANDARD	**Other**
MEB-LIGHTING, CUSTOM, ADDITIONAL	EBB-CUSTOM, CUSTOM
MEB-LIGHTING, STANDARD	EBB-CUSTOM, PROCESS AND SYSTEMS
	MEB-CUSTOM, ALL
PROCESS	MEB-CUSTOM, CUSTOM
EBB-AIR COMPRESSOR, <= 100 HP	MEB-CUSTOM, DRY TYPE TRANSFORMERS
EBB-AIR COMPRESSOR, <= 75 HP	MEB-CUSTOM, HVAC
EBB-CUSTOM, CUSTOM	**Refrig**
EBB-CUSTOM, PROCESS AND SYSTEMS	EBB-REFRIGERATION, REFRIGERATORS AND FRE
EBB-PROCESS, CUSTOM	**VAR**

Table F-2 Measure Names Recorded for 2009 ECB Projects—Connecticut Light & Power

MAJOR MEASURE CATEGORIES **Measure Subcategories** Individual Measures	
COOLING	CO2 Controls
Ch,Refr,Acomp	CO2 sensored ventilation demand cntrl
200 ton McQuay chiller	CO2 Sensors
Air cool Chiller York	CO2 Sensors - Payment Correction
Trane cenrifugal chiller CVHF0485	Coolchoice
Trane RTAA Air cooled	COOLING MOTORS
YK MaxE Centrifugal Chiller w/ VFD	Daikin system with Venmar ERV units
Motors	Demand Controlled Ventilation
AHU-1	Differential Enthalphy Control
AHU-2A	Differential Enthalpy Control of O.A.
AHU-2B	Differential Enthalpy Controls
AHU-3	Differential Enthalpy Econ Controls
AHU-4	Dual Enthalpy Controls
AHU-4 SUPPLY FAN	Dual Enthalpy RTU -3, 4, 5
AHU-4 POWERED EXHAUST FAN	Efficient Chiller
AHU-5 POWERED EXHAUST FAN	Electric Chiller
AHU-5 SUPPLY FAN	Energy Efficient Air Conditioning
AIR COOLED CONDENSER UNIT	Heat Recovery Unit
Baldor EM2531T	High Efficiency Chiller
CHWP-1	HVAC
CHWP-1,2	HVAC CU's and AHU's
CHWP-2,3	HVAC VFD
CHWP-2,3,4	New Chiller
CHWP-5,6	New Condenser units
Condeser Water Pumps P-5, P-5A	Occupancy Control of air cond. Units
CWP-1	Oversized Cooling Tower w/ VFDs and wetbuld reset
CWP-1,2	Reflective Roofing
P-5,6	RTU-2, 4, 5, and 6 Dual Enthalpy
P-6,7	RTU-3.1 Supply Fan VFD
Other	RTU-3.2and3.3 Supply Fan VFD
(3) 375 TON WATER COOLED	RTUs and Splits
1 H. E. AIR COOLED CHILLER	Split system 20 ton HVAC
100 TON AIR COOLED CHILLER	Sun Controls/Daylighting
1100 ton VFD Chillers	Upgrade Windows
Add. Paymer per 8/6/09 Cap removal	Variable Frequency Drives
AIR COOLED CHILLER	VFD - Chilled Water Pumps
Air Cooled Chillers	VFD Control of Chilled Water Pumps
CHWP VFD	VFD Control of CWP
CO2	VFD Control of HVAC Fans
CO2 Control of Outside Air	VFD HVAC Fans
CO2 Control of VFD's on Fans	VFD Installation

MAJOR MEASURE CATEGORIES **Measure Subcategories** Individual Measures	
VFD on Chilled Water pump	Carrier 48HGF014A--511AE
VFDs - Chilled Water Pumps	Carrier 48HJT009-H-5--HY
VFD's CHW	Carrier 48PG06
VFDs ON CHILLED WATER	Carrier 48PG08
VFDs on Chilled Water Pumps	Carrier 48PGD08-D-6--H7
VFD's on Chilled Water Pumps	Carrier 48PGDM28
VFDs ON CHW. PUMPS	Carrier 48PGEM04-5-BP
VFD's on HVAC Fans	Carrier 48PGEM07A5BP
VFDs on Primary Chilled Water Pumps	Carrier 48PGEM08BA-5-BP
VFDs to Replace Inlet Guide Vanes	Carrier 48PGEM12-D-5-HV
Water-Cooled Chillers	Carrier 48PGEM20-B-50-BP
(blank)	Carrier 48PGMC20-H-5--TF
RTU_Split	Carrier 48PGMC28-D-5--TF
20 ton Trane YCH241E3H A/C Units	Carrier 48PGNC24-AJ6
25 Ton Unit	Carrier 48PGNC28CJ6
48HGF014AA-5--JE	Carrier 50HE-004
4A7A6048C and CE60D44	Carrier 50HE-005
4A7A6060C and CE60D44	Carrier 50HE-006
4YCY4024	Carrier 50HG016
AAON RM - 016	Carrier 50PG-M08-A
AAON RM - 026	Carrier PGEM12
AHU-1/ CU-1	Carrier PGEM24
AHU-10 SFHFF25	Carrier RTU 7
AHU-2 /CU-2	CU-1
AHU-4 TRANE SFHFF60	Daikin RXS12DVJU
AHU-6 SFHFF55	Daikin RXS18DVJU
AHU-8 TRANE SFHFF25	Differential Enthalpy
American Standard	FHPGS036
American Standard 4A6H5030A1	FHPGS048
American Standard 4A7A5024A1	Fujitsu 24RLQ
American Standard 5 ton splits	Goodman SSX160601A
American Standard TCD181E300A	Heail H4A418GKA
American Standard YFD241C3HAC	Heil H4A36GKD/EDD4X48F
AS 2A7A8036C1	Heil H4A418GKA
AS 2A7A8048C1	Heil H4A418GKD
AS 2A7A8060C1	Heil H4A418KD
Bryant 165ANA042B	Heil H4A424GKA
Bryant 165ANA048	Heil H4A424GKD
CARRIER	Heil N4A430A
Carrier 25HPA560H30	LCA248H4V
Carrier 48HED005---5--HY	Lennox LGA090H4B
Carrier 48HEE003---3--HY	Lennox LGA102H2B

MAJOR MEASURE CATEGORIES **Measure Subcategories** Individual Measures	
Lennox LGA120H2B	RTU-2, 3, and 4 - LGC156H4B
Lennox LGA180H4B	RTU-3
Lennox LGA240H4B	RTU-3 TRANE YCD181C3LACA
Lennox LGA240H4BH	RTU-3, LCG 210H4BH
lennox lgc048s2bs	RTU-3.1
Lennox LGC156H	RTU-3.2 and RTU-3.3
Lennox LGC156H2B	RTU-4
Lennox LGC180H	RTU-5
Lennox LGC180H2B	RTU-6
Lennox LGC210H	RTU-7, LCG 180H4BM
Lennox LGC210H2	RTU-8, LCG 180H4
lennox rtu-22	RTU-9, LCG 180H4
Lennox SG036H4B	Samsung AQV36JA
Lennox SG060H4B	Samsung AQV36JAX
Lennox SG120H4B	Sanyo 24KS72 / 24KLS72
Lennox SG240H4B	Sanyo C2472
LENNOX SGA060H4	SERESCO POOL PACK
lennox sga120h4	Split Unit RAUC-C30
Lennox SSB 036	Trane 4TTR4060C1
Lennox SSB036H4S43Y/CBX32MV-036	Trane 4TTX5036
Lennox SSB048	Trane 4TTX5036A
Lennox SSB048H4S43Y/CBX32MV-048	Trane 4TTX5042A1
Lennox SSB060	Trane 4TTX5048
Lennox SSB060H4S43Y/BCX32MV-060	Trane 4TWR4036A1
Lennox TSA048H4N41Y	Trane 4TWX5024A1
LGA210H2	Trane 4TXCC049B3HC
LGA240H2	Trane 4YCY4024A1064A
Mitsubish MSZ-FD09NA	Trane TCH241C300C
Mitsubishi PLA-A36BA and PUZ-A36NHA	Trane TFD241
RAHU-8 (Trane YCD151C3HA)	Trane YCD181C3HACA
Rheem RARL036JEZ	Trane YCD211E4HC
RTU 6-7	Trane YCD241C4HC
Rtu 8-9	Trane YCH241C3H0C
RTU1	Trane YFD181
RTU-1	Trane YFD181C3LG
RTU-1, LCG 360H4BH	TRANE YFD181C4LH
RTU-1,2	Trane YFD240E4HC
RTU-1,2 Trane (YHC090A3)	Trane YFD241
RTU-1-TRANE-THC102	Trane YFD241C4HGC
RTU2	TRANE YFD241C4LL
RTU-2	Trane YFD300B4HAH
RTU-2 Trane TFH-151	Trane YFD301C4HGC

MAJOR MEASURE CATEGORIES **Measure Subcategories** Individual Measures	
Trane YFD301E3HLAA	**W to air HP**
Trane YFD301E4HA	CARRIER
Trane YFH241C3LBC	EC-024
Trane YHC036E3RLA	EC-048
Trane YHC036E3RLAOKD	EC-070
trane YHC048E	EC-096
Trane YHC048E3EMA	HP-1
Trane YHC048E3RHA	HP-2
Trane YHC048E3RLAOJD	HP-4
Trane YHC048E4RMA00YG	HP-5
Trane YHC060E 3RHA	HP-7
Trane YHC060E1RHA008F	HP-8
Trane YHC060E4RHA	HP-9
Trane YHC060E4RHA00YG	Samsung EH035CAV
Trane YHC060E4RLA	WSHP-B1
Trane YHC060E4RMA00YG	WSHP-B2
Trane YHC06OE3RMA	WSHP-B3
Trane YHC072A3RHA	WSHP-B4
Trane YHC072A3RLA	WSHP-M1
Trane YHC072A4RLA	WSHP-M2
Trane YHC092	WSHP-M4
Trane YHC092A3RHA1007	WSHP-ME
Trane YHC092A3RHA2Z	
Trane YHC092A3RLA32C	**HEATING**
Trane YHC092A4R	**Motors**
Trane YHC092ARLA	0
Trane YHC102A3RMA33C	AHU-1
Trane YHC102A4R	AHU-10 POWERED EXHAUST FAN
YFD151E4HCA	AHU-10 SUPPLY FAN
YFD181E4LCA	AHU-2
YFD211E4HGA	AHU-8 POWERED EXHAUST FAN
YHC048E1	AHU-8 SUPPLY FAN
YHC060E3	AHU-9 POWERED EXHAUST FAN
YHC060E4RMA	AHU-9 SUPPLY FAN
YHC092	CHWP-3,4
YHC092A3	HEAT RECOVERY UNIT-1 SUPP. and EXH.
YHC092A3EHA2X	Hot water pump
york	Hot water Pumps P-29, P-30
York ZH102N15P2VAA4	Hot water pumps P-6, P-6a
York ZH120N20B2AAA4	HWP 1and2
York ZH120N20P2VAA4	HWP-1, HWP-2
York ZJ300N32J2VBA1	HWP-1,2

MAJOR MEASURE CATEGORIES **Measure Subcategories** Individual Measures	
HWP-1,2,3	Heat Recovery Unit
HWP-3,4	HEATING MOTORS
HWP3and4	HI EFF BOILERS
HYDRONIC PUMP P-1, P-2 HEATING WATER	High E Glazing
MAU-1	High Efficiency Boiler
Measure 3: HWP-1, HWP-2	High Efficiency Boilers
P-1	High Efficiency Condensing Boiler
P-1, P-2 HWPs	High Efficiency, Condensing Boilers
P-1, P-2 Heating pumps	Hot Water Pump VFDs
P-1,2,3	Increased roof insulation to R-30
P-2	Infrared Radiant tube heaters
P-2, P-3	Install 1 Vitodens 100-W boiler
P-3	Install 2 Thermal Solutions gas
P-3,4	Install 2 AERCO gas fired hot
P-3,4,5,6,7,8,9,10 HWPs	Install 2 condensing gas furnaces
P-4	Install 2 high efficiency gas boilers
P-4,5	INSTALL 2 NEW BOILERS
P-5	Install 2 Thermal Solutions Model
P-7	Install 5 infrares indirect radiant
PRIMARY HOT WATER HEATING LOOP	Installed Efficient Boiler
SECONDARY HOT WATER HEATING LOOP	IR Radiant Heater - Large Warehouse
Other	IR Radiant Heater - Small Warehouse
(2) Buderus GB 312/240 boilers	New Boiler
(2) condensing gas furnaces	New Boilers
Add 02 trim and parallel position	New High Efficiency Boilers
Add 5.5" Insulation	New High Efficiency Furnaces
Attic and crawl air sealing	Robur Gas Fired Heat Pump
Attic insulation	Upgrade to low -e glazing
Boiler	Upgrade to R-49 ceiling Ins
Boiler Rm 1	Upgrade to rR-22 Wall ins.
Boiler room 2 condensing boilers	Upgrade to slab heating
CO2 Controls	VFD
CO2 Demand Ventilation Control	VFD - Hot Water Pumps
Condensing boiler	VFD Control of Hot Water Pumps
Condensing Boilers	VFD Control of HWP
Condensing Furnace	VFD for heating pumps
Condensing Furnace 1964 Wing	VFD Hot water Pumping System
Crawl space insulation	VFD on Hot water pump
Daikin system with Venmar ERV units	VFDs - Hot Water Pumps
Envelope Improvements	VFD's for Hot water pumps
Gas Fired Boilers	VFD's HW
Gas Fired Condensing Boiler	VFDs ON HOT WATER

MAJOR MEASURE CATEGORIES **Measure Subcategories** Individual Measures	
VFDs on Hot Water Pumps	**LIGHTING**
VFD's on Hot Water Pumps	**Other**
VFDs ON HW PUMPS	20k cap.
VFDs ON HW. PUMPS	Daylighitng
Vfd's on HWP	Daylight dimming controls
Waste Heat Recovery	Daylight Sensors
water-source heat pumps	Daylighting Controls
(blank)	ECB Lighting
VFDs on Hot Water Pumps	Energy efficient lighting
VFD's on Hot Water Pumps	Energy-efficient Lighting
VFDs ON HW PUMPS	EO - New Lighting (wtd avg lifetime used)
VFDs ON HW. PUMPS	Exhibit Lighting
Vfd's on HWP	Hi Efficiency Lighting
Waste Heat Recovery	High Efficiency Lighting
water-source heat pumps	High Performance Lighting
(blank)	High Performance Lighting Design
RTU_Split	Install new lighting
American Standard 4A6H5030A1	Install new store lighting
Carrier 25HPA560H30	Install new warehouse lighting
Daikin RXS18DVJU	Lighitng
Fujitsu 24RLQ	Lightgin
Samsung AQV36JAX	Lighting
Trane 4TWR4036A1	Lighting Controls
Trane 4TWX5024A1	Lighting Controls - Daylight Dimming
W to air HP	Lighting Controls - Occ Sensors
EC-024	Lighting Controls - Occ. Sensors
EC-048	Lighting Controls - Occupancy Sensors
EC-070	Lighting Controls Occupancy Sensors
EC-096	Lighting Controls-Occupancy Sensors
WSHP-B1	Lighting Design
WSHP-B2	Lighting Fixtures
WSHP-B3	Lighting Occupancy Sensors
WSHP-B4	Lighting System
WSHP-M1	NEW E. E. LIGHTING
WSHP-M2	NEW E.E. LIGHTING
WSHP-M4	New High Performance Lighting
WSHP-ME	New High Performance Lighting Design
HOT WATER	New High Performance Lighting System
Other	New Hi-Po Lighting Design
High Efficiency DHW heater	NEW LIGHTING
High Efficiency DHW heaters	New Lighting Design
	OCC SENSORS

MAJOR MEASURE CATEGORIES **Measure Subcategories** Individual Measures	
OCC. SENSORS	ECB IR D212 NC Cycling Air Dryer
Occ. sensors in perimeter offices	ECB MTA HX-125 Cycling Air Dryer
OCCUPANCY SENSORS	ECB QGD-25 VFD 25 HP Air Compressor
Occupancy Sensors on lights	ECB-IRN20H-CC VSD 20 HP Compressor
Photocell sensor controls - Garage	GA-22 VSD 30 HP Air Compressor
sensors	Gardner Denver SAV50 Air Comp
(blank)	Gardner Denver VS110 Air Compressor
	Gardner Denver(2)VS30 Air Comp.
PROCESS	GD SAV50 50HPAir Compressor
Motors	GD VS20 25hp Air Compressor
7.5 HP pump motor	GD VS30-40HP Air Compressor
Compressor	Heat Exchanger
CWP -1	High efficiency air compressor
CWP-2	Ingersoll Rand D255 Cycling Air Dryer
Elevator	Ingersoll Rand D41NC Cycling Air Dry
GX-1,2	Ingersoll Rand IRN30HCC Air Comp
Other	Ingersoll Rand IRN30HCC VSAir Comp
(2) Drain-all 1700 no loss drains	Ingersoll Rand NVC1000 Air Dryer
(2)Quincy QSI-750P$ Air Compressor	Install 7.5 HP VFD on new pump
(ECB) IR EH1000 Dryer	Install new all-electric 55 T. PIMM
(ECB) IR IRN200H-2S VS 200hp Air Comp	Installl 2 60 Hpraw water pumps
(ECB) IR UP6-15VSD VS Air Compressor	IR D127NC Cycling Air Dryer
0	IR DN127NC Cycling Air Dryer
1 new 600 Ton PIMM	IR IRN100H-OF VS Air Compressor
15 HP Atlas VSD Air Compressor	IR IRN20H-CC 20hp Air Compressor
15 HP Ingersoll Rand VSD Compressor	IR IRN2511-TAS Compressor
2 new 525 Ton PIMMs	IR IRN25H 25hp Air Compressor
25 HP VSD CompAir Compressor	IR IRN25H-CC Nivana Air Compressor
2PIMMS	IR IRN30H-CC air compressor
3 new PIMMs	IR IRN50H-CC 50HP Air Compressor
40 HP Atlas Copco VSD Compressor	IR NVC 1600A Cycling Air Dryer
450 ton PandF ht.exch. System	IR NVC300 Cycling Air Dryer
50 HP Atlas Copco VSD Compressor	IR NVC300 dryer
ACE2000 pressure controller	IR NVC600 Cycling Air Dryer
Air Cooled Cycling Water Chiller	IR UP6-15C125 VS Air Compressor
Air dryer Gardner Denver 500	IR UP6-16VSD Air Compressor
Air System Pressure Controller	IRN100H-CC VS Air Compressor
Atlas Copco GA55VSDAP compressor	IRN25C VS 25HP Air Compressor
CO2 Control of Garage Exhaust	IRN60H 60hp Ingersoll-Rand Comp
Dominick Hunter DRD265 Cycling Air Dryer	IRNV300 Ingersoll-Rand Air Dryer
Domnick Hunter DRD325 Cycling Dry	Kaeser air compressor SFC11
DRD 800 Cycling Air Dryer	Kaeser SM-15 air compressor dryer

MAJOR MEASURE CATEGORIES **Measure Subcategories** Individual Measures	
Modify dust collection system	**REFRIGERATION**
Modify hoods, add baffels	**Other**
MTA DEG0100 Cycling Air Dryer	11 snow guns
MTA DEG0125 Cycling Air Dryer	Install
MTA DEG0150 Cycling Air Dryer	Install 3 motors this store
MTA DEG0150 Cycling Dryer	LED Lights in Reach In Freezers
MTA DEG0425 Cycling Air Dryer	
MTA DEG0425 Dryer Capped Balance	**MOTOR**
MTA-DEG0325 Cycling Air Dryer	**Motors**
New 110 Ton PIMM	0
New 110T. PIMM	10HP ODP High Efficiecy Motor
New 225 Ton PIMM	30HP ODP High Efficiecy Motor
New 397 Ton PIMM	AH-3 supply
new 397 Yon PIMM	AHU-1 RETURN
New 55 ton PIMM	AHU-1 SUPPLY
new 55Ton PIMM	AHU-1,2
New Compressor	AHU-1,2 EXHAUST
New Quincy F5120 Compressor	AHU-1,2 SUPPLY
OandM 240 Gal Receiver Tank and Regulator	AHU-1,2,3A,3B,4 RETURN/EXHAUST
Ozone washers	AHU-1,2,3B SUPPLY
Polestar Smart DRD265 Cycling Dryer	AHU-10
PoleStar Smart DRD325 Cycling Dryer	AHU-13
Premium Air Dryer	AHU-15, 18, 19
Process Boiler	AHU-16s
Quincy QGB20VSD Air Compressor	AHU-2 Return
Quincy QGB25VFD Air Comp	AHU-2 Supply
Quincy QGB30VFD Air Compressor	AHU-2 Supply fan
Quincy QGB30VSD Air Compressor	AHU-24s, -25s, HV-1s
Quincy QGB40-VFD Air Compressor	AHU-2s, -6s, -1r, RTU-1s
Quincy QGD25VS 25hp Air Comp	AHU-3 Return
Quincy QGD25VS 25hp Air Comp.	AHU-3,7
Quincy QGD30VSD Air Compressor	AHU-3A SUPPLY
Quincy QGV50-VS Air Compressor	AHU-4 SUPPLY
Quincy QSI300Power$ync Air Comp	AHU-4 SUPPLY
Repipe air distribution sys,lower press	AHU-4 Return
Sullair 2209V 30HPVS Air Compressor	AHU-4 Supply
Sullair 7509PV VS 100hp(Two)Air Comp	AHU-4, 5, 6
upgrade 450 ton chiller	AHU-5
Vacuum Pump with VSD	AHU-6
VFD Air Cormpressor	AHU-7
VFD'S	AHU-8
	AHU-9

MAJOR MEASURE CATEGORIES **Measure Subcategories** Individual Measures	
AHUs SUPPLY FAN	HV-5 Supply
AHUs RETURN FAN	HV-6 Return
AHU-SF 1,2	HV-6 Supply
AHU-SF 3	ICE RINK DEHUMIDIFICATION UNIT EXHAUST
AHU-SF 4, 5, 6	ICE RINK DEHUMIDIFICATION UNIT SUPPLY
Baldor 3312T	IEF-1
Baldor EM3218T	KEF-1
Baldor EM3313T	KEF-1,2
Baldor EM4103T	Leeson 116754
CAF-1	Marathon FVB215TTFS6526 JTL
EF-1	Marathon FVD215TTFS6501 HTL
EF-19	MAU-1
EF-20	mixers
EF-22	P-1, -2, -3, -4, AHU-1s
EF-3, 4	P-7,8
EF-34, 35, 36, 37	P-AHU-1,2,3,7
EF-41, 42	POOL DEHUMIDIFICATION SYSTEM OA
EF-51	POOL DEHUMIDIFICATION SYSTEM EXHAUST
EF-7	POOL DEHUMIDIFICATION SYSTEM SUPPLY
ERV-1 EXHAUST	RAF-1, AHU-11s, -26r, RTU-2r
ERV-1 SUPPLY	RAF-2, AHU-13s, -14s, HV-6s, -7s
ERV-2 EXHAUST	RAF-4, AHU-4s, -7s, -9s, -10s, -15as
ERV-2 SUPPLY	RAF-5, -6, AHU-12s, -17s, -18s, -19s
FP1	RAHU-1r,8s
Geothermal pumps	RAHU-1s, 5s
grit pumps	RAHU-2s,2r,9s,9r, EF-3-6
Hayes 3344	RAHU-3s
Hayes 344A (Baldor EM4314T)	RAHU-4s,5r,
HRU-1 RETURN	Return Fans
HRU-1 SUPPLY	RF-1 LL Exhaust fan
HRU-2 RETURN	RF-1,2
HRU-2 SUPPLY	RF-3
HRU-3 RETURN	RF-4,5,6,7
HRU-3 SUPPLY	RTD feed pumps
HV-1 Return	RTU 6,7 return
HV-1 Supply	RTU 6,7,8,9 Supply
HV2 supply	RTU 8,9, return
HV-3 Return	RTU-10-S
HV-3 Supply	RTU-12-R
HV-4 Return	RTU-14-R
HV-4 Supply	RTU-16-R
HV-5 Return	RTU-17-R

MAJOR MEASURE CATEGORIES **Measure Subcategories** Individual Measures	
RTU-17-S	**OTHER**
RTU-1-R	**Other**
RTU-21-R	75 hp air compressor
RTU-21-S	Add 2 20 HP power flex 70 vfd's to new
RTU-22-R	Add 2 5hp power flex 70 vfd's to new
RTU-22-S	Air-to-Air Heat Recovery
RTU-3-R	Als05: CO2 sensors
RTU-3-S	Atlas Copco GA18VS 25HPAir Comp
RTU-4-R	CO Controls - Parking Garage Fans
RTU-5-R	CO2 Control
RTU-5-S	CO2 CONTROL OF O. A.
RTU-6-R	CO2 CONTROL OF OA
RTU-7-R	CO2 Control of Outside Air
RTU-8-R	CO2 Control of VFDs for Gym Fans
RTU-9-R	CO2 Sensors
RTU-9-S	Demand Ventilation CO2 Sensing Syst
RTU-RETURN/EXHAUST	Energy Efficient Windows
RTU-SUPPLY	ENERGY SAVING POOL COVER
RWP-1,2	Energy Star Transformers
SBR blowers	EnergyStar Transformers
Supply Fans	HRU and HVAC occupancy sensors
US Motor U7P2B	HVAC Units
Weg 007180T3E213T	HVAC VFDs
(blank)	HVAC vfd's
Other	Install 7 Ground loop water
10 HP Exhaust Fan VFD	Install new 200 gal. heat recovery syst.
2-500HP Turbo Blowers	Kaeser SFC45 VS 60hp Air Comp.
AHU-1,2 VFDs	New AC motorandvfd
Als02: High E motors	Return Fan VFDs
Als03: CO Monitoring in garage	VFD Control of HVAC Fans
ECMs	VFD on HVAC fans
Energy-efficient Elevators	VFDS - AHU Fans
Fan VFD	VFD's - AHU Fans
High Efficiency Motors	VFDs - HVAC Fans
INSTALL 20 PREMIUM EFFICIENCY	VFD's AHU's
OTHER MOTORS	VFDs for Geothermal HP System
Premium Efficiency Motors	VFDs on Air Handling Fans
Premium Efficient Motors	VFDs ON FANS
VFD - HVAC Fans	VFD's ON FANS
VFD's Fan	VFDs on Geothermal Pumps
VFDs on HVAC Fans	VFDs on SBR blowers
(blank)	VFDs on slidge blowers

MAJOR MEASURE CATEGORIES **Measure Subcategories** Individual Measures	
Transformers	Transformer

SITE REPORTS

Click the icon below to access the individual reports for the sites visited during the analysis.

Site Reports.pdf

ABOUT GLOBAL

Global Energy Partners is a premier provider of energy and environmental engineering and technical services to utilities, energy companies, research organizations, government/regulatory agencies and private industry.

Global's offerings range from strategic planning to turn-key program design and implementation and technology applications.

Global is a wholly-owned subsidiary of EnerNOC, Inc. committed to helping its clients achieve strategic business objectives with a staff of world-class experts, state of the art tools, and proven methodologies.

Global Energy Partners
500 Ygnacio Valley Road, Suite 450
Walnut Creek, CA 94596

P: 925.482.2000
F: 925.284.3147
E: gephq@gepllc.com