# 2008 Energy Opportunities Program

## Final Impact Evaluation Report

Prepared for: The Energy Conservation and Management Board
The United Illuminating Company
The Connecticut Light & Power Company

Final Report: Middletown, Connecticut, June 18, 2010

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# 1. Executive Summary

This report summarizes the annual energy, summer demand and winter demand savings associated with the 2008 Energy Opportunities Program. KEMA designed this impact evaluation in collaboration with The Energy Conservation Management Board (ECMB), The United Illuminating Company (UI), and Connecticut Light & Power Company (CL&P), hereafter referred to collectively as the "Sponsors."

The Energy Opportunities (EO) program is a significant component of Connecticut's energy efficiency portfolio. It accounted for over 114,245 MWh of gross (tracking) energy savings in the 2008 program year. The corresponding seasonal peak demand reductions were nearly 18 MW and 11.7 MW for summer and winter, respectively.

The results contained herein are based on a sample of fifty-five (55) projects that were selected using statistical sampling techniques and expanded to represent the 2008 population of EO projects. Unless stated otherwise, all demand impacts in this report adhere to the specifications of "seasonal peak demand resources" as defined in ISO New England forward capacity market (FCM) documentation.

In the following tables, KEMA summarizes the impact evaluation findings in traditional tables which compare adjusted gross evaluated savings to gross tracking estimates for annual energy, summer peak demand, and winter peak demand. In Section 8: Program Results, KEMA presents "reporting templates" which echo these high-level results while detailing differences between gross tracking and adjusted gross evaluated estimates using six, discrete factors. Presentations later in the report – Table 8-1, Table 8-2, and Table 8-3 – have the benefit of being both highly detailed and consistent with impact evaluation reporting methods throughout New England.

**Table 1-1: 2008 Energy Opportunities Annual Energy Savings**

| Sector | Annual Energy Savings | | | |
|---|---|---|---|---|
| | Gross Tracking kWh | Adj. Gross Evaluated kWh | Realization Rate | Rel. Prec. (90% Conf.) |
| Lighting | 87,598,461 | 86,586,322 | 98.8% | ±5.4% |
| Non-Lighting | 26,646,974 | 22,462,392 | 84.3% | ±18.5% |
| **Total** | **114,245,435** | **109,048,714** | **95.5%** | **±5.7%** |

Table 1-1 presents the annual energy savings summary. This evaluation concluded that the 2008 Energy Opportunities program has achieved 109,049 MWh of annual energy savings compared to 114,245 MWh in the tracking system. As evidenced above, the **adjusted gross**

**energy realization rate** is 95.5% with statistical precision of ±5.7% at the 90% confidence level. By sector, the adjusted gross energy realization rate is 98.8% ± 5.4% for lighting measures and 84.3% ± 18.5% for non-lighting measures. For annual energy savings, it is customary to target ±10% relative precision at the 90% confidence interval. At the program level, this impact evaluation of the 2008 Energy Opportunities program has met and exceeded this target.

**Table 1-2: 2008 Energy Opportunities Summer Demand Impacts**

| Sector | Summer Peak Demand Impacts | | | |
|---|---|---|---|---|
| | Gross Tracking kW | Adj. Gross Evaluated kW | Realization Rate | Rel. Prec. (80% Conf.) |
| Lighting | 12,653 | 13,255 | 104.8% | ±12.1% |
| Non-Lighting | 5,338 | 4,284 | 80.2% | ±10.2% |
| **Total** | **17,991** | **17,539** | **97.5%** | **±9.5%** |

Table 1-2 presents an identical summary for summer peak demand impacts. This evaluation concluded that the 2008 Energy Opportunities program has achieved 17.54 MW of summer peak demand compared to 17.99 MW in the tracking system. Accordingly, the **adjusted gross summer demand realization rate** is 97.5% with statistical precision of ±9.5% at the 80% confidence level. By sector, the adjusted gross summer demand realization rate is 104.8% ± 12.1% for lighting measures and 80.2% ± 10.2% for non-lighting measures. For demand reduction values, sampling must achieve statistical accuracy and precision of no less than 80% confidence level and 10% relative precision (“80/10”) in order to comply with ISO New England’s M-MVDR[1]. At the program-level, the adjusted gross summer demand realization rate achieves this important analytical objective.

**Table 1-3: 2008 Energy Opportunities Winter Demand Impacts**

| Sector | Winter Peak Demand Impacts | | | |
|---|---|---|---|---|
| | Gross Tracking kW | Adj. Gross Evaluated kW | Realization Rate | Rel. Prec. (80% Conf.) |
| Lighting | 10,380 | 11,073 | 106.7% | ±10.1% |
| Non-Lighting | 1,319 | 1,797 | 136.3% | ±26.9% |
| **Total** | **11,698** | **12,870** | **110.0%** | **±9.5%** |

Finally, Table 1-3 summarizes the winter peak demand impacts. The 2008 Energy Opportunities program has achieved 12.87 MW of winter peak demand compared to 11.70 MW in the tracking system. Accordingly, the **adjusted gross winter demand realization rate** is 110.0% with statistical precision of ±9.5% at the 80% confidence level. By sector, the adjusted

[1] ISO New England Inc., ISO New England Manual for Measurement and Verification of Demand Reduction Value from Demand Resources (Manual M-MVDR).

gross winter demand realization rate is 106.7% ± 10.1% for lighting measures and 136.3% ± 26.9% for non-lighting measures. At the program-level, the adjusted gross winter demand realization rate also achieves the important "80/10" analytical objective.

One can draw some conclusions from these results. First, commercial and industrial lighting measures are performing well in the 2008 Energy Opportunities program. With adjusted gross energy and demand realization rates near or above unity, EO lighting is successful and consistent with other large C&I retrofit programs in the region. This reflects positively on both the maturity of lighting as an efficiency measure and on the ability of implementers to deliver lighting savings with consistent and accurate ex-ante savings estimates.

Non-lighting realization rates and relative precision estimates were more variable than their lighting counterparts. This is also consistent with other large C&I programs in the region, but it does not necessarily reflect poorly on the EO program itself. The evaluation team anticipated higher variability and diversity of measures in the non-lighting category and therefore employed an error ratio of 0.8 to allocate 25/55=45% of the sites to a category with just 23% of the annual savings. When one considers the precision of each adjusted gross realization rate, non-lighting measures may be performing as well as, if not better than, the lighting sector.

Despite some uncertainty in the non-lighting sector, this impact evaluation was successful in fulfilling its objectives of 90/10 for energy and 80/10 for demand savings at the program-level. These findings may justify deemphasizing the lighting segment and focusing more resources on non-lighting measures in future Energy Opportunities impact evaluations.

# 2. Introduction

This report summarizes the annual energy, summer demand and winter demand savings associated with the 2008 Energy Opportunities Program. KEMA designed this impact evaluation in collaboration with The Energy Conservation Management Board (ECMB), The United Illuminating Company (UI), and Connecticut Light & Power Company (CL&P), hereafter referred to collectively as the "Sponsors."

The primary objectives of this impact evaluation were to:

1. Derive new estimates of Adjusted Gross Energy and Demand Savings Realization Rates by measure category for the 2008 Energy Opportunities program;
2. Review the formulas, calculations, and coincidence factors found in the Connecticut Program Savings Documentation (PSD) and recommend any changes as appropriate based upon study findings.

Also of importance to this impact evaluation was monitoring equipment compliance with ISO New England's Manual M-MVDR and a discussion of potential bias and the steps taken to prevent biases.

## 2.1 The Energy Opportunities Program

The goal of the Energy Opportunities program is to improve the energy efficiency of a customer's existing facility by capturing retrofit opportunities. These opportunities are realized by: 1) exchanging functioning yet inefficient equipment within the commercial or industrial environment with higher efficiency equipment; 2) retrofitting existing equipment with energy-saving devices, modifications, or controls; and 3) improving a facility's performance.

The Energy Opportunities program is a commercial & industrial efficiency program that promotes energy efficiency retrofits within existing buildings. To qualify for the EO program, commercial and industrial customers must use more than 200 kW. Other customers, such as municipalities and state and federal facilities, may also take advantage of the services offered under the EO program.

Services offered under the EO program are as follows:

- Walk-Through Energy Audits
- Co-Funded Engineering Studies
- Complete Energy Audits

- Single Measure Analysis
- Energy End-Use Analysis
- Vendor Proposal Review
- Financial Incentives

The EO program is designed to handle a wide range of energy saving retrofit projects. Typical projects receiving incentives include lighting, HVAC, refrigeration, compressed air, controls, process optimization and custom measures. Technologies eligible for incentives may include, but are not limited to: HVAC economizers, HVAC optimization, HVAC equipment, LED lighting technologies, refrigeration equipment, refrigeration system optimization, process equipment and controls, DDC (direct digital control), envelope measures, premium efficient motors, variable speed drives, energy management systems, lighting & lighting controls, compressed air systems, chillers, windows & treatments, ultrasonic humidifiers and custom measures.

## 2.2 Impact Evaluation Overview

The primary objective of this study was to derive new estimates of adjusted gross energy and demand savings realization rates. Integral to this goal was a comprehensive review of the formulas and calculations found in the program savings documentation (PSD). KEMA gave particular attention to the coincidence factors used in the PSD, but the adjusted gross demand realization rates were based upon coincidence factors derived during this study.

KEMA computed and presented results with respect to the following six (6) adjustment factors:

- Documentation adjustment,
- Technology adjustment,
- Quantity adjustment,
- Operation adjustment,
- Coincidence adjustment, and
- Interactive (heating and cooling) adjustment.

As decided at the kick off meeting in collaboration with the Sponsors, this impact evaluation was designed to achieve a relative precision of ±10% at the 80% confidence interval ("80/10") for overall coincident demand impacts for the entire Connecticut program (both UI and CL&P). KEMA's statistical approach is detailed in Section 3: Sample Design and Site Selection and Appendix A: Stratified Ratio Estimation.

There is an important distinction in Connecticut with regard to the computation of coincident peak demand reduction value (DRV). Many FCM participants in New England submit energy-efficiency as an **On-Peak Demand Resource** which involves assessing coincidence with the time-dependent definition of “Demand Resource On-Peak Hours.” Alternatively, United Illuminating and Connecticut Light and Power submit their DRV as a **Seasonal Peak Demand Resource** which involves assessing coincidence with a probabilistic condition as defined by “Demand Resource Seasonal Peak Hours.” These seasonal performance hours are more complex to define because they are conditional in nature and depend upon the relationship between real time system load and the most recent 50/50 system peak load forecast. KEMA defines the aforementioned peak periods and details our approach to assessing coincidence in Appendix B: Peak Period Coincidence.

All of the metering equipment that KEMA employed for this evaluation meets the accuracy requirements set forth in the ISO New England (ISO-NE) M&V Manual and are calibrated according to manufacturer recommendations. The meters employed in this evaluation are documented in Appendix C: Meter Compliance.

# 3. Sample Design and Site Selection

A critical step in estimating EO Program impacts was selecting an appropriate evaluation sample that was designed to achieve the relative precision requirements of the Sponsors. The RFP stated these requirements to be ±10% precision at an 80% confidence interval for overall coincident demand impacts for each electric utility service territory, or as otherwise required to be consistent with the current protocols and requirements in the ISO New England Manual M-MVDR.

KEMA's intimate understanding of the M-MVDR is that the results of the evaluation can be utilized by multiple sponsors, either within one load zone or across multiple load zones, as long as the results are adjusted for bias. In this case, both sponsors are located in the same load zone and implement the program in a similar manner. For these reasons, KEMA and the Sponsors agreed that UI and CL&P can pursue an evaluation of their combined service territories at 80/10 for this program and comply with the M-MVDR.

KEMA presented a variety of sample design iterations with sample sizes ranging from 35 to 80 total sites and different allocations between Lighting and Non-Lighting projects. While impact evaluation results for similar programs in neighboring states suggest that error ratios of 0.4 and 0.7 (Lighting and Non-Lighting, respectively) are appropriate sample design assumptions for mature C&I programs, KEMA recommended boosting the error ratios an additional 0.1 to be more conservative. The group concurred that error ratio assumptions of 0.5 and 0.8 (Lighting and Non-Lighting, respectively) would be worthwhile given the lack of empirical data on both the Energy Opportunities program and also coincident demand performance according to seasonal peak definitions. KEMA indicated that these error ratio assumptions would necessitate a total sample size of 55 sites.

**Table 3-1: End Use Allocation and Expected Relative Precision**

| End Use Category | Population Size (N) | Total kW Summer | Sample Size (n) | Expected Precision |
|---|---|---|---|---|
| Lighting | 574 | 12,652.7 | 30 | ±11.6% |
| Non-Lighting | 184 | 5,338.3 | 25 | ±15.1% |
| **Total** | **758** | **17,991.0** | **55** | **±9.3%** |

Table 3-1 presents the end use allocation and expected precision of the total sample size of 55 sites as decided at the kick off meeting. With a sample of 30 Lighting and 25 Non-Lighting sites, KEMA expected to achieve ±11.6% precision for Lighting, ±15.1% precision for Non-Lighting, and ±9.3% precision overall based on the error ratios above.

**Table 3-2: Lighting Sample Design**

| Stratum | Max kW Summer | Population Size (N) | Total kW Summer | Sample Size (n) | Weight (N/n) |
|---|---|---|---|---|---|
| 1 | 14.9 | 373 | 1,608.8 | 6 | 62.167 |
| 2 | 32.2 | 96 | 2,169.9 | 6 | 16.000 |
| 3 | 57.2 | 56 | 2,456.8 | 6 | 9.333 |
| 4 | 133.4 | 33 | 2,760.0 | 6 | 5.500 |
| 5 | 702.4 | 16 | 3,657.1 | 6 | 2.667 |
| **Total** | | **574** | **12,652.7** | **30** | |

Table 3-2 presents the sample design for lighting measures. According to the five strata sample design above, KEMA performed on-site visits at 30 of the 574 projects. As decided at the project kick off meeting, the sample was designed on UI/CL&P estimates of coincident peak summer kW impact.

**Table 3-3: Non-Lighting Sample Design**

| Stratum | Max kW Summer | Population Size (N) | Total kW Summer | Sample Size (n) | Weight (N/n) |
|---|---|---|---|---|---|
| 1 | 17.9 | 133 | 357.0 | 5 | 26.600 |
| 2 | 45.0 | 21 | 634.1 | 4 | 5.250 |
| 3 | 74.2 | 13 | 739.9 | 4 | 3.250 |
| 4 | 126.0 | 8 | 792.4 | 4 | 2.000 |
| 5 | 263.0 | 5 | 1,065.6 | 4 | 1.250 |
| 6 | 691.0 | 4 | 1,749.3 | 4 | 1.000 |
| **Total** | | **184** | **5,338.3** | **25** | |

Table 3-3 presents the sample design for non-lighting measures. KEMA performed on-site visits at 25 of the 184 projects according to the six strata sample design above.

# 4. Measurement, Verification, and Analysis

KEMA submitted a final work plan to the Sponsors on July 22, 2009. It included our general plan for measurement and analysis of the sample projects selected from the 2008 Energy Opportunities program population. This measurement and analysis plan detailed the steps involved in reviewing project documentation, characterizing the project scope, and planning for the site visit and subsequent measurement and analysis.

Prior to scheduling a site visit, evaluation engineers first familiarized themselves with the project via a thorough review of existing program documents available from the Sponsors' files, along with documentation from any additional technical or implementation contractors. The purpose of this **comprehensive file review** was three-fold. First, a documentation review provided a double check of the program tracking system values for each measure by comparing the tracking system values to the estimates contained in the file. It is in this stage that any **documentation adjustments** were revealed. Second, it was an opportunity to assess the appropriateness of the applied engineering algorithms, factors, and assumptions in determining energy savings and demand impacts. It is in this stage that evaluators checked consistency with UI and CL&P **program savings documentation**. Finally, file reviews provided a means for evaluators to gather relevant information on the project in preparation for the on-site visit. This entire process was critical to the development of an appropriate and comprehensive approach for each sample site.

## 4.1 Data Collection

Field personnel visited each sampled facility to verify the installed measures and perform all necessary data collection to estimate adjusted gross savings impacts. KEMA performed on-site visits to satisfy the following tasks:

- Identify whether the measures were installed and operating as intended;
- Verify compliance with inspection reports and the PSD;
- Confirm the make/model of equipment;
- Develop a confident estimate of operating hours across a typical year;
- Install measurement equipment in accordance with the evaluation plan;
- Review the baseline operating condition of the efficiency measure;
- Perform necessary measurements to discern post-installation energy usage; and
- Formulate an engineering estimation of gross energy savings.

In the context of an energy analysis, most efficiency measures can be characterized as either time-dependent or load-dependent, each type requiring a distinct data collection approach.

**Time-dependent** equipment typically runs at constant load according to a time-of-day operating schedule. Mathematically, hour-of-day and day-of-week are usually the most relevant variables in the energy savings analysis of these measures. Lighting is the most prevalent time-dependent measure, as are some simple motor applications. Since lighting dominated the 2008 Energy Opportunities program, time-dependent measures were the most prevalent type encountered in the sample.

The energy consumption of **load-dependent** equipment, on the other hand, correlates better with additional explanatory variables such as outdoor temperature or production level. Thus, using this definition, all weather-sensitive measures such as HVAC installations are fundamentally load-dependent. This category also includes industrial process measures that run based upon demand for product, as well as compressed air measures that operate according to system pressure and air flow.

A key task in the site-specific data collection process is the installation of **measurement equipment** to aid in the development of independent estimates savings. The type of measure influences the measurement strategy used. Instantaneous power readings, time-of-use loggers, electrical current loggers, and multi-channel three-phase power loggers all were utilized to inform the savings calculations with a direct measurement of electrical usage and/or hours of operation. For this study, KEMA collected no less than three weeks of data and often collected substantially more in order to span a substantial summer period when New England loads were expected to be near peak.

## 4.2 Measurement Accuracy and Bias

Of particular importance to this impact evaluation was metering equipment compliance with ISO New England's Manual M-MVDR and mitigation of bias from metering equipment, methods, within-facility sampling, and other potential threats to validity. Statistical precision gets a lot of attention in efficiency program evaluation; however, statistical results can be misleading if there is bias or non-statistical error in the underlying data.

In Section 7: Statistical Significance, the ISO New England Manual M-MVDR requires Project Sponsors to describe methods for mitigating and controlling bias in demand estimates. These manuals list many sources of potential bias beyond statistical precision such as accuracy and calibration of measurement tools, measurement error, sensor placement bias, and non-random selection of equipment and/or circuits to monitor.

In Appendix C: Meter Compliance, we summarize the steps taken to ensure that our metering equipment is of the highest quality, well-maintained, and appropriately synchronized and calibrated before deployment on any metering study.  Field personnel installing these devices are experienced and trained to recognize and minimize potential biases from within-facility sampling and non-random sensor placement.

Before visiting each of the 55 sites, the site-specific approach was reviewed by a senior engineer to approve and guide field personnel in appropriate placement of metering equipment to mitigate bias and also provide a reasonable failsafe level of redundancy for predominant efficiency equipment.

## 4.3 Site-Specific Analysis

**Analysis (Time-Dependent):** Time-of-use data from each logger was reviewed to identify the influence on annual trends such as seasonal effects (e.g., daylight savings), production, and occupancy swings (e.g., vacations). Detailed review of time-of-use data often revealed explicable patterns that agree with other data sources, such as on-site interviews or equipment control schedules.  Evaluators annualized short-term metered data and entered field-verified equipment and quantities into a spreadsheet for analysis of adjusted gross energy and demand impacts.

**Analysis (Load-Dependent):** KEMA evaluated load sensitive measures using regression analyses that relate the measured data to an influential variable such as indoor and/or outdoor temperature or machine loading.  In general, HVAC measures were analyzed with respect to typical meteorological year temperature data across all 8,760 hours per year.  Other non-weather sensitive loads, such as process measures or air compressors, were assessed using the same 8,760 method but also correlated to non-weather data, e.g. compressed air usage as appropriate.

# 5. Review of Program Savings Documentation

In addition to developing adjusted gross realization rates through site-specific M&V and statistical methods, another important element of this study was a technical review of the formulas, calculations, and coincidence factors found in the Connecticut Program Savings Documentation (PSD) version date 10/01/2008.

This PSD includes a total of nine (9) measures under the “C&I Retrofit” category which are applicable to Energy Opportunities program:

- Standard Lighting
- Refrigerator LED
- Cooling – Electric Chiller
- Cooling – HVAC
- Cooling – Gas-Driven Chiller
- Custom Measure
- Cooler Night Covers
- Evaporator Fan Controls
- Evaporator Fans Motor Replacement

KEMA reviewed the formulas and parameters documented in the PSD for these measures and found most to be appropriate. KEMA has no substantive recommendations that would warrant changes to the PSD. Some comments follow:

1. While the formulas for Standard Lighting include interactive HVAC effects, the extent of “INT_ADJ” in Table 6-1 (to follow) and the 3.9% interactive adjustment for annual energy savings in Table 1-1 suggests HVAC interaction is being underestimated in the current savings assumptions. It is unclear whether this is due to shortcomings in the Standard Lighting factor $S_c$ or if there is neglect of HVAC interaction in Custom Lighting projects. KEMA’s hourly lighting analyses suggest that fewer coincident demand impacts for HVAC interactive are being realized as well.
2. Algorithms for Chillers and HVAC are reasonable and consistent with those employed elsewhere in the region (as informed by NEEP project A2). This impact evaluation does not have sufficient sample coverage for unitary HVAC measures to draw any conclusions on the appropriateness of the coincidence factors in PSD table 1.1.1.

KEMA also examined whether the documented savings in the impact evaluation sample were consistent with the PSD. To the extent that the sample spanned the nine (9) measures listed above, KEMA found that projects adhered well to PSD algorithms and input parameters.

# 6. Gross Impacts in the Sample

In this section, we present detailed tables of tracking savings, adjustments, and evaluated gross savings.

Table 6-1, Table 6-2, and Table 6-3 present the results for each of the fifty-five (55) projects included in the on-site sample. Each table shows a Project number, the Sector (lighting = "LTG" and non-lighting = "NONLTG"), the tracking savings value (in green), gross adjustments (in yellow), and the adjusted gross evaluated estimate and percent difference (in orange). These data are consistent with the reporting template which captures discrepancies or adjustments in selected categories, defined and analyzed as follows:

- **Documentation Adjustment** (DOC_ADJ) reflects any change in savings due to discrepancies in project documentation. Evaluators recalculated the tracking estimates of savings using all information documented in the project file. All tracking system discrepancies and documentation errors are reflected in this adjustment factor.
- **Technology adjustment** (TECH_ADJ) accounts for all discrepancies between the technology (equipment type, efficiency, system configuration, etc.) identified in the paperwork and that observed in the field. Adjustments to baseline assumptions are also contained in this technology adjustment factor.
- **Quantity adjustment** (QTY_ADJ) reflects any discrepancies between the quantity or size of the documented equipment versus the measures observed in the field.
- **Operational adjustment** (OPER_ADJ) reflects the change in savings due to the observation or monitoring of different operating hours at the site compared to those in the tracking system estimate of savings (not applicable to demand savings).
- **Coincident adjustment** (COIN_ADJ) represents the savings difference between connected and coincident/diversified demand impacts (not applicable to energy savings).
- **Interactive adjustment** (INT_ADJ) accounts for changes in savings due to interaction between the installed measures and other (generally HVAC) systems among the sampled sites.

This list of adjustments differs slightly from those conceptualized in the RFP. While originally calling for a "controls adjustment," the evaluation team decided to eliminate the factor on the basis that it was an artifact from a lighting controls study and not relevant to this impact evaluation. Also, the RFP did not explicitly request a "coincidence adjustment," but it is necessary to capture differences – some substantial – between the ex-ante coincidence factors and the adjustment gross demand impacts derived from direct measurement and coincidence analysis relative to ISO New England's "Demand Resource Seasonal Peak Hours."

The majority of energy adjustments were associated with “operational” changes that occurred between the assumptions used to generate the tracking system savings and the actual, observed operations.  Similarly, the majority of demand adjustments were “coincidence” changes that reflect differences between the tracking system demand impact and a rigorous, hourly (8,760) coincidence analysis versus the seasonal peak approach detailed in Appendix B: Peak Period Coincidence.

## Table 6-1: Gross Energy Savings Adjustments (Sample)

| PROJECT | SECTOR | Tracking kWh | DOC_ADJ | TECH_ADJ | QTY_ADJ | OPER_ADJ | INT_ADJ | Gross kWh | % Diff. |
|---|---|---|---|---|---|---|---|---|---|
| _dnv | LTG | 1,539,036 | 197 | 0 | 0 | -536,190 | 49,336 | 1,052,380 | -31.6% |
| 9AbE | NONLTG | 467,000 | 0 | 0 | 0 | 86,483 | 2,627 | 556,110 | 19.1% |
| 9IDe | NONLTG | 224,155 | -151,548 | 0 | 0 | -65,299 | 0 | 7,308 | -96.7% |
| 9iEY | LTG | 60,416 | 0 | 0 | 0 | 44,353 | -6,257 | 98,512 | 63.1% |
| 9IFu | LTG | 46,964 | 0 | 0 | 0 | 2,317 | -6,969 | 42,312 | -9.9% |
| 9jpW | LTG | 804,712 | -5 | 0 | 0 | -122,118 | 51,679 | 734,267 | -8.8% |
| 9MhY | LTG | 305,471 | 39 | 0 | -2,246 | 10,424 | 31,493 | 345,180 | 13.0% |
| 9OhM | LTG | 156,096 | 5 | -57 | 6,024 | -105,453 | 6,570 | 63,185 | -59.5% |
| 9pTJ | LTG | 11,655 | 0 | 0 | 0 | 32 | 0 | 11,687 | 0.3% |
| 9rDs | LTG | 222,135 | 0 | 0 | 0 | -15,707 | 12,810 | 219,238 | -1.3% |
| 9TMw | LTG | 741,341 | 0 | 0 | 0 | -25,748 | 11,621 | 727,214 | -1.9% |
| 9w2W | NONLTG | 58,587 | 0 | 0 | 0 | -50,066 | 0 | 8,521 | -85.5% |
| CE07C015 | LTG | 335,531 | 0 | 0 | 367 | 59,438 | 41,176 | 436,512 | 30.1% |
| CE07C015 | NONLTG | 325,987 | 0 | 0 | 0 | -211,683 | 0 | 114,304 | -64.9% |
| CE07H004 | NONLTG | 125,343 | 0 | 0 | 0 | 2,034 | 0 | 127,377 | 1.6% |
| CE07H014 | NONLTG | 148,848 | 7,625 | 0 | 0 | -6,284 | 0 | 150,189 | 0.9% |
| CE07L212 | LTG | 979,388 | -2 | 0 | 0 | -18,219 | 53,333 | 1,014,500 | 3.6% |
| CE07L282 | LTG | 60,057 | -7 | 0 | 0 | -4,157 | 3,917 | 59,810 | -0.4% |
| CE07S138 | NONLTG | 10,559 | 0 | 0 | 0 | 872 | 0 | 11,431 | 8.3% |
| CE07S142 | LTG | 807,587 | 0 | 0 | 9,374 | -84,679 | 62,399 | 794,681 | -1.6% |
| CE07S142 | NONLTG | 119,171 | 0 | 0 | 0 | 7,976 | 0 | 127,147 | 6.7% |
| CE07S160 | NONLTG | 30,230 | 0 | 0 | 0 | 9,731 | 0 | 39,961 | 32.2% |
| CE08L024 | LTG | 4,841 | 1,512 | 0 | 2,986 | -4,608 | -362 | 4,369 | -9.8% |
| CE08L048 | LTG | 84,398 | -1 | 0 | 0 | 42,921 | 775 | 128,093 | 51.8% |
| CE08L068 | LTG | 1,176 | 0 | -816 | 540 | 197 | 137 | 1,234 | 4.9% |
| CE08L069 | LTG | 288 | 0 | -108 | 0 | 73 | 31 | 284 | -1.4% |
| CE08L112 | LTG | 16,923 | 0 | 0 | 0 | -2,998 | 0 | 13,925 | -17.7% |
| CE08S048 | NONLTG | 1,077,564 | 0 | 0 | 0 | 331,043 | 0 | 1,408,607 | 30.7% |
| EA07C008 | LTG | 625,855 | 0 | 0 | 0 | 65,124 | 44,915 | 735,894 | 17.6% |
| EA07H003 | NONLTG | 364,177 | 0 | 0 | 0 | -161,889 | 0 | 202,288 | -44.5% |
| EA07L041 | LTG | 327,935 | 0 | 0 | 0 | 7,220 | 43,434 | 378,589 | 15.4% |
| EA07L059 | LTG | 547,347 | 0 | 0 | -285,326 | -160,441 | 8,174 | 109,753 | -79.9% |
| EA07L066 | LTG | 2,112,757 | -75 | 0 | 0 | 79,122 | 6,569 | 2,198,372 | 4.1% |
| EA07L155 | LTG | 685,328 | 0 | 12,647 | -27,456 | 104,651 | 95,538 | 870,709 | 27.0% |
| EA07L209 | LTG | 2,749,011 | 0 | 0 | 0 | -220,455 | 157,016 | 2,685,572 | -2.3% |
| EA07S085 | NONLTG | 239,335 | 0 | 0 | 0 | -72,736 | 0 | 166,599 | -30.4% |
| EA07S112 | NONLTG | 173,678 | 0 | 0 | 0 | -30,539 | 0 | 143,139 | -17.6% |
| EA07S143 | NONLTG | 614,963 | -134,080 | 0 | 0 | 249,368 | -269 | 729,982 | 18.7% |
| WE07C020 | NONLTG | 2,358,113 | 0 | 0 | 0 | 151,997 | 0 | 2,510,110 | 6.4% |
| WE07C021 | NONLTG | 34,339 | 0 | 0 | 0 | 177 | 0 | 34,516 | 0.5% |
| WE07H001 | NONLTG | 736,049 | 0 | 0 | 0 | -389,544 | 0 | 346,505 | -52.9% |
| WE07H004 | NONLTG | 199,054 | 0 | 0 | 0 | 5,774 | 0 | 204,828 | 2.9% |
| WE07H006 | NONLTG | 246,770 | 0 | 0 | 0 | -92,332 | 0 | 154,438 | -37.4% |
| WE07H011 | NONLTG | 557,206 | 0 | 0 | 0 | -448,939 | 0 | 108,267 | -80.6% |
| WE07H012 | NONLTG | 853,509 | 0 | 0 | 0 | -640,288 | 0 | 213,221 | -75.0% |
| WE07H013 | NONLTG | 99,384 | 0 | 0 | 0 | -45,369 | 0 | 54,015 | -45.7% |
| WE07H014 | NONLTG | 307,968 | 97,995 | 0 | 0 | 256,144 | 0 | 662,107 | 115.0% |
| WE07L037 | LTG | 173,353 | 0 | 0 | 0 | -29,915 | 20,191 | 163,629 | -5.6% |
| WE07L063 | LTG | 493,025 | 0 | -1,734 | 0 | -33,062 | 2,831 | 461,060 | -6.5% |
| WE07L096 | LTG | 648,748 | -42 | 0 | 0 | -111,387 | 73,411 | 610,730 | -5.9% |
| WE07L141 | LTG | 442,910 | 1 | 0 | -115,314 | -29,113 | 36,951 | 335,435 | -24.3% |
| WE07L182 | LTG | 79,645 | 0 | 5,865 | -802 | -11,107 | 2,104 | 75,705 | -4.9% |
| WE07P128 | NONLTG | 5,939 | 0 | 0 | 0 | 28,122 | 0 | 34,061 | 473.5% |
| WE07S109 | NONLTG | 8,139 | 0 | 0 | 0 | 164 | 0 | 8,303 | 2.0% |
| WE08L028 | LTG | 167,536 | 29,294 | 0 | 0 | -52,300 | 10,322 | 154,851 | -7.6% |

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### Table 6-2: Gross Summer Demand Savings Adjustments (Sample)

| PROJECT | SECTOR | Tracking kWS | DOC_ADJ | TECH_ADJ | QTY_ADJ | COIN_ADJ | INT_ADJ | Gross kWS | % Diff. |
|---|---|---|---|---|---|---|---|---|---|
| _dnv | LTG | 210.2 | 0.0 | 0.0 | 0.0 | -25.3 | 27.2 | 212.0 | 0.9% |
| 9AbE | NONLTG | 64.0 | 0.0 | 0.0 | 0.0 | 5.9 | -0.9 | 69.1 | 7.9% |
| 9IDe | NONLTG | 40.7 | 0.0 | 0.0 | 0.0 | -39.3 | 0.0 | 1.4 | -96.5% |
| 9iEY | LTG | 16.7 | 0.0 | 0.0 | 0.0 | -11.0 | -1.0 | 4.7 | -71.9% |
| 9IFu | LTG | 11.8 | 0.0 | 0.0 | 0.0 | 0.5 | -1.4 | 10.9 | -7.6% |
| 9jpW | LTG | 133.4 | 0.0 | 0.0 | 0.0 | -10.6 | 23.6 | 146.4 | 9.7% |
| 9MhY | LTG | 36.8 | 0.0 | 0.0 | -0.4 | 5.1 | 11.3 | 52.9 | 43.6% |
| 9OhM | LTG | 41.0 | 0.0 | -0.1 | 0.2 | -25.9 | 4.1 | 19.3 | -53.0% |
| 9pTJ | LTG | 1.0 | 0.0 | 0.0 | 0.0 | 0.4 | 0.0 | 1.3 | 38.0% |
| 9rDs | LTG | 28.9 | 0.0 | 0.0 | 0.0 | 2.0 | 8.0 | 38.9 | 34.6% |
| 9TMw | LTG | 99.5 | 0.0 | 0.0 | 0.0 | 7.9 | 6.6 | 114.0 | 14.6% |
| 9w2W | NONLTG | 2.0 | 0.0 | 0.0 | 0.0 | -2.0 | 0.0 | 0.0 | -100.0% |
| CE07C015 | LTG | 57.4 | 0.0 | 0.0 | 0.2 | -7.1 | 14.0 | 64.5 | 12.4% |
| CE07C015 | NONLTG | 50.4 | 0.0 | 0.0 | 0.0 | -4.5 | 0.0 | 45.9 | -8.9% |
| CE07H004 | NONLTG | 76.5 | 0.0 | 0.0 | 0.0 | -16.8 | 0.0 | 59.7 | -22.0% |
| CE07H014 | NONLTG | 257.1 | 0.0 | 0.0 | 0.0 | -254.3 | 0.0 | 2.8 | -98.9% |
| CE07L212 | LTG | 275.6 | -0.1 | 0.0 | 0.0 | -190.5 | 19.6 | 104.6 | -62.1% |
| CE07L282 | LTG | 30.8 | 0.0 | 0.0 | 0.0 | -28.7 | 0.9 | 3.1 | -90.1% |
| CE07S138 | NONLTG | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | N/A |
| CE07S142 | LTG | 135.8 | -0.3 | 0.0 | 1.5 | 12.0 | 32.7 | 181.7 | 33.8% |
| CE07S142 | NONLTG | 96.0 | 0.0 | 0.0 | 0.0 | 10.0 | 0.0 | 106.0 | 10.4% |
| CE07S160 | NONLTG | 20.8 | 0.0 | 0.0 | 0.0 | -12.1 | 0.0 | 8.8 | -57.9% |
| CE08L024 | LTG | 0.8 | 0.1 | 0.0 | 0.7 | -1.1 | 0.0 | 0.6 | -25.9% |
| CE08L048 | LTG | 14.9 | 0.0 | 0.0 | 0.0 | 3.4 | 2.6 | 20.8 | 39.7% |
| CE08L068 | LTG | 0.3 | 0.0 | 0.0 | 0.0 | -0.2 | 0.0 | 0.1 | -55.3% |
| CE08L069 | LTG | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | -20.0% |
| CE08L112 | LTG | 3.6 | 0.0 | 0.0 | 0.0 | -2.1 | 0.0 | 1.6 | -56.6% |
| CE08S048 | NONLTG | 106.7 | 0.0 | 0.0 | 0.0 | 3.0 | 0.0 | 109.7 | 2.8% |
| EA07C008 | LTG | 57.0 | 0.1 | 0.0 | 0.0 | 67.7 | 17.3 | 142.0 | 149.4% |
| EA07H003 | NONLTG | 140.0 | 0.0 | 0.0 | 0.0 | 15.8 | 0.0 | 155.8 | 11.3% |
| EA07L041 | LTG | 38.8 | 0.0 | 0.0 | 0.0 | 6.7 | 13.0 | 58.5 | 50.9% |
| EA07L059 | LTG | 235.8 | 0.0 | 0.0 | -133.8 | -87.2 | 2.9 | 17.8 | -92.5% |
| EA07L066 | LTG | 215.3 | 0.1 | 0.0 | 0.0 | 42.8 | 3.2 | 261.3 | 21.4% |
| EA07L155 | LTG | 88.3 | 0.0 | 1.9 | -4.2 | 14.3 | 27.4 | 127.7 | 44.6% |
| EA07L209 | LTG | 219.3 | 0.0 | 0.0 | 0.0 | -13.1 | 30.9 | 237.1 | 8.1% |
| EA07S085 | NONLTG | 20.6 | 0.0 | 0.0 | 0.0 | 27.4 | 0.0 | 48.0 | 133.0% |
| EA07S112 | NONLTG | 20.3 | 0.0 | 0.0 | 0.0 | -3.4 | 0.0 | 16.9 | -16.9% |
| EA07S143 | NONLTG | 74.2 | 0.0 | 0.0 | 0.0 | 3.1 | 0.0 | 77.3 | 4.2% |
| WE07C020 | NONLTG | 263.0 | 0.0 | 0.0 | 0.0 | 63.7 | 0.0 | 326.7 | 24.2% |
| WE07C021 | NONLTG | 9.8 | 0.0 | 0.0 | 0.0 | 4.3 | 0.0 | 14.1 | 44.1% |
| WE07H001 | NONLTG | 524.0 | 0.0 | 0.0 | 0.0 | -47.6 | 0.0 | 476.4 | -9.1% |
| WE07H004 | NONLTG | 179.0 | 0.0 | 0.0 | 0.0 | -44.2 | 0.0 | 134.8 | -24.7% |
| WE07H006 | NONLTG | 267.7 | 0.0 | 0.0 | 0.0 | -138.9 | 0.0 | 128.8 | -51.9% |
| WE07H011 | NONLTG | 126.0 | 0.0 | 0.0 | 0.0 | 25.6 | 0.0 | 151.6 | 20.3% |
| WE07H012 | NONLTG | 691.0 | 0.0 | 0.0 | 0.0 | -585.4 | 0.0 | 105.6 | -84.7% |
| WE07H013 | NONLTG | 46.6 | 0.0 | 0.0 | 0.0 | -17.3 | 0.0 | 29.3 | -37.1% |
| WE07H014 | NONLTG | 266.6 | 0.0 | 0.0 | 0.0 | 13.5 | 0.0 | 280.2 | 5.1% |
| WE07L037 | LTG | 19.8 | 0.0 | 0.0 | 0.0 | 2.1 | 6.6 | 28.5 | 44.4% |
| WE07L063 | LTG | 47.6 | 0.0 | -0.2 | 0.0 | 6.7 | 1.3 | 55.3 | 16.2% |
| WE07L096 | LTG | 58.6 | 0.0 | 0.0 | 0.0 | 7.9 | 20.9 | 87.4 | 49.2% |
| WE07L141 | LTG | 68.0 | 0.0 | 0.0 | -15.1 | 4.7 | 15.6 | 73.1 | 7.5% |
| WE07L182 | LTG | 20.4 | 0.0 | 3.2 | -0.4 | -0.4 | 1.2 | 24.1 | 18.1% |
| WE07P128 | NONLTG | 0.5 | 0.0 | 0.0 | 0.0 | 3.0 | 0.0 | 3.5 | 589.2% |
| WE07S109 | NONLTG | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | N/A |
| WE08L028 | LTG | 44.5 | 0.0 | 0.0 | 0.0 | 1.6 | 7.4 | 53.5 | 20.2% |

## Table 6-3: Gross Winter Demand Savings Adjustments (Sample)

| PROJECT | SECTOR | Tracking kWW | DOC_ADJ | TECH_ADJ | QTY_ADJ | COIN_ADJ | INT_ADJ | Gross kWW | % Diff. |
|---|---|---|---|---|---|---|---|---|---|
| _dnv | LTG | 172.2 | 0.0 | 0.0 | 0.0 | -0.4 | 0.0 | 171.9 | -0.2% |
| 9AbE | NONLTG | 0.0 | 0.0 | 0.0 | 0.0 | 51.2 | 1.5 | 52.6 | N/A |
| 9IDe | NONLTG | 0.0 | 0.0 | 0.0 | 0.0 | 1.9 | 0.0 | 1.9 | N/A |
| 9iEY | LTG | 13.1 | 0.0 | 0.0 | 0.0 | 6.9 | -2.3 | 17.7 | 35.2% |
| 9IFu | LTG | 9.7 | 0.0 | 0.0 | 0.0 | 0.3 | -2.3 | 7.8 | -20.0% |
| 9jpW | LTG | 104.8 | 0.1 | 0.0 | 0.0 | 38.9 | 0.0 | 143.8 | 37.2% |
| 9MhY | LTG | 30.3 | 0.0 | 0.0 | -0.4 | 11.6 | 0.0 | 41.5 | 37.0% |
| 9OhM | LTG | 0.0 | 0.0 | -0.1 | 0.2 | 8.7 | 0.0 | 8.9 | N/A |
| 9pTJ | LTG | 0.8 | 0.0 | 0.0 | 0.0 | 0.6 | 0.0 | 1.3 | 75.7% |
| 9rDs | LTG | 22.7 | 0.0 | 0.0 | 0.0 | 10.1 | -0.5 | 32.4 | 42.4% |
| 9TMw | LTG | 81.9 | 0.0 | 0.0 | 0.0 | 18.9 | 0.0 | 100.8 | 23.1% |
| 9w2W | NONLTG | 2.0 | 0.0 | 0.0 | 0.0 | -2.0 | 0.0 | 0.0 | -100.0% |
| CE07C015 | LTG | 50.1 | 0.0 | 0.0 | 0.2 | 31.2 | 0.0 | 81.5 | 62.5% |
| CE07C015 | NONLTG | 6.1 | 0.0 | 0.0 | 0.0 | -6.1 | 0.0 | 0.0 | -100.0% |
| CE07H004 | NONLTG | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | N/A |
| CE07H014 | NONLTG | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | N/A |
| CE07L212 | LTG | 226.9 | -0.1 | 0.0 | 0.0 | -33.3 | 0.0 | 193.5 | -14.7% |
| CE07L282 | LTG | 24.8 | 0.0 | 0.0 | 0.0 | -18.6 | 0.0 | 6.2 | -75.1% |
| CE07S138 | NONLTG | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | N/A |
| CE07S142 | LTG | 113.3 | -0.3 | 0.0 | 1.5 | -2.4 | 0.0 | 112.1 | -1.1% |
| CE07S142 | NONLTG | 0.0 | 0.0 | 0.0 | 0.0 | 10.5 | 0.0 | 10.5 | N/A |
| CE07S160 | NONLTG | 20.8 | 0.0 | 0.0 | 0.0 | -9.8 | 0.0 | 11.0 | -47.0% |
| CE08L024 | LTG | 0.6 | 0.1 | 0.0 | 0.7 | -1.0 | 0.0 | 0.4 | -29.5% |
| CE08L048 | LTG | 10.6 | 0.0 | 0.0 | 0.0 | 5.8 | 0.0 | 16.4 | 54.6% |
| CE08L068 | LTG | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | -14.3% |
| CE08L069 | LTG | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | -41.1% |
| CE08L112 | LTG | 2.3 | 0.0 | 0.0 | 0.0 | -1.9 | 0.0 | 0.5 | -80.7% |
| CE08S048 | NONLTG | 0.0 | 0.0 | 0.0 | 0.0 | 137.1 | 0.0 | 137.1 | N/A |
| EA07C008 | LTG | 49.3 | 0.0 | 0.0 | 0.0 | 30.4 | 0.0 | 79.7 | 61.5% |
| EA07H003 | NONLTG | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | N/A |
| EA07L041 | LTG | 31.9 | 0.0 | 0.0 | 0.0 | 13.6 | 0.0 | 45.5 | 42.5% |
| EA07L059 | LTG | 194.2 | 0.0 | 0.0 | -133.8 | -40.6 | 0.0 | 19.8 | -89.8% |
| EA07L066 | LTG | 177.3 | -0.1 | 0.0 | 0.0 | 80.8 | 0.0 | 257.9 | 45.5% |
| EA07L155 | LTG | 72.7 | 0.0 | 1.9 | -4.2 | 30.0 | 0.0 | 100.4 | 38.1% |
| EA07L209 | LTG | 180.6 | 0.0 | 0.0 | 0.0 | 27.1 | 0.0 | 207.8 | 15.1% |
| EA07S085 | NONLTG | 12.4 | 0.0 | 0.0 | 0.0 | 8.8 | 0.0 | 21.2 | 70.9% |
| EA07S112 | NONLTG | 20.3 | 0.0 | 0.0 | 0.0 | -2.3 | 0.0 | 18.0 | -11.4% |
| EA07S143 | NONLTG | 74.2 | 0.0 | 0.0 | 0.0 | -12.6 | 0.0 | 61.6 | -16.9% |
| WE07C020 | NONLTG | 274.0 | 0.0 | 0.0 | 0.0 | 1.6 | 0.0 | 275.6 | 0.6% |
| WE07C021 | NONLTG | 1.2 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 1.7 | 41.9% |
| WE07H001 | NONLTG | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | N/A |
| WE07H004 | NONLTG | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | N/A |
| WE07H006 | NONLTG | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | N/A |
| WE07H011 | NONLTG | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | N/A |
| WE07H012 | NONLTG | 0.0 | 0.0 | 0.0 | 0.0 | 0.7 | 0.0 | 0.7 | N/A |
| WE07H013 | NONLTG | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | N/A |
| WE07H014 | NONLTG | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | N/A |
| WE07L037 | LTG | 16.3 | 0.0 | 0.0 | 0.0 | 3.9 | 0.0 | 20.2 | 24.2% |
| WE07L063 | LTG | 39.2 | 0.0 | -0.2 | 0.0 | 13.3 | 0.0 | 52.3 | 33.4% |
| WE07L096 | LTG | 48.2 | 0.0 | 0.0 | 0.0 | 21.4 | 0.0 | 69.6 | 44.3% |
| WE07L141 | LTG | 56.0 | 0.0 | 0.0 | -15.1 | 12.5 | 0.0 | 53.4 | -4.6% |
| WE07L182 | LTG | 17.0 | 0.0 | 3.2 | -0.4 | -19.2 | 0.0 | 0.7 | -96.0% |
| WE07P128 | NONLTG | 2.4 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 2.9 | 21.1% |
| WE07S109 | NONLTG | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | N/A |
| WE08L028 | LTG | 36.7 | 0.0 | 0.0 | 0.0 | -18.5 | 0.0 | 18.1 | -50.6% |

# 7. Summary Analysis

After the development of adjusted gross savings for each sample point, the KEMA analytical team expands the site-specific results to the population using stratified ratio estimation techniques. This analysis was implemented using Model Based Statistical Sampling (MBSS) techniques and Roger Wright's Load Research System (LRS) in SAS® software. In this analysis, KEMA assessed the statistical precision achieved and reassessed the error ratios and coefficients of variation used in estimating the original sample sizes.

The savings estimates detailed above in Table 6-1, Table 6-2, and Table 6-3 were combined in a stratified ratio estimation (SRE) analysis framework. Case weights were developed and applied to each sample participant as per Section 3: Sample Design and Site Selection to develop the total gross estimates of savings by sector (lighting/non-lighting) and at the combined program level. A brief, technical outline of the SRE approach is detailed in Appendix A: Stratified Ratio Estimation.

**Figure 7-1: Scatter Plot of Annual Energy Savings**

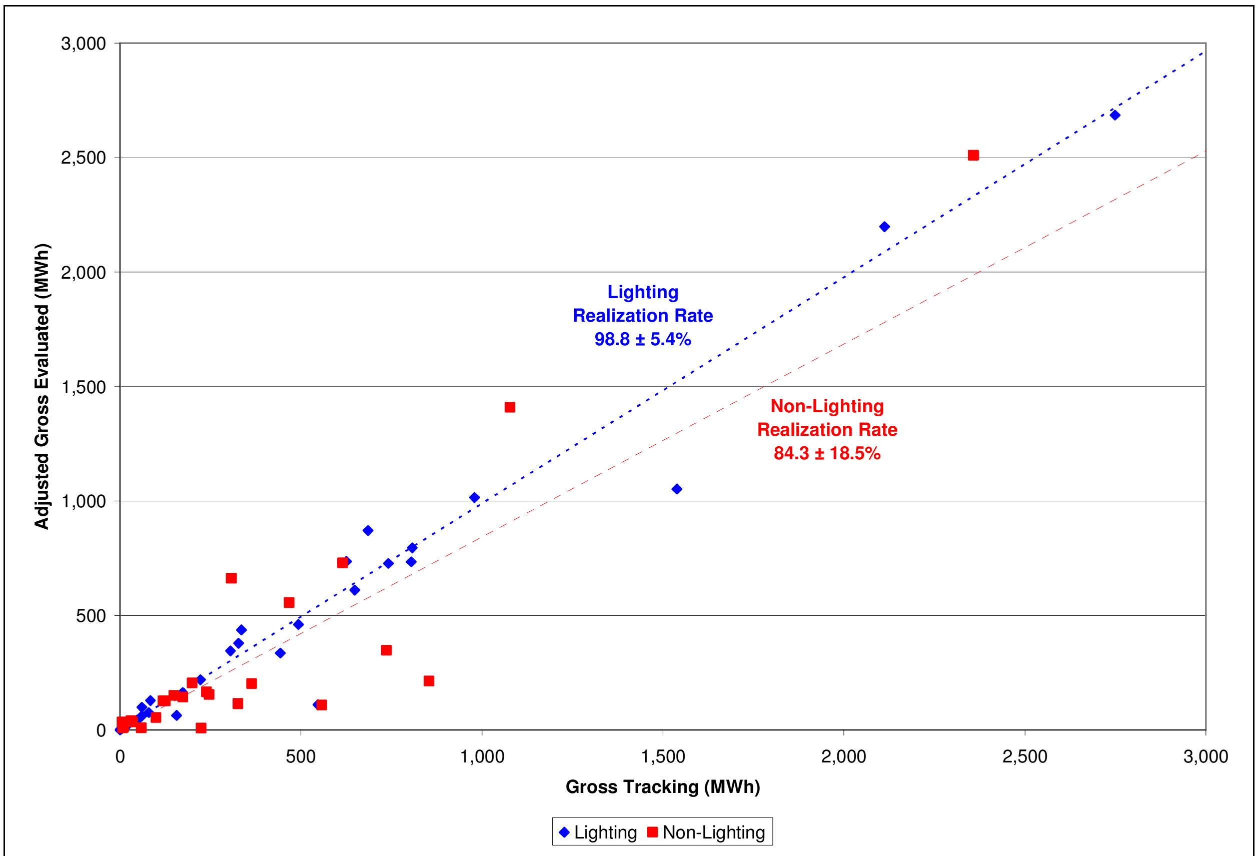


Figure 7-1 helps illustrate how the variability present in the lighting and non-lighting samples drives the resultant realization rates and precisions. The preceding figure plots data from Table 6-1: “Tracking kWh” data are on the x-axis and “Gross kWh” data are on the y-axis. Lighting and non-lighting data are plotted as separate series in blue and red, respectively.

As seen in Figure 7-1, with the exception of one minor outlier (approximately 1,500 MWh gross tracking), all thirty (30) of the lighting sample points (in blue) follow the lighting realization rate line with minimal variability. In contrast, the twenty-five (25) non-lighting sample points (in red) show considerably more variation around the non-lighting realization rate.

It is important to note that the realization rates and precisions on the figure above are not “trend lines” of these sample data but rather superimposed population-level results from stratified ratio estimation (SRE) analyses that incorporate the case weights of each sample point.

# 8. Program Results

In the following tables, KEMA summarizes the impact evaluation findings in detailed "reporting templates." These tables emphasize high-level results while allocating differences between gross tracking and adjusted gross evaluated estimates to six, discrete factors.

Table 8-1 presents the 2008 EO total savings summary and reflects a wide array of potential gross adjustments. Annual energy savings were dominated by a -7.8% operational adjustment albeit moderated by a +3.9% interactive adjustment. For summer demand savings, a -10.0% coincidence adjustment was nearly offset by a +9.6% adjustment for HVAC interaction. For winter demand savings, a notable +15.1% adjustment in seasonal coincidence is countered by minor negative adjustments for installed quantity and HVAC interaction.

**Table 8-1: 2008 Energy Opportunities Total Savings Adjustments**

| 2008 Energy Opportunities | Energy | | Summer Demand | | Winter Demand | |
|---|---|---|---|---|---|---|
| All Measures | kWh | % Gross | $kW_{seas}$ | % Gross | $kW_{seas}$ | % Gross |
| **A. Gross Savings (Tracking)** | **114,245,435** | | **17,991** | | **11,698** | |
| B. Documentation Adjustment | 543,691 | 0.5% | 7 | 0.0% | 3 | 0.0% |
| C. Technology Adjustment | 99,244 | 0.1% | 63 | 0.4% | 66 | 0.6% |
| D. Quantity Adjustment | -1,420,857 | -1.2% | -446 | -2.5% | -463 | -4.0% |
| E. Operational Adjustment | -8,876,448 | -7.8% | N/A | N/A | N/A | N/A |
| F. Coincident Adjustment | N/A | N/A | -1,800 | -10.0% | 1,765 | 15.1% |
| G. Interactive Adjustment | 4,457,648 | 3.9% | 1,724 | 9.6% | -199 | -1.7% |
| **H. Adjusted Gross Savings (Evaluated)** | **109,048,714** | **95.5%** | **17,539** | **97.5%** | **12,870** | **110.0%** |
| **I. Gross Realization Rate** | **95.5%** | | **97.5%** | | **110.0%** | |
| **J. Relative Precision** | **±5.7%** | | **±9.5%** | | **±9.5%** | |
| **K. Confidence Interval** | **90%** | | **80%** | | **80%** | |

As evidenced above, the **adjusted gross energy realization rate** is 95.5% with statistical precision of ±5.7% at the 90% confidence level. The **adjusted gross summer demand realization rate** is 97.5% with statistical precision of ±9.5% at the 80% confidence level. The **adjusted gross winter demand realization rate** is 110.0% with a precision of ±9.5% at the 80% confidence level.

For annual energy savings, it is customary to target ±10% relative precision at the 90% confidence interval. For demand reduction values, sampling must achieve statistical accuracy and precision of no less than 80% confidence level and 10% relative precision in order to comply with ISO New England's M-MVDR2. The program-level adjusted gross savings estimates in Table 8-1 exceed these targets and achieve this important analytical objective.

Table 8-2 and Table 8-3 break the total 2008 EO savings down into two end use categories: Lighting and Non-Lighting measures. In the RFP, a list of seven major measure categories were considered for pursuit in this study, but after reexamining program population data and research priorities, the evaluation team chose to limit research resolution to these two categories. The large majority of 2008 EO savings (77%) were in the Lighting measure category, and the remaining Non-Lighting measures were too diverse to target within available evaluation resources.

**Table 8-2: 2008 Energy Opportunities Lighting Savings Adjustments**

| 2008 Energy Opportunities Lighting Measures | Energy | | Summer Demand | | Winter Demand | |
|---|---|---|---|---|---|---|
| | kWh | % Gross | $kW_{seas}$ | % Gross | $kW_{seas}$ | % Gross |
| **A. Gross Savings (Tracking)** | **87,598,461** | | **12,653** | | **10,380** | |
| B. Documentation Adjustment | 408,986 | 0.5% | 7 | 0.1% | 3 | 0.0% |
| C. Technology Adjustment | 99,244 | 0.1% | 63 | 0.5% | 66 | 0.6% |
| D. Quantity Adjustment | -1,420,857 | -1.6% | -446 | -3.5% | -463 | -4.5% |
| E. Operational Adjustment | -4,547,563 | -5.2% | N/A | N/A | N/A | N/A |
| F. Coincident Adjustment | N/A | N/A | -748 | -5.9% | 1,292 | 12.4% |
| G. Interactive Adjustment | 4,448,051 | 5.1% | 1,727 | 13.6% | -205 | -2.0% |
| **H. Adjusted Gross Savings (Evaluated)** | **86,586,322** | **98.8%** | **13,255** | **104.8%** | **11,073** | **106.7%** |
| **I. Gross Realization Rate** | **98.8%** | | **104.8%** | | **106.7%** | |
| **J. Relative Precision** | **±5.4%** | | **±12.1%** | | **±10.1%** | |
| **K. Confidence Interval** | **90%** | | **80%** | | **80%** | |

Table 8-2 summarizes the results for 2008 EO lighting measures. The adjusted gross realization rates for annual energy savings, summer demand and winter demand were 98.8%, 104.8% and 106.7% respectively. For annual energy, the operational (-5.2%) and interactive (+5.1%) were nearly offsetting. For summer and winter demand, substantial upward adjustments were associated with interactive effects and coincidence, respectively. The strong lighting realization rates and relative precision estimates are consistent with other large C&I impact evaluations in the region.

[2] ISO New England Inc., ISO New England Manual for Measurement and Verification of Demand Reduction Value from Demand Resources (Manual M-MVDR).

### Table 8-3: 2008 Energy Opportunities Non-Lighting Savings Adjustments

| 2008 Energy Opportunities Non-Lighting Measures | Energy | | Summer Demand | | Winter Demand | |
|---|---|---|---|---|---|---|
| | kWh | % Gross | $kW_{seas}$ | % Gross | $kW_{seas}$ | % Gross |
| **A. Gross Savings (Tracking)** | **26,646,974** | | **5,338** | | **1,319** | |
| B. Documentation Adjustment | 134,705 | 0.5% | 0 | 0.0% | 0 | 0.0% |
| C. Technology Adjustment | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| D. Quantity Adjustment | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| E. Operational Adjustment | -4,328,885 | -16.2% | N/A | N/A | N/A | N/A |
| F. Coincident Adjustment | N/A | N/A | -1,051 | -19.7% | 473 | 35.8% |
| G. Interactive Adjustment | 9,597 | 0.0% | -3 | -0.1% | 6 | 0.5% |
| **H. Adjusted Gross Savings (Evaluated)** | **22,462,392** | **84.3%** | **4,284** | **80.2%** | **1,797** | **136.3%** |
| **I. Gross Realization Rate** | **84.3%** | | **80.2%** | | **136.3%** | |
| **J. Relative Precision** | **±18.5%** | | **±10.2%** | | **±26.9%** | |
| **K. Confidence Interval** | **90%** | | **80%** | | **80%** | |

Table 8-3 presents the results for 2008 EO non-lighting measures. The adjusted gross realization rates for annual energy savings, summer demand and winter demand were 84.3%, 80.2% and 136.3% respectively. In contrast to the distributed adjustments in the previous lighting table, Table 1-3 has notable, singular adjustments in each “%Gross” column. Annual energy shows a -16.2% operational adjustment while summer and winter demand show -19.7% and +35.8% coincidence adjustments, respectively.

The non-lighting realization rates and relative precision estimates are less consistent than their lighting counterparts. Since non-lighting measures comprise just 23% of the 2008 EO program population, these results are not as influential on total program savings.

# 9. Conclusions

Commercial and industrial lighting measures are performing particularly well in the 2008 Energy Opportunities program. This is important since lighting represents 77% of total program savings. With adjusted gross energy and demand realization rates near or above unity, EO lighting is consistent with other large C&I retrofit programs in the region. This also reflects positively on both the maturity of lighting as an efficiency measure and on the ability of implementers to deliver lighting savings with consistent and accurate ex-ante savings estimates.

Non-lighting realization rates and relative precision estimates were more variable than their lighting counterparts. This is also consistent with other large C&I programs in the region, but it does not *necessarily* reflect poorly on the EO program itself. The evaluation team anticipated higher variability and diversity of measures in the non-lighting category, so the team employed an error ratio of 0.8 to allocate 25/55=45% of the sites to a category with just 23% of the annual savings. When one considers the precision of the adjusted gross realization rates, non-lighting measures may be performing as well as, if not better than, the lighting sector. Even with these less certain non-lighting results, this impact evaluation was successful in fulfilling its objectives of 90/10 for energy and 80/10 for demand savings at the program level.

Despite some initial concern regarding the challenges of evaluating coincident demand against ISO New England “Seasonal Peak Hours,” the ex-ante seasonal peak demand estimates are highly consistent with the evaluated results. The evaluation methods are indeed complex (assumptions are documented in Appendix B: Peak Period Coincidence), but in the end evaluators are confident that the seasonal peak approach is being employed appropriately by the Energy Opportunities program.

As for Connecticut’s Program Savings Documentation, KEMA found that the algorithms and input parameters in the PSD were largely appropriate and applied consistently across the sample of projects. KEMA has no substantive recommendations that would warrant changes to the PSD. The offsetting Lighting operational (-5.2%) and interactive (+5.1%) adjustments in Table 8-2 are interesting; however, the sample of non-Custom lighting projects is likely too small to conclude a concern with actual PSD assumptions.

# 10. Appendix A: Stratified Ratio Estimation

This impact evaluation used site visits and engineering analysis to derive the ex-post gross savings estimates for each individual sample participant. In turn, the statistical analysis combines these ex-post gross savings estimates for the sample participants with their tracking system counterparts in a stratified ratio estimation (SRE) framework to produce the independent estimates of gross program impacts, i.e., annual energy savings.

Case weights developed at the time of the sample design are updated, if necessary, and used to develop the population weighted estimates of the total ex-post gross savings and ex-post net savings. The case weights are defined for each sample point based on the number of participants in the population (N) represented by each sample point (n). Therefore, the case weights are defined as $w_k = (N_h / n_h)$.

The equations for the combined stratified ratio estimator are presented below:

$$
\begin{aligned}
\hat{Y}_{ra} &= bX \text{, where} \\
b &= \frac{\bar{y}}{\bar{x}} \\
\bar{y} &= \frac{1}{\hat{N}} \sum_{k=1}^{n} w_k \, y_k \\
\bar{x} &= \frac{1}{\hat{N}} \sum_{k=1}^{n} w_k \, x_k \\
\hat{N} &= \sum_{k=1}^{n} w_k
\end{aligned}
$$

This first set of equations present the population estimate of y, e.g., the ex-post gross annual savings as beta times the population tracking system estimate of savings, namely, bX. The beta coefficient (b) is the ratio of weighted mean y to weighted mean x, where y is the engineering estimate of savings derived from the on-sites and x is the tracking system estimate of savings.

Next, we present equations for the weighted mean estimate of y, the weighted mean estimate of x and the estimate of N, i.e., the number of projects in the population. Equations for the confidence interval of the estimate, the estimated variance, the within-stratum variance of the sample residual, e, and the sample residual are presented below:

$$\hat{Y}_{ra} \pm 1.645\sqrt{V\left(\hat{Y}_{ra}\right)} \text{ where}$$

$$V\left(\hat{Y}_{ra}\right) = \sum_{h=1}^{H} N_h^2\left(1-\frac{n_h}{N_h}\right)\frac{s_h^2(e)}{n_h}$$

$$s_h^2(e) = \frac{1}{n_h-1}\sum_{k\in s_h}\left(e_k-\bar{e}_h\right)^2$$

$$e_k = y_k - bx_k$$

Finally, the precision of the estimate $\hat{Y}_{ra}$ can be calculated using the equation:

$$rp = \frac{1.645\sqrt{V\left(\hat{Y}_{ra}\right)}}{\hat{Y}_{ra}}$$

# 11. Appendix B: Peak Period Coincidence

This section describes KEMA's methodology for estimating coincident peak demand in this impact evaluation of the 2008 Energy Opportunities program.

## 11.1 Peak Period Definitions

In the ISO New England Forward Capacity Market, a participant may submit energy-efficiency "other demand resources" as one of three different types: On-Peak, Seasonal Peak, and Critical Peak. For this purpose of this discussion, the Critical Peak will be omitted. The important point is that some readers may be more familiar with the On-Peak Demand Resource, but United Illuminating and Connecticut Light and Power participate in FCM as Seasonal Peak Demand Resources. The distinction is simply that the demand reduction value is computed as the average demand across the corresponding "Peak Hours" period. The following definitions are taken from ISO New England's FERC Electric Tariff No. 3:

> "**Demand Resource On-Peak Hours** are hours ending 1400 through 1700, Monday through Friday on non-holidays during the months of June, July, and August and hours ending 1800 through 1900, Monday through Friday on non-holidays during the months of December and January.
>
> "**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."[3]

It is considerably more complex to assess coincidence relative to the Demand Resource Seasonal Peak Hours, because they are conditional in nature and depend upon the relationship between real time system load and the most recent 50/50 system peak load forecast. The remainder of this section details KEMA's analytical approach to this challenge.

## 11.2 Summer Seasonal kW Reduction

The calculation of the summer seasonal peak demand reduction was based on the performance hours that were used to evaluate the Demand Reduction Values (DRV). Seasonal demand

[3] ISO New England, FERC Electric Tariff No. 3, General Terms and Conditions, Section I.2 – Rules of Construction; Definitions, Effective: January 24, 2010, Original Sheet No. 15L.

performance hours for ISO-NE FCM are defined as hours when the real time ISO-NE system load meets or exceeds 90% of the predicted seasonal peak from the most recent Capacity, Electricity, Load and Transmission Report (CELT report). The peak load forecast for the summer 2009 season was 27,875 kW, and 90% of that was 25,088 kW. There was only one hour during the summer 2009 season when the load reached 25,100 kW. This occurred on August 18, 2009 at hour ending 3 pm. The evaluation used a blend of both Hartford and Bridgeport real weather data for the summer of 2009 to calculate the weighted Total Heat Index (THI) of 79.7 for Connecticut at this hour. The Total Heat Index is a forecast variable used by ISO-NE. It is calculated as follows;

$THI = 0.5 \times DBT + 0.3 \times DPT + 15$ Where,

THI = Total Heat Index

DBT = Dry Bulb Temperature (°F)

DPT = Dew Point Temperature (°F)

ISO-NE also uses a variable called a Weighted Heat Index (WHI) which is a three day weighted average of the THI and is calculated as follows;

$WHI = 0.59 \times THI_{di\ hi} + 0.29 \times THI_{d(i-1)\ hi} + 0.12 \times THI_{d(i-2)\ hi}$ Where,

WHI = Weighted Heat Index

$THI_{di\ hi}$= Total Heat Index for the current day and hour

$THI_{d(i-1)\ hi}$= Total Heat Index for previous day and same hour

$THI_{d(i-2)\ hi}$= Total Heat Index for two days prior and same hour

Since there was only one hour for the summer of 2009 at which the ISO-NE system load met 90% of the CELT forecast peak, evaluators also looked at the summer of 2008 to find any additional hours. There were nine hours in early June of 2008 in which the ISO-NE system load met or exceeded 90% of the CELT forecast peak for the summer of 2008.

Table 11-1 provides the summer 2008 seasonal peak hours along with the system load, percent of CELT forecast peak and the Total Heat Index (THI) at the two weather stations in Connecticut.

**Table 11-1: 2008 Summer Seasonal Peak Hours and System Load**

| Date | Hour | System Load (kW) | Percent of Peak | Weighted THI |
|---|---|---|---|---|
| 6/9/2008 | 15 | 25,166 | 90% | 82.6 |
| 6/9/2008 | 16 | 25,398 | 91% | 82.4 |
| 6/9/2008 | 17 | 25,444 | 91% | 81.9 |
| 6/10/2008 | 13 | 25,451 | 91% | 83.3 |
| 6/10/2008 | 14 | 25,965 | 93% | 82.0 |
| 6/10/2008 | 15 | 26,102 | 94% | 82.7 |
| 6/10/2008 | 16 | 26,059 | 93% | 81.8 |
| 6/10/2008 | 17 | 26,138 | 94% | 81.7 |
| 6/10/2008 | 18 | 25,729 | 92% | 80.0 |

The peak load data and the weighted THI and WHI data for 2009 were used to create linear regressions of peak system load as a function of THI and WHI. The analysis focused on non-holiday weekdays from June through July during hours ending 13 through 18. Evaluators used the time window of hours ending 13 to 18 because of the above observed peaks in the 2008 season that occurred outside of the 1 pm to 5 pm daily peak time period.

The following THI & WHI cutoff points were the result of the regression analyses. These represent the selection points at which both the THI and WHI from a blended Connecticut TMY3 weather file must be greater than in order to trigger a summer seasonal peak hour.

THI Cutoff Point: 79.8
WHI Cutoff Point: 79.9

Table 11-2 provides a summary of the THI, WHI and number of summer seasonal hours for the blended Connecticut TMY3 weather file used in the analysis by month and for the summer season. These are the total number of TMY3 hours applied to the evaluation year that meet the above criteria for being selected as a summer seasonal peak hour.

**Table 11-2: Summary of Summer Seasonal Hours for Weighted CT TMY3 File**

| | Mean THI | Mean WHI | # of Hours |
|---|---|---|---|
| June | 80.8 | 80.3 | 1 |
| July | 81.2 | 80.9 | 20 |
| August | 81.2 | 80.6 | 8 |
| **Summer** | **81.2** | **80.8** | **29** |

## 11.3 Winter Seasonal kW Reduction

The calculation of the winter seasonal peak demand reduction was based on the performance hours that were used to evaluate the Demand Reduction Values (DRV). Seasonal demand performance hours for ISO-NE FCM are defined as hours when the real time ISO-NE system load meets or exceeds 90% of the predicted seasonal peak from the most recent Capacity, Electricity, Load and Transmission Report (CELT report).

The peak load forecast for the winter 2008/2009 season was 23,030 kW, 90% of which was 20,727 kW. There were a total of two hours during the winter 2008/2009 season when the load was 21,004 kW or greater. Table 11-3 provides a list of the winter seasonal peak hours along with the system load, the percentage of forecasted peak and the weighted dry bulb temperature (DBT) for each hour for Connecticut.

**Table 11-3: Winter 07/08 Seasonal Peak Hours and System Loads**

| Date | Hour Ending | System Load (MW) | % of Peak | Weighted DBT |
|---|---|---|---|---|
| 12/8/2008 | 18 | 21,026 | 91% | 20.0 |
| 12/8/2008 | 19 | 21,004 | 91% | 17.8 |
| **Average** | | **21,015** | **91%** | **18.9** |

Since there were only two hours for the winter of 2008/2009 during which the ISO-NE system load met 90% of the CELT forecast peak, we also looked at the winter of 2007/2008 to find any additional hours. The peak load forecast for the winter 2007/2008 season was 23,070 kW, and 90% of which was 20,763 kW. There were a total of seven hours during the winter 2007/2008 season when the load was 20,945 kW or greater. Table 11-4 provides a list of the winter seasonal peak hours along with the system load the percentage of forecasted peak and the dry bulb temperature (DBT) for each hour at the five weather stations used for this evaluation.

**Table 11-4: Winter 07/08 Seasonal Peak Hours and System Loads**

| Date | Hour Ending | System Load (MW) | % of Peak | Weighted DBT |
|---|---|---|---|---|
| 12/13/2007 | 18 | 21,305 | 92% | 24.2 |
| 12/13/2007 | 19 | 20,976 | 91% | 23.2 |
| 12/17/2007 | 18 | 20,960 | 91% | 26.2 |
| 12/17/2007 | 19 | 20,945 | 91% | 26.0 |
| 1/3/2008 | 18 | 21,699 | 94% | 10.8 |
| 1/3/2008 | 19 | 21,774 | 94% | 7.5 |
| 1/3/2008 | 20 | 21,334 | 92% | 8.2 |
| **Average** | | **21,285** | **92%** | **18.0** |

The 2008/2009 peak load data and the weighted Connecticut temperature data were used to create linear regressions of peak system load as a function of dry bulb temperature. The results of the regression were used to identify the seasonal peak hours using the blended Connecticut TMY3 weather data. The analysis focused on low temperature periods in December and January during hours ending 18, 19 and to a lesser extent hour ending 20. Evaluators included hour ending 20 because of the above observed peaks in the 2007/2008 season that occurred outside of the 5 pm to 7 pm daily peak time period.

The following DBT cutoff points were the result of the regression analyses. These represent the selection points at which both the DBT from the blended Connecticut TMY3 weather file must be less than in order to trigger a winter seasonal peak hour.

Hour Ending 18 & 19 DBT Cutoff Point: 22.0°F
Hour Ending 20 DBT Cutoff Point: 16.7°F

Table 11-5 provides a summary of the Dry Bulb Temperature (DBT) and number of winter seasonal hours for the blended Connecticut TMY3 weather file use in the analysis by month and for the winter season.

**Table 11-5: Summary of Winter Seasonal Hours for Weighted CT TMY3 File**

| | Mean DBT | # of Hours |
|---|---|---|
| December | N/A | 0 |
| January | 16.5 | 7 |
| Winter | 16.5 | 7 |

# 12. Appendix C: Meter Compliance

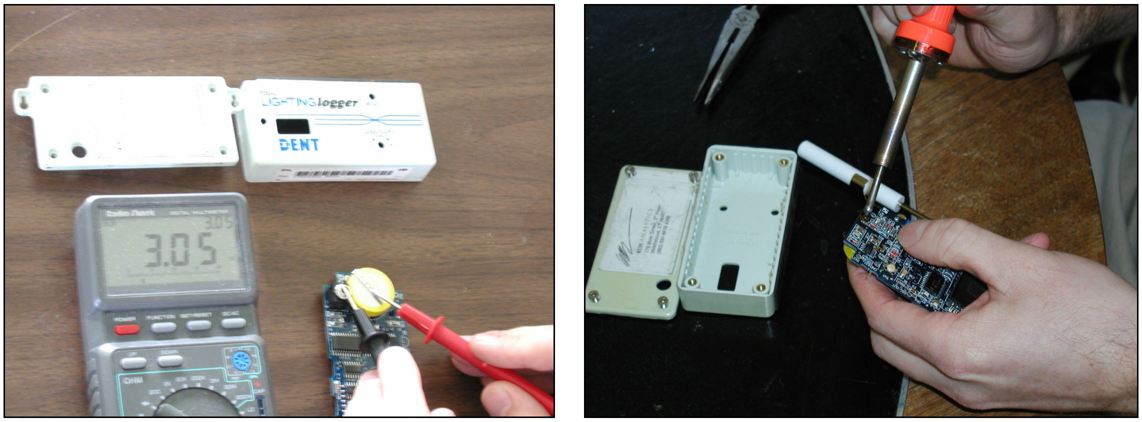
## Lighting Loggers

All of the data gathered on lighting hours of use in this study were collected with Dent Instruments Time-Of-Use (TOU) Lighting Loggers. These loggers use a photocell and an internal time clock to record timestamps of when the lights go on and off. The logger software exports time-series data in a format that provides the percent "on time" during each interval in the metering period. KEMA processed these data files using SAS code to annualize the monitored data into typical hourly profiles to be applied to line-item fixtures in detail analysis spreadsheets. With the exception of certain lighting controls measures where ELITEpro power loggers were installed (see next section), no power measurements were used in standard lighting analyses. Therefore the only source of measurement error is related to the accuracy and calibration of the internal time clocks in the lighting loggers.

Section 10.2 of the ISO-NE M&V manual specifies that measurement tools must be synchronized in time within an accuracy of ±2 minutes per month with the National Institute of Standards and Technology ("NIST") clock. The Dent TOU Lighting Logger contains a solid state circuit that meets the ±2 minutes per month standard for time drift. KEMA standard operating procedure for all lighting projects is to synchronize all lighting loggers at the start of a lighting project to a computer that is linked to our network server and synchronized with a NIST source clock. This procedure also allows us to confirm that the logger is communicating properly and providing data output in advance of deployment.

Periodically, KEMA checks the battery voltage of the loggers to make sure that the voltage is sufficient to power the unit for the duration of the study. The loggers are equipped with a 3.0 Volt battery that typically provides 3.2 Volts, but the loggers will continue to function properly until the voltage drops below 2.6 Volts. KEMA replaces all batteries when the voltage is below 3.0 Volts, which usually occurs after the loggers have been in use for three years or more.

**Figure 12-1: Testing and Replacement of Lighting Logger Battery**




## Power Loggers

All of the kW data directly measured in this study were collected with Dent Instruments ELITEpro™ Energy Loggers. The ELITEpro™ is one of the most popular devices for short-term M&V of electrical performance. In a NEEP report entitled “Review of ISO New England Measurement and Verification Equipment Requirements” and dated April 24, 2008, RLW Analytics, Inc. concluded that the ELITEpro™ is compliant with ISO New England M&V requirements.

It complies with M-MVDR Requirement #11 for real-time clock accuracy specifications of ±2 minutes per month. As with lighting loggers, KEMA standard operating procedure for all lighting projects is to synchronize all lighting loggers at the start of a lighting project to a computer that is linked to our network server and synchronized with a NIST source clock. This procedure also allows us to confirm that the logger is communicating properly and providing data output in advance of deployment. The ELITEpro™ communicates its battery voltage via the interface software, and KEMA only uses loggers with battery voltage in an acceptable operating range to ensure functionality throughout the study.

To measure current and hence power, the ELITEpro™ requires external current sensors, and Dent Instruments sells a variety of current transformers for the device. Dent and Magnelab make split-core CTs in a wide array of physical and amperage rating sizes with ±1.0% accuracy from 10% to 130% of the rated current. Using RSS, the combined (net) kW accuracy of the ELITEpro™ with any of the ±1.0% split-core CTs is ±1.7% which complies with M-MVDR Requirement #6 for a kW accuracy of ±2.0%.

**Figure 12-2: Dent Instruments ELITEpro Calibration Statement**

DENT INSTRUMENTS

**ELITE***pro*™

Calibration Stability & Traceability Statement
February, 2006

The **ELITE***pro*™ design includes an internal reference voltage source and self-calibration circuitry. The firmware program in the **ELITE***pro*™ instructs the instrument to recalibrate itself twice per day, at 12:00 noon and again at 12:00 midnight. The combination of a robust, inherently stable electrical design and its self-calibration feature make the **ELITE***pro*™ highly resistant to aging and drift phenomena that cause calibration errors. Our experience with this device indicates that the calibration of the **ELITE***pro* remains within the manufacturer's specifications for a minimum of three years, and in most cases factory recalibration is never required.

The calibration of each **ELITE***pro*™ is traceable to the National Institute of Standards and Technology (NIST) using these reference instruments.

- Hewlett Packard 34401A Multimeter, Serial #s US36014292, US36082468
- Hewlet Packard 6253A Dual Power Supply, Serial # 241A-07086

# 13. Appendix D: Hourly Impact Profiles

In the following figures, KEMA depicts the hourly impacts of the 2008 Energy Opportunities program in an "Energy Print" graphical format. An Energy Print is an extremely efficient presentation of 8,760 data points which often elucidates consumption (or in this case, savings) patterns by hour-of-day and season. These Energy Prints present hourly impacts from hour 1 of January 1, 2008 (bottom left pixel) through hour 24 of December 31, 2008 (top right pixel). The hours of the day are plotted vertically on the y-axis, and the days of the year are plotted horizontally along the x-axis. The amount of energy savings is represented by the changes in color as indicated on the legend to the left of the Energy Print.

**Figure 13-1: Energy Print of 2008 EO Program Savings**

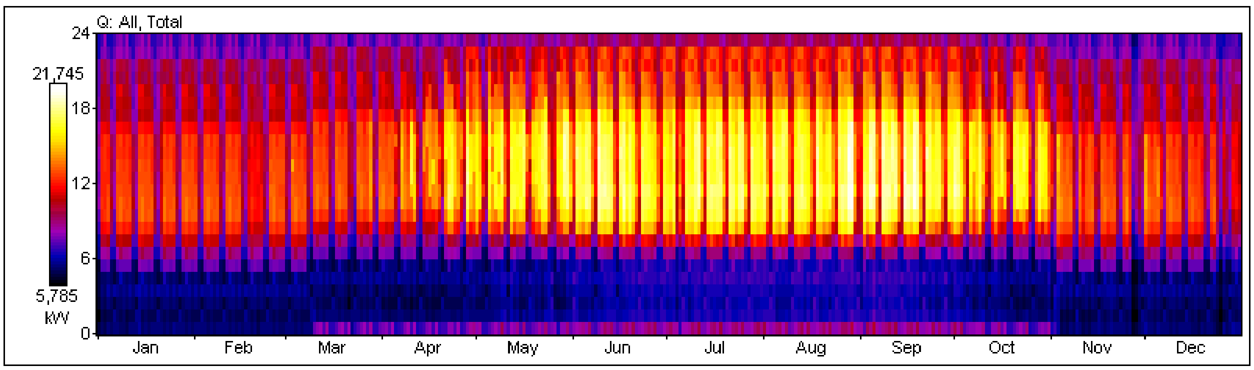



Figure 13-1 shows the hourly savings profile for the 2008 Energy Opportunities program in an Energy Print format. One can see features such as weekends in the vertical stripes, daylight saving time by the one hour "shift" in March through October, and temperature sensitivity by the brightness of the savings in the daylight hours of summer months.

**Figure 13-2: Energy Print of 2008 EO Lighting Savings**

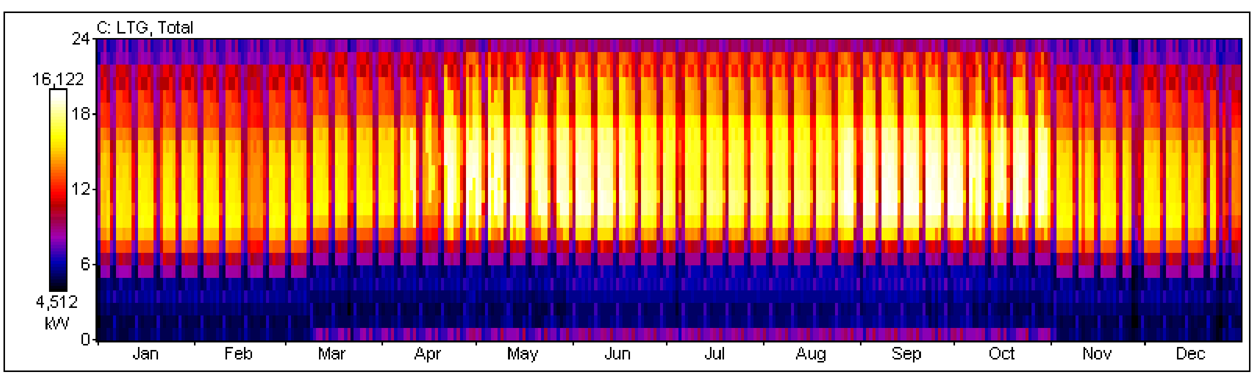
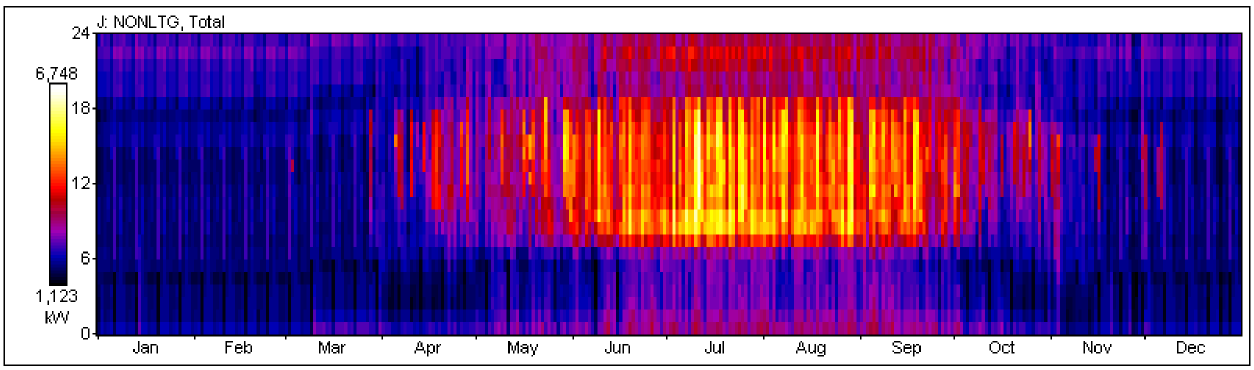


Figure 13-2 isolates the lighting savings for the 2008 Energy Opportunities program. Here we see some similar features to the preceding program level Energy Print, but with dampened temperature dependency. Temperature dependency for lighting measures would be limited to HVAC interaction. To the trained eye, a slight bimodal temperature dependency is evident with brightness in May/June and Sept/Oct; evaluators believe this is due to the inclusion of several large, school lighting projects which use less lighting and cooling in the summer months. Apart from this slight temperature dependence, this lighting profile is very structured and shows savings concentrated between 7 AM and 4 PM with a steep drop off after 11 PM.

**Figure 13-3: Energy Print of 2008 EO Non-Lighting Savings**




Finally, Figure 13-3 shows only the non-lighting measures in the 2008 Energy Opportunities program. This profile is very temperature dependent, although not exclusively so. Other measures than HVAC – refrigeration, process VSDs, and manufacturing schedules – are blended into this profile. As with all Energy Prints, one must consult the legend on the left for scaling perspective. In the non-lighting profile above, there is over 1 MW of base savings in the black areas.

Table 13-1 presents the average weekday kW impacts for the 2008 Energy Opportunities program by hour and month. This data was requested by one of the evaluation Sponsors, and KEMA's hourly analysis methods facilitate development of this information for our valued clients. The following table reflects expanded, program-level impacts for both lighting and non-lighting measures, combined. These data are consistent with the results depicted in the Figure 13-1 Energy Print.

**Table 13-1: Average Weekday kW Impact by Hour and Month (Total Program)**

| Hour | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7,291 | 7,351 | 7,402 | 7,230 | 7,684 | 8,238 | 8,400 | 8,417 | 8,431 | 7,650 | 7,247 | 7,368 |
| 2 | 6,971 | 7,024 | 7,052 | 6,899 | 7,221 | 7,895 | 8,020 | 8,019 | 8,008 | 7,263 | 6,896 | 6,946 |
| 3 | 7,295 | 7,350 | 7,359 | 7,281 | 7,547 | 8,200 | 8,369 | 8,346 | 8,314 | 7,601 | 7,223 | 7,251 |
| 4 | 7,627 | 7,683 | 7,684 | 7,656 | 7,869 | 8,510 | 8,722 | 8,713 | 8,575 | 7,920 | 7,588 | 7,587 |
| 5 | 7,475 | 7,535 | 7,546 | 7,808 | 7,750 | 8,503 | 8,820 | 8,749 | 8,467 | 7,842 | 7,585 | 7,445 |
| 6 | 9,391 | 9,563 | 9,575 | 9,911 | 9,842 | 10,689 | 10,773 | 10,829 | 10,558 | 9,997 | 9,421 | 9,172 |
| 7 | 10,719 | 10,866 | 10,887 | 11,425 | 11,854 | 13,446 | 13,681 | 13,761 | 13,091 | 11,665 | 10,769 | 10,427 |
| 8 | 12,655 | 12,791 | 12,978 | 13,648 | 14,990 | 17,129 | 17,240 | 17,298 | 16,610 | 14,490 | 12,623 | 12,284 |
| 9 | 14,031 | 14,165 | 14,443 | 15,288 | 16,745 | 18,800 | 18,729 | 18,921 | 18,611 | 16,451 | 14,067 | 13,651 |
| 10 | 14,857 | 14,991 | 15,269 | 16,451 | 18,041 | 19,532 | 19,163 | 19,535 | 19,642 | 17,741 | 14,893 | 14,465 |
| 11 | 14,823 | 14,939 | 15,246 | 16,707 | 18,393 | 19,591 | 19,349 | 19,729 | 19,799 | 18,108 | 14,948 | 14,612 |
| 12 | 14,682 | 14,817 | 15,140 | 16,805 | 18,370 | 19,233 | 18,803 | 19,193 | 19,470 | 18,134 | 14,771 | 14,536 |
| 13 | 14,494 | 14,617 | 14,947 | 16,839 | 18,347 | 19,184 | 18,782 | 19,238 | 19,431 | 18,166 | 14,625 | 14,335 |
| 14 | 14,452 | 14,575 | 14,994 | 16,787 | 18,446 | 19,250 | 18,927 | 19,371 | 19,418 | 18,137 | 14,649 | 14,331 |
| 15 | 14,296 | 14,382 | 14,698 | 16,684 | 18,409 | 19,017 | 18,823 | 19,189 | 19,206 | 17,886 | 14,473 | 14,165 |
| 16 | 14,268 | 14,362 | 14,681 | 16,259 | 17,974 | 18,649 | 18,421 | 18,786 | 18,944 | 17,595 | 14,473 | 14,137 |
| 17 | 13,565 | 13,705 | 13,915 | 15,272 | 17,122 | 17,747 | 17,899 | 18,136 | 17,965 | 16,081 | 13,639 | 13,463 |
| 18 | 12,517 | 12,612 | 12,736 | 13,930 | 15,710 | 16,392 | 16,580 | 16,753 | 16,544 | 14,514 | 12,535 | 12,448 |
| 19 | 12,741 | 12,833 | 12,923 | 13,755 | 15,085 | 15,674 | 15,417 | 15,664 | 15,916 | 14,381 | 12,731 | 12,564 |
| 20 | 12,596 | 12,674 | 12,787 | 13,125 | 14,471 | 15,306 | 15,051 | 15,204 | 15,395 | 13,852 | 12,478 | 12,425 |
| 21 | 11,745 | 11,816 | 11,891 | 12,160 | 13,317 | 14,369 | 14,327 | 14,318 | 14,261 | 12,766 | 11,589 | 11,475 |
| 22 | 11,759 | 11,839 | 11,932 | 12,160 | 13,173 | 14,453 | 14,645 | 14,529 | 14,404 | 12,839 | 11,649 | 11,630 |
| 23 | 9,925 | 10,024 | 10,015 | 10,115 | 10,794 | 11,590 | 11,695 | 11,658 | 11,767 | 10,651 | 9,811 | 9,784 |
| 24 | 9,560 | 9,567 | 9,635 | 9,614 | 9,966 | 10,637 | 10,775 | 10,779 | 10,827 | 9,918 | 9,382 | 9,437 |

Table 13-2 presents the average weekend kW impacts for the 2008 Energy Opportunities program by hour and month.

**Table 13-2: Average Weekend kW Impact by Hour and Month (Total Program)**

| Hour | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7,410 | 7,428 | 7,438 | 7,360 | 7,857 | 8,276 | 8,488 | 8,572 | 8,605 | 7,570 | 7,468 | 7,361 |
| 2 | 7,299 | 7,316 | 7,322 | 7,229 | 7,702 | 8,198 | 8,433 | 8,455 | 8,442 | 7,440 | 7,341 | 7,274 |
| 3 | 6,982 | 6,997 | 7,001 | 6,909 | 7,456 | 7,777 | 8,114 | 8,129 | 8,145 | 7,104 | 7,020 | 6,947 |
| 4 | 7,703 | 7,716 | 7,719 | 7,620 | 8,128 | 8,533 | 8,787 | 8,829 | 8,897 | 7,829 | 7,735 | 7,654 |
| 5 | 6,929 | 6,942 | 6,933 | 7,048 | 7,397 | 7,877 | 8,132 | 8,161 | 8,080 | 7,136 | 7,019 | 6,882 |
| 6 | 7,109 | 7,122 | 7,129 | 7,112 | 7,600 | 8,022 | 8,407 | 8,323 | 8,226 | 7,297 | 7,158 | 7,057 |
| 7 | 8,405 | 8,415 | 8,423 | 8,526 | 9,559 | 10,302 | 10,948 | 10,747 | 10,484 | 8,836 | 8,485 | 8,395 |
| 8 | 9,181 | 9,195 | 9,203 | 9,523 | 11,141 | 12,311 | 13,312 | 13,050 | 12,462 | 9,927 | 9,323 | 9,201 |
| 9 | 10,479 | 10,507 | 10,522 | 11,109 | 13,051 | 13,971 | 14,551 | 14,448 | 14,390 | 11,565 | 10,673 | 10,470 |
| 10 | 10,691 | 10,725 | 10,702 | 11,696 | 13,192 | 13,904 | 14,439 | 14,308 | 14,357 | 12,126 | 10,852 | 10,582 |
| 11 | 11,539 | 11,570 | 11,581 | 13,162 | 14,531 | 15,136 | 15,569 | 15,498 | 15,575 | 13,292 | 12,007 | 11,604 |
| 12 | 11,034 | 11,067 | 11,098 | 12,676 | 14,222 | 14,609 | 15,067 | 14,949 | 15,052 | 13,211 | 11,519 | 11,094 |
| 13 | 11,083 | 11,116 | 11,130 | 12,881 | 14,241 | 14,561 | 14,963 | 14,953 | 15,206 | 13,372 | 11,664 | 11,173 |
| 14 | 11,556 | 11,590 | 11,612 | 13,749 | 14,791 | 14,901 | 15,225 | 15,251 | 15,563 | 14,120 | 12,267 | 11,657 |
| 15 | 11,594 | 11,629 | 11,662 | 13,821 | 14,865 | 14,914 | 15,185 | 15,236 | 15,384 | 14,019 | 12,365 | 11,738 |
| 16 | 11,433 | 11,467 | 11,557 | 13,425 | 13,920 | 14,465 | 14,726 | 14,800 | 14,958 | 13,874 | 11,986 | 11,578 |
| 17 | 10,636 | 10,666 | 10,744 | 12,127 | 12,824 | 13,457 | 13,817 | 13,814 | 13,909 | 12,601 | 10,927 | 10,788 |
| 18 | 10,003 | 10,028 | 10,078 | 10,792 | 11,909 | 12,480 | 12,853 | 12,975 | 12,889 | 11,409 | 10,237 | 10,071 |
| 19 | 9,853 | 9,887 | 9,877 | 10,291 | 11,254 | 11,920 | 12,159 | 12,232 | 12,255 | 10,716 | 10,020 | 9,914 |
| 20 | 9,839 | 9,861 | 9,838 | 10,005 | 11,007 | 11,621 | 11,917 | 11,923 | 11,986 | 10,542 | 9,908 | 9,898 |
| 21 | 10,294 | 10,305 | 10,283 | 10,472 | 11,572 | 12,600 | 13,073 | 12,969 | 12,571 | 11,094 | 10,386 | 10,354 |
| 22 | 10,090 | 10,093 | 10,072 | 10,244 | 11,376 | 12,227 | 12,799 | 12,676 | 12,318 | 10,739 | 10,162 | 10,138 |
| 23 | 9,235 | 9,226 | 9,220 | 9,288 | 10,023 | 10,571 | 10,853 | 10,844 | 10,808 | 9,721 | 9,318 | 9,275 |
| 24 | 8,928 | 8,919 | 8,972 | 8,906 | 9,485 | 9,802 | 10,117 | 10,165 | 10,146 | 9,213 | 9,027 | 8,954 |

Table 13-3 presents the average weekday kW impacts for **lighting measures only** in the 2008 Energy Opportunities program by hour and month. These data are consistent with the results depicted in the Figure 13-2 Energy Print.

**Table 13-3: Average Weekday kW Impact by Hour and Month (Lighting Only)**

| Hour | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5,365 | 5,440 | 5,439 | 5,490 | 5,521 | 5,663 | 5,612 | 5,683 | 5,798 | 5,639 | 5,388 | 5,421 |
| 2 | 5,227 | 5,299 | 5,275 | 5,356 | 5,295 | 5,563 | 5,511 | 5,567 | 5,619 | 5,450 | 5,221 | 5,195 |
| 3 | 5,566 | 5,637 | 5,602 | 5,710 | 5,644 | 5,939 | 5,904 | 5,963 | 5,969 | 5,813 | 5,554 | 5,530 |
| 4 | 5,907 | 5,981 | 5,959 | 6,011 | 5,997 | 6,327 | 6,267 | 6,347 | 6,305 | 6,148 | 5,900 | 5,877 |
| 5 | 5,853 | 5,944 | 5,909 | 6,002 | 5,963 | 6,347 | 6,324 | 6,383 | 6,261 | 6,064 | 5,848 | 5,832 |
| 6 | 7,671 | 7,867 | 7,839 | 7,923 | 7,839 | 8,201 | 8,006 | 8,209 | 8,096 | 8,036 | 7,575 | 7,471 |
| 7 | 8,984 | 9,157 | 9,129 | 9,276 | 9,363 | 9,787 | 9,454 | 9,718 | 9,804 | 9,435 | 8,908 | 8,697 |
| 8 | 10,986 | 11,147 | 11,274 | 11,481 | 12,221 | 12,722 | 12,041 | 12,490 | 12,859 | 12,081 | 10,810 | 10,616 |
| 9 | 12,315 | 12,444 | 12,635 | 12,917 | 13,874 | 14,266 | 13,437 | 13,958 | 14,652 | 13,868 | 12,119 | 11,912 |
| 10 | 13,130 | 13,252 | 13,464 | 13,824 | 15,121 | 15,251 | 14,383 | 14,923 | 15,672 | 15,091 | 12,919 | 12,704 |
| 11 | 13,067 | 13,171 | 13,384 | 13,914 | 15,138 | 15,214 | 14,409 | 14,909 | 15,585 | 15,179 | 12,886 | 12,762 |
| 12 | 12,968 | 13,082 | 13,303 | 14,064 | 15,141 | 15,031 | 14,110 | 14,637 | 15,478 | 15,136 | 12,803 | 12,680 |
| 13 | 12,862 | 12,963 | 13,171 | 14,084 | 15,024 | 14,917 | 14,050 | 14,532 | 15,347 | 15,141 | 12,690 | 12,564 |
| 14 | 12,819 | 12,915 | 13,138 | 14,030 | 14,966 | 14,914 | 14,097 | 14,538 | 15,298 | 15,042 | 12,682 | 12,555 |
| 15 | 12,663 | 12,730 | 12,910 | 13,926 | 14,863 | 14,682 | 13,968 | 14,362 | 15,097 | 14,832 | 12,514 | 12,388 |
| 16 | 12,449 | 12,530 | 12,705 | 13,529 | 14,570 | 14,451 | 13,728 | 14,102 | 14,880 | 14,575 | 12,327 | 12,242 |
| 17 | 11,774 | 11,893 | 11,980 | 12,767 | 13,797 | 13,794 | 13,396 | 13,649 | 14,007 | 13,386 | 11,678 | 11,672 |
| 18 | 10,855 | 10,942 | 11,014 | 11,640 | 12,727 | 12,731 | 12,346 | 12,563 | 12,946 | 12,097 | 10,767 | 10,782 |
| 19 | 10,908 | 11,001 | 11,076 | 11,610 | 12,601 | 12,728 | 12,242 | 12,493 | 12,948 | 12,131 | 10,811 | 10,739 |
| 20 | 10,487 | 10,582 | 10,689 | 10,970 | 11,952 | 12,434 | 12,010 | 12,167 | 12,500 | 11,576 | 10,415 | 10,347 |
| 21 | 9,655 | 9,732 | 9,811 | 9,996 | 10,837 | 11,305 | 10,881 | 11,046 | 11,360 | 10,533 | 9,539 | 9,412 |
| 22 | 9,561 | 9,641 | 9,722 | 9,946 | 10,500 | 11,164 | 10,921 | 11,005 | 11,181 | 10,418 | 9,512 | 9,445 |
| 23 | 7,524 | 7,629 | 7,625 | 7,811 | 8,159 | 8,526 | 8,397 | 8,452 | 8,728 | 8,176 | 7,514 | 7,389 |
| 24 | 7,320 | 7,333 | 7,377 | 7,511 | 7,539 | 7,864 | 7,785 | 7,838 | 7,970 | 7,632 | 7,247 | 7,184 |

Table 13-4 presents the average weekend kW impacts for **lighting measures only** in the 2008 Energy Opportunities program by hour and month.

**Table 13-4: Average Weekend kW Impact by Hour and Month (Lighting Only)**

| Hour | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5,705 | 5,719 | 5,729 | 5,736 | 5,852 | 6,093 | 6,033 | 6,100 | 6,174 | 5,845 | 5,724 | 5,657 |
| 2 | 5,790 | 5,805 | 5,810 | 5,816 | 5,907 | 6,255 | 6,177 | 6,212 | 6,257 | 5,926 | 5,815 | 5,767 |
| 3 | 5,475 | 5,487 | 5,492 | 5,498 | 5,674 | 5,868 | 5,860 | 5,902 | 5,965 | 5,615 | 5,493 | 5,442 |
| 4 | 6,187 | 6,197 | 6,201 | 6,207 | 6,339 | 6,630 | 6,560 | 6,610 | 6,698 | 6,330 | 6,195 | 6,138 |
| 5 | 5,535 | 5,546 | 5,547 | 5,553 | 5,744 | 5,933 | 5,931 | 5,987 | 6,003 | 5,666 | 5,534 | 5,469 |
| 6 | 5,427 | 5,438 | 5,437 | 5,430 | 5,630 | 5,802 | 5,801 | 5,851 | 5,879 | 5,555 | 5,425 | 5,358 |
| 7 | 6,467 | 6,476 | 6,461 | 6,467 | 6,913 | 7,121 | 7,156 | 7,196 | 7,237 | 6,659 | 6,471 | 6,424 |
| 8 | 7,255 | 7,267 | 7,240 | 7,328 | 8,097 | 8,309 | 8,405 | 8,452 | 8,451 | 7,558 | 7,278 | 7,224 |
| 9 | 8,562 | 8,588 | 8,565 | 8,713 | 9,886 | 9,743 | 9,684 | 9,826 | 10,004 | 8,955 | 8,599 | 8,516 |
| 10 | 8,789 | 8,815 | 8,790 | 9,184 | 10,169 | 10,178 | 10,063 | 10,264 | 10,370 | 9,451 | 8,792 | 8,642 |
| 11 | 9,659 | 9,687 | 9,663 | 10,277 | 11,366 | 11,302 | 11,219 | 11,415 | 11,433 | 10,529 | 9,663 | 9,507 |
| 12 | 9,110 | 9,142 | 9,123 | 9,740 | 10,825 | 10,727 | 10,557 | 10,773 | 10,803 | 10,319 | 9,124 | 8,946 |
| 13 | 9,180 | 9,214 | 9,198 | 9,870 | 10,872 | 10,665 | 10,491 | 10,712 | 10,887 | 10,397 | 9,208 | 9,040 |
| 14 | 9,652 | 9,686 | 9,667 | 10,709 | 11,403 | 11,160 | 10,971 | 11,181 | 11,405 | 11,076 | 9,691 | 9,549 |
| 15 | 9,497 | 9,533 | 9,515 | 10,401 | 11,281 | 11,071 | 10,922 | 11,087 | 11,274 | 10,775 | 9,562 | 9,454 |
| 16 | 9,390 | 9,426 | 9,407 | 10,396 | 10,914 | 10,985 | 10,758 | 10,926 | 11,101 | 10,729 | 9,454 | 9,346 |
| 17 | 8,726 | 8,758 | 8,741 | 9,492 | 9,981 | 10,309 | 10,286 | 10,379 | 10,346 | 9,820 | 8,792 | 8,699 |
| 18 | 8,206 | 8,232 | 8,204 | 8,611 | 9,192 | 9,588 | 9,616 | 9,646 | 9,696 | 9,206 | 8,307 | 8,276 |
| 19 | 8,058 | 8,094 | 8,068 | 8,448 | 8,894 | 9,399 | 9,413 | 9,447 | 9,525 | 8,707 | 8,168 | 8,132 |
| 20 | 7,767 | 7,794 | 7,774 | 8,016 | 8,508 | 8,995 | 9,076 | 9,088 | 9,140 | 8,325 | 7,865 | 7,848 |
| 21 | 8,234 | 8,258 | 8,239 | 8,501 | 9,088 | 9,609 | 9,608 | 9,622 | 9,461 | 8,818 | 8,328 | 8,315 |
| 22 | 8,011 | 8,033 | 8,014 | 8,250 | 8,860 | 9,233 | 9,296 | 9,307 | 9,184 | 8,547 | 8,103 | 8,091 |
| 23 | 6,874 | 6,894 | 6,889 | 7,079 | 7,536 | 7,741 | 7,790 | 7,806 | 7,860 | 7,332 | 6,960 | 6,945 |
| 24 | 6,814 | 6,839 | 6,854 | 6,951 | 7,203 | 7,365 | 7,421 | 7,441 | 7,489 | 7,131 | 6,903 | 6,880 |

Table 13-5 presents the average weekday kW impacts for **non-lighting measures only** in the 2008 Energy Opportunities program by hour and month. These data are consistent with the results depicted in the Figure 13-3 Energy Print.

**Table 13-5: Average Weekday kW Impact by Hour and Month (Non-Lighting Only)**

| Hour | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1,926 | 1,910 | 1,963 | 1,740 | 2,163 | 2,574 | 2,788 | 2,733 | 2,633 | 2,010 | 1,859 | 1,946 |
| 2 | 1,744 | 1,725 | 1,777 | 1,543 | 1,927 | 2,332 | 2,509 | 2,452 | 2,389 | 1,813 | 1,675 | 1,751 |
| 3 | 1,729 | 1,713 | 1,757 | 1,571 | 1,904 | 2,260 | 2,464 | 2,383 | 2,345 | 1,788 | 1,669 | 1,721 |
| 4 | 1,720 | 1,702 | 1,725 | 1,644 | 1,872 | 2,182 | 2,455 | 2,366 | 2,270 | 1,772 | 1,688 | 1,711 |
| 5 | 1,622 | 1,592 | 1,637 | 1,806 | 1,787 | 2,156 | 2,495 | 2,366 | 2,206 | 1,779 | 1,737 | 1,612 |
| 6 | 1,720 | 1,696 | 1,736 | 1,989 | 2,003 | 2,489 | 2,768 | 2,620 | 2,462 | 1,961 | 1,846 | 1,701 |
| 7 | 1,735 | 1,708 | 1,758 | 2,148 | 2,491 | 3,659 | 4,227 | 4,043 | 3,287 | 2,230 | 1,861 | 1,730 |
| 8 | 1,669 | 1,644 | 1,704 | 2,167 | 2,769 | 4,407 | 5,200 | 4,808 | 3,751 | 2,409 | 1,813 | 1,669 |
| 9 | 1,716 | 1,721 | 1,808 | 2,371 | 2,871 | 4,534 | 5,292 | 4,963 | 3,960 | 2,583 | 1,947 | 1,739 |
| 10 | 1,728 | 1,740 | 1,805 | 2,626 | 2,920 | 4,281 | 4,779 | 4,612 | 3,970 | 2,650 | 1,973 | 1,761 |
| 11 | 1,756 | 1,768 | 1,862 | 2,793 | 3,255 | 4,377 | 4,940 | 4,820 | 4,214 | 2,930 | 2,062 | 1,849 |
| 12 | 1,714 | 1,736 | 1,837 | 2,741 | 3,229 | 4,203 | 4,693 | 4,556 | 3,993 | 2,998 | 1,968 | 1,857 |
| 13 | 1,633 | 1,654 | 1,776 | 2,755 | 3,324 | 4,267 | 4,732 | 4,706 | 4,084 | 3,025 | 1,935 | 1,771 |
| 14 | 1,633 | 1,660 | 1,856 | 2,757 | 3,480 | 4,336 | 4,830 | 4,833 | 4,120 | 3,096 | 1,968 | 1,776 |
| 15 | 1,633 | 1,653 | 1,787 | 2,758 | 3,547 | 4,336 | 4,855 | 4,827 | 4,109 | 3,055 | 1,958 | 1,776 |
| 16 | 1,818 | 1,831 | 1,976 | 2,730 | 3,404 | 4,198 | 4,693 | 4,684 | 4,064 | 3,020 | 2,146 | 1,895 |
| 17 | 1,791 | 1,813 | 1,935 | 2,505 | 3,325 | 3,953 | 4,503 | 4,488 | 3,958 | 2,695 | 1,960 | 1,791 |
| 18 | 1,662 | 1,670 | 1,722 | 2,290 | 2,983 | 3,662 | 4,235 | 4,189 | 3,598 | 2,417 | 1,768 | 1,666 |
| 19 | 1,834 | 1,832 | 1,847 | 2,145 | 2,484 | 2,946 | 3,175 | 3,171 | 2,968 | 2,251 | 1,920 | 1,825 |
| 20 | 2,109 | 2,093 | 2,098 | 2,156 | 2,519 | 2,872 | 3,041 | 3,037 | 2,895 | 2,276 | 2,063 | 2,078 |
| 21 | 2,089 | 2,083 | 2,080 | 2,164 | 2,480 | 3,064 | 3,447 | 3,272 | 2,901 | 2,233 | 2,050 | 2,062 |
| 22 | 2,198 | 2,197 | 2,210 | 2,214 | 2,673 | 3,289 | 3,724 | 3,524 | 3,224 | 2,421 | 2,137 | 2,185 |
| 23 | 2,401 | 2,395 | 2,390 | 2,304 | 2,635 | 3,064 | 3,298 | 3,207 | 3,038 | 2,475 | 2,297 | 2,396 |
| 24 | 2,240 | 2,234 | 2,258 | 2,104 | 2,427 | 2,773 | 2,990 | 2,941 | 2,857 | 2,286 | 2,136 | 2,254 |

Table 13-6 presents the average <u>weekend</u> kW impacts for **non-lighting measures only** in the 2008 Energy Opportunities program by hour and month.

**Table 13-6: Average Weekend kW Impact by Hour and Month (Lighting Only)**

| Hour | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1,706 | 1,709 | 1,709 | 1,625 | 2,006 | 2,184 | 2,454 | 2,472 | 2,431 | 1,725 | 1,744 | 1,704 |
| 2 | 1,509 | 1,512 | 1,512 | 1,413 | 1,795 | 1,942 | 2,256 | 2,243 | 2,185 | 1,514 | 1,526 | 1,507 |
| 3 | 1,507 | 1,510 | 1,509 | 1,411 | 1,782 | 1,909 | 2,255 | 2,228 | 2,180 | 1,489 | 1,527 | 1,505 |
| 4 | 1,516 | 1,518 | 1,519 | 1,414 | 1,789 | 1,903 | 2,227 | 2,220 | 2,199 | 1,499 | 1,540 | 1,516 |
| 5 | 1,394 | 1,396 | 1,386 | 1,495 | 1,654 | 1,944 | 2,201 | 2,174 | 2,077 | 1,470 | 1,485 | 1,413 |
| 6 | 1,682 | 1,683 | 1,692 | 1,682 | 1,970 | 2,220 | 2,606 | 2,472 | 2,347 | 1,742 | 1,733 | 1,699 |
| 7 | 1,938 | 1,940 | 1,962 | 2,059 | 2,646 | 3,181 | 3,792 | 3,551 | 3,247 | 2,177 | 2,014 | 1,971 |
| 8 | 1,926 | 1,928 | 1,963 | 2,195 | 3,044 | 4,002 | 4,906 | 4,597 | 4,010 | 2,369 | 2,045 | 1,977 |
| 9 | 1,916 | 1,919 | 1,957 | 2,396 | 3,165 | 4,228 | 4,868 | 4,622 | 4,386 | 2,611 | 2,075 | 1,955 |
| 10 | 1,902 | 1,910 | 1,912 | 2,512 | 3,023 | 3,726 | 4,376 | 4,044 | 3,988 | 2,675 | 2,060 | 1,939 |
| 11 | 1,881 | 1,883 | 1,917 | 2,885 | 3,165 | 3,834 | 4,350 | 4,083 | 4,141 | 2,763 | 2,344 | 2,097 |
| 12 | 1,924 | 1,925 | 1,975 | 2,937 | 3,397 | 3,882 | 4,510 | 4,176 | 4,249 | 2,893 | 2,396 | 2,148 |
| 13 | 1,903 | 1,902 | 1,932 | 3,011 | 3,369 | 3,896 | 4,472 | 4,241 | 4,319 | 2,976 | 2,456 | 2,133 |
| 14 | 1,905 | 1,904 | 1,945 | 3,040 | 3,388 | 3,741 | 4,253 | 4,070 | 4,158 | 3,044 | 2,576 | 2,108 |
| 15 | 2,097 | 2,096 | 2,147 | 3,420 | 3,583 | 3,843 | 4,263 | 4,149 | 4,110 | 3,245 | 2,803 | 2,284 |
| 16 | 2,042 | 2,041 | 2,150 | 3,029 | 3,006 | 3,479 | 3,968 | 3,875 | 3,857 | 3,146 | 2,532 | 2,231 |
| 17 | 1,910 | 1,909 | 2,003 | 2,635 | 2,843 | 3,148 | 3,531 | 3,436 | 3,563 | 2,781 | 2,135 | 2,089 |
| 18 | 1,797 | 1,795 | 1,874 | 2,181 | 2,717 | 2,893 | 3,236 | 3,329 | 3,193 | 2,203 | 1,930 | 1,795 |
| 19 | 1,795 | 1,793 | 1,809 | 1,844 | 2,360 | 2,521 | 2,746 | 2,785 | 2,731 | 2,009 | 1,852 | 1,783 |
| 20 | 2,072 | 2,068 | 2,065 | 1,988 | 2,499 | 2,626 | 2,841 | 2,836 | 2,846 | 2,217 | 2,042 | 2,050 |
| 21 | 2,060 | 2,048 | 2,044 | 1,971 | 2,484 | 2,992 | 3,464 | 3,347 | 3,110 | 2,276 | 2,058 | 2,039 |
| 22 | 2,078 | 2,060 | 2,058 | 1,994 | 2,517 | 2,994 | 3,503 | 3,369 | 3,134 | 2,192 | 2,059 | 2,047 |
| 23 | 2,361 | 2,332 | 2,331 | 2,209 | 2,487 | 2,831 | 3,062 | 3,038 | 2,948 | 2,389 | 2,358 | 2,330 |
| 24 | 2,113 | 2,080 | 2,118 | 1,955 | 2,283 | 2,437 | 2,697 | 2,724 | 2,657 | 2,082 | 2,124 | 2,074 |