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# NEW HAMPSHIRE UTILITIES LARGE COMMERCIAL & INDUSTRIAL (C&I) RETROFIT AND NEW EQUIPMENT & CONSTRUCTION PROGRAM IMPACT EVALUATION

# Final Report

## New Hampshire Electric and Gas Utilities

**Date:** September 25, 2015

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# 1 EXECUTIVE SUMMARY

DNV GL was engaged by the New Hampshire Electric and Gas Utilities (the sponsors) to perform an impact evaluation of their Large Commercial and Industrial Retrofit Program, New Equipment and Construction Program, and the Eversource Energy Rewards RFP Program (Large C&I programs). The main objectives of this evaluation were to:

- Verify actual energy and demand savings for each program for the state, by program track (custom vs. prescriptive), and fuel type (gas vs. electric),
- Explain the reasons for discrepancies between tracked and evaluated savings,
- Review the tracking system savings methodologies, and make appropriate recommendations for improvement with an overarching desire to assist the utilities in revising savings inputs and methods as opposed to providing adjustment factors, and
- Report on customers' overall satisfaction of the programs.

## 1.1 2012 Program Activity Summary

The Large C&I Retrofit Program provides financial and technical services to facilitate the replacement of old, inefficient equipment with new energy efficient equipment in existing facilities for large commercial and industrial customers (defined as electric customers with an average monthly demand of greater than 200 kW and for gas customers that consume 40,000 therms per year or more). The Large C&I New Equipment and Construction Program offers financial and technical services to commercial, industrial and institutional customers that are building a new facility, undergoing a major renovation, or replacing failed equipment. The Energy Rewards RFP Program offers incentives on a competitive basis to C&I customers (with a demand of 350+ kW) who achieve measurable energy savings through the installation of energy efficiency measures.

Table 1 presents the number of participants and electric and gas savings by program and sponsor for the 2012 New Hampshire Large C&I Programs. A total of 264 customers received electric savings measures and saved 30,242 MWh, while 94 customers received gas savings measures and saved 89,730 MMBtu in 2012. The Large C&I Retrofit was responsible for the majority of the electric savings with 181 customers receiving and 17,992 MWh of savings. On the gas side, the Large C&I Retrofit and C&I New Equipment and Construction Programs each had 47 customers but the Large C&I Retrofit Program was responsible for the bulk of the savings with 58,170 MMBtu.

**Table 1: 2012 NH Large C&I Program Electric and Gas Savings by Program and Sponsor**

| Sponsor | Electric Participants | Electric Savings (MWh) | Gas Participants | Gas Savings (MMBtu) |
|---|---|---|---|---|
| **Large C&I Retrofit Program** | | | | |
| Liberty Utilities | 13 | 2,572 | 45 | 42,047 |
| New Hampshire Electric Cooperative (NHEC) | 23 | 1,261 | 0 | 0 |
| Eversource | 123 | 10,630 | 0 | 0 |
| Unitil | 22 | 3,529 | 2 | 16,123 |
| Large C&I Retrofit Program Total | **181** | **17,992** | **47** | **58,170** |
| **C&I New Equipment & Construction Program** | | | | |
| Liberty Utilities | 5 | 353 | 29 | 27,315 |
| Eversource | 62 | 8,960 | 0 | 0 |
| Unitil | 12 | 1,500 | 18 | 4,245 |
| C&I New Equipment & Construction Program Total | **79** | **10,813** | **47** | **31,560** |
| **Eversource RFP Program** | | | | |
| Eversource | 4 | 1,437 | 0 | 0 |
| RFP Program Total | **4** | **1,437** | **0** | **0** |
| **All Large C&I Programs** | | | | |
| Liberty Utilities | 18 | 2,924 | 74 | 69,362 |
| New Hampshire Electric Cooperative (NHEC) | 23 | 1,261 | 0 | 0 |
| Eversource | 189 | 21,027 | 0 | 0 |
| Unitil | 34 | 5,029 | 20 | 20,368 |
| **All Large C&I Programs Total** | **264** | **30,242** | **94** | **89,730** |

## 1.2 Key Study Methods

### 1.2.1 Sampling

In order to attain the evaluation objectives, DNV GL conducted on-site visits and surveys at a sample of participant sites. Using the Model Based Statistical Sampling (MBSS) techniques provided in Appendix B, Table 2 presents the sample which was developed to achieve the desired ±10% precision at the 80% confidence interval around kWh, MMBtu (gas), and peak demand savings at the program and fuel type level. To calculate the sample sizes needed for these results, we used an error ratio of 0.35 for electric and 0.45 for gas, which are somewhat aggressive but reasonable for programs with high quality tracking savings estimates. For the state level, we estimated that 68 on-site visits could achieve 80/10 estimates for each program and fuel.

**Table 2: Final Sample Sizes and Estimated Precisions of Energy Savings at 80% Confidence**

| Program (Fuel) | N | ER | n0 | n1 | Estimated Precision at 80% Confidence Interval |
|---|---|---|---|---|---|
| C&I New Equipment & Construction (Electric) | 79 | 35% | 21 | 17 | 9.1% |
| Large C&I Retrofit (Electric) | 181 | 35% | 21 | 21 | 9.2% |
| Eversource RFP (Electric) | 4 | 35% | 21 | 4 | 0.0% |
| **All Programs (Electric)** | **264** | **35%** | **63** | **42** | **6.3%** |
| C&I New Equipment & Construction (Gas) | 47 | 45% | 33 | 14 | 9.3% |
| Large C&I Retrofit (Gas) | 47 | 45% | 33 | 12 | 9.4% |
| **All Programs (Gas)** | **94** | **45%** | **66** | **26** | **6.9%** |
| **Grand Total** | **358** | **-** | **126** | **68** | **6.3%** |

### 1.2.2 Data Collection

Each site visit consisted of a verification of installed equipment, a discussion with facility personnel regarding the baseline characteristics of the measure, collection and analysis of monitored or trended data as well as relevant weather data. Sites with cooling measures were monitored during the cooling months and sites with heating measures were monitored during the heating months. Monitoring was performed for a minimum of four weeks. Spot power monitoring was performed as needed to assess the efficiency of the unit of interest. When possible, energy management system data was used to obtain additional information and operating schedules.

All of the monitoring equipment used in the determination of demand reduction and coincidence complies with the requirements of the ISO-New England Manual for Measurement and Verification of Demand Resources (M-MVDR). One possible exception is EMS trend data collected from the customer site. DNV GL employed a couple different methods to verify the accuracy of EMS data, including attempting to collect make and model number, and monitoring select points using compliant meters.

### 1.2.3 Data Analysis

The short-term data collected from the monitoring devices was used to develop time-of-use load profiles and estimate total run-times during the monitoring period. In determining operating schedules from the short-term time-of-use data, annual trends such as seasonal effects, weather, production, and occupancy swings were accommodated to the extent they were supported by the data.

The savings for constant load measures (such as lighting) were calculated as line-by-line comparisons of pre- and post-retrofit electrical use. Pre and post retrofit energy estimates were developed for each line item within each measure. Weather sensitive measures (such as HVAC and refrigeration measures) were analyzed in an 8,760 hour spreadsheet using TMY3 normalized weather data.

Once all of the site analyses were completed, DNV GL extrapolated the results to develop final estimates of annual energy (kWh and MMBtu) savings, and peak demand savings as appropriate for each program. The expansion and analysis of results was performed using the adjustment factors derived from observed discrepancies in technology, quantities, hours of operation, and interactive effects as appropriate. All reported results were sample weighted and statistically represent the population.

## 1.3 Results

### 1.3.1 Energy Savings Results by Program and Fuel Type

Table 3 presents energy savings results by program and fuel type. Overall, these results are very favorable with realization rates near 100% (and precisions that are ±8.0% or better at the 80% confidence interval) for electric programs and 91.4% (±3.2% precision at the 80% confidence interval) for gas programs. Energy savings results by program track (prescriptive vs custom) are provided in the body of this report.

**Table 3: Electric and Gas Energy Savings Results by Program**

| Parameter/Adjustment | Electric Programs (MWh) | | | | | Gas Programs (MMBtu) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | New Construction (n=17) | Retrofit (n=21) | RFP (n=4) | NC and Retro Only (n=38) | % Gross NC and Retro Only | New Construction (n=14) | Retrofit (n=12) | All Gas (n=26) | % Gross |
| Tracking Savings | 10,813 | 17,992 | 1,437 | 28,805 | | 31,560 | 58,170 | 89,730 | - |
| Documentation Adj. | -13 | -398 | -9 | -411 | -1.4% | 864 | -2,632 | -1,768 | -2.0% |
| Technology Adj. | 229 | 20 | 0 | 249 | 0.9% | -2,485 | 0 | -2,485 | -2.8% |
| Quantity Adj. | -364 | -662 | 1 | -1,026 | -3.6% | 0 | 0 | 0 | 0.0% |
| Operational Adj. | 308 | 32 | 42 | 340 | 1.2% | -1,262 | -2,195 | -3,457 | -4.0% |
| HVAC Interactive Adj. | 233 | 575 | 0 | 808 | 2.8% | 0 | 0 | 0 | 0.0% |
| Adjusted Gross Savings | 11,205 | 17,559 | 1,471 | 28,764 | 99.9% | 28,676 | 53,343 | 82,020 | 91.4% |
| Gross Realization Rate | 103.6% | 97.6% | 102.4% | 99.9% | - | 90.9% | 91.7% | 91.4% | - |
| Relative Precision | ±8.0% | ±6.6% | ±0.0% | ±7.1% | - | ±7.2% | ±2.5% | ±3.2% | - |
| Confidence Interval | 80% | 80% | 80% | 80% | - | 80% | 80% | 80% | - |
| Error Ratio | 0.31 | 0.27 | 0.0 | 0.29 | - | 0.35 | 0.16 | 0.24 | - |

### 1.3.2 Connected and Peak Demand Savings Results by Program

The next two tables summarize the demand and energy savings factor results by program, fuel, and program track. The connected kW realization rate is the ratio between the evaluation connected kW savings and the tracking system connected kW savings. The coincidence factors are calculated as the proportion of time that program measures are in use during each respective peak period. Table 4 presents these results by program and fuel.

The connected demand realization rate for each program is over 100% and 129.9% overall. The overall ISO-NE summer on-peak[1] demand realization rate is 73.0%; with program-level results that range from 55.6% for new construction to 116.4% for the RFP Program. The ISO-NE winter on-peak[2] demand realization rates are a little more stable with program-level results that range from 80.1% to 97.6% for an overall winter rate of 89.4%. The overall ISO-NE summer on-peak coincidence factor is 52.3%, while the overall ISO-NE winter on-peak coincidence factor is 68.8%. The program-level percent on-peak kWh results are relatively stable with an overall average of 55.2%. These savings factor results by program track (prescriptive vs custom) are provided in the body of this report.

[1] Non-holiday weekdays between 1pm-5pm from June-August.
[2] Non-holiday weekdays between 5pm-7pm from December-January.

**Table 4: Summary of Savings Factors by Program**

| Savings Factors, Realization Rates | New Construction (n=17) | Retrofit (n=21) | RFP (n=4) | All Electric (n=42) |
|---|---|---|---|---|
| kW Factors | | | | |
| Connected kW Realization Rate | 172.2% (±47.3%) | 103.9% (±10.5%) | 158.6% (±0.0%) | 129.9% (±21.8%) |
| Summer Coincidence Factor | 31.9% (±45.1%) | 67.3% (16.9%) | 73.4% (±0.0%) | 52.3% (±20.9%) |
| Winter Coincidence Factor | 56.7% (±17.8%) | 81.0% (±22.5%) | 50.5% (0.0%) | 68.8% (±14.7%) |
| Summer kW Interactive Factor | 101.2% (±2.9%) | 109.6% (±3.1%) | 100.0% (±0.0%) | 107.6% (2.5%) |
| Winter kW Interactive Factor | 100.0% (±0.0%) | 100.0% (±0.0%) | 100.0% (±0.0%) | 100.0% (±0.0%) |
| Summer kW Realization Rate | 55.6% (±65.4%) | 76.6% (±20.1%) | 116.4% (±0.0%) | 73.0% (±19.8%) |
| Winter kW Realization Rate | 97.6% (±50.5%) | 84.2% (±24.8%) | 80.1% (±0.0%) | 89.4% (±22.5%) |
| kWh Factor | | | | |
| % On-Peak kWh | 47.0% (±7.1%) | 59.6% (±5.7%) | 48.5% (±0.0) | 55.2% (±4.5%) |

Note: The precisions at the 80% confidence interval are provided in parentheses next to each result.

### 1.3.3 On and Off Peak kWh and Coincidence Factor Results by End Use

Table 5 presents the on-peak and off peak kWh results according to the end use categories currently used by the sponsors. Summer is defined as June through September and winter is considered to be all other months. On-peak hours are defined as Monday through Friday 7am-11pm and off peak hours are all other hours. The table shows the current program assumption, evaluation result weighted by connected kW and case-weighted to represent the population, the quantity of monitored sites the evaluation value is based on (sample size), and the precision at the 80% confidence interval.

Only results that fall outside the range of our precision estimate when compared to their program assumption counterpart and have a sample size of at least nine are presented. The full results are presented in the main body of this report in Table 19.

**Table 5: On-Peak and Off Peak kWh Results by End Use**

| End Use | Current Program Assumption | Sample Size | Weighted Evaluation Result | Precision at 80% CI |
|---|---|---|---|---|
| **Winter Peak Energy (Weekdays, Oct-May, 7am-11pm)** | | | | |
| CI Lighting | 37% | 23 | 41.4%* | ±3.2% |
| CI Lighting OS | 37% | 14 | 42.7%* | ±3.7% |
| CI Lighting LED | 37% | 9 | 42.6%* | ±4.9% |
| CI Process | 15% | 17 | 33.0%* | ±5.5% |

*These results fall outside of the range of our precision estimates.

Table 6 provides similar results for coincidence factors. For the summer on-peak coincidence factors, the evaluation lighting, occupancy sensor, and process results were found to be statistically different from the current program assumptions. For winter on-peak coincidence factors, the LED lighting and process results were found to be outside the range of our precision estimate. The full results can be found in Table 20.

**Table 6: Coincidence Factor Results by End Use**

| Load Shape | Current Program Assumption | Sample Size | Weighted Evaluation Result | Precision at 80% CI |
|---|---|---|---|---|
| **Summer Demand Coincidence Factors (Weekday, Non-Holidays, Jun-Aug, 1pm-5pm)** | | | | |
| CI Lighting | 85% | 23 | 60.2%* | ±8.0% |
| CI Lighting OS | 15% | 14 | 40.3%* | ±11.5% |
| CI Process | 100% | 16 | 73.8%* | ±6.8% |
| **Winter Demand Coincidence Factors (Weekday, Non-Holidays, Dec-Jan, 5pm-7pm)** | | | | |
| CI Lighting LED | 48% | 9 | 84.3%* | ±11.7% |
| CI Process | 100% | 16 | 57.9%* | ±15.3% |

*These results fall outside of the range of our precision estimates.

### 1.3.4 Participant Survey Results

A customer feedback survey was performed with all customers visited on site to assess participant perceptions of and satisfaction with the services related to the Large C&I Programs. The instrument used can be found in Appendix A. The results of the sixty-three completed interviews summarized below. Whenever possible, the results are compared to those from the most recent Large C&I evaluation completed in New Hampshire, which was completed in 2006.

Key results from the participant survey include:

- 98% of participants reporting being satisfied with the improvements they received through the program in this current study, which is nearly the same as that noted in the 2006 study (100%).
- On a scale of 1 (very negative) to 5 (very positive), participants provided an average rating of 4.6 for their impression of the program and 4.5 for their satisfaction with the program. These results are nearly identical to those from the 2006 study where participants provided average impression and satisfaction ratings of 4.6.
- Nearly 70% of the participants in the current evaluation did not have any suggestions on how to improve the program. The most common responses of those that did are similar to those from the 2006 evaluation; "provide larger rebates", "increase program awareness", "improve explanation of program offerings and services", and "provide certified installers".
- The large majority of respondents (94%) felt that hearing about the programs through their account representative was the best way for them to learn about the programs. Nearly three in ten participants reported becoming aware of the program through word-of-mouth in the form of co-workers and referrals.
- Nearly all respondents (98%) felt that the Large C&I Programs have been worth the effort they had to expend to participate.
- The majority of respondents (89%) reported that they are "Very Likely" to participate again in the future.
- Respondents provided an average rating of 4.4 for satisfaction with the time required to participate in the program on a scale of 1 (very dissatisfied) to 5 (very satisfied).
- Respondents provided an average rating of 4.3 for how easy it was to understand the program on a scale of 1 (very difficult) to 5 (very easy).
- Respondents provided an average rating of 4.3 for the time required to participate in the program on a scale of 1 (a lot of time) to 5 (very little time).

- Respondents provided an average rating of 4.2 for the effort required to apply for program incentives on a scale of 1 (a lot of effort) to 5 (very little effort).
- Respondents provided an average rating of 4.2 for the completeness and accuracy of program marketing materials on a scale of 1 (very incomplete and inaccurate) to 5 (very complete and accurate).
- Respondents most often cited a lack of money and time as the barriers that most often prevent businesses such as theirs from participating in the program.

### 1.3.5 Summary of Tracking Systems and Supporting Documentation

The tracking information and supporting documentation provided by the sponsors provided the basic information needed to support an evaluation. However, there were many inconsistencies between the various utility databases. Not all of the sponsor databases had completely populated winter and connected demand savings estimates. Some sponsors do not track on-peak kWh savings or measure quantities. Program data was not tracked at the measure level so measure locations (space types or room names) were not present. Sometimes this information could be found in the project file but this was not always the case.

Baseline assumptions and working spreadsheets and calculations were not present in many of the project files, which made it difficult to confirm if the tracking savings were accurate. This lack of variable input detail makes it difficult to determine the exact reasons for any discrepancies that were found. This was particularly true for non-lighting measures.

Technical Resource Manuals (TRMs) from across the nation were referenced in the non-lighting savings documentation, which resulted in a wide range of savings for the same measure. The TRMs are often region specific and assumptions may not apply to New Hampshire weather or demographics. Preference should be given to regional TRMs first.

## 1.4 Conclusions and Recommendations

Overall, the programs appear to be very well liked and participants are satisfied with its services. Both the electric and gas energy savings results are favorable with very good realization rates. As the energy and demand conclusions show, many of the discrepancies found revolve around tracking system errors and lack of supporting documentation. For this reason the recommendations around these conclusions can be found in the tracking system and supporting documentation section below.

We note that some of the recommendations provided below may have been undertaken by the utilities already as part of the process of providing interim feedback on this study or as a result of ongoing program improvements. It is also important to note that if the sponsors implement the recommendations made below, then they may not need to apply the realization rates that are reported.

**Energy Savings Conclusions**:

- The gross savings realization rates by program, fuel, and program track (prescriptive vs. custom) were all between 91% and 104%. In particular, we note that the prescriptive realization rates were very tight with a realization rate of 99% for electric prescriptive measures and 102% for gas prescriptive measures.
- Only minor discrepancies were found between tracking and the M&V site work, including minor adjustments in quantities found for electric measures and operational adjustments to gas measures.

**Connected Demand Savings Conclusions**:

- The high connected demand realization rate for the new construction program (172.2%) is driven by one very large custom snow gun site which had zero connected kW savings in the tracking system while nearly 1,800 kW savings were calculated based on the site visit. Removing this site from the analysis would result in a realization rate of 94.4% (±26.0% at 80% CI).
- The 158.6% connected demand realization rate for the RFP Program is driven by two custom sites which had calculated evaluation savings that were nearly twice as high as their corresponding tracking system estimates. Removing these sites from the analysis would result in a realization rate of 114.2%.

**Summer On-Peak Demand Savings Conclusions:**

- The 55.6% summer on-peak demand realization rate for the new construction program is primarily driven by the results from two large lighting sites. The decrease in savings at one of the sites was actually driven by a large difference in the connected demand savings. At the other site, the tracking system assumed a summer coincidence factor of 85% but the evaluation site visit revealed that the installed fixtures only operated 12% of the time during the summer peak. Removing these two sites from the analysis would result in a summer peak demand realization rate of 90.2% (±22.8% at 80% CI).
- The 116.4% summer on-peak demand realization rate for the RFP program is driven by one large custom site for which the tracking system assumes a 100% summer coincidence factor and a connected demand savings estimate of 59.8 kW. The documentation revealed (and the on-site visit confirmed) that the connected demand was actually 120.4 kW and the on-site monitoring found the summer coincidence factor to be 80%, which is an increase of 160% over the tracking assumption. Removing this site from the analysis would result in a realization rate of 96.7% (±0.0% at 80% CI).
- The 76.6% summer on-peak demand realization rate for the retrofit program is driven by decreases in the monitored coincidence factors found at two large prescriptive lighting sites as compared to their tracking system assumptions, as well as the removal of the process measures installed at another site. Removal of these three sites would result in a realization rate of 97.0% (±17.4% at 80% CI).

**Winter On-Peak Demand Savings Conclusions:**

- The winter on-peak demand realization rate for the new construction program is very stable; with a 97.6% realization rate.
- The 80.1% winter on-peak demand realization rate for the RFP program is driven by decreases in the monitored winter coincidence factors found at all four of the RFP program sites as compared to their tracking system assumptions.
- The 84.2% winter on-peak demand realization rate for the retrofit program is driven primarily by decreases in the monitored coincidence factors for the prescriptive lighting and process measures for the largest retrofit site in the sample. Removing this site from the analysis would result in a realization rate of 97.3% (±12.7% at 80% CI).

**On-Peak and Off Peak kWh Conclusions by End Use**:

- Overall, the on-peak and off peak energy results are very comparable to the current program assumptions as only four winter peak energy results (C&I lighting, occupancy sensors, LEDs, and process) fall outside the range of their respective precision estimates when compared to the current program assumptions for each. The process result falls outside of the precision range by 14% but the other three results fall outside of the precision range by 2% or less.

**On-Peak and Off Peak kWh Recommendations by End Use:**

- Due to the comparability of many of these results to the current program assumptions, we recommend that the sponsors only consider changing the assumptions related to process measures.
- While the C&I lighting, occupancy sensor, and LED results do fall outside of the precision range, it is by such a small margin that we do not recommend a change to the current assumptions for these measures.

**On-Peak Coincidence Factor Conclusions by End Use**:

- The lighting, occupancy sensor, and process summer on-peak coincidence factors results all fell outside of the range of their precision estimates when compared to the current program assumptions for each.
- The LED lighting and process winter on-peak coincidence factor results fell outside out the range of their precision estimates as compared to the current program assumption.

**On-Peak Coincidence Factor Recommendations by End Use**:

- Based on the results of this study, we recommend that the sponsors consider changing their current summer on-peak coincidence factor assumptions for lighting, occupancy sensors, and process measures.
- We recommend that the sponsors consider changing their winter on-peak coincidence factor assumption for LED lighting and process measures to be consistent with the results of this study.
- These considerations should be informed by analysis of the applicability of the study findings to current and future program participant populations, in terms of the distribution of peak savings by building type and the overall accuracy (statistical precision and bias) of the corresponding coincident peak savings calculations.

**Participant Survey Conclusions:**

- Nearly all (98%) of the participants in the sample reported that they were satisfied with the measures that they received through the program and felt that the programs were worth the effort that they had to expend to participate.
- The large majority (89%) of participants reported that they are "very likely" to participate in the programs again in the future.
- Participants were satisfied with the program process; giving average ratings of 4.2 or higher for all aspects of the program on a scale of 1(very dissatisfied) to 5 (very satisfied).
- Most participants that were surveyed reported being made aware of the programs through their account representatives and felt that this was the best way for them to learn about the programs.
- Participants reported that a "lack of funding for improvements" was the most common barrier for other businesses to get involved in the programs.
- Participants most commonly reported that "saving money" and "the program incentives" were the main reasons why they decided to participate in the program.
- The most common suggestions for program improvement provided by participants were similar to those from the 2006 evaluation; "provide larger rebates" and "increase program awareness/marketing".
- One common suggestion for improvement that was not mentioned in the 2006 study was to "provide incentives for a larger selection of products".

**Participant Survey Recommendations**:

- Due to the highly positive results of the participant survey, we recommend that the sponsors continue to make customers aware of the programs through the channels that are currently in place; particularly through account representatives.
- We recognize that the custom channel allows customers to bring current technologies that they are interested in to the program for incentive consideration. We recommend that the sponsors continue this opportunity for customers so they are aware of and can pursue the latest cutting-edge technologies with program assistance.

**Tracking System and Supporting Documentation Conclusions**:

- The tracking information and supporting documentation provided by the sponsors provided the basic information needed to support an evaluation.
- There were many inconsistencies between the various utility databases.

  - Not all sponsor databases had completely populated winter and connected demand estimates.
  - Some sponsors do not track on-peak kWh savings or measure quantities.
  - Measure locations (space types or room names) were not present in the tracking system. Sometimes this information could be found in the project file but this was not always the case.
  - One sponsor tracked net savings while the others tracked gross savings.
- Baseline assumptions and working spreadsheets and calculations were not present in many of the project files. This lack of variable input detail makes it difficult to determine the exact reasons for any discrepancies that were found. This was particularly true for non-lighting measures.
- On a couple of occasions Technical Resource Manuals (TRMs) from across the nation were referenced in the non-lighting savings documentation, which resulted in a wide range of savings for the same measure. The TRMs are often region specific and assumptions may not apply to New Hampshire weather or demographics.

**Tracking System and Supporting Documentation Recommendations**:

- We recommend that the sponsors' tracking systems contain all of the information needed to perform a thorough evaluation including:
  - Gross Annual kWh Savings
  - Summer kW Savings (connected load)
  - Winter kW Savings (connected load)
  - Measure quantities
  - Measure installation location
- We recommend that the sponsors consider claiming connected demand and winter on-peak demand savings for snow gun installations. As noted in the results section, if this measure had a connected demand tracking estimate, the realization rate would have been much closer to 100%. This is an example of where an adjustment to how tracking savings are calculated would make the tracking system more accurate and reduce tracking savings adjustments as part of the realization rate.
- We recommend that the sponsors consider adopting common savings algorithms and assumptions for all of the various measure installations that occur through the Large C&I Programs, similar to the common assumptions spreadsheet that Eversource provided for on-peak kWh and load shapes. If the sponsors decide to adopt algorithms and assumptions from another state, we recommend that preference be given to regional TRMs first. DNV GL understands that Liberty Utilities' data for this evaluation was in-transition and stored by National Grid. As a separate effort in reviewing Liberty Utilities tracking systems for ISO-NE Forward Capacity Market purposes, DNV GL found that the Liberty Utilities tracking system addresses these issues.
- We recommend that the sponsors consider requiring that the project files contain the assumptions and working spreadsheet calculations used to estimate the savings present in the tracking system. This would include measure quantities, baseline and installed efficiency assumptions, and operation assumptions such as hours of use and full load equivalent hours (FLEH).
- We recommend that the sponsors consider processes to improve the accuracy of the tracking data, such as a quarterly review. This process could include high-level reviews such as looking for instances where connected savings values are zero, where summer on-peak demand savings for exterior lighting fixtures exceed zero, and where weather dependent measures have zero demand savings during the peak during which they are expected to operate. For all sites with large energy savings, this review should also include verification that the physical calculation of the tracking savings is present in the project file.

# 2 PROGRAM OVERVIEW AND STUDY OBJECTIVES

DNV GL was engaged by the New Hampshire Electric and Gas Utilities and the New Hampshire Public Utility Commission (the sponsors) to perform an impact evaluation of the Large Commercial and Industrial Retrofit Program, New Equipment and Construction Program, and the Eversource Energy Rewards RFP Program (Large C&I programs). The Large C&I Retrofit Program provides financial and technical services to facilitate the replacement of old, inefficient equipment with new energy efficient equipment in existing facilities for large commercial and industrial customers (defined as electric customers with an average monthly demand of greater than 200 kW and for gas customers that consume 40,000 therms per year or more). The Large C&I New Equipment and Construction Program offers financial and technical services to commercial, industrial and institutional customers that are building a new facility, undergoing a major renovation, or replacing failed equipment. The Energy Rewards Program offers incentives on a competitive basis to C&I customers (with a demand of 350 kW or more) who achieve measurable energy savings through the installation of energy efficiency measures. There are 358 customer accounts that participated in the Large C&I programs in 2012.

Table 7 presents the number of participants and electric and gas savings by program and sponsor for the 2012 New Hampshire Large C&I Programs. A total of 264 customers received electric savings measures and saved 30,242 MWh, while 94 customers received gas savings measures and saved 89,730 MMBtu in 2012. The Large C&I Retrofit was responsible for the majority of the electric savings with 181 customers receiving and 17,992 MWh of savings. On the gas side, the Large C&I Retrofit and C&I New Equipment and Construction Programs each had 47 customers but the Large C&I Retrofit Program was responsible for the bulk of the savings with 58,170 MMBtu.

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| **Large C&I Retrofit Program** | | | | |
| Liberty Utilities | 13 | 2,572 | 45 | 42,047 |
| New Hampshire Electric Cooperative (NHEC) | 23 | 1,261 | 0 | 0 |
| Eversource | 123 | 10,630 | 0 | 0 |
| Unitil | 22 | 3,529 | 2 | 16,123 |
| Large C&I Retrofit Program Total | **181** | **17,992** | **47** | **58,170** |
| **C&I New Equipment & Construction Program** | | | | |
| Liberty Utilities | 5 | 353 | 29 | 27,315 |
| Eversource | 62 | 8,960 | 0 | 0 |
| Unitil | 12 | 1,500 | 18 | 4,245 |
| C&I New Equipment & Construction Program Total | **79** | **10,813** | **47** | **31,560** |
| **Eversource RFP Program** | | | | |
| Eversource | 4 | 1,437 | 0 | 0 |
| RFP Program Total | **4** | **1,437** | **0** | **0** |
| **All Large C&I Programs** | | | | |
| Liberty Utilities | 18 | 2,924 | 74 | 69,362 |
| New Hampshire Electric Cooperative (NHEC) | 23 | 1,261 | 0 | 0 |
| Eversource | 189 | 21,027 | 0 | 0 |
| Unitil | 34 | 5,029 | 20 | 20,368 |
| **All Large C&I Programs Total** | **264** | **30,242** | **94** | **89,730** |

The electric and gas savings are presented by end use in Table 8 and Table 9, respectively. Lighting, process, and HVAC measures account for nearly 83% of all electric savings. The remaining electric savings were generated by motors/VFDs (11.2%) and refrigeration (0.3%). HVAC measures produced 71.4% of the gas savings while the remainder was due to hot water (18.1%), custom (10.4%), and process (0.1%) measures. Prescriptive measures accounted for the majority of the electric savings (58.6%), while custom measures dominated the gas savings (95.3%).

**Table 8: 2012 Large C&I Program Electric Savings in MWh by End Use and Program Track**

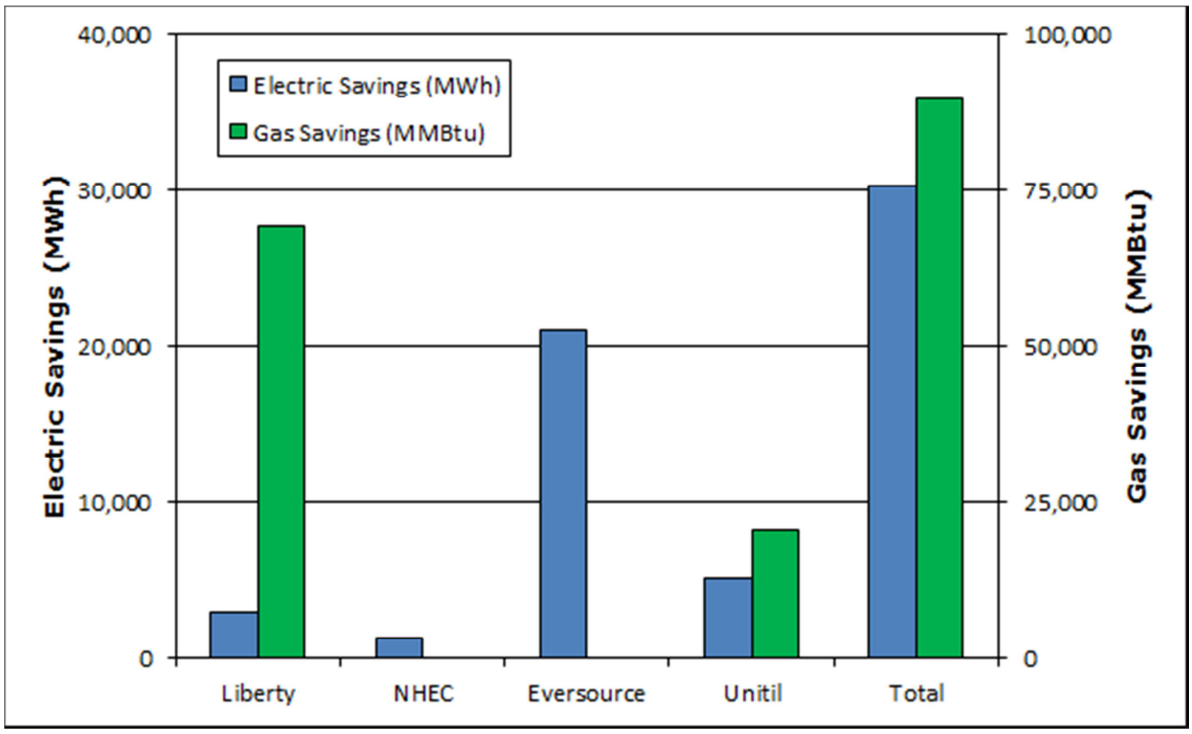

| End Use | Custom Total | Total Prescriptive | Grand Total |
|---|---|---|---|
| Custom | 1,733 | 0 | 1,733 |
| HVAC | 3,232 | 1,622 | 4,854 |
| Lighting | 3,543 | 11,744 | 15,287 |
| Motors/VFDs | 16 | 3,373 | 3,388 |
| Process | 3,915 | 985 | 4,900 |
| Refrigeration | 79 | 0 | 79 |
| **Grand Total MWh** | **12,518** | **17,724** | **30,242** |

**Table 9: 2012 Large C&I Program Gas Savings in MMBtu by End Use and Program Track**


| End Use | Custom Total | Total Prescriptive | Grand Total |
|---|---|---|---|
| Co-Generation | 9,303 | 0 | 9,303 |
| Hot Water | 16,123 | 156 | 16,279 |
| HVAC | 60,058 | 3,972 | 64,030 |
| Process | 0 | 117 | 117 |
| **Grand Total MMBtu** | **85,485** | **4,245** | **89,730** |

Figure 1 presents the electric and gas energy savings by sponsor. Eversource was responsible for the majority (69.5%) of the 2012 Large C&I Programs electric savings. Unitil, Liberty, and NHEC contributed 16.6%, 9.7%, and 4.2%, respectively. Liberty was the largest gas savings contributor with 77.3%, while Unitil was responsible for the remaining 22.7%.

**Figure 1: Electric and Gas Energy Savings by Sponsor**




## 2.1 Study Objectives

The primary objectives of this study were to:

- Verify actual energy and demand savings for each program for the state, by program track (custom vs. prescriptive), and by fuel type (gas vs. electric),
- Explain the reasons for discrepancies between tracked and evaluated savings,
- Review the tracking system savings methodologies, and make appropriate recommendations for improvement with an overarching desire to assist the utilities in revising savings inputs and methods as opposed to providing adjustment factors,
- Report on customers' overall satisfaction of the programs,
- Deliver a written report of evaluation methodologies and findings, and
- Provide an oral presentation of the findings to the Sponsors and other Interested Parties.

To accomplish this, DNV GL conducted an on-site based impact evaluation with metering and verification. This evaluation design provided a data rich effort that fed measure-level analyses to verify the actual energy (kWh and MMBtu), demand (kW), and peak and off-peak demand savings associated with participation in New Hampshire's Large C&I electric and gas programs. In the results section, realization rates are provided for each of these items; along with conclusions and recommendations intended to aid the sponsors in improving future tracking quality and accuracy.

# 3 EVALUATION METHODOLOGY

The evaluation methodology was founded around the performance of on-site visits to a statistically selected sample. Each site visit included verifying the type and quantity of measures installed, gathering baseline information (when available) and hours of use for all installed energy efficiency measures at the site. We

also performed interviews with site personnel to gather information on their perceptions of and satisfaction with services received from the programs. Metering time of use and/or true power was also performed as needed at sites to inform savings estimates. All final measure level savings analyses were aggregated at the site level and expanded to estimate overall program impacts as well as at the desired levels of disaggregation. This section of the report provides information on the methods employed in this process.

## 3.1 On-Site Sample Design Methodology

The primary goal of the sample design was to determine the gross impacts of the 2012 Large C&I Programs for both electric and gas and to provide realization rates with clearly provided reasons for any discrepancies with the tracked savings. The final results are provided at the state level, by program, program track (custom vs. prescriptive), and fuel type (gas vs. electric).

Using the Model Based Statistical Sampling (MBSS) techniques provided in Appendix B, Table 10 presents the sample which was developed to achieve the desired ±10% precision at the 80% confidence interval around energy savings (kWh for electric and MMBtu for gas) at the program level for each fuel type. To calculate the sample sizes needed for these results, we used an error ratio of 0.35 for electric and 0.45 for gas, which are somewhat aggressive but reasonable for programs with high quality tracking savings estimates. For the state level, we estimated that 68 on-site visits could achieve 80/10 estimates for each program and fuel.

**Table 10: Final Sample Sizes and Estimated Precisions of Energy Savings at 80% Confidence**

| Program (Fuel) | N | ER | n0 | n1 | Estimated Precision at 80% Confidence Interval |
|---|---|---|---|---|---|
| C&I New Equipment & Construction (Electric) | 79 | 35% | 21 | 17 | 9.1% |
| Large C&I Retrofit (Electric) | 181 | 35% | 21 | 21 | 9.2% |
| Eversource RFP (Electric) | 4 | 35% | 21 | 4 | 0.0% |
| **All Programs (Electric)** | **264** | **35%** | **63** | **42** | **6.3%** |
| C&I New Equipment & Construction (Gas) | 47 | 45% | 33 | 14 | 9.3% |
| Large C&I Retrofit (Gas) | 47 | 45% | 33 | 12 | 9.4% |
| **All Programs (Gas)** | **94** | **45%** | **66** | **26** | **6.9%** |
| **Grand Total** | **358** | **-** | **126** | **68** | **6.3%** |

The primary sample was then assigned to a team of site auditors, who scheduled their own visits. In order to minimize customer intrusion and maximize recruitment rates, the auditors were flexible with visit days and times are performed; including early morning and evening visits as necessary.

Table 11 presents the final disposition of the recruitment calls made for the 68 on-site visits based on the disposition codes provided in The American Association for Public Opinion Research's (AAPOR) Standard Definitions.[3] Based on the algorithms provided in this document we calculate a 98.5% response rate and a 1.5% refusal rate.

The response rate is an indicator of potential bias associated with sample-specific estimates of population parameters. We cite it as an indicator since an assessment of the extent of bias due to non-response really rests upon any differences there might be between those customers that allowed the visit and those that we

[3] http://www.aapor.org/AAPORKentico/AAPOR_Main/media/MainSiteFiles/StandardDefinitions2011_1.pdf

were unsuccessfully able to schedule. Since the recruitment was performed for an impact study, we might expect the greatest risk of bias to this study being a sample of "refusers" that were avoiding the verification of known poorly-operating or non-performing equipment. In fact, there was only one participant in our M&V sample that refused a visit, which was due to a strict company policy that does not allow metering. As such, we do not believe the response and refusal rates experienced in this study have resulted in any particular bias in the impact results provided.

**Table 11: Final M&V On-site Recruitment Disposition**

| Disposition Code | Disposition Description | Total |
|---|---|---|
| 1.1 | Completion | 68 |
| 2.11 | Refusal | 1 |
| **Total Customers Called** | | **69** |

## 3.2 Data Collection and Analysis Methodology

Each site visit consisted of a verification of installed equipment, a discussion with facility personnel regarding the baseline characteristics of the measure, collection and analysis of monitored or trended data as well as relevant weather data, and performance of an on-site survey to gather information on perceptions of and satisfaction with the services received from the programs.

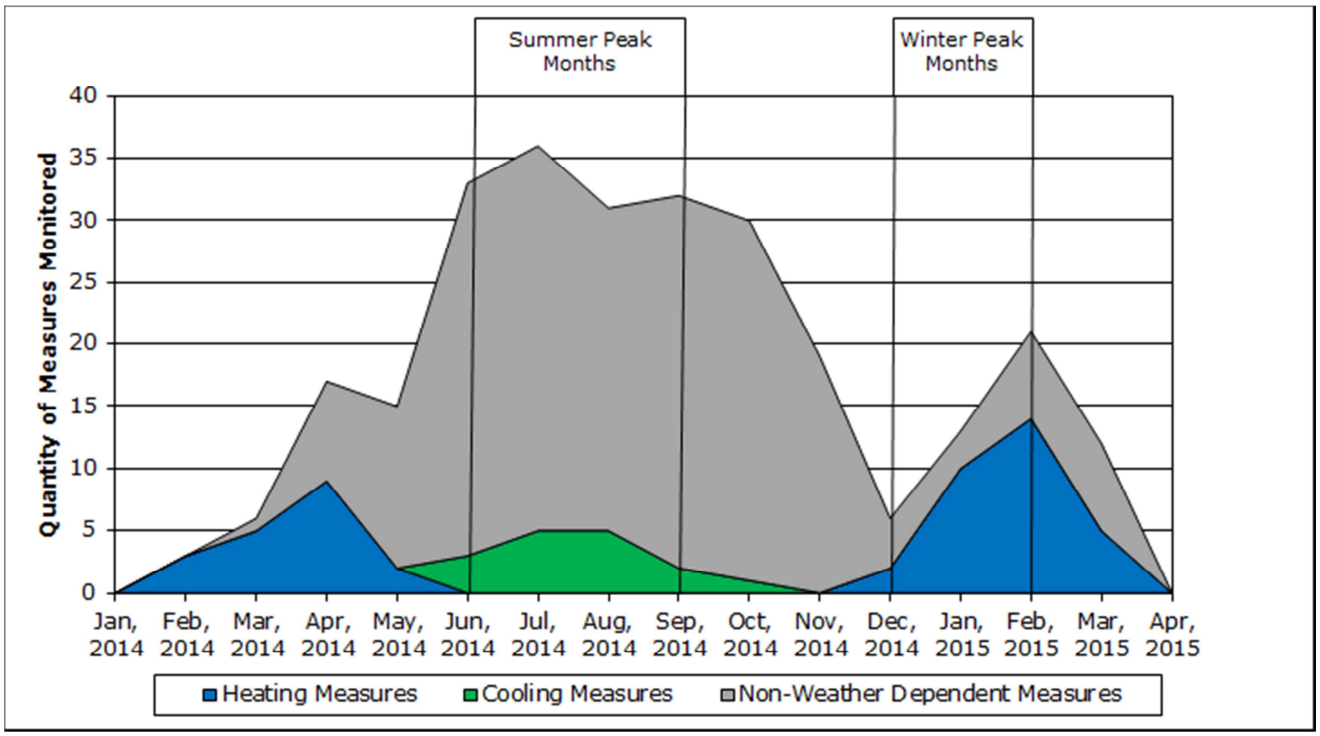
Table 12 below lists all of the measures encountered in this impact evaluation along with a description of the evaluation approaches used and key evaluation inputs for each measure. The whole building approach was only applied to gas measures that used the same approach to calculate the tracking system savings. In these cases, the model that was used to calculate tracking savings was adjusted to account for any differences found during the on-site visit. The analysis methodology for the most common measures can be found in Appendix F.

**Table 12: Evaluation Approaches Used by Measure Type**

| Major Measure Categories | Evaluation Approaches Used | Key Evaluation Input/s |
|---|---|---|
| Lighting | Retrofit Isolation – Time-of-Use Loggers | Wattage, Hours of Use, HVAC Types (for Interactive) |
| Compressed Air | Retrofit Isolation – Power Loggers | Capacity, Pressure, kW/CFM, Storage, Controls, Dryer |
| Process | Retrofit Isolation – Power Loggers, Time-of-Use Loggers, Instantaneous Power Measurements, Energy Management System Trends, Local Digital Control Output, Manufacturers' Design Performance Criteria | Horsepower (hp), kW, Temperature, Speed, Capacity, Operating Time, Interactive Loads, Production Capacity |
| Variable Frequency Drives | Retrofit Isolation – Power Loggers, Energy Management System Trends, Local Digital Control Output | hp, kW, Indoor/Outdoor Temperature/Humidity, Motor Efficiencies/Loads, Operating Schedules, cfm/gpm |
| Weatherization | Retrofit isolation or Whole Building Approach (Billing Analysis or Building Simulation) | Area, Assembly R-value, Infiltration cfm, Indoor/Outdoor Temperatures, Heating/Cooling Efficiencies |
| HVAC | Retrofit Isolation – Power Loggers, Time-of-Use Loggers or Whole Building Approach (Billing Analysis or Building Simulation) | Capacity, Efficiency, Operating Schedules, Seasonal Operation |
| Motors | Retrofit Isolation – Power Loggers, Time-of-Use Loggers | hp, kW, Efficiencies, Operating Hours |
| Condensing Boiler | Retrofit Isolation or Whole Building Approach (Billing Analysis or Building Simulation) | Size (output), Efficiency, Supply/Return Temperatures, Blower/Pump Motor Modulation, Outdoor Temperatures |
| Boiler Controls | Retrofit Isolation or Whole Building Approach (Billing Analysis or Building Simulation) | Size (output), Efficiency, Supply/Return Temperatures, Blower/Pump Motor Modulation, Outdoor Temperatures |
| Boiler Reset Controls | Retrofit Isolation or Whole Building Approach (Billing Analysis or Building Simulation) | Size (output), Efficiency, Supply/Return Temperatures, Blower/Pump Motor Modulation, Outdoor Temperatures |
| Programmable Thermostats | Retrofit Isolation or Whole Building Approach (Billing Analysis or Building Simulation) | Efficiency, Occupancy Schedules, Indoor/Outdoor Temperatures, Conductivity, Envelope R-values |
| Process Heat Recovery | Retrofit Isolation or Whole Building Approach (Billing Analysis or Building Simulation) | Supply/Exhaust cfm and Temperatures, Operating Schedules, Exchanger Efficiency, Heating/Cooling Efficiency |
| Steam Traps | Retrofit Isolation or Whole Building Approach (Billing Analysis or Building Simulation) | Trap Type/Diameter, Steam Pressure/Temperature, Heating Efficiency |
| Ventilation | Retrofit Isolation or Whole Building Approach (Billing Analysis or Building Simulation) | cfm, Supply/Return/Mixed/Outside Air Temperature, CO2 Concentration, Operating Schedule, Heating/Cooling Efficiency |
| Boiler Stack Economizer | Retrofit Isolation or Whole Building Approach (Billing Analysis or Building Simulation) | Capacity, Efficiency, Operating Schedule, Stack Temperature, Outdoor Air Temperature |

As Figure 2 shows, sites we staggered our metering and verification site work such that cooling measures were monitored during the cooling months and heating measures were monitored during the heating months. It is important to note that all five electric sites that had heating-season measures installed (snow guns, heating system motors/VFDs, etc.) were monitored during the winter peak months that occurred during this evaluation (December, 2014 and January, 2015). All heating-season sites performed in early 2014 were gas sites.

**Figure 2: Quantity of Measures Monitored During Evaluation Period**




Monitoring was performed for an average of seven weeks. Spot power monitoring was performed as needed to assess the efficiency of the unit of interest. When possible, energy management system data was used to obtain additional information and operating schedules. All of the monitoring equipment (shown in Table 13), which was used to determine demand reduction and coincidence, complies with the requirements of the ISO-New England Manual for Measurement and Verification of Demand Resources (M-MVDR). One possible exception is EMS trend data collected from the customer site. DNV GL employed a couple different methods to verify the accuracy of EMS data, including attempting to collect make and model number, and monitoring select points using compliant meters.

**Table 13: Electric Monitoring Equipment Used**

| Equipment Type | Quantity Used |
|---|---|
| DENT Lighting SmartLogger | 365 |
| DENT ELITEPro Power Logger | 35 |
| Onset HOBO H22 Power & Temperature Logger | 2 |
| DENT Current SmartLogger | 1 |

DNV GL followed three basic steps when installing lighting and non-lighting monitoring equipment: 1) Selection, 2) Placement, and 3) Calibration. During the selection stage, the appropriate number of loggers needed was determined and the need for redundant logging was assessed. Placement of monitoring equipment loosely mimicked a stratified selection of the monitoring points to assure measurements were representative of the measure. This was based upon space types, controls that are present and discrete schedules as observed on-site. Finally, calibration was performed to secure the reliability of the data received. Lighting loggers are relatively simple to calibrate: on/off transitions for lighting loggers can be confirmed at the time of installation by either adjusting a sensitivity screw or by visually inspecting the status LCD on the unit. Non-lighting metering required deployment using a computer for calibration and control.

Data collected from the monitoring devices was used to develop time-of-use load profiles and estimate total run-times during the monitoring period. Short-term metered data, like that obtained in this study, pose challenges in accurately expanding the data from the monitored period to a typical year. In determining operating schedules from the short-term time-of-use data, annual trends such as seasonal effects (e.g., daylight savings), weather, production, and occupancy swings (such as vacations, business cycles, etc.) were accommodated to the extent they were supported by the data.

The savings for constant load measures (such as lighting) were calculated as line-by-line comparisons of pre- and post-retrofit electrical use. Pre and post retrofit energy estimates were developed for each line item within each measure. Weather sensitive measures (such as HVAC and refrigeration measures) were analyzed in an 8,760 hour spreadsheet using TMY3 normalized weather data. All analyses were conducted in a manner that allowed us to provide discrepancies between the tracked and gross savings according to each of the adjustments shown in Table 14.

**Table 14: Data Analysis Adjustment Factors**

| Adjustment Factor | Description |
|---|---|
| Documentation Adjustment | The Documentation Adjustment reflects any change in savings due to discrepancies in project documentation. Evaluators recalculate the tracking estimates of savings using all savings assumptions and operating parameters documented in the project file. |
| Technology Adjustment | The Technology Adjustment reflects the change in savings due to the identification of a different technology at the site than represented in the tracking system estimate of savings. |
| Quantity Adjustment | The Quantity Adjustment reflects the change in savings due to the identification of a different quantity of installed measure/s at the site than presented in the tracking system estimate of savings. |
| Operational Adjustment | The Operational Adjustment reflects the change in savings due to the observation or monitoring of different operating parameters at the site than represented in the tracking system estimate of savings. |
| HVAC Interactive Adjustment | The HVAC Interactive Adjustment reflects changes in savings due to interaction between the installed measure and HVAC systems. |

Once all of the site analyses were completed, DNV GL extrapolated the results to develop final estimates of annual energy (kWh and MMBtu) savings, and peak demand savings as appropriate for each program. The expansion and analysis of results was performed using the adjustment factors derived from observed discrepancies in technology, quantities, hours of operation, and interactive effects as appropriate. All reported results were sample weighted and statistically represent the population or appropriate population sub-groups.

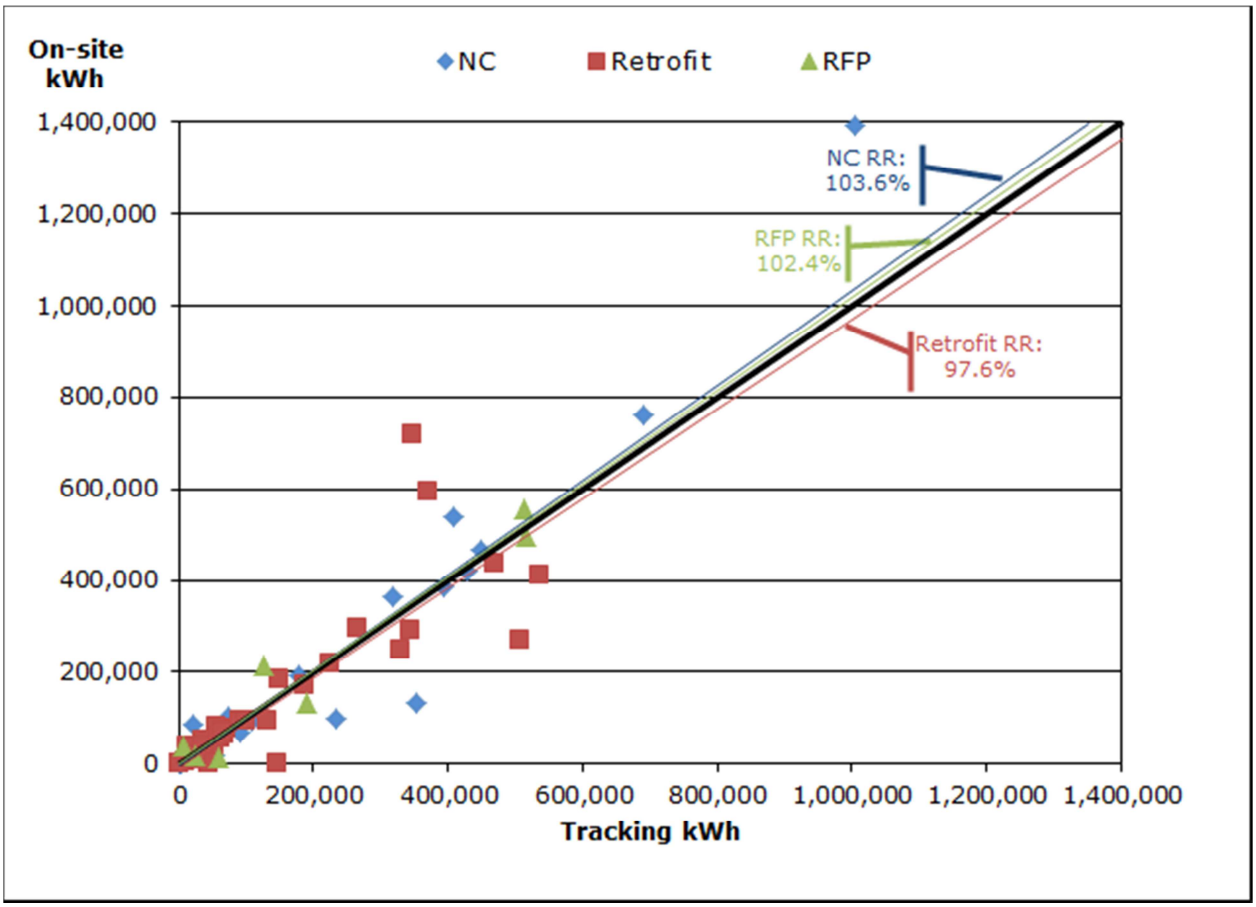
# 4 RESULTS

This section presents the results of the evaluation by program, program track (custom vs. prescriptive), and fuel type; followed by a summary of recommendations. Electric results are also provided by end use in Appendix E. It is important to note that the tracking savings, which are the basis for these evaluations, are consistent with the summaries presented above. The results and recommendations rest upon the findings of this study and DNV GL's vast experience performing on-site visits and metering studies.

## 4.1 Energy Savings by Program, Program Track, and Fuel Type

Figure 3 presents a scatter plot of evaluation results versus tracking savings for annual electric energy (kWh) by program. A one-to-one reference line is plotted as a bolded line on the diagonal of the figure. All sample points would fall along this line if the on-site M&V savings were identical to the tracking estimates. The plotted sample points are generally close to the reference line which suggests a more precise overall estimate of impacts and a lower error ratio. The realization rates for all three programs are very close to 100%. For all electric program combined the realization rate is 100.0%. Appendix C contains the site-level results and reasons for all discrepancies found for each of the sample points plotted below.

**Figure 3: Scatter Plot of Annual kWh Savings by Program**




Similarly, Figure 4 plots the evaluation results against the tracking savings annual gas energy (MMBtu) by program. The new construction program realization rate is 90.9%, while for the retrofit program it is 91.7%. The overall gas realization rate is 91.4%. This scatter plot is also relatively close to the one-to one reference line.

**Figure 4: Scatter Plot of Annual MMBtu Savings by Program**

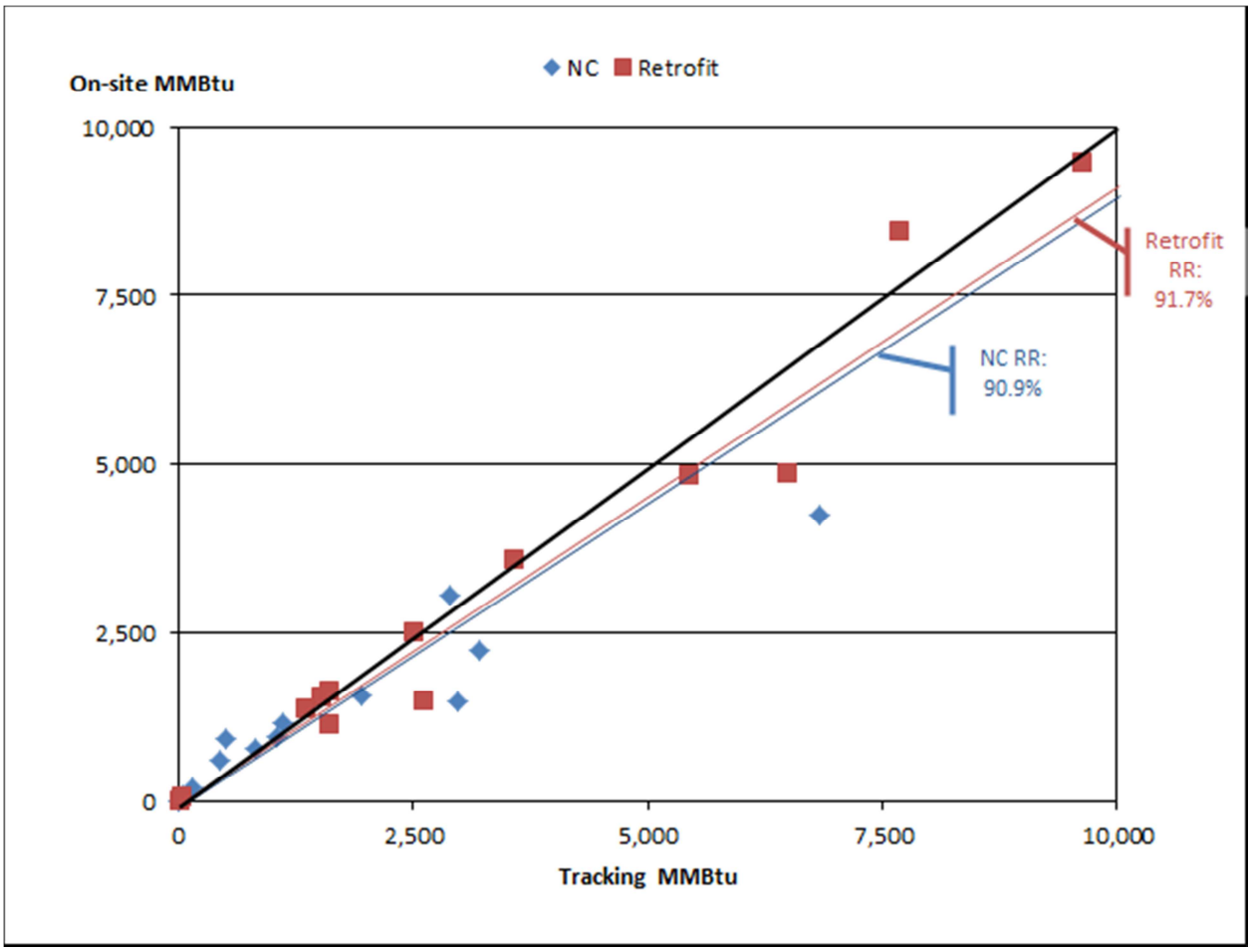



Table 15 presents energy savings results by program and fuel type. Overall, these results are very favorable with realization rates near 100% (and precisions that are ±8.0% or better at the 80% confidence interval) for electric programs and 91.4% (±3.2% precision at the 80% confidence interval) for gas programs.

For electric programs, the quantity adjustment accounted for the largest reduction to the tracking savings estimate, which is due to program measures not found to be installed during the on-site visits. The HVAC interactive adjustment accounted for the largest increase, due to the fact that it is not included in the tracking savings estimate.

For gas programs, the largest reduction to the tracking savings estimate occurred due to operational adjustments across both the new construction and retrofit programs and technology adjustments in the new construction program. The negative operational adjustment indicates that program products were measured to operate less than assumed in the tracking system savings estimate. The negative technology adjustment is indicative of decreases in the change of efficiency between the baseline measure and the program-installed measure as compared to the assumption in the tracking savings estimate. These changes can occur when the observed delta efficiency is lower than assumed in the tracking system.

**Table 15: Electric and Gas Energy Savings Results by Program**

| Parameter/Adjustment | Electric Programs (MWh) | | | | | Gas Programs (MMBtu) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | New Construction (n=17) | Retrofit (n=21) | RFP (n=4) | NC and Retro Only (n=38) | % Gross NC and Retro Only | New Construction (n=14) | Retrofit (n=12) | All Gas (n=26) | % Gross |
| Tracking Savings | 10,813 | 17,992 | 1,437 | 28,805 | | 31,560 | 58,170 | 89,730 | - |
| Documentation Adj. | -13 | -398 | -9 | -411 | -1.4% | 864 | -2,632 | -1,768 | -2.0% |
| Technology Adj. | 229 | 20 | 0 | 249 | 0.9% | -2,485 | 0 | -2,485 | -2.8% |
| Quantity Adj. | -364 | -662 | 1 | -1,026 | -3.6% | 0 | 0 | 0 | 0.0% |
| Operational Adj. | 308 | 32 | 42 | 340 | 1.2% | -1,262 | -2,195 | -3,457 | -4.0% |
| HVAC Interactive Adj. | 233 | 575 | 0 | 808 | 2.8% | 0 | 0 | 0 | 0.0% |
| Adjusted Gross Savings | 11,205 | 17,559 | 1,471 | 28,764 | 99.9% | 28,676 | 53,343 | 82,020 | 91.4% |
| Gross Realization Rate | 103.6% | 97.6% | 102.4% | 99.9% | - | 90.9% | 91.7% | 91.4% | - |
| Relative Precision | ±8.0% | ±6.6% | ±0.0% | ±7.1% | - | ±7.2% | ±2.5% | ±3.2% | - |
| Confidence Interval | 80% | 80% | 80% | 80% | - | 80% | 80% | 80% | - |
| Error Ratio | 0.31 | 0.27 | 0.0 | 0.29 | - | 0.35 | 0.16 | 0.24 | - |

Energy savings results are shown by program track (prescriptive or custom) in Table 16 below. The realization rate for prescriptive measures is nearly 100% for electric programs and over 100% for gas programs; indicating that prescriptive savings estimates are generally very accurate. The realization rates for custom measures are slightly higher for electric programs but lower for gas programs, which are realizing 90.9% of the tracking savings.

**Table 16: Electric and Gas Energy Savings Results by Program Track**

| Parameter/Adjustment | Electric Programs (MWh) | | | | Gas Programs (MMBtu) | | | |
|---|---|---|---|---|---|---|---|---|
| | Prescriptive (n=28) | Custom (n=17) | All Electric (n=45[4]) | % Gross | Prescriptive (n=4) | Custom (n=22) | All Gas (n=26) | % Gross |
| Tracking Savings | 17,724 | 12,518 | 30,242 | - | 4,245 | 85,485 | 89,730 | - |
| Documentation Adj. | -417 | -2 | -420 | -1.4% | 0 | -1,768 | -1,768 | -2.0% |
| Technology Adj. | 248 | 0 | 248 | 0.8% | 0 | -2,485 | -2,485 | -2.8% |
| Quantity Adj. | -383 | -642 | -1,025 | -3.4% | 0 | 0 | 0 | 0.0% |
| Operational Adj. | -108 | 490 | 382 | 1.3% | 87 | -3,545 | -3,457 | -4.0% |
| HVAC Interactive Adj. | 556 | 251 | 807 | 2.7% | 0 | 0 | 0 | 0.0% |
| Adjusted Gross Savings | 17,620 | 12,615 | 30,235 | 100.0% | 4,332 | 77,687 | 82,020 | 91.4% |
| Gross Realization Rate | 99.4% | 100.8% | 100.0% | - | 102.1% | 90.9% | 91.4% | - |
| Relative Precision | ±5.8% | ±9.1% | ±5.0% | - | ±8.6% | ±3.3% | ±3.2% | - |
| Confidence Interval | 80% | 80% | 80% | - | 80% | 80% | 80% | - |
| Error Ratio | 0.26 | 0.31 | 0.28 | - | 0.16 | 0.25 | 0.24 | - |

## 4.2 Connected and Peak Demand Savings for the State, by Program, and by Program Track

Figure 5 is a scatter plot of evaluation connected demand savings versus those from the tracking savings by program. Most plotted points are very close to the reference line, which indicates that most of the evaluation savings are very close to the tracking estimates. This is particularly true for the retrofit program which has a realization rate of 103.9%.

The high connected demand realization rates for the new construction (172.2%) and RFP (158.6%) programs are due to the results from a few large sites. The new construction program result is primarily influenced by one very large custom site which had zero connected kW savings in the tracking system while nearly 1,800 connected kW savings based on the evaluation site visit. Removing this site from the analysis would result in a connected demand realization rate of 94.4% (±26.0% at 80% CI) for the new construction program.

The RFP program result is largely driven by two sites which had evaluation connected demand savings that nearly doubled the tracking system estimates. In both of these cases, the increase in connected demand savings was calculated using the documentation in the project file and verified during the on-site visit. Removing these sites from the analysis would result in a connected demand realization rate of 114.2% (±0.0% at 80% CI) for the RFP program.

[4] This total exceeds the total from the previous table due to sites which received both custom and prescriptive measures.

**Figure 5: Scatter Plot of Connected kW Savings by Program**

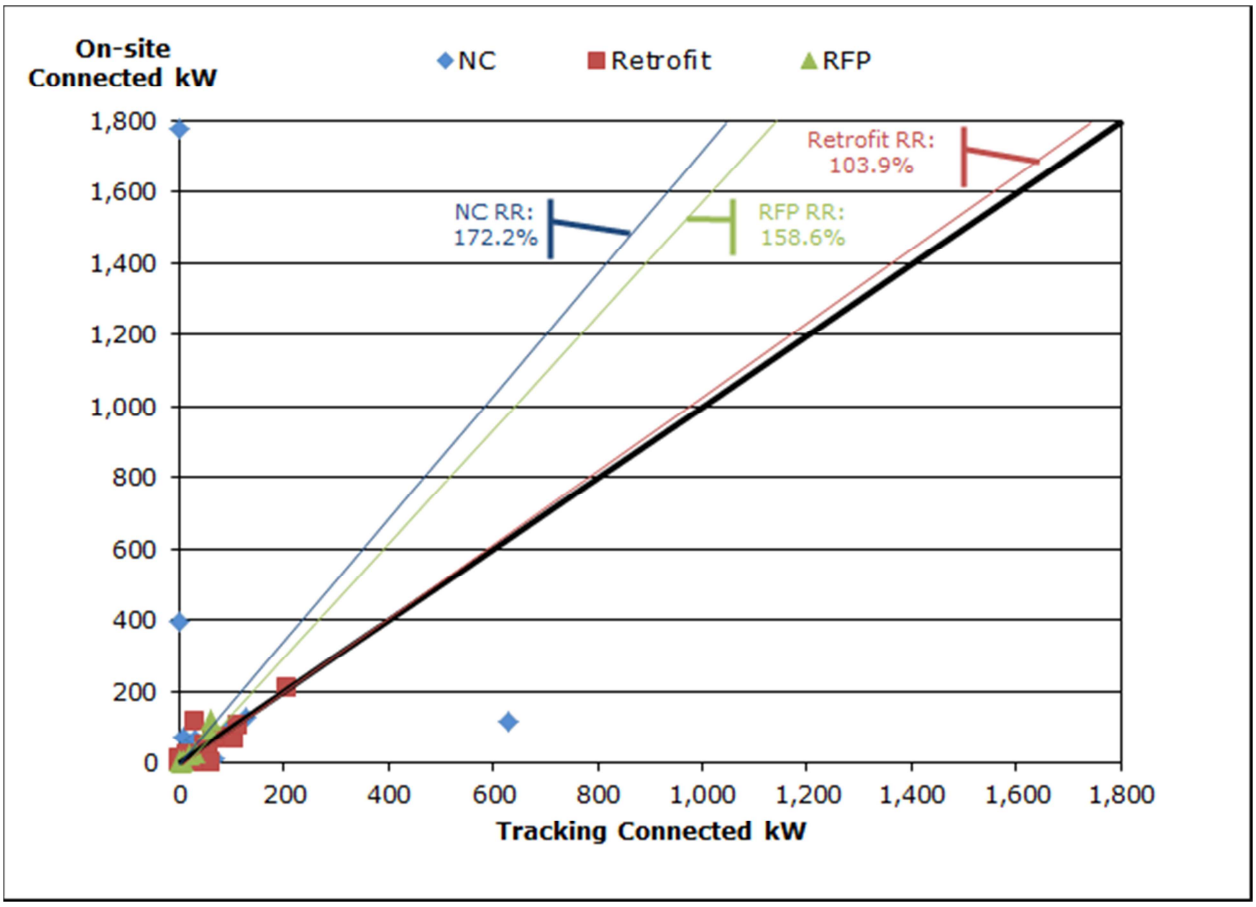



Figure 6 presents a scatter plot of evaluation ISO-NE summer on-peak[5] demand savings versus those from the tracking savings by program.

The low summer on-peak demand realization rate for the new construction program is primarily driven by the results from two large lighting sites. The decrease in savings at one of the sites was actually driven by a large difference in the connected demand savings. The tracking and evaluation summer on-peak coincidence factor is 85% for this site, but the tracking system connected demand savings was 70.2 kW as compared to the 13.8 kW that was found in the project documentation and confirmed during the site visit. At the other site, the tracking system assumed a summer on-peak coincidence factor of 85% but the evaluation site visit revealed that the installed fixtures only operated 12% of the time during the summer peak. Removing these two sites from the analysis would result in a summer on-peak demand realization rate of 90.2% (±22.8% at 80% CI) for the new construction program.

Conversely, the high summer on-peak demand realization rate for the RFP program is driven by one large custom site for which the tracking system assumes a 100% summer on-peak coincidence factor and a connected demand savings estimate of 59.8 kW. The documentation revealed (and the on-site visit confirmed) that the connected demand was actually 120.4 kW and the on-site monitoring found the

[5] Non-holiday weekdays between 1pm-5pm during June-August.

summer on-peak coincidence factor to be 80%, which is an increase of 160% over the tracking assumption. Removing this site from the analysis would result in a summer on-peak demand realization rate of 96.7% (±0.0% at 80% CI) for the RFP program.

The 76.6% summer on-peak demand realization rate for the retrofit program is driven by decreases in the monitored coincidence factors found at two large prescriptive lighting sites as compared to their tracking system assumptions, as well as the removal of the process measures installed at another site. Removal of these three sites would result in a realization rate of 97.0% (±17.4% at 80% CI).

**Figure 6: Scatter Plot of Summer On-Peak kW Savings by Program**

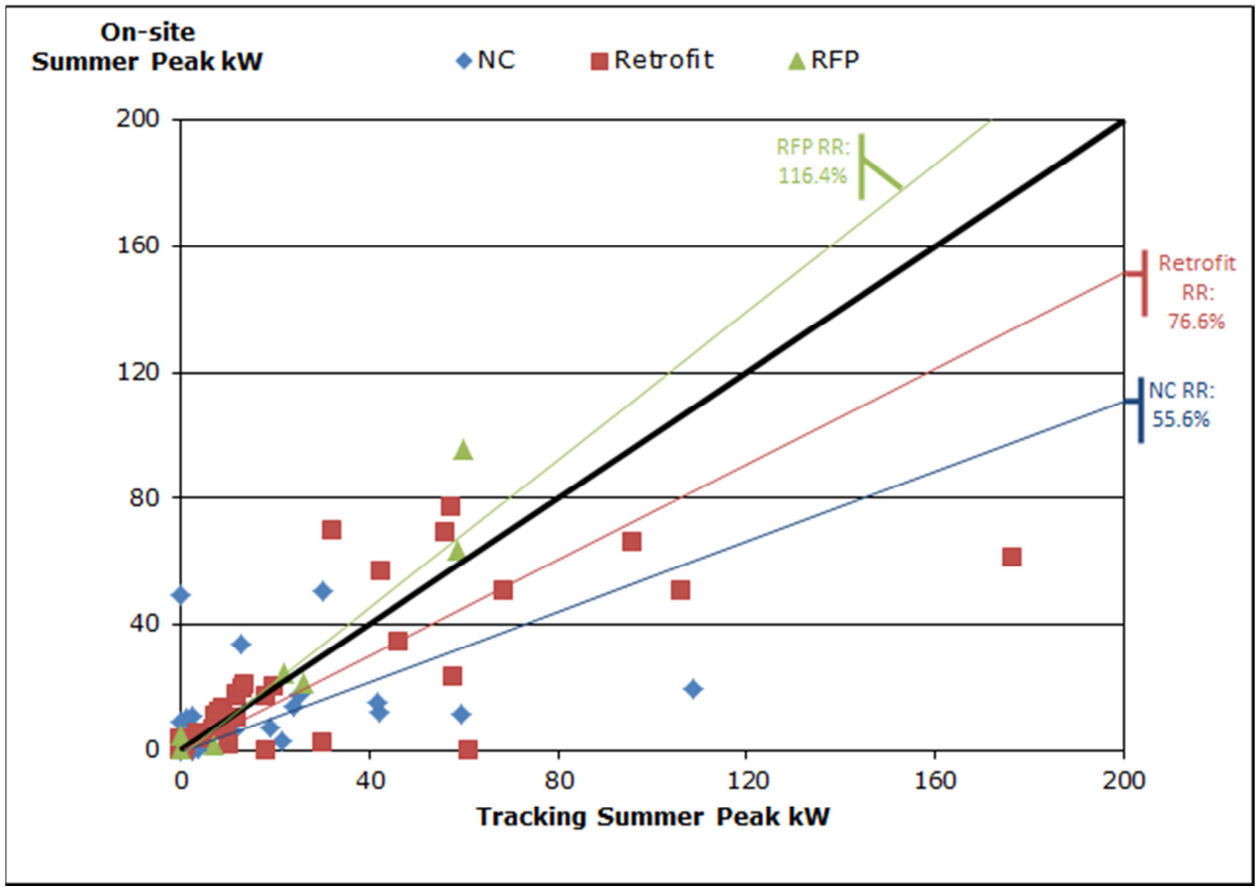


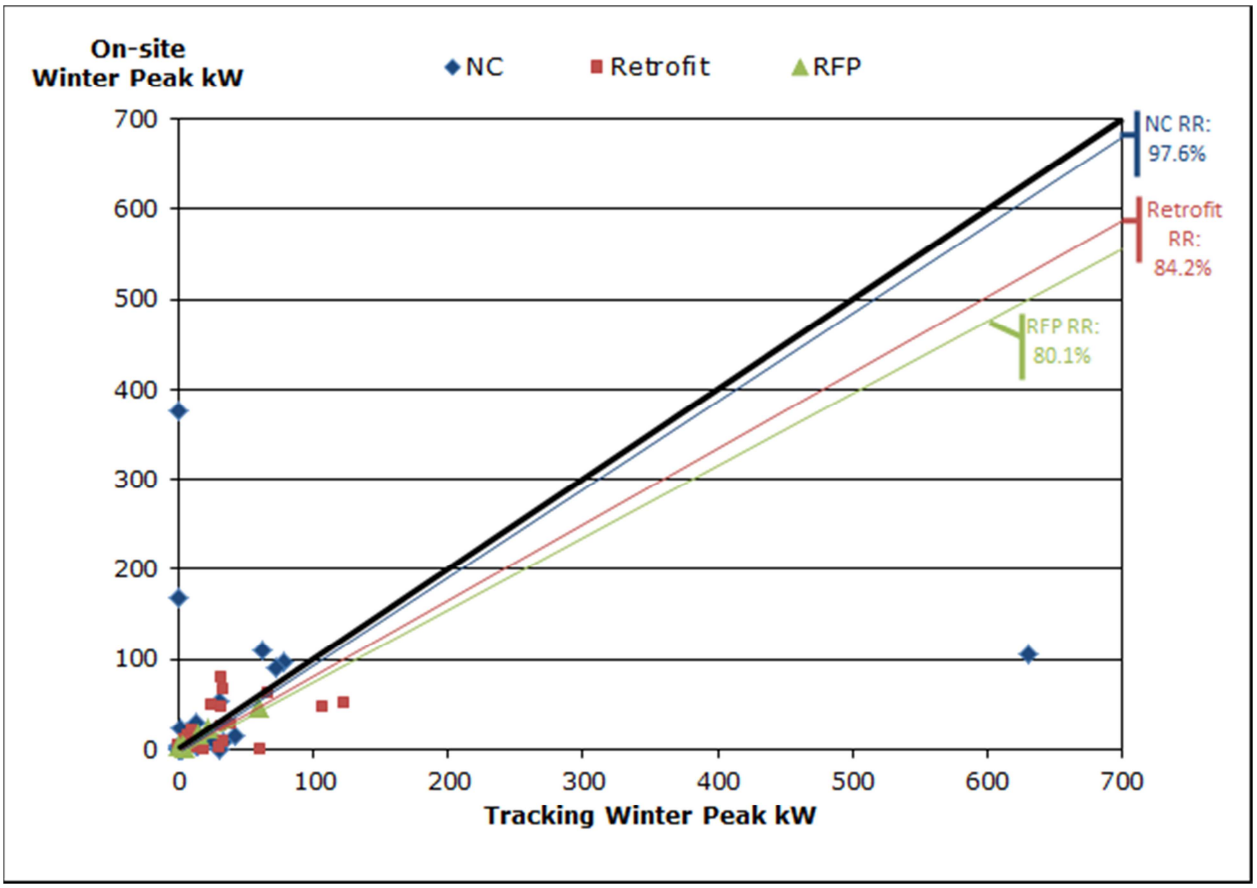

Figure 7 shows the scatter plot of evaluation ISO-NE winter on-peak[6] demand savings versus those from the tracking savings by program.

The 80.1% winter on-peak demand realization rate for the RFP program is driven by decreases in the monitored winter coincidence factors found at all four of the RFP program sites as compared to their tracking system assumptions.

[6] Non-holiday weekdays between 5pm-7pm during December-January.

The 84.2% winter on-peak demand realization rate for the retrofit program is driven by decreases in the monitored coincidence factors for the prescriptive lighting and process measures for the largest retrofit site in the sample. Removing this site from the analysis would result in a winter on-peak demand realization rate of 97.3% (±12.7% at 80% CI) for the retrofit program.

**Figure 7: Scatter Plot of Winter Peak kW Savings by Program**




The next two tables summarize the demand and energy savings factor results by program, fuel, and program track. The connected kW realization rate is the ratio between the evaluation connected kW savings and the tracking system connected kW savings. The coincidence factors are calculated as the proportion of time that program measures are in use during each respective peak period. Table 17 presents these results by program and fuel.

The connected demand realization rate for each program is over 100% and 129.9% overall. The overall summer on-peak demand realization rate is 73.0%; with program-level results that range from 55.6% for new construction to 116.4% for the RFP Program. The winter on-peak demand realization rates are a little more stable with program-level results that range from 80.1% to 97.6% for an overall winter rate of 89.4%. The overall summer on-peak coincidence factor is 52.3%, while the overall winter on-peak coincidence

factor is 68.8%. The program-level percent on-peak kWh results are relatively stable with an overall average of 55.2%.

**Table 17: Summary of Savings Factors by Program**

| Savings Factors, Realization Rates | New Construction (n=17) | Retrofit (n=21) | RFP (n=4) | All Electric (n=42) |
|---|---|---|---|---|
| kW Factors | | | | |
| Connected kW Realization Rate | 172.2% (±47.3%) | 103.9% (±10.5%) | 158.6% (±0.0%) | 129.9% (±21.8%) |
| Summer Coincidence Factor | 31.9% (±45.1%) | 67.3% (16.9%) | 73.4% (±0.0%) | 52.3% (±20.9%) |
| Winter Coincidence Factor | 56.7% (±17.8%) | 81.0% (±22.5%) | 50.5% (0.0%) | 68.8% (±14.7%) |
| Summer kW Interactive Factor | 101.2% (±2.9%) | 109.6% (±3.1%) | 100.0% (±0.0%) | 107.6% (2.5%) |
| Winter kW Interactive Factor | 100.0% (±0.0%) | 100.0% (±0.0%) | 100.0% (±0.0%) | 100.0% (±0.0%) |
| Summer kW Realization Rate | 55.6% (±65.4%) | 76.6% (±20.1%) | 116.4% (±0.0%) | 73.0% (±19.8%) |
| Winter kW Realization Rate | 97.6% (±50.5%) | 84.2% (±24.8%) | 80.1% (±0.0%) | 89.4% (±22.5%) |
| kWh Factor | | | | |
| % On-Peak kWh | 47.0% (±7.1%) | 59.6% (±5.7%) | 48.5% (±0.0) | 55.2% (±4.5%) |

Note: The precisions at the 80% confidence interval are provided in parentheses next to each result.

Table 18 provides the same results by program track and indicates that the custom measure results may be skewing some of the program-level results presented above.

**Table 18: Summary of kW Savings Factors by Program Track**

| Savings Factors, Realization Rates | Prescriptive (n=28) | Custom (n=17) | All Electric (n=45[7]) |
|---|---|---|---|
| kW Factors | | | |
| Connected kW Realization Rate | 92.1% (±13.6%) | 385.7% (±54.2%) | 129.9% (±21.8%) |
| Summer Coincidence Factor | 74.7% (±13.6%) | 15.8% (±53.6%) | 52.3% (±20.9%) |
| Winter Coincidence Factor | 76.1% (±18.2%) | 51.2% (±22.5%) | 68.8% (±14.7%) |
| Summer kW Interactive Factor | 107.3% (±2.7%) | 109.6% (±3.8%) | 107.6% (2.5%) |
| Winter kW Interactive Factor | 100.0% (±0.0%) | 100.0% (±0.0%) | 100.0% (±0.0%) |
| Summer kW Realization Rate | 73.8% (±21.9%) | 66.9% (±76.3%) | 73.0% (±19.8%) |
| Winter kW Realization Rate | 44.2% (±22.7%) | 197.6% (±58.7%) | 89.4% (±22.5%) |
| kWh Factor | | | |
| % On-Peak kWh | 58.8% (±5.0%) | 43.5% (±6.5%) | 55.2% (±4.5%) |

Note: The precisions at the 80% confidence interval are provided in parentheses next to each result.

## 4.3 On-Peak and Off Peak kWh Results

Table 19 presents the on-peak and off peak kWh results according to the end use categories currently used by the sponsors. Summer is defined as June through September and winter is considered to be all other months. On-peak hours are defined as Monday through Friday 7am-11pm and off peak hours are all other

[7] This total exceeds the total from the previous table due to sites which received both custom and prescriptive measures.

hours.  The table shows the current program assumption, evaluation result weighted by connected kW and case-weighted to represent the population, the quantity of monitored sites the evaluation value is based on (sample size), and the precision at the 80% confidence interval.  Results that fall outside the range of our precision estimate when compared to their program assumption counterpart and have a sample size of at least nine are marked with an asterisk.

**Table 19: On-Peak and Off Peak kWh Results by End Use**

| End Use | Current Program Assumption | Sample Size | Weighted Evaluation Result | Precision at 80% CI |
|---|---|---|---|---|
| **Winter Peak Energy (Weekdays, Oct-May, 7am-11pm)** | | | | |
| CI Lighting | 37% | 23 | 41.4%* | ±3.2% |
| CI Lighting OS | 37% | 14 | 42.7%* | ±3.7% |
| CI Lighting LED | 37% | 9 | 42.6%* | ±4.9% |
| CI Process | 15% | 17 | 33.0%* | ±5.5% |
| CI Cooling | 0% | 8 | 6.8% | ±35.0% |
| CI Parking Lot Lights | 31% | 5 | 21.7% | ±0.6% |
| CI Heating | 30% | 3 | 44.4% | ±4.3% |
| **Winter Off Peak Energy (All Other Hours, Oct-May)** | | | | |
| CI Lighting | 29% | 23 | 25.4% | ±4.8% |
| CI Lighting OS | 29% | 14 | 24.9% | ±5.7% |
| CI Lighting LED | 29% | 9 | 24.2% | ±8.9% |
| CI Process | 35% | 17 | 35.8% | ±4.9% |
| CI Cooling | 0% | 8 | 7.0% | ±35.9% |
| CI Parking Lot Lights | 41% | 5 | 50.3% | ±2.1% |
| CI Heating | 70% | 3 | 55.6% | ±3.4% |
| **Summer Peak Energy (Weekdays, Jun-Sept, 7am-11pm)** | | | | |
| CI Lighting | 19% | 23 | 20.6% | ±3.0% |
| CI Lighting OS | 19% | 14 | 20.1% | ±3.5% |
| CI Lighting LED | 19% | 9 | 21.2% | ±5.2% |
| CI Process | 24% | 17 | 15.6% | ±4.9% |
| CI Cooling | 48% | 8 | 40.4% | ±7.6% |
| CI Parking Lot Lights | 10% | 5 | 6.2% | ±7.1% |
| CI Heating | 0% | 3 | 0.0% | - |
| **Summer Off Peak Energy (All Other Hours, Jun-Sept)** | | | | |
| CI Lighting | 15% | 23 | 12.6% | ±5.1% |
| CI Lighting OS | 15% | 14 | 12.3% | ±6.0% |
| CI Lighting LED | 15% | 9 | 12.0% | ±8.4% |
| CI Process | 26% | 17 | 15.6% | ±15.5% |
| CI Cooling | 52% | 8 | 45.8% | ±8.9% |
| CI Parking Lot Lights | 17% | 5 | 21.8% | ±2.2% |
| CI Heating | 0% | 3 | 0.0% | - |

***These results fall outside of the range of our precision estimates.**

Table 20 provides similar results for on-peak coincidence factors. For the summer on-peak coincidence factors, the evaluation lighting, occupancy sensor, and process results were found to be statistically different from the current program assumptions. For winter on-peak coincidence factors, the LED lighting and process results were found to be outside the range of our precision estimate.

**Table 20: Coincidence Factor Results by End Use**

| Load Shape | Current Program Assumption | Sample Size | Weighted Evaluation Result | Precision at 80% CI |
|---|---|---|---|---|
| **Summer Demand Coincidence Factors (Weekday, Non-Holidays, Jun-Aug, 1pm-5pm)** | | | | |
| CI Lighting | 85% | 23 | 60.2%* | ±8.0% |
| CI Lighting OS | 15% | 14 | 40.3%* | ±11.5% |
| CI Lighting LED | 85% | 9 | 82.7% | ±10.1% |
| CI Process | 100% | 16 | 73.8%* | ±6.8% |
| CI Cooling | 34% | 8 | 44.4% | ±23.0% |
| CI Parking Lot Lights | 0% | 5 | 0.0% | - |
| CI Heating | 0% | 3 | 0.0% | - |
| **Winter Demand Coincidence Factors (Weekday, Non-Holidays, Dec-Jan, 5pm-7pm)** | | | | |
| CI Lighting | 48% | 23 | 46.4% | ±11.3% |
| CI Lighting OS | 14% | 14 | 26.1% | ±18.4% |
| CI Lighting LED | 48% | 9 | 84.3%* | ±11.7% |
| CI Process | 100% | 16 | 57.9%* | ±15.3% |
| CI Cooling | 0% | 8 | 0.0% | - |
| CI Parking Lot Lights | 80% | 5 | 100.0% | - |
| CI Heating | 100% | 3 | 60.8% | 27.7% |

*These results fall outside of the range of our precision estimates.

Appendix D presents similar end use-level results as they relate to the Forward Capacity Auction (FCA) that the sponsors participate in through ISO-New England.

## 4.4 Participant Survey Results

As mentioned above, a customer feedback survey was performed with customers on site to assess participant perceptions of and satisfaction with the services related to the Large C&I Programs. The instrument used can be found in Appendix A. Three customers refused the survey. At two other sites, the only person who was familiar with the program and the measures that were installed was no longer with the company. The results of the sixty-three completed interviews summarized below. Whenever possible, the results are compared to those from the most recent Large C&I evaluation completed in New Hampshire, which was completed in 2006.

**Program Satisfaction**

Table 21 shows how customers responded when asked if they are satisfied with the performance of the improvements that they received through the programs. All but one customer responded positively, which is very similar to the responses given during the 2006 evaluation. The one respondent who is not satisfied reported that the lamps and ballasts that his company received through the program "burn out all the time and are expensive to replace."

**Table 21: Satisfaction with Energy Efficiency Improvements**

| Are you satisfied with the performance of the energy efficiency improvements received through the Programs? | 2006 Evaluation (n=47) | Current Evaluation (n=63) |
|---|---|---|
| Yes | 100% | 98% |
| No | 0% | 2% |

Table 22 provides the average rating given when customers were asked to rate their impression of the programs and satisfaction with the programs on a scale of 1 (very negative) to 5 (very positive). The average ratings provided were both very positive and nearly identical to those provided during the 2006 evaluation.

**Table 22: Program Satisfaction Ratings**

| Average Rating on a Scale of 1 (Very Negative to 5 (Very Positive) | 2006 Evaluation (n=44) | Current Evaluation (n=63) |
|---|---|---|
| Impression of the Program | 4.6 | 4.6 |
| Satisfaction with the Program | 4.6 | 4.5 |

Table 23 shows customer suggestions for program improvement from the last two Large C&I Program evaluations performed in New Hampshire. Nearly 70% of the participants in the current evaluation did not have any suggestions on how to improve the program. The most common responses of those that did are similar to those from the 2006 evaluation; "provide larger rebates", "increase program awareness", "improve explanation of program offerings and services", and "provide certified installers".

The one relatively new common response (5 customers) provided in this evaluation that was not provided in 2006 was to "provide incentives for a larger selection of products." Two customers requested that "LEDs get added to the program offerings", two other customers requested an "expansion of the prescriptive offerings", and one customer wanted "more options with regards to lamps and ballasts".

**Table 23: Suggestions for Program Improvement**

| Suggestion | % of 2006 Evaluation Sample (n=46)* | % of Current Evaluation Sample (n=63)* |
|---|---|---|
| Provide Incentives for Larger Selection of Products | 0% | 8% |
| Make More Funds Available/Provide Larger Rebates | 20% | 6% |
| Increase Marketing, Awareness of Program | 20% | 5% |
| Provide Incentives Sooner | 0% | 3% |
| Improve Explanation of Program Services/Offerings | 7% | 2% |
| Certify Installers | 2% | 2% |
| Provide More Advanced Notice of Incentive Availability | 4% | 0% |
| Work More Closely With Large Energy Users | 4% | 0% |
| Reduce Paperwork | 4% | 0% |
| Simplify Program Requirements | 4% | 0% |
| Make Program Timing More Flexible | 4% | 0% |
| Provide Help With Problem Contractors | 4% | 0% |
| Perform More Energy Audits | 2% | 0% |
| Be More Involved in Project Design Phase | 2% | 0% |
| Add Prescriptive Rebates | 2% | 0% |
| Partner With Vendors | 2% | 0% |

* Multiple responses allowed.

**Participation and Expectations**

Table 24 shows that participants most often reported hearing of the Large C&I Programs through utility account representatives. The large majority of respondents (94%) felt that hearing about the programs through their account representative was the best way for them to learn about the programs. Nearly three in ten participants reported becoming aware of the program through word-of-mouth in the form of co-workers and referrals. We regard this as a healthy sign that the program is relatively successful in the market.

**Table 24: How Participants Heard of the Large C&I Programs**

| Method of Awareness (n=63) | % of Respondents* |
|---|---|
| Utility Account Rep | 67% |
| From A Co-Worker | 19% |
| Referral from Another Company | 10% |
| Utility Mailing | 10% |
| Utility Website | 6% |
| The Internet | 3% |
| Radio Ads | 2% |
| Newspaper Ads | 2% |

* Multiple responses allowed.

Table 25 shows that most participants decided to get involved in the program in order to save money or energy or to reduce maintenance costs. Other reasons provided by respondents include: "to reduce their carbon footprint", "to adjust to the new industry standard", and "to increase the longevity of their energy consuming equipment".

**Table 25: Why Participants Decided to Participate in the Large C&I Programs**

| Reason for Participation (n=63) | % of Respondents* |
|---|---|
| To Reduce Energy Bills/Save Money | 68% |
| The Program Incentives | 51% |
| To Improve Efficiency/Save Energy | 44% |
| To Reduce Initial Purchase Costs | 32% |
| To Reduce Maintenance Costs | 17% |
| Needed to Replace Non-Working Equipment | 3% |
| Technical Assistance | 2% |
| Took Advice of Installer/Designer/Contractor/Utility Rep | 2% |
| Due to Past Participation | 2% |

* Multiple responses allowed.

Nearly all respondents (98%) felt that the Large C&I Programs have been worth the effort they had to expend to participate. The large majority (89%) reported that they are "Very Likely" to participate again in the future.

**Ease of Participation**

Survey respondents were asked to estimate the length of program participation from the point at which the application was submitted to when the measures were installed. Responses ranged from four days to two years; with an average of 16 weeks or four months.

Table 26 provides the ratings provided by respondents on various aspects of program participation on a scale of one to five. Respondents provided very positive ratings with all aspects having an average rating of 4.2 or higher.

**Table 26: Ratings of Various Aspects of Program Participation**

| Aspect of Participation (Scale) | Average Rating |
|---|---|
| Satisfaction with the time required to participate (1= very dissatisfied to 5=very satisfied) | 4.4 |
| How easy it was to understand the program (1=very difficult to 5=very easy) | 4.3 |
| Time required to participate in the program (1=a lot of time to 5=very little time) | 4.3 |
| Effort required to apply for program incentives (1=a lot of effort to 5=very little effort) | 4.2 |
| Completeness & accuracy of program marketing materials (1=very incomplete and inaccurate to 5=very complete and accurate) | 4.2 |

When asked to provide their opinions on the barriers which might cause a business such as theirs to choose not to participate in the Large C&I Programs, most responses revolved around a lack of money and time as shown in the bullets below. Interestingly, none of the respondents who reported a lack of money as a barrier made mention of the financing options that are offered to program participants.

- Lack of funding for improvements (35 respondents)
- None (10)
- Lack of program awareness (4)
- Return on investment has to be two years or lower (3)
- Lack of both money and time (3)
- Lack of a need for improvements (2)
- Lack of time (2)

**How Energy Is Used**

Table 27 provides the respondent-reported average proportion of total facility energy consumption by end use. Respondents estimated that 83% of their total energy use is spent on lighting, heating, cooling, and process equipment. The remainder is spent on motors, refrigeration, and other types of equipment. Most survey respondents (68%) did not know how much of their facility's operational costs were spent on energy but those that did provided an average proportion of 37%.

**Table 27: Percent of Total Energy Expended By End Use**

| End Use | Average % of Total Energy Expended |
|---|---|
| Lighting | 29% |
| Heating | 20% |
| Cooling | 18% |
| Process Equipment | 17% |
| Motors | 10% |
| Refrigeration | 5% |
| Other* | 2% |
| Total | 100% |

* Battery chargers, conveyors, vehicles, and cooking equipment.

**Other Energy Efficiency Opportunities**

Respondents were also asked if there were any other energy efficiency opportunities that exist in their facilities. Many customers (44%) reported that there were not any other opportunities in their facility. For those that did, the most frequent responses are shown in Table 28. The table also shows if each measure was recommended through the program, why it wasn't installed if it was recommended, and the level of interest the respondents have in installing it.

Lighting and HVAC measures received the most mentions. In most cases, measures offered through the program were recommended but not installed because "the payback was too long" or because such installations need "to be bid out" per company policy. Most respondents did not report a high level of interest in any of these measures and a fair number said that they would wait at least a year before pursuing any of them.

**Table 28: Other Energy Efficiency Opportunities**

| Opportunity | # of Respondents (n=35) | Were These Measures Recommended Through the Program? | | If Yes, why did you choose not to Install These Measures Through the Program? | Level of Interest | | |
|---|---|---|---|---|---|---|---|
| | | Yes | No | | High | Moderate | Will Wait At Least One Year |
| Lighting | 27 | 20 | 7 | -Cost too high/Payback was too long. (16 respondents)<br>-Has to be bid out. (2)<br>-Considering new technologies. (1)<br>-Retrofit needs to occur during off hours and there aren't many. (1) | 10 | 6 | 11 |
| HVAC | 21 | 18 | 3 | -Cost too high/Payback was too long. (13)<br>-Has to be bid out. (4)<br>-Retrofit needs to occur during off hours and there aren't many. (1) | 8 | 11 | 2 |
| Motors & VFDs | 10 | 10 | 0 | -Cost too high/Payback was too long. (7)<br>-Equipment we wanted wasn't incentivized. (2)<br>-Retrofit needs to occur during off hours and there aren't many. (1) | 4 | 3 | 3 |
| Non-Lighting Controls | 5 | 4 | 1 | -Cost too high/Payback was too long. (2)<br>-Equipment we wanted wasn't incentivized. (2) | 0 | 3 | 2 |
| Air Compressors | 3 | 2 | 1 | -Cost too high/Payback was too long. (3) | 2 | 1 | 0 |
| Lighting Controls | 3 | 1 | 0 | -Cost too high/Payback was too long. (3) | 2 | 1 | 0 |

## 4.5 Summary of Tracking Systems and Supporting Documentation

The tracking information and supporting documentation provided by the sponsors provided the basic information needed to support an evaluation. Customer information (contacts, addresses, phone numbers, etc.), energy and summer on-peak peak demand savings, and measure types were very well populated in each sponsor's tracking system. However, there were many inconsistencies between the various utility databases. Not all of the sponsor databases had completely populated winter on-peak and connected demand savings estimates. Some sponsors do not track on-peak kWh savings or measure quantities. Program data was not tracked at the measure level so measure locations (space types or room names) were not present. Sometimes this information could be found in the project file but this was not always the case.

Baseline assumptions and working spreadsheets and calculations were often not present in the project files, which made it difficult to confirm if the tracking savings were accurate. In these instances, it was necessary

to reverse engineer the tracking savings from a combination of site and tracking data but, even then, the savings could not always be replicated precisely. This lack of variable input detail makes it difficult to determine the exact reasons for any discrepancies that were found. This was particularly true for non-lighting measures.

Technical Resource Manuals (TRMs) from across the nation were referenced in the non-lighting savings documentation, which resulted in a wide range of savings for the same measure. The TRMs are often region specific and assumptions may not apply to New Hampshire weather or demographics. Preference should be given to regional TRMs first.

# 5 CONCLUSIONS AND RECOMMENDATIONS

This section summarizes the conclusions and recommendations of this study based on the results presented above. Overall, the programs appear to be very well liked and participants are satisfied with its services. Both the electric and gas energy savings results are favorable with very good realization rates. Poorer realization rates were found for peak demand savings estimates. As the energy and demand conclusions show, many of the discrepancies found revolve around tracking system errors and lack of supporting documentation. For this reason, the recommendations around these conclusions can be found in the tracking system and supporting documentation section below.

It is important to note that if the sponsors implement the recommendations made below, then they may not need to apply the realization rates that are reported.

## 5.1 Electric and Gas Energy Savings

**Energy Savings Conclusions**:

- Overall, the electric and gas energy savings results were very positive and suggest that the tracking savings estimates in the year evaluated is reasonable and accurate.
- The gross savings realization rates by program, fuel, and program track (prescriptive vs. custom) were all between 91% and 104%. In particular, we note that the prescriptive realization rates were very tight with a realization rate of 99% for electric prescriptive measures and 102% for gas prescriptive measures.
- Only minor discrepancies were found between tracking and the M&V site work, including minor adjustments in quantities found for electric measures and operational adjustments to gas measures.

## 5.2 Electric Demand Savings

**Connected Demand Savings Conclusions**:

- The high connected demand realization rate for the new construction program (172.2%) is driven primarily by one very large custom snow gun site which had zero connected kW savings in the tracking system while nearly 1,800 kW savings was calculated based on the site visit. Removing this site from the analysis would result in a realization rate of 94.4% (±26.0% at 80% CI).
- The 158.6% connected demand realization rate for the RFP Program is driven by two custom sites which had calculated evaluation savings that were nearly twice as high as their corresponding tracking system estimates. In both of these cases, the increase in connected demand savings was calculated using the

documentation in the project file and verified during the on-site visit. Removing these sites from the analysis would result in a realization rate of 114.2% (±0.0% at 80% CI).

**Summer On-Peak Demand Savings Conclusions:**

- The 55.6% summer on-peak demand realization rate for the new construction program is primarily driven by the results from two large lighting sites. The decrease in savings at one of the sites was actually driven by a large difference in the connected demand savings. The tracking and evaluation summer coincidence factor was 85% for this site, but the tracking system connected demand savings was 70.2 kW for this site as compared to the 13.8 kW that was found in the project documentation and confirmed during the site visit. At the other site, the tracking system assumed a summer coincidence factor of 85% but the evaluation site visit revealed that the installed fixtures only operated 12% of the time during the summer peak. Removing these two sites from the analysis would result in a summer on-peak demand realization rate of 90.2% (±22.8% at 80% CI).
- The 116.4% summer on-peak demand realization rate for the RFP program is driven by one large custom site for which the tracking system assumes a 100% summer coincidence factor and a connected demand savings estimate of 59.8 kW. The documentation revealed (and the on-site visit confirmed) that the connected demand was actually 120.4 kW and the on-site monitoring found the summer coincidence factor to be 80%, which is an increase of 160% over the tracking assumption. Removing this site from the analysis would result in a realization rate of 96.7% (±0.0% at 80% CI).
- The 76.6% summer on-peak demand realization rate for the retrofit program is driven by decreases in the monitored coincidence factors found at two large prescriptive lighting sites as compared to their tracking system assumptions, as well as the removal of the process measures installed at another site. Removal of these three sites would result in a realization rate of 97.0% (±17.4% at 80% CI).

**Winter Peak Demand Savings Conclusions:**

- The winter on-peak demand realization rate for the new construction program is very stable; with a 97.6% realization rate.
- The 80.1% winter on-peak demand realization rate for the RFP program is driven by decreases in the monitored winter coincidence factors found at all four of the RFP program sites as compared to their tracking system assumptions.
- The 84.2% winter on-peak demand realization rate for the retrofit program is driven primarily by decreases in the monitored coincidence factors for the prescriptive lighting and process measures for the largest retrofit site in the sample. Removing this site from the analysis would result in a realization rate of 97.3% (±12.7% at 80% CI).

## 5.3 On-Peak and Off Peak kWh and Coincidence Factors by End Use

**On-Peak and Off Peak kWh Conclusions by End Use**:

- Overall, the on-peak and off peak energy results are very comparable to the current program assumptions as only four winter peak energy results (C&I lighting, occupancy sensors, LEDs, and process) fall outside the range of their respective precision estimates when compared to the current

program assumptions for each. Three of these results (C&I lighting, occupancy sensors, and LEDs) are outside of the precision range by 2% or less. The process result falls outside of the precision range by 14%.

**On-Peak and Off Peak kWh Recommendations by End Use**:

- Due to the comparability of many of these results to the current program assumptions, we recommend that the sponsors only consider changing the assumptions related to process measures.
- While the C&I lighting, occupancy sensor, and LED results do fall outside of the precision range, it is by such a small margin that we do not recommend a change to the current assumptions for these measures at this time.

**On-Peak Coincidence Factor Conclusions by End Use**:

- The lighting, occupancy sensor, and process summer on-peak coincidence factors results all fell outside of the range of their respective precision estimates when compared to the current program assumptions for each.
- The LED lighting and process winter on-peak coincidence factor results fell outside out the range of their precision estimates as compared to the current program assumption.

**On-Peak Coincidence Factor Recommendations by End Use**:

- Based on the results of this study, we recommend that the sponsors consider changing their current summer on-peak coincidence factor assumptions for lighting, occupancy sensors, and process measures.
- We recommend that the sponsors consider changing their winter on-peak coincidence factor assumption for LED lighting and process measures to be consistent with the results of this study.
- These considerations should be informed by analysis of the applicability of the study findings to current and future program participant populations, in terms of the distribution of peak savings by building type and the overall accuracy (statistical precision and bias) of the corresponding coincident peak savings calculations.

## 5.4 Participant Survey Results

**Participant Survey Conclusions**:

- Nearly all (98%) of the participants in the sample reported that they were satisfied with the measures that they received through the program and felt that the programs were worth the effort that they had to expend to participate.
- The large majority (89%) of participants reported that they are "very likely" to participate in the programs again in the future.
- Participants were satisfied with the program process; giving average ratings of 4.2 or higher for all aspects of the program on a scale of 1(very dissatisfied) to 5 (very satisfied).
- Most participants that were surveyed reported being made aware of the programs through their account representatives and felt that this was the best way for them to learn about the programs.

- Participants reported that a "lack of funding for improvements" was the most common barrier for other businesses to get involved in the programs.
- Participants most commonly reported that "saving money" and "the program incentives" were the main reasons why they decided to participate in the program.
- The most common suggestions for program improvement provided by participants were similar to those from the 2006 evaluation; "provide larger rebates" and "increase program awareness/marketing".
- One common suggestion for improvement that was not mentioned in the 2006 study was to "provide incentives for a larger selection of products".

**Participant Survey Recommendations**:

- Due to the highly positive results of the participant survey, we recommend that the sponsors continue to make customers aware of the programs through the channels that are currently in place; particularly through account representatives.
- We recognize that the custom channel allows customers to bring current technologies that they are interested in to the program for incentive consideration. We recommend that the sponsors continue this opportunity for customers so they are aware of and can pursue the latest cutting-edge technologies with program assistance.

## 5.5 Tracking System and Supporting Documentation

**Tracking System and Supporting Documentation Conclusions**:

- The tracking information and supporting documentation provided by the sponsors provided the basic information needed to support an evaluation. Customer information (contacts, addresses, phone numbers, etc.), energy and summer on-peak demand savings, and measure types were very well populated in each sponsor's tracking system.
- There were many inconsistencies between the various utility databases.
    - Not all of the sponsor databases had completely populated winter and connected demand savings estimates.
    - Some sponsors do not track on-peak kWh savings or measure quantities.
    - Measure locations (space types or room names) were not present in the tracking system. Sometimes this information could be found in the project file but this was not always the case.
    - One sponsor tracked net savings while the others tracked gross savings.
- Baseline assumptions and working spreadsheets and calculations were not present in many of the project files, which made it difficult to confirm if the tracking savings were accurate. In these instances, it was necessary to reverse engineer the tracking savings from a combination of site and tracking data but, even then, the savings could not always be replicated precisely. This lack of variable input detail makes it difficult to determine the exact reasons for any discrepancies that were found. This was particularly true for non-lighting measures.

- On a couple of occasions Technical Resource Manuals (TRMs) from across the nation were referenced in the non-lighting savings documentation, which resulted in a wide range of savings for the same measure. The TRMs are often region specific and assumptions may not apply to New Hampshire weather or demographics.

**Tracking System and Supporting Documentation Recommendations**:

- We recommend that the sponsors' tracking systems contain all of the information needed to perform a thorough evaluation including:
  - Gross Annual kWh Savings
  - Summer kW Savings (connected load)
  - Winter kW Savings (connected load)
  - Measure quantities
  - Measure installation location
- We recommend that the sponsors consider claiming connected demand and winter on-peak demand savings for snow gun installations. As noted in the results section, if this measure had a connected demand tracking estimate, the realization rate would have been much closer to 100%. This is an example of where an adjustment to how tracking savings are calculated would make the tracking system more accurate and reduce tracking savings adjustments as part of the realization rate.
- We recommend that the sponsors consider adopting common savings algorithms and assumptions for all of the various measure installations that occur through the Large C&I Programs, similar to the common assumptions spreadsheet that Eversource provided for on-peak kWh and load shapes. If the sponsors decide to adopt algorithms and assumptions from another state, we recommend that preference be given to regional TRMs first. DNV GL understands that Liberty Utilities' data for this evaluation was in-transition and stored by National Grid. As a separate effort in reviewing Liberty Utilities tracking systems for ISO-NE Forward Capacity Market purposes, DNV GL found that the Liberty Utilities tracking system addresses these issues.
- We recommend that the sponsors consider requiring that the project files contain the assumptions and working spreadsheet calculations used to estimate the savings present in the tracking system. This would include measure quantities, baseline and installed efficiency assumptions, and operation assumptions such as hours of use and full load equivalent hours (FLEH).
- We recommend that the sponsors consider processes to improve the accuracy of the tracking data, such as a quarterly review. This process could include high-level reviews such as looking for instances where connected savings values are zero, where summer on-peak demand savings for exterior lighting fixtures exceed zero, and where weather dependent measures have zero demand savings during the peak during which they are expected to operate. For all sites with large energy savings, this review should also include verification that the physical calculation of the tracking savings is present in the project file.

# A. On-Site Customer Feedback Survey

**Introduction:** Hi, my name is _____ and I'm with DNV GL on behalf of <UTILITY> (customer should be expecting our visit, as recruitment occurred previously). <UTILITY> and the other electric and gas utilities in New Hampshire are conducting a study to verify the energy savings from energy efficiency improvements installed through their Large C&I Programs (Large Commercial and Industrial Retrofit Program, New Equipment and Construction Program, and Energy Rewards RFP Program). As we mentioned on the phone, we are an energy consulting firm that has been hired to collect on-site data and calculate energy savings for projects that received a rebate from <UTILITY>'s energy efficiency programs. During our visit we will visually inspect the improvements that were installed through the programs and will install metering devices that will monitor their usage for approximately four weeks. We would also like to ask you some questions about your involvement with the program. This should take about fifteen minutes of your time and your responses will be kept entirely confidential.

**PS. Program Satisfaction**

PS1. Are you satisfied with the performance of the improvements that you received through the Large C&I Programs? Why not?

a. Yes
b. No → [DESCRIBE WHY NOT S1b_des] _____
_____
c. Don't know
d. Refused

PS2. Is there anything else you think the Programs might have done that would have increased your satisfaction with the performance of those improvements?

a. Yes → [DESCRIBE S2a_des] _____
_____
b. No
c. Don't know
d. Refused

For the next two questions, when answering my questions, please consider all your organization's interactions with the program. That is, please consider interactions with the program regarding any energy efficiency improvement—whether implemented or not—as well as any other interactions with the program."

PS3. I'd like to know your overall impression of the Program, based on anything you may have seen or heard. On a scale of 1 to 5, where 5 means Very Positive and 1 means Very Negative, what is your overall impression of the Programs? Please give me a number between 1 and 5 to tell me your overall impression.

a. Rating _____
b. Don't Know
c. Refused

PS4. Using a scale of 1 to 5, where 1 means not at all satisfied and 5 means very satisfied, how satisfied is your organization with the Programs?

a. Rating _____
b. Don't Know
c. Refused

PS4_1. a. Why do you say that?

_____

_____

PS5. Do you have any suggestions on how <UTILITY> could improve the program or have any additional comments you would like to make about the programs?

_____

_____

**PE. Participation and Expectations**

PE1. I'm going to read you a list of ways that you might have heard about the Large C&I Programs. Please let me know if you heard of the program through any of the following sources. [READ CATEGORIES]

a. A mailing that you received from your utility
b. Referral from another company
c. Utility account rep referral
d. Radio ads
e. Newspaper ads
f. A utility-sponsored event (home show, community fair, etc.)
g. The Internet
h. Utility website
i. NHSaves.com website
j. (Other) [SPECIFY] _____
k. (Don't know)

PE2A. Which of the marketing materials you mentioned previously was most influential in your decision to participate in the Large C&I Program? Insert all listed options from PE1 – If only one mentioned in PE1 skip to PE2B

PE2B. What do you remember about the message that you received from this material?

_____

_____

_____

PE3. To you, would there have been a better way to learn about the programs?

a. No
b. Yes → How?

_____

PE4. Why did you decide to participate in the Large C&I Programs? [DO NOT READ, RECORD UP TO 3 RESPONSES]

a. To reduce maintenance costs
b. To reduce initial purchase costs
c. The program incentive(s)
d. The technical assistance offered
e. To reduce energy bills/save money
f. To improve efficiency/save energy
g. Took the advice of installer/designer/contractor/utility rep
h. Needed to replace non-working equipment
i. Because of past program participation
j. Other [SPECIFY] _____
k. Don't know

PE5. Based on your experience with participating in the Large C&I Programs, are there additional factors that might cause you to participate in the programs again in the future?

a. No

b. Yes → Which factors would motivate you to participate now? [DO NOT READ, RECORD UP TO 3 RESPONSES]

1. To reduce maintenance costs
2. To reduce initial purchase costs
3. The program incentive(s)
4. The technical assistance offered
5. To reduce energy bills/save money
6. To improve efficiency/save energy
7. Took the advice of installer/designer/contractor/utility rep
8. Needed to replace non-working equipment
9. Because of past program participation
10. Other [SPECIFY] _____

PE6. Have the Large C&I Programs been worth the effort you had to expend to participate?

a. No → Why not? _____

b. Yes

PE7. How likely are you to participate in a Large C&I Programs again in the future? [READ CATEGORIES]

a. Very Unlikely
b. Somewhat Unlikely
c. Somewhat Likely
d. Very Likely

**EP. Ease of Participation**

EP1. Approximately how long (in weeks or months) did it take to participate from the point at which you submitted the application to the point where the measures were installed? _____ Weeks / Months (circle one)

EP2. On a scale of 1 to 5, where 1 is "very dissatisfied" and 5 is "very satisfied", how satisfied are you with the time it took to participate? _____ (99=Don't Know)

EP3. On a scale of 1 to 5, where 1 is "very difficult" and 5 is "very easy", how would you rate the effort required of you to apply for Large C&I Program incentives? _____ (99=Don't Know)

EP4. What, if anything, could be done to make the application process easier?

_____

_____

_____

EP5. On a scale of 1 to 5, where 1 is "very slow" and 5 is "very quick", how would you rate the time required of you to participate in the Large C&I Programs? _____ (99=Don't Know)

EP6. On a scale of 1 to 5, where 1 is "very difficult" and 5 is "very easy", how easy was it to understand the Large C&I Programs? _____ (99=Don't Know)

EP7. On a scale of 1 to 5, where 1 is "very incomplete and inaccurate" and 5 is "very complete and accurate", how complete and accurate were the program marketing materials that you received? _____ (99=Don't Know)

EP8. In your opinion, what barriers exist that might cause a business such as yours to choose not to participate in the Large C&I Programs?

_____

_____

_____

**EU. How Energy is Used**

EU1. What percent of the energy used by your facility would you estimate is expended on each of the following end uses:

a. Lighting _____ %
b. Heating _____%
c. Cooling _____%
d. Motors _____ %
e. Process _____ % (i.e., compressed air equipment, machinery)
f. Refrigeration _____%
g. Other _____% Specify: _____
(Note: Sum of 'a.' through 'g.' above should equal 100%)

EU2. What percent of your facility's operational costs would you estimate are spent on energy? _____ %

**OO. Other Energy Efficiency Opportunities**

OO1. To your knowledge, are there other energy efficiency opportunities that currently exist in your building? While we are focusing on electric and gas-related opportunities, we'd also like to know about other types of opportunities that you might be interested in.

a. Yes → please describe these opportunities.
1. _____
2. _____
3. _____
4. _____
5. _____

b. No

OO2. Ask question OO2- OO3 for all measures mentioned in OO1.

| Was the [insert measure from OO1] recommended through the programs? | | [IF YES], Why did you choose not to install them through the programs? |
|---|---|---|
| 1. | Yes/No (circle one) | |
| 2. | Yes/No (circle one) | |
| 3. | Yes/No (circle one) | |
| 4. | Yes/No (circle one) | |
| 5. | Yes/No (circle one) | |

OO3. How interested are you in pursuing installing [insert measure from OO1] at this time?
1. High level or interest / Moderate interest / Will wait at least one year (circle one)
2. High level or interest / Moderate interest / Will wait at least one year (circle one)
3. High level or interest / Moderate interest / Will wait at least one year (circle one)
4. High level or interest / Moderate interest / Will wait at least one year (circle one)
5. High level or interest / Moderate interest / Will wait at least one year (circle one)

## B. Sampling Methodology

The equations used to estimate the required sample size based upon known data relationships are as follows and includes as inputs the Z constant (driven by the desired level of confidence, in this case 1.282 for 80%), the population size (N), the required sample size before adjusting for the size of the population ($n_0$), the error ratio (E) and the desired relative precision (R).

$$n_0 = \left(\frac{z \times E}{R}\right)^2 \qquad n_1 = \left(\frac{n_0}{1 + \frac{n_0}{N}}\right)$$

Using stratified ratio estimation we were able to select the most efficient sample using the information that is available about the population. Stratified ratio estimation estimates the ratio between the population total of y and the population total of x for any pair of variables x and y. Given a stratified sample of n customers for which both x and y are observed, we define the case weight of each customer i to be $w_i = N_h / n_h$ . Here $N_h$ is the number of customers in stratum h in the population and $n_h$ is the number of customers in stratum h in the sample. Then we calculate the stratified ratio estimator as

$$b = \frac{\sum_{i=1}^{n} w_i \, y_i}{\sum_{i=1}^{n} w_i \, x_i}$$

The standard error for the stratified ratio estimator *b* is calculated in two steps:

1. Calculate the residual $e_i = y_i - b x_i$ for each sample customer,
2. Calculate the standard error $se(b) = \frac{1}{\hat{X}} \sqrt{\sum_{i=1}^{n} w_i (w_i - 1) e_i^2}$ where $\hat{X} = \sum_{i=1}^{n} w_i \, x_i$ .

If we know the true population mean of *x*, denoted $\mu_x$ , the ratio estimator for the population mean of *y* is given by the equations:

$$\hat{\mu}_y = b \, \mu_x$$

Similarly, if we know the true population total of x, denoted $X$ , the ratio estimator for the population total of y is given by the equations:

$$\hat{Y} = b \, X$$

The standard error for the mean and population total are calculated using the following equations:

$$se\left(\hat{\mu}_y\right) = se(b)\mu_x$$

$$se\left(\hat{Y}\right) = se(b)\,X$$

Here $se(b)$ is the standard error of the stratified ratio estimator defined above. In each case, the error bound at the 80% level of confidence is calculated by multiplying the appropriate standard error by 1.282. The 80% confidence interval is the estimate plus or minus the standard error.

## C. Site Level Results

**Table 29: Electric Sample Tracking System Savings Estimates**

| DNVGL ID | Program | End Use | Measure | Program Track | Facility Type | Annual kWh | On-Peak % Annual kWh | Connected kW | Summer kW Coincidence Factor | Winter kW Coincidence Factor | Average Hours of Use |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LC10000006 | New Construction | Lighting | Systems | Prescriptive | Medical (Hospital) | 36,388 | N/A | 4.19 | 72% | 0% | 8,678 |
| LC10000006 | New Construction | Lighting | Controls | Prescriptive | Medical (Hospital) | 2,805 | N/A | 1.54 | 28% | 0% | 1,760 |
| LC10000006 | New Construction | HVAC | Chillers | Prescriptive | Medical (Hospital) | 54,793 | N/A | N/A | N/A | N/A | 3,500 |
| LC10000006 | New Construction | Motors | VFDs | Prescriptive | Medical (Hospital) | 73,028 | N/A | N/A | N/A | N/A | 7,576 |
| LC10000010 | Retrofit | Lighting | Systems | Prescriptive | Retail | 345,321 | N/A | 67.69 | 80% | 65% | 5,102 |
| LC10000016 | Retrofit | Lighting | Systems | Prescriptive | University/College | 330,243 | N/A | 80.56 | 99% | 0% | 4,099 |
| LC10000016 | Retrofit | Lighting | Controls | Prescriptive | University/College | 1,140 | N/A | 0.48 | 1% | 0% | 2,400 |
| LC10000016 | Retrofit | Motors | VFDs | Prescriptive | University/College | 346,953 | N/A | N/A | N/A | N/A | 2,926 |
| NC10000004 | Retrofit | Lighting | Systems | Prescriptive | Grocery | 72,200 | N/A | 10.61 | 100% | 100% | 6,805 |
| NC10000016 | Retrofit | Lighting | Systems | Prescriptive | Other | 1,080 | N/A | 0.72 | 100% | 100% | 1,092 |
| NC10000018 | Retrofit | Lighting | Systems | Prescriptive | Restaurant | 53,971 | N/A | 11.74 | 98% | 98% | 4,597 |
| NC10000018 | Retrofit | Lighting | Controls | Prescriptive | Restaurant | 1,349 | N/A | 0.29 | 2% | 2% | 4,588 |
| PC10000002 | RFP | Lighting | Systems | Custom | Manufacturing | 25,434 | 48% | 4.09 | 100% | 100% | 6,219 |
| PC10000009 | New Construction | Lighting | Systems | Custom | Exterior | 428,758 | 35% | 97.89 | 100% | 100% | 4,380 |
| PC10000014 | New Construction | Lighting | Systems | Prescriptive | Retail | 232,914 | 65% | 49.60 | 100% | 100% | 4,696 |
| PC10000018 | Retrofit | Lighting | Systems | Prescriptive | Other | 186,702 | 37% | 23.50 | 84% | 84% | 7,945 |
| PC10000018 | Retrofit | Lighting | Controls | Prescriptive | Other | 18,808 | 37% | 0.00 | 16% | 16% | 5,624 |
| PC10000023 | Retrofit | Lighting | Systems | Custom | Grocery | 56,990 | 50% | 8.68 | 100% | 100% | 6,566 |
| PC10000023 | Retrofit | Lighting | Systems | Prescriptive | Grocery | 90,570 | 40% | 13.82 | 100% | 100% | 6,554 |
| PC10000025 | Retrofit | Lighting | Systems | Prescriptive | Manufacturing | 265,216 | 86% | 65.84 | 92% | 92% | 4,028 |
| PC10000025 | Retrofit | Lighting | Controls | Prescriptive | Manufacturing | 12,240 | 65% | 0.00 | 8% | 8% | 2,000 |
| PC10000028 | New Construction | HVAC | VAVs | Prescriptive | Manufacturing | 8,728 | 100% | 6.30 | 100% | 0% | Unknown |
| PC10000028 | New Construction | Lighting | Systems | Prescriptive | Office | 126,487 | 80% | 29.56 | 92% | 92% | 4,278 |
| PC10000028 | New Construction | Lighting | Controls | Prescriptive | Office | 4,665 | 80% | 2.44 | 8% | 8% | 1,835 |
| PC10000030 | New Construction | Lighting | Systems | Prescriptive | School | 143 | 65% | 0.07 | 100% | 100% | 2,200 |
| PC10000030 | Retrofit | Lighting | Systems | Prescriptive | School | 130,545 | 65% | 68.00 | 45% | 90% | 1,920 |
| PC10000030 | Retrofit | Lighting | Controls | Prescriptive | School | 9,605 | 65% | 0.00 | 5% | 10% | 1,217 |

| DNVGL ID | Program | End Use | Measure | Program Track | Facility Type | Annual kWh | On-Peak % Annual kWh | Connected kW | Summer kW Coincidence Factor | Winter kW Coincidence Factor | Average Hours of Use |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PC10000034 | New Construction | Lighting | Systems | Custom | Exterior | 392,974 | 35% | 89.72 | 100% | 100% | 4,380 |
| PC10000046 | New Construction | HVAC | RTUs | Prescriptive | Manufacturing | 1,485 | 69% | 1.80 | 100% | 22% | Unknown |
| PC10000073 | New Construction | Lighting | Systems | Prescriptive | University/College | 23,840 | 65% | 70.20 | 44% | 44% | 340 |
| PC10000073 | New Construction | Lighting | Controls | Prescriptive | University/College | 7,480 | 35% | 0.00 | 56% | 56% | 646 |
| PC10000073 | New Construction | HVAC | VRV | Prescriptive | University/College | 691,990 | 35% | 630.00 | 16% | 100% | 1,098 |
| PC10000073 | Retrofit | Lighting | Systems | Prescriptive | University/College | 11,630 | 35% | 1.30 | 100% | 100% | 8,946 |
| PC10000075 | New Construction | Custom | Snow Guns | Custom | Other | 408,385 | 35% | N/A | 0% | 0% | Unknown |
| PC10000089 | New Construction | Lighting | Systems | Custom | Office | 447,895 | 65% | 128.00 | 100% | 100% | 3,499 |
| PC10000098 | Retrofit | Lighting | Systems | Prescriptive | Office | 66,986 | 86% | 21.50 | 100% | 100% | 3,116 |
| PC10000106 | Retrofit | Lighting | Systems | Prescriptive | Retail | 63,945 | 65% | 14.20 | 100% | 100% | 4,503 |
| PC10000108 | New Construction | Lighting | Systems | Prescriptive | School | 89,864 | 100% | 28.10 | 10% | 21% | 3,198 |
| PC10000108 | New Construction | Lighting | Controls | Prescriptive | School | 22,466 | 100% | 7.00 | 3% | 5% | 212 |
| PC10000108 | New Construction | HVAC | VRV Systems | Custom | School | 55,529 | 83% | 14.00 | 100% | 100% | 3,966 |
| PC10000118 | RFP | Lighting | Systems | Custom | Manufacturing | 190,882 | 37% | 30.55 | 100% | 100% | 6,248 |
| PC10000118 | RFP | Process | Comp Air | Custom | Manufacturing | 125,137 | 65% | 21.68 | 100% | 100% | 5,772 |
| PC10000124 | New Construction | HVAC | VFDs | Prescriptive | Grocery | 18,150 | 50% | 2.40 | 100% | 100% | 7,563 |
| PC10000124 | New Construction | HVAC | Economizers | Prescriptive | Grocery | 18,135 | 40% | 10.50 | 100% | 50% | 1,727 |
| PC10000124 | New Construction | Custom | EMS | Custom | Grocery | 109,825 | 35% | 30.65 | 100% | 100% | 3,583 |
| PC10000124 | New Construction | Custom | Motors | Prescriptive | Grocery | 353,215 | 35% | 41.85 | 100% | 100% | 8,440 |
| PC10000127 | Retrofit | Lighting | Controls | Prescriptive | Manufacturing | 14,040 | 37% | 0.00 | 0% | 0% | 2,000 |
| PC10000127 | Retrofit | Motors | VFDs | Prescriptive | Manufacturing | 61,543 | 54% | N/A | N/A | N/A | 5,558 |
| PC10000138 | New Construction | Process | Pumps | Custom | Manufacturing | 317,172 | 37% | 30.00 | 100% | 100% | 4,660 |
| PC10000146 | New Construction | Process | Comp Air | Prescriptive | Manufacturing | 3,601 | 70% | 0.80 | 100% | 100% | 8,760 |
| PC10000147 | RFP | Lighting | Systems | Custom | Manufacturing | 58,130 | 37% | 8.00 | 51% | 51% | 7,266 |
| PC10000147 | RFP | Lighting | Controls | Custom | Manufacturing | 7,148 | 37% | 0.00 | 0% | 0% | 1,110 |
| PC10000147 | RFP | Custom | Water Treatment & Pumps | Custom | Manufacturing | 517,084 | 37% | 59.80 | 100% | 100% | 8,647 |
| PC10000175 | Retrofit | Lighting | Systems | Prescriptive | Retail | 224,604 | 65% | 49.90 | 100% | 100% | 4,501 |

| DNVGL ID | Program | End Use | Measure | Program Track | Facility Type | Annual kWh | On-Peak % Annual kWh | Connected kW | Summer kW Coincidence Factor | Winter kW Coincidence Factor | Average Hours of Use |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PC10000177 | RFP | Process | Comp Air | Custom | Manufacturing | 513,043 | 37% | 58.70 | 100% | 100% | 8,740 |
| PC10000202 | Retrofit | Lighting | Systems | Prescriptive | Retail | 34,653 | 100% | 14.10 | 100% | 100% | 2,458 |
| PC10000202 | Retrofit | Process | Comp Air | Prescriptive | Retail | 32,960 | 100% | 10.30 | 100% | 100% | 3,236 |
| PC10000205 | Retrofit | Motors | VFDs | Prescriptive | Retail | 37,956 | 37% | 4.87 | 100% | 100% | 7,794 |
| PC10000205 | Retrofit | Lighting | Systems | Prescriptive | Warehouse | 36,179 | 37% | 4.40 | 100% | 100% | 8,223 |
| PC10000205 | Retrofit | Lighting | Controls | Prescriptive | Warehouse | 0 | 37% | 0.00 | 25% | 18% | 0 |
| PC10000205 | Retrofit | Custom | Process Piping Insulation | Custom | Warehouse | 60,658 | 37% | 6.90 | 100% | 100% | 8,760 |
| PC10000209 | Retrofit | Lighting | Systems | Custom | Grocery | 63,945 | 50% | 9.70 | 100% | 100% | 6,592 |
| PC10000209 | Retrofit | Lighting | Systems | Prescriptive | Grocery | 100,785 | 40% | 15.38 | 100% | 100% | 6,553 |
| PC10000214 | New Construction | Custom | Snow Guns | Custom | Other | 1,003,520 | 25% | N/A | 0% | 0% | 408 |
| PC10000216 | Retrofit | Process | Motors | Custom | Manufacturing | 146,532 | 100% | 61.06 | 100% | 100% | 2,400 |
| PC10000216 | Retrofit | Process | VFDs | Custom | Manufacturing | 43,786 | 100% | 18.25 | 100% | 100% | 2,400 |
| UC10000031 | Retrofit | Process | Comp Air | Prescriptive | Manufacturing | 149,796 | N/A | 17.10 | 80% | 54% | 8,760 |
| UC10000032 | Retrofit | Lighting | Controls | Prescriptive | Medical (Hospital) | 370,129 | N/A | 207.83 | 31% | 22% | 1,774 |
| UC10000032 | Retrofit | Motors | VFDs | Prescriptive | Medical (Hospital) | 468,940 | N/A | 106.27 | 100% | 109% | 4,413 |
| UC10000032 | Retrofit | Motors | Motors | Prescriptive | Medical (Hospital) | 26,280 | N/A | 30.00 | 100% | 100% | 876 |
| UC10000032 | Retrofit | HVAC | AHUs | Custom | Medical (Hospital) | 508,080 | N/A | 58.00 | 80% | 54% | 8,760 |
| UC10000036 | New Construction | Lighting | Systems | Prescriptive | Retail | 9,879 | N/A | 1.88 | 62% | 50% | 5,252 |
| UC10000036 | New Construction | Lighting | Controls | Prescriptive | Retail | 207 | N/A | 0.00 | 6% | 6% | 1,575 |
| UC10000049 | New Construction | HVAC | Chillers | Prescriptive | School | 27,900 | N/A | 11.16 | 100% | 0% | 2,500 |
| UC10000049 | New Construction | Lighting | Systems | Prescriptive | School | 52,500 | N/A | 25.00 | 97% | 67% | 2,100 |
| UC10000049 | New Construction | Motors | VFDs | Prescriptive | School | 177,870 | N/A | 12.64 | 100% | 100% | Unknown |
| UC10000049 | Retrofit | Lighting | Systems | Prescriptive | School | 537,450 | N/A | 112.64 | 85% | 60% | 4,772 |

## Table 30: Electric Sample Evaluation Savings Estimates

| DNVGL ID | Program | End Use | Measure | Program Track | Facility Type | Annual kWh | kWh HVAC Factor | On-Peak % Annual kWh | Conn. kW | Summer On-Peak kW CF | Summer On-Peak kW HVAC Factor | Winter On-Peak kW CF | Winter On-Peak kW HVAC Factor | Average Hours of Use |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LC10000006 | New Construction | Lighting | Systems | Prescriptive | Medical (Hospital) | 5,690 | 108% | 48% | 1.35 | 42% | 127% | 40% | 100% | 7,121 |
| LC10000006 | New Construction | Lighting | Controls | Prescriptive | Medical (Hospital) | 5,758 | 109% | 45% | 1.38 | 27% | 127% | 58% | 100% | 3,546 |
| LC10000006 | New Construction | HVAC | Chillers | Prescriptive | Medical (Hospital) | 18,242 | 0% | 54% | 11.12 | 65% | 100% | 0% | 100% | 883 |
| LC10000006 | New Construction | Motors | VFDs | Prescriptive | Medical (Hospital) | 102,716 | 0% | 47% | 19.40 | 56% | 100% | 35% | 100% | 5,824 |
| LC10000010 | Retrofit | Lighting | Systems | Prescriptive | Retail | 292,623 | 106% | 73% | 67.69 | 100% | 114% | 100% | 100% | 4,667 |
| LC10000016 | Retrofit | Lighting | Systems | Prescriptive | University/College | 249,006 | 106% | 60% | 71.14 | 81% | 88% | 40% | 100% | 4,295 |
| LC10000016 | Retrofit | Lighting | Controls | Prescriptive | University/College | 831 | 102% | 34% | 0.26 | 28% | 85% | 20% | 100% | 3,082 |
| LC10000016 | Retrofit | Motors | VFDs | Prescriptive | University/College | 715,663 | 0% | 44% | 115.13 | 60% | 100% | 69% | 100% | 6,216 |
| NC10000004 | Retrofit | Lighting | Systems | Prescriptive | Grocery | 76,970 | 109% | 59% | 10.61 | 100% | 126% | 100% | 100% | 6,664 |
| NC10000016 | Retrofit | Lighting | Systems | Prescriptive | Other | 106 | 81% | 44% | 1.52 | 1% | 127% | 0% | 100% | 86 |
| NC10000018 | Retrofit | Lighting | Systems | Prescriptive | Restaurant | 41,378 | 109% | 63% | 9.76 | 62% | 128% | 64% | 100% | 4,009 |
| NC10000018 | Retrofit | Lighting | Controls | Prescriptive | Restaurant | 1,127 | 109% | 57% | 0.29 | 42% | 126% | 50% | 100% | 3,528 |
| PC10000002 | RFP | Lighting | Systems | Custom | Manufacturing | 17,845 | 100% | 38% | 4.68 | 17% | 100% | 74% | 100% | 4,363 |
| PC10000009 | New Construction | Lighting | Systems | Custom | Exterior | 420,996 | 100% | 28% | 97.89 | 0% | 100% | 100% | 100% | 4,301 |
| PC10000014 | New Construction | Lighting | Systems | Prescriptive | Retail | 98,841 | 110% | 50% | 49.56 | 19% | 126% | 22% | 100% | 1,806 |
| PC10000018 | Retrofit | Lighting | Systems | Prescriptive | Other | 172,097 | 110% | 47% | 17.81 | 86% | 131% | 78% | 100% | 7,945 |
| PC10000018 | Retrofit | Lighting | Controls | Prescriptive | Other | 15,357 | 109% | 30% | 3.34 | 21% | 126% | 32% | 100% | 4,195 |
| PC10000023 | Retrofit | Lighting | Systems | Custom | Grocery | 83,699 | 110% | 47% | 8.68 | 100% | 126% | 100% | 100% | 8,737 |
| PC10000023 | Retrofit | Lighting | Systems | Prescriptive | Grocery | 96,725 | 111% | 59% | 13.82 | 100% | 126% | 98% | 100% | 6,299 |
| PC10000025 | Retrofit | Lighting | Systems | Prescriptive | Manufacturing | 297,444 | 111% | 70% | 68.01 | 80% | 126% | 71% | 100% | 3,951 |
| PC10000025 | Retrofit | Lighting | Controls | Prescriptive | Manufacturing | 12,913 | 111% | 61% | 6.12 | 38% | 126% | 71% | 100% | 1,898 |
| PC10000028 | New Construction | HVAC | VAVs | Prescriptive | Manufacturing | 9,334 | 0% | 51% | 11.23 | 30% | 100% | 0% | 100% | 1,609 |
| PC10000028 | New Construction | Lighting | Systems | Prescriptive | Office | 106,342 | 105% | 60% | 22.57 | 68% | 114% | 62% | 100% | 4,565 |
| PC10000028 | New Construction | Lighting | Controls | Prescriptive | Office | 3,642 | 111% | 60% | 1.64 | 31% | 127% | 28% | 100% | 2,003 |
| PC10000030 | New Construction | Lighting | Systems | Prescriptive | School | 106 | 100% | 82% | 0.08 | 25% | 100% | 26% | 100% | 1,680 |
| PC10000030 | Retrofit | Lighting | Systems | Prescriptive | School | 95,826 | 101% | 79% | 71.98 | 33% | 100% | 12% | 100% | 1,203 |
| PC10000030 | Retrofit | Lighting | Controls | Prescriptive | School | 4,609 | 100% | 80% | 6.34 | 8% | 100% | 8% | 100% | 788 |
| PC10000034 | New Construction | Lighting | Systems | Custom | Exterior | 385,859 | 100% | 28% | 89.72 | 0% | 100% | 100% | 100% | 4,301 |

| DNVGL ID | Program | End Use | Measure | Program Track | Facility Type | Annual kWh | kWh HVAC Factor | On-Peak % Annual kWh | Conn. kW | Summer On-Peak kW CF | Summer On-Peak kW HVAC Factor | Winter On-Peak kW CF | Winter On-Peak kW HVAC Factor | Average Hours of Use |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PC10000046 | New Construction | HVAC | RTUs | Prescriptive | Manufacturing | 4,148 | 0% | 49% | 4.78 | 28% | 100% | 0% | 100% | 3,809 |
| PC10000073 | New Construction | Lighting | Systems | Prescriptive | University/College | 50,386 | 111% | 69% | 13.77 | 86% | 99% | 56% | 100% | 481 |
| PC10000073 | New Construction | Lighting | Controls | Prescriptive | University/College | 10,409 | 111% | 97% | 8.58 | 44% | 75% | 37% | 100% | 1,089 |
| PC10000073 | New Construction | HVAC | VRV | Prescriptive | University/College | 758,499 | 0% | 46% | 117.23 | 42% | 100% | 91% | 100% | 6,470 |
| PC10000073 | Retrofit | Lighting | Systems | Prescriptive | University/College | 13,632 | 110% | 50% | 2.71 | 71% | 97% | 52% | 100% | 10,773 |
| PC10000075 | New Construction | Custom | Snow Guns | Custom | Other | 539,068 | 0% | 48% | 395.16 | 0% | 100% | 43% | 100% | 1,364 |
| PC10000089 | New Construction | Lighting | Systems | Custom | Office | 464,528 | 110% | 48% | 127.97 | 12% | 126% | 86% | 100% | 3,294 |
| PC10000098 | Retrofit | Lighting | Systems | Prescriptive | Office | 67,357 | 107% | 69% | 23.98 | 61% | 116% | 43% | 100% | 2,559 |
| PC10000106 | Retrofit | Lighting | Systems | Prescriptive | Retail | 74,895 | 112% | 65% | 14.21 | 100% | 126% | 96% | 100% | 4,725 |
| PC10000108 | New Construction | Lighting | Systems | Prescriptive | School | 68,676 | 112% | 72% | 20.27 | 68% | 40% | 17% | 100% | 3,190 |
| PC10000108 | New Construction | Lighting | Controls | Prescriptive | School | 84,786 | 113% | 65% | 75.22 | 14% | 51% | 30% | 100% | 438 |
| PC10000108 | New Construction | HVAC | VRV Systems | Custom | School | 55,529 | 0% | 83% | 14.00 | 100% | 100% | 100% | 100% | 3,966 |
| PC10000118 | RFP | Lighting | Systems | Custom | Manufacturing | 132,821 | 100% | 58% | 30.79 | 70% | 100% | 55% | 100% | 4,300 |
| PC10000118 | RFP | Process | Comp Air | Custom | Manufacturing | 214,779 | 0% | 46% | 24.79 | 98% | 100% | 99% | 100% | 8,664 |
| PC10000124 | New Construction | HVAC | VFDs | Prescriptive | Grocery | 17,756 | 0% | 48% | 4.24 | 0% | 100% | 84% | 100% | 4,183 |
| PC10000124 | New Construction | HVAC | Economizers | Prescriptive | Grocery | 19,221 | 0% | 47% | 7.04 | 82% | 100% | 0% | 100% | 2,731 |
| PC10000124 | New Construction | Custom | EMS | Custom | Grocery | 94,778 | 0% | 28% | 54.18 | 17% | 100% | 0% | 100% | 1,749 |
| PC10000124 | New Construction | Custom | Motors | Prescriptive | Grocery | 132,557 | 0% | 47% | 16.61 | 93% | 100% | 89% | 100% | 7,979 |
| PC10000127 | Retrofit | Lighting | Controls | Prescriptive | Manufacturing | 39,811 | 110% | 38% | 7.02 | 38% | 126% | 56% | 100% | 5,148 |
| PC10000127 | Retrofit | Motors | VFDs | Prescriptive | Manufacturing | 55,106 | 0% | 63% | 11.07 | 76% | 100% | 76% | 100% | 4,977 |
| PC10000138 | New Construction | Process | Pumps | Custom | Manufacturing | 361,867 | 0% | 49% | 68.06 | 74% | 100% | 79% | 100% | 5,317 |
| PC10000146 | New Construction | Process | Comp Air | Prescriptive | Manufacturing | -350 | 0% | 64% | -0.04 | 100% | 100% | 100% | 100% | 8,760 |
| PC10000147 | RFP | Lighting | Systems | Custom | Manufacturing | 13,560 | 100% | 49% | 6.76 | 24% | 100% | 25% | 100% | 2,824 |
| PC10000147 | RFP | Lighting | Controls | Custom | Manufacturing | 40,794 | 100% | 45% | 6.44 | 76% | 100% | 75% | 100% | 6,336 |
| PC10000147 | RFP | Custom | Water Treatment & Pumps | Custom | Manufacturing | 495,334 | 0% | 49% | 120.40 | 80% | 100% | 39% | 100% | 4,114 |
| PC10000175 | Retrofit | Lighting | Systems | Prescriptive | Retail | 221,069 | 106% | 69% | 49.91 | 100% | 114% | 100% | 100% | 4,166 |

| DNVGL ID | Program | End Use | Measure | Program Track | Facility Type | Annual kWh | kWh HVAC Factor | On-Peak % Annual kWh | Conn. kW | Summer On-Peak kW CF | Summer On-Peak kW HVAC Factor | Winter On-Peak kW CF | Winter On-Peak kW HVAC Factor | Average Hours of Use |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PC10000177 | RFP | Process | Comp Air | Custom | Manufacturing | 555,667 | 0% | 47% | 96.04 | 66% | 100% | 50% | 100% | 5,786 |
| PC10000202 | Retrofit | Lighting | Systems | Prescriptive | Retail | 52,575 | 100% | 58% | 13.70 | 77% | 100% | 15% | 100% | 3,806 |
| PC10000202 | Retrofit | Process | Comp Air | Prescriptive | Retail | 9,165 | 0% | 78% | 4.45 | 44% | 100% | 17% | 100% | 2,900 |
| PC10000205 | Retrofit | Motors | VFDs | Prescriptive | Retail | 30,829 | 0% | 48% | 3.95 | 93% | 100% | 85% | 100% | 7,807 |
| PC10000205 | Retrofit | Lighting | Systems | Prescriptive | Warehouse | 41,728 | 110% | 47% | 4.40 | 100% | 126% | 100% | 100% | 8,062 |
| PC10000205 | Retrofit | Lighting | Controls | Prescriptive | Warehouse | 1,851 | 110% | 46% | 3.49 | 7% | 127% | 5% | 100% | 481 |
| PC10000205 | Retrofit | Custom | Process Piping Insulation | Custom | Warehouse | 60,658 | 0% | 37% | 6.90 | 100% | 100% | 100% | 100% | 8,760 |
| PC10000209 | Retrofit | Lighting | Systems | Custom | Grocery | 70,590 | 111% | 60% | 9.74 | 99% | 126% | 100% | 100% | 6,555 |
| PC10000209 | Retrofit | Lighting | Systems | Prescriptive | Grocery | 95,592 | 112% | 68% | 15.76 | 100% | 126% | 100% | 100% | 5,409 |
| PC10000214 | New Construction | Custom | Snow Guns | Custom | Other | 1,392,155 | 0% | 42% | 1,775.66 | 0% | 100% | 21% | 0% | 784 |
| PC10000216 | Retrofit | Process | Motors | Custom | Manufacturing | 0 | 0% | 0% | 0.00 | 0% | 100% | 0% | 100% | 0 |
| PC10000216 | Retrofit | Process | VFDs | Custom | Manufacturing | 0 | 0% | 0% | 0.00 | 0% | 100% | 0% | 100% | 0 |
| UC10000031 | Retrofit | Process | Comp Air | Prescriptive | Manufacturing | 185,657 | 0% | 46% | 21.50 | 97% | 100% | 99% | 100% | 8,760 |
| UC10000032 | Retrofit | Lighting | Controls | Prescriptive | Medical (Hospital) | 527,019 | 96% | 45% | 208.05 | 23% | 127% | 25% | 100% | 2,630 |
| UC10000032 | Retrofit | Motors | VFDs | Prescriptive | Medical (Hospital) | 437,848 | 0% | 46% | 66.37 | 76% | 100% | 72% | 100% | 6,597 |
| UC10000032 | Retrofit | Motors | Motors | Prescriptive | Medical (Hospital) | 17,339 | 0% | 47% | 2.76 | 78% | 100% | 79% | 100% | 6,285 |
| UC10000032 | Retrofit | HVAC | AHUs | Custom | Medical (Hospital) | 271,715 | 0% | 44% | 53.96 | 64% | 100% | 49% | 100% | 5,035 |
| UC10000036 | New Construction | Lighting | Systems | Prescriptive | Retail | 15,384 | 110% | 57% | 1.99 | 100% | 127% | 100% | 100% | 7,122 |
| UC10000036 | New Construction | Lighting | Controls | Prescriptive | Retail | 662 | 107% | 2% | 0.56 | 0% | 100% | 0% | 100% | 1,096 |
| UC10000049 | New Construction | HVAC | Chillers | Prescriptive | School | 18,182 | 0% | 51% | 9.82 | 62% | 100% | 0% | 100% | 3,606 |
| UC10000049 | New Construction | Lighting | Systems | Prescriptive | School | 39,995 | 107% | 57% | 21.03 | 26% | 51% | 15% | 100% | 1,585 |
| UC10000049 | New Construction | Motors | VFDs | Prescriptive | School | 194,865 | 0% | 59% | 38.07 | 89% | 100% | 80% | 100% | 5,119 |
| UC10000049 | Retrofit | Lighting | Systems | Prescriptive | School | 411,016 | 107% | 55% | 105.87 | 70% | 90% | 58% | 100% | 4,250 |

## Table 31: Electric Sample Realization Rates

| DNVGL ID | Program | End Use | Measure | Program Track | Facility Type | Annual kWh (Excluding HVAC) | Annual kWh (Including HVAC) | kWh HVAC Factor | On-Peak % Annual kWh | Conn. kW | Summer kW CF | Winter kW CF | Avg. Hours of Use |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LC10000006 | New Construction | Lighting | Systems | Prescriptive | Medical (Hospital) | 14% | 16% | 23% | N/A | 32% | 16% | 16% | 82% |
| LC10000006 | New Construction | Lighting | Controls | Prescriptive | Medical (Hospital) | 188% | 205% | 28% | N/A | 90% | 11% | 23% | 201% |
| LC10000006 | New Construction | HVAC | Chillers | Prescriptive | Medical (Hospital) | 33% | 33% | N/A | N/A | N/A | N/A | N/A | 25% |
| LC10000006 | New Construction | Motors | VFDs | Prescriptive | Medical (Hospital) | 141% | 141% | N/A | N/A | N/A | N/A | N/A | 77% |
| LC10000010 | Retrofit | Lighting | Systems | Prescriptive | Retail | 80% | 85% | 28% | N/A | 100% | 100% | 100% | 91% |
| LC10000016 | Retrofit | Lighting | Systems | Prescriptive | University /College | 71% | 75% | 20% | N/A | 88% | 67% | 33% | 105% |
| LC10000016 | Retrofit | Lighting | Controls | Prescriptive | University /College | 71% | 73% | 0% | N/A | 56% | 0% | 0% | 128% |
| LC10000016 | Retrofit | Motors | VFDs | Prescriptive | University /College | 206% | 206% | N/A | N/A | N/A | N/A | N/A | 212% |
| NC10000004 | Retrofit | Lighting | Systems | Prescriptive | Grocery | 98% | 107% | 20% | N/A | 100% | 83% | 83% | 98% |
| NC10000016 | Retrofit | Lighting | Systems | Prescriptive | Other | 12% | 10% | 20% | N/A | 211% | 1% | 0% | 8% |
| NC10000018 | Retrofit | Lighting | Systems | Prescriptive | Restaurant | 70% | 77% | 20% | N/A | 83% | 51% | 53% | 87% |
| NC10000018 | Retrofit | Lighting | Controls | Prescriptive | Restaurant | 77% | 84% | 1% | N/A | 101% | 1% | 1% | 77% |
| PC10000002 | RFP | Lighting | Systems | Custom | Mfg. | 70% | 70% | 0% | 79% | 114% | 17% | 74% | 70% |
| PC10000009 | New Construction | Lighting | Systems | Custom | Exterior | 98% | 98% | 0% | 80% | 100% | 0% | 100% | 98% |
| PC10000014 | New Construction | Lighting | Systems | Prescriptive | Retail | 38% | 42% | 20% | 77% | 100% | 16% | 18% | 38% |
| PC10000018 | Retrofit | Lighting | Systems | Prescriptive | Other | 84% | 92% | 20% | 127% | 76% | 56% | 50% | 100% |
| PC10000018 | Retrofit | Lighting | Controls | Prescriptive | Other | 75% | 82% | 2% | 81% | N/A | 3% | 4% | 75% |
| PC10000023 | Retrofit | Lighting | Systems | Custom | Grocery | 133% | 147% | 20% | 94% | 100% | 83% | 83% | 133% |
| PC10000023 | Retrofit | Lighting | Systems | Prescriptive | Grocery | 96% | 107% | 20% | 147% | 100% | 83% | 82% | 96% |
| PC10000025 | Retrofit | Lighting | Systems | Prescriptive | Mfg. | 101% | 112% | 20% | 82% | 103% | 62% | 54% | 98% |
| PC10000025 | Retrofit | Lighting | Controls | Prescriptive | Mfg. | 95% | 105% | 1% | 94% | N/A | 3% | 5% | 95% |
| PC10000028 | New Construction | HVAC | VAVs | Prescriptive | Mfg. | 107% | 107% | N/A | 51% | N/A | 30% | 0% | NA |
| PC10000028 | New Construction | Lighting | Systems | Prescriptive | Office | 80% | 84% | 10% | 75% | 76% | 58% | 53% | 107% |
| PC10000028 | New Construction | Lighting | Controls | Prescriptive | Office | 71% | 78% | 1% | 75% | 67% | 2% | 2% | 109% |
| PC10000030 | New Construction | Lighting | Systems | Prescriptive | School | 74% | 74% | 0% | 126% | 129% | 25% | 26% | 76% |
| PC10000030 | Retrofit | Lighting | Systems | Prescriptive | School | 73% | 73% | 1% | 121% | 106% | 30% | 11% | 63% |
| PC10000030 | Retrofit | Lighting | Controls | Prescriptive | School | 48% | 48% | 0% | 123% | NA | 1% | 1% | 65% |
| PC10000034 | New Construction | Lighting | Systems | Custom | Exterior | 98% | 98% | 0% | 80% | 100% | 0% | 100% | 98% |

| DNVGL ID | Program | End Use | Measure | Program Track | Facility Type | Annual kWh (Excluding HVAC) | Annual kWh (Including HVAC) | kWh HVAC Factor | On-Peak % Annual kWh | Conn. kW | Summer kW CF | Winter kW CF | Avg. Hours of Use |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PC10000046 | New Construction | HVAC | RTUs | Prescriptive | Mfg. | 279% | 279% | N/A | 72% | N/A | 28% | 0% | NA |
| PC10000073 | New Construction | Lighting | Systems | Prescriptive | University /College | 191% | 211% | 28% | 106% | 20% | 43% | 28% | 142% |
| PC10000073 | New Construction | Lighting | Controls | Prescriptive | University /College | 125% | 139% | 8% | 277% | NA | 14% | 12% | 169% |
| PC10000073 | New Construction | HVAC | VRV | Prescriptive | University /College | 110% | 110% | N/A | 131% | 19% | 261% | 91% | 589% |
| PC10000073 | Retrofit | Lighting | Systems | Prescriptive | University /College | 107% | 117% | 20% | 142% | 209% | 59% | 44% | 120% |
| PC10000075 | New Construction | Custom | Snow Guns | Custom | Other | 132% | 132% | N/A | 138% | N/A | N/A | N/A | N/A |
| PC10000089 | New Construction | Lighting | Systems | Custom | Office | 94% | 104% | 20% | 73% | 100% | 10% | 72% | 94% |
| PC10000098 | Retrofit | Lighting | Systems | Prescriptive | Office | 94% | 101% | 20% | 80% | 112% | 51% | 36% | 82% |
| PC10000106 | Retrofit | Lighting | Systems | Prescriptive | Retail | 105% | 117% | 20% | 100% | 100% | 83% | 80% | 105% |
| PC10000108 | New Construction | Lighting | Systems | Prescriptive | School | 68% | 76% | 20% | 72% | 72% | 13% | 3% | 100% |
| PC10000108 | New Construction | Lighting | Controls | Prescriptive | School | 335% | 377% | 24% | 65% | 1075% | 10% | 20% | 206% |
| PC10000108 | New Construction | HVAC | VRV Systems | Custom | School | 100% | 100% | N/A | 100% | 100% | 100% | 100% | 100% |
| PC10000118 | RFP | Lighting | Systems | Custom | Mfg. | 70% | 70% | 0% | 156% | 101% | 70% | 55% | 69% |
| PC10000118 | RFP | Process | Comp Air | Custom | Mfg. | 172% | 172% | N/A | 71% | 114% | N/A | N/A | 150% |
| PC10000124 | New Construction | HVAC | VFDs | Prescriptive | Grocery | 98% | 98% | N/A | 96% | 177% | N/A | N/A | 55% |
| PC10000124 | New Construction | HVAC | Economizers | Prescriptive | Grocery | 106% | 106% | N/A | 117% | 67% | N/A | N/A | 158% |
| PC10000124 | New Construction | Custom | EMS | Custom | Grocery | 86% | 86% | N/A | 81% | 177% | N/A | N/A | 49% |
| PC10000124 | New Construction | Custom | Motors | Prescriptive | Grocery | 38% | 38% | N/A | 134% | 40% | N/A | N/A | 95% |
| PC10000127 | Retrofit | Lighting | Controls | Prescriptive | Mfg. | 257% | 284% | N/A | 103% | N/A | 28% | 41% | 257% |
| PC10000127 | Retrofit | Motors | VFDs | Prescriptive | Mfg. | 90% | 90% | N/A | 116% | N/A | N/A | N/A | 90% |
| PC10000138 | New Construction | Process | Pumps | Custom | Mfg. | 50% | 50% | N/A | 131% | N/A | N/A | N/A | 73% |
| PC10000146 | New Construction | Process | Comp Air | Prescriptive | Mfg. | -10% | -10% | N/A | 93% | N/A | N/A | N/A | 100% |
| PC10000147 | RFP | Lighting | Systems | Custom | Mfg. | 23% | 23% | 0% | 132% | 84% | 12% | 13% | 39% |
| PC10000147 | RFP | Lighting | Controls | Custom | Mfg. | 571% | 571% | 0% | 122% | N/A | 37% | 37% | 571% |
| PC10000147 | RFP | Custom | Water Treatment & Pumps | Custom | Mfg. | 96% | 96% | N/A | 132% | 201% | N/A | N/A | 48% |
| PC10000175 | Retrofit | Lighting | Systems | Prescriptive | Retail | 93% | 98% | 20% | 106% | 100% | 83% | 83% | 93% |
| PC10000177 | RFP | Process | Comp Air | Custom | Mfg. | 108% | 108% | N/A | 127% | 164% | N/A | N/A | 66% |

| DNVGL ID | Program | End Use | Measure | Program Track | Facility Type | Annual kWh (Excluding HVAC) | Annual kWh (Including HVAC) | kWh HVAC Factor | On-Peak % Annual kWh | Conn. kW | Summer kW CF | Winter kW CF | Avg. Hours of Use |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PC10000202 | Retrofit | Lighting | Systems | Prescriptive | Retail | 152% | 152% | 0% | 58% | 97% | 77% | 15% | 155% |
| PC10000202 | Retrofit | Process | Comp Air | Prescriptive | Retail | 28% | 28% | N/A | 78% | N/A | N/A | N/A | 90% |
| PC10000205 | Retrofit | Motors | VFDs | Prescriptive | Retail | 81% | 81% | N/A | 129% | N/A | N/A | N/A | 100% |
| PC10000205 | Retrofit | Lighting | Systems | Prescriptive | Warehouse | 104% | 115% | 0% | 128% | 100% | 100% | 100% | 98% |
| PC10000205 | Retrofit | Lighting | Controls | Prescriptive | Warehouse | N/A | N/A | 1% | 125% | N/A | 7% | 5% | N/A |
| PC10000205 | Retrofit | Custom | Process Piping Insulation | Custom | Warehouse | 100% | 100% | N/A | 100% | N/A | N/A | N/A | 100% |
| PC10000209 | Retrofit | Lighting | Systems | Custom | Grocery | 99% | 110% | 20% | 119% | 100% | 83% | 83% | 99% |
| PC10000209 | Retrofit | Lighting | Systems | Prescriptive | Grocery | 85% | 95% | 20% | 170% | 102% | 83% | 83% | 83% |
| PC10000214 | New Construction | Custom | Snow Guns | Custom | Other | 139% | 139% | N/A | 167% | N/A | N/A | N/A | N/A |
| PC10000216 | Retrofit | Process | Motors | Custom | Mfg. | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| PC10000216 | Retrofit | Process | VFDs | Custom | Mfg. | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| UC10000031 | Retrofit | Process | Comp Air | Prescriptive | Mfg. | 124% | 124% | N/A | N/A | N/A | N/A | N/A | 100% |
| UC10000032 | Retrofit | Lighting | Controls | Prescriptive | Medical (Hospital) | 148% | 142% | N/A | N/A | 100% | 18% | 19% | 148% |
| UC10000032 | Retrofit | Motors | VFDs | Prescriptive | Medical (Hospital) | 93% | 93% | N/A | N/A | N/A | N/A | N/A | 150% |
| UC10000032 | Retrofit | Motors | Motors | Prescriptive | Medical (Hospital) | 66% | 66% | N/A | N/A | N/A | N/A | N/A | 717% |
| UC10000032 | Retrofit | HVAC | AHUs | Custom | Medical (Hospital) | 53% | 53% | N/A | N/A | N/A | N/A | N/A | 57% |
| UC10000036 | New Construction | Lighting | Systems | Prescriptive | Retail | 141% | 156% | 20% | N/A | 106% | 67% | 67% | 136% |
| UC10000036 | New Construction | Lighting | Controls | Prescriptive | Retail | 299% | 320% | 1% | N/A | N/A | 0% | 0% | 70% |
| UC10000049 | New Construction | HVAC | Chillers | Prescriptive | School | 65% | 65% | N/A | N/A | 88% | 62% | N/A | 144% |
| UC10000049 | New Construction | Lighting | Systems | Prescriptive | School | 71% | 76% | 0% | N/A | 84% | 26% | 15% | 75% |
| UC10000049 | New Construction | Motors | VFDs | Prescriptive | School | 110% | 110% | N/A | N/A | 301% | 89% | 80% | N/A |
| UC10000049 | Retrofit | Lighting | Systems | Prescriptive | School | 72% | 76% | 18% | N/A | 94% | 59% | 49% | 89% |

## Table 32: Electric Sample Reasons for Savings Discrepancies

| DNVGL ID | Program | End Use | Measure | Program Track | Facility Type | Primary Reasons for Discrepancies |
|---|---|---|---|---|---|---|
| LC10000006 | New Construction | Lighting | Systems | Prescriptive | Medical (Hospital) | Tracking savings include net effects, which reduces the savings by 4%. Seventeen 2L2'T8 fixtures were found installed instead of 2L4' T8 fixtures as reported in the tracking system which reduces savings by 18%. Sixty other 2L4' T8 fixtures were not installed accounting for a 46% reduction in savings. Evaluation hours of use are 18% less than assumed in the tracking system estimate. The cooling credit increased savings by 1%. |
| LC10000006 | New Construction | Lighting | Controls | Prescriptive | Medical (Hospital) | Tracking savings include net effects, which reduces the savings by 4%. The tracking system reported the installation of controls on three more fixtures than found on site, reducing savings by 10%. The on-site reduction in hours of use is more than twice as high as the assumption in the tracking system. The cooling credit increased savings by 17%. |
| LC10000006 | New Construction | HVAC | Chillers | Prescriptive | Medical (Hospital) | The tracking savings contain net effects and are calculated using 250-ton capacity and 3,500 full load hours. This is aggressive in NH even for a hospital. The installed 250-ton chiller is oversized for the existing load. It is designed for 5 AHUS and only 2 are installed. The rest of the capacity is for future expansion. The site evaluation finds 888 EFLH instead of the 3,500 hour level. Also, the chiller is operating at an average of 0.584 kW/ton. This is higher than expected, and is due to the chiller operating at a less efficient range on the chiller curve. |
| LC10000006 | New Construction | Motors | VFDs | Prescriptive | Medical (Hospital) | Monitoring found that the supply/return fans operate 8,760 hours. This is consistent with a hospital and the areas the fans serve. Tracking savings are based upon 3,000 annual hours and contain net effects. Tracking savings equations were not shown and recreating values from the TRMs did not yield the tracking values. Baseline operation was estimated using motor HP. 0.746 kW/HP conversion factor, 70% load factor, 87% power factor, and 63.5% motor efficiency. Tracking savings appear to be based upon some unknown kWh/HP/HR variables. It is impossible to reverse engineer those individual values because savings for each motor type is not provided, only a total kWh for all motors. The savings also include a variable speed drive on a cooling tower fan. The motor in the tracking is listed as 5.0 HP. Monitoring shows that the motor is at least 10.0 HP. We could not get access to the motor as it was deep in the tower and ID plates provided no HP information. The CT fan operation was assumed to be 2,000 hours, which is 1,500 hours less that the chiller measure. CT fan savings were calculated using the annualized chiller operating hours 5,121 [ 1:1 correlation] |
| LC10000010 | Retrofit | Lighting | Systems | Prescriptive | Retail | Tracking savings include net effects, which reduces the savings by 12%. Evaluation hours of use are 9% less than assumed in the tracking system estimate. The cooling credit increased savings by 5%. |
| LC10000016 | Retrofit | Lighting | Systems | Prescriptive | University /College | The tracking savings contain net effects. According to the customer, the documentation used to support the tracking savings are based on the original proposal of work and not the final installations. The customer provided the information on the final installations which match what was found on-site and provide savings that are 33% less than reported in the tracking system. Five percent was recovered due to increases in operation and an additional 4% was recovered due to the cooling credit. |
| LC10000016 | Retrofit | Lighting | Controls | Prescriptive | University /College | The tracking savings contain net effects. According to the customer, the documentation used to support the tracking savings are based on the original proposal of work and not the final installations. The customer provided the information on the final installations which match what was found on-site and provide savings that are 62% less than reported in the tracking system. Thirty-three percent was recovered due to increases in operation and an additional 2% was recovered due to the cooling credit. |

| DNVGL ID | Program | End Use | Measure | Program Track | Facility Type | Primary Reasons for Discrepancies |
|---|---|---|---|---|---|---|
| LC10000016 | Retrofit | Motors | VFDs | Prescriptive | University /College | The tracking savings contain net effects and are based on deemed savings so we are unable to be sure about why they are different from the evaluated savings. However, the evaluation hours of use are more than double the estimate found in the project file. |
| NC10000004 | Retrofit | Lighting | Systems | Prescriptive | Grocery | The evaluation hours of use are 2% lower than assumed in the tracking system estimate. The cooling credit increased savings by 9%. |
| NC10000016 | Retrofit | Lighting | Systems | Prescriptive | Other | The tracking savings are 54% lower than the savings calculated using the detail in the project file. Evaluation hours of use are 92% less than assumed in the tracking system estimate. The area where the fixtures are installed is served by electric resistance heat and packaged A/C. The overall interactive effect is a 2% reduction in savings. |
| NC10000018 | Retrofit | Lighting | Systems | Prescriptive | Restaurant | Seven 19-watt LEDs and 80 4-watt LED candle lamps were not found on-site as reported by the tracking system, which caused a 17% decrease in savings. Evaluation hours of use are 13% less than assumed in the tracking system estimate. The cooling credit increased savings by 6%. |
| NC10000018 | Retrofit | Lighting | Controls | Prescriptive | Restaurant | The on-site reduction in hours of use is 23% lower than assumed in the tracking system. The cooling credit increased savings by 7%. |
| PC10000002 | RFP | Lighting | Systems | Custom | Mfg. | The evaluation hours of use are 30% less than assumed in the tracking system estimate. |
| PC10000009 | New Construction | Lighting | Systems | Custom | Exterior | Evaluation hours of use are 2% less than assumed in the tracking system estimate. |
| PC10000014 | New Construction | Lighting | Systems | Prescriptive | Retail | The evaluation hours of use are 62% lower than assumed in the tracking system estimate. The area in this facility where all of these fixtures are installed contains daylighting so all but 70 of them only operate when there is not enough outside light to illuminate the area. The other 70 are on 24/7. The cooling credit increased savings by 4%. |
| PC10000018 | Retrofit | Lighting | Systems | Prescriptive | Other | The tracking system project description matches the detail in the project file but the tracking savings are 16% higher than the savings produced by using the detail provided in the project files. The cooling credit increased savings by 9%. |
| PC10000018 | Retrofit | Lighting | Controls | Prescriptive | Other | The on-site reduction in hours of use is 25% lower than assumed in the tracking system. The cooling credit increased savings by 7%. |
| PC10000023 | Retrofit | Lighting | Systems | Custom | Grocery | The on-site hours of use are 33% higher than assumed in the tracking system estimate. The cooling credit increased savings by 14%. |
| PC10000023 | Retrofit | Lighting | Systems | Prescriptive | Grocery | The on-site hours of use are 4% lower than assumed in the tracking system estimate. The cooling credit increased savings by 11%. |
| PC10000025 | Retrofit | Lighting | Systems | Prescriptive | Mfg. | The savings calculated using the detail in the project file is 3% higher than the savings reported in the tracking system. The evaluation hours of use are 2% lower than assumed in the tracking system estimate. The cooling credit increased savings by 11%. |
| PC10000025 | Retrofit | Lighting | Controls | Prescriptive | Mfg. | The on-site reduction in hours of use in 5% lower than assumed in the tracking system. The cooling credit increased savings by 11%. |
| PC10000028 | New Construction | HVAC | VAVs | Prescriptive | Mfg. | Tracking savings equations and savings variables were not provided. The TRM used was not indicated. Monitoring found that the RTUs had distinct operating schedules. |

| DNVGL ID | Program | End Use | Measure | Program Track | Facility Type | Primary Reasons for Discrepancies |
|---|---|---|---|---|---|---|
| PC10000028 | New Construction | Lighting | Systems | Prescriptive | Office | The tracking system savings contained the installation of 345-3L4'T8s. The on-site found all of these fixtures to be 2L4'T8s. The on-site found 24 fewer 6LT5s than reported in the tracking system. The on-site hours of use are 7% higher than assumed in the tracking system estimate. The cooling credit increased savings by 4%. |
| PC10000028 | New Construction | Lighting | Controls | Prescriptive | Office | The tracking system savings contained the occupancy sensors on 3L4'T8s. The on-site found all of these fixtures to be 2L4'T8s. The on-site reduction in hours of use in 9% higher than assumed in the tracking system. The cooling credit increased savings by 8%. |
| PC10000030 | New Construction | Lighting | Systems | Prescriptive | School | The savings calculated based on the information in the site file resulted in a 2% decrease in savings. Evaluation hours of use are 24% less than assumed in the tracking system estimate. |
| PC10000030 | Retrofit | Lighting | Systems | Prescriptive | School | The savings calculated from the detail in the project file are 10% higher than the savings in the tracking system. The evaluation hours are 37% less than those assumed in the tracking system. |
| PC10000030 | Retrofit | Lighting | Controls | Prescriptive | School | Eight of the occupancy sensors found in the project detail were not found on-site; resulting in a 17% decrease in savings. The evaluation reduction in hours of use is 35% lower than assumed in the tracking system. |
| PC10000034 | New Construction | Lighting | Systems | Custom | Exterior | Evaluation hours of use are 2% less than assumed in the tracking system estimate. |
| PC10000046 | New Construction | HVAC | RTUs | Prescriptive | Mfg. | The project file contained no usable calculations or assumptions. The increased savings is due to extended operating hours. There is a lot of cycling going on, but RTU operation can occur any hour of the week including weekends. We even had monitored usage on the 4th of July on all four of the RTUs. |
| PC10000073 | New Construction | Lighting | Systems | Prescriptive | University /College | The project file contained lump sum counts of the fixtures installed at this newly constructed facility by fixture type. The field engineer recorded the counts and types of all of the fixtures found. Baseline assumptions were made consistent with those from other new construction projects we've viewed during this evaluation. The changes in fixture types and quantities found accounted for a 49% increase in savings. Evaluation hours are 42% higher than those assumed in the tracking system and the cooling credit increased savings by an additional 20%. |
| PC10000073 | New Construction | Lighting | Controls | Prescriptive | University /College | The project file contained lump sum counts of the lighting controls installed at this newly constructed facility. The field engineer recorded the counts and types of fixtures controlled for all of the controls found. Evaluation hours reduction is 20% higher than those assumed in the tracking system and the cooling credit increased savings by an additional 14%. |
| PC10000073 | New Construction | HVAC | VRV | Prescriptive | University /College | The new equipment is operating about 7% less efficiently than estimated. However, the occupied period is longer than baseline assumptions. This would have required more electric resistance usage and contributes to the overall savings increase. |
| PC10000073 | Retrofit | Lighting | Systems | Prescriptive | University /College | The tracking savings are 14% higher than the savings calculated using the pre/post information provided in the project file. The evaluation hours of use are 21% greater than assumed in the tracking system estimate. The cooling credit increased savings by 11%. |
| PC10000075 | New Construction | Custom | Snow Guns | Custom | Other | The site file did not provide any savings calculations; only annual savings per gun. No baseline conditions, temperatures, annual snow making hours, compressor data, water gallons, of pump data is provided. The savings were increased upon the assumption that the snow making season is longer than the tracking estimates. While it is not possible to reverse engineer precise operation, annual operation of 750 – 1,000 hours may constitute tracking savings. This is still less than the wet bulb snowmaking hours for both the past season and the TMY3 weather data. |

| DNVGL ID | Program | End Use | Measure | Program Track | Facility Type | Primary Reasons for Discrepancies |
|---|---|---|---|---|---|---|
| PC10000089 | New Construction | Lighting | Systems | Custom | Office | Evaluation hours of use are 6% less than assumed in the tracking system estimate. The cooling credit increased savings by 10%. |
| PC10000098 | Retrofit | Lighting | Systems | Prescriptive | Office | The on-site visit found 22 more fixtures than reported in the tracking system which accounted for a 12% increase in savings. The evaluation hours of use are 18% lower than assumed in the tracking system estimate. The cooling credit increased savings by 7%. |
| PC10000106 | Retrofit | Lighting | Systems | Prescriptive | Retail | The evaluation hours of use are 5% higher than assumed in the tracking system estimate. The cooling credit increased savings by 12%. |
| PC10000108 | New Construction | Lighting | Systems | Prescriptive | School | There was a 1% decrease in savings due to technology changes, a 30% decrease in savings due to quantity differences, and an 8% increase due to cooling interaction. |
| PC10000108 | New Construction | Lighting | Controls | Prescriptive | School | There was a 28% increase in savings due to quantity differences. The reduction in hours of use observed in the field was more than twice the reduction reported in the tracking system. Savings increased by an additional 43% due to cooling interaction. |
| PC10000108 | New Construction | HVAC | VRV Systems | Custom | School | No discrepancy was found. |
| PC10000118 | RFP | Lighting | Systems | Custom | Mfg. | One more 218-watt induction fixture was found on the exterior of the building than was reported in the project file. The evaluation hours of use are 31% less than assumed in the tracking system savings estimate. |
| PC10000118 | RFP | Process | Comp Air | Custom | Mfg. | The tracking savings are based on deemed savings so we are unable to be sure about why they are different from the evaluated savings. However, the evaluation hours of use are 50% higher than the estimate found in the project file. |
| PC10000124 | New Construction | HVAC | VFDs | Prescriptive | Grocery | The new equipment is operating about 7% less efficiently than estimated. However, the occupied period is longer than baseline assumptions. This would have required more electric resistance usage and contributes to the overall savings increase. |
| PC10000124 | New Construction | HVAC | Dual Enthalpy Economizers | Prescriptive | Grocery | The savings difference reflects the difference between design efficiency and the efficiencies used in the tracking calculations. |
| PC10000124 | New Construction | Custom | EMS | Custom | Grocery | The monitoring showed that the night setback was not as deep as anticipated for the fan operation. There is some cooling savings from the DX air conditioning. |
| PC10000124 | New Construction | Custom | Motors | Prescriptive | Grocery | The variation is due to calculation methodology and assumptions. The tracking calculates savings for all fans using one equation which assumes that all 633 fans are larger fans, when in fact only 123 of them are. |
| PC10000127 | Retrofit | Lighting | Controls | Prescriptive | Mfg. | The on-site reduction in hours of use is more than two and a half times greater than assumed in the tracking system. The cooling credit increased savings by 26%. |
| PC10000127 | Retrofit | Motors | VFDs | Prescriptive | Mfg. | The tracking savings are based on deemed savings so we are unable to be sure about why they are different from the evaluated savings. However, the evaluation hours of use are 10% lower than the estimate found in the project file. |
| PC10000138 | New Construction | Process | Pumps | Custom | Mfg. | The new extruder operated at more full load hours compared with tracking estimates. The increase in operating hours is partially offset by a higher load factor. Our monitored load factor is 42.2% greater than the tracking estimate. |
| PC10000146 | New Construction | Process | Comp Air | Prescriptive | Mfg. | The tracking savings are based on deemed savings so we are unable to be sure about why they are different from the evaluated savings. However, the cycling air dryer was not cycling (turning off) which likely accounts for the negative savings. |

| DNVGL ID | Program | End Use | Measure | Program Track | Facility Type | Primary Reasons for Discrepancies |
|---|---|---|---|---|---|---|
| PC10000147 | RFP | Lighting | Systems | Custom | Mfg. | The tracking savings are not supported by the description of the measures that were replaced and installed. The evaluation hours of use are 61% less than assumed in the tracking system estimate. |
| PC10000147 | RFP | Lighting | Controls | Custom | Mfg. | The average reduction in hours of use is almost five times higher than assumed in the tracking system savings. |
| PC10000147 | RFP | Custom | Water Treatment & Pumps | Custom | Mfg. | The difference in savings is due to changes in production (there were shifts in seasonal production loads and slightly less product made) and in the weather load impacts on total plant. Tracking savings are based upon a single average temperature impact while we use actual hourly temperatures. |
| PC10000175 | Retrofit | Lighting | Systems | Prescriptive | Retail | The evaluation hours of use are 7% less than assumed in the tracking system estimate. The cooling credit increased savings by 6%. |
| PC10000177 | RFP | Process | Comp Air | Custom | Mfg. | The evaluation hours of use are 8% higher than assumed in the tracking system savings estimate. |
| PC10000202 | Retrofit | Lighting | Systems | Prescriptive | Retail | Only 62 of the 64 fixtures reported installed in the tracking system were found installed during the site visit. The evaluation hours of use are 55% higher than assumed in the tracking system estimate. |
| PC10000202 | Retrofit | Process | Comp Air | Prescriptive | Retail | The tracking savings are based on deemed savings so we are unable to be sure about why they are different from the evaluated savings. |
| PC10000205 | Retrofit | Motors | VFDs | Prescriptive | Retail | The tracking savings are based on deemed savings so we are unable to be sure about why they are different from the evaluated savings. |
| PC10000205 | Retrofit | Lighting | Systems | Prescriptive | Warehouse | The sum of the fixture savings in the file is 6% higher than the total reported in the file and in the tracking system. The evaluation hours of use are 2% lower than assumed in the tracking system estimate. The cooling credit increased savings by 11%. |
| PC10000205 | Retrofit | Lighting | Controls | Prescriptive | Warehouse | Controls' savings were not included in tracking savings but do appear in the project file and were installed through the program. |
| PC10000205 | Retrofit | Custom | Process Piping Insulation | Custom | Warehouse | No discrepancy was found. |
| PC10000214 | New Construction | Custom | Snow Guns | Custom | Other | The savings are primarily due to longer snow making operation than the tracking estimates. The tracking estimates used 480 annual snow making hours. Our analysis annualizes out at 1,402 hours. These hours are very weather dependent and are also manually adjusted by the snow makers for location and snow quality. The tracking estimates assume that the snowmaking occurs for 20 full days over a 134 day ski season. The sites want to make as much snow as possible to cover any warm periods and there is no thing as too much snow. The savings offset comes in the performance of the compressors and pumps. The site evaluation under estimated the compressed air requirements at the site. The compressors were estimated to consume 71,195 kWh for the season. There are six packaged compressors at the site that operate in stages and provide redundancy. The tracking estimate is the equivalent of running one compressor alone for most of the season. Not realistic. So, the savings variance is due to longer than anticipated snowmaking, estimated compressed air reduction across the entire plant, and TMY3 annualized weather data that normalizes operation over time. |

| DNVGL ID | Program | End Use | Measure | Program Track | Facility Type | Primary Reasons for Discrepancies |
|---|---|---|---|---|---|---|
| PC10000209 | Retrofit | Lighting | Systems | Custom | Grocery | The evaluation hours of use are 1% less than assumed in the tracking system estimate. The cooling credit increased savings by 11%. |
| PC10000209 | Retrofit | Lighting | Systems | Prescriptive | Grocery | The sum of the fixture savings in the file is 2% higher than the total reported in the file and in the tracking system. The evaluation hours of use are 17% lower than assumed in the tracking system estimate. The cooling credit increased savings by 5%. |
| PC10000216 | Retrofit | Process | Motors | Custom | Mfg. | Both motors and VFDs were removed. |
| PC10000216 | Retrofit | Process | VFDs | Custom | Mfg. | Both motors and VFDs were removed. |
| UC10000031 | Retrofit | Process | Comp Air | Prescriptive | Mfg. | The tracking savings are based on deemed savings so we are unable to be sure about why they are different from the evaluated savings. |
| UC10000032 | Retrofit | Lighting | Controls | Prescriptive | Medical (Hospital) | The on-site reduction in hours of use is 48% greater than assumed in the tracking system. The cooling interaction savings is 5% lower than assumed in the tracking system. |
| UC10000032 | Retrofit | Motors | VFDs | Prescriptive | Medical (Hospital) | Baseline and installed kW were not provided but annual operating hours were included. The same equipment changes mentioned in motors applies here. The two 20 HP motors [P5D and P6D] have been removed. And the pump set of P25 and P26 serving AC10 are no longer in service. |
| UC10000032 | Retrofit | Motors | Motors | Prescriptive | Medical (Hospital) | Pumps P5D and P6D have been removed from the facility. This reduces the connected motor load by 40-HP and nearly 30.0 kW. Pumps P25 and P26 are still in place, but are no longer used. The provided additional capacity to cooling coils. They are not needed as capacity issues have been resolved through repairs and maintenance. They will not be used in the future. |
| UC10000032 | Retrofit | HVAC | AHUs | Custom | Medical (Hospital) | Evaluation hours of use are 43% lower than assumed in the tracking system savings estimate. |
| UC10000036 | New Construction | Lighting | Systems | Prescriptive | Retail | While the total number of lamps was nearly equal between the tracking and on-site conditions, the quantities of fixtures and fixture types were different. These differences caused the evaluation savings to be 5% higher than the tracking savings. The evaluation hours of use are 36% higher than assumed in the tracking system estimate. The cooling credit increased savings by 15%. |
| UC10000036 | New Construction | Lighting | Controls | Prescriptive | Retail | The file review found more than three times the savings reported in the tracking system. The average reduction in hours of use is 30% lower than the tracking system assumption. The cooling credit increased savings by 21%. |
| UC10000049 | New Construction | HVAC | Chillers | Prescriptive | School | There weren't any calculations that show how the savings were derived. This measure installs one efficient 10-ton unit. The manufacturer's specifications show 12.0 total unit kW. The installed 25-ton chiller is rated at 27.4 total kW. Our monitoring shows that both chillers are taken offline on October 1st. We monitored into mid-November and found no additional usage. This is appropriate as outside air economizer can provide cooling, if necessary, in place of the compressors. Cooling begins April 1st. That provides a 183-day cooling season and a total of 4,392 cooling hours. The combined power for both the 10-ton and 25-ton units is 39.4 kW. |
| UC10000049 | New Construction | Motors | VFDs | Prescriptive | School | Savings were presented as a total and not by individual unit or by fan type. Most of the motors serve lab and science areas. Our monitoring over 113-days shows continuous operation for several units [lab exhaust fans LEFs and science area RTUs 1 & 4] and high usage for the remaining units [RTUs 2 & 3]. The time frame includes summer periods, transition over to the normal school schedule, and holidays. We're confident that our monitored hours are accurate. All units have significantly higher annual run times over TRM designated end usages. |

| DNVGL ID | Program | End Use | Measure | Program Track | Facility Type | Primary Reasons for Discrepancies |
|---|---|---|---|---|---|---|
| UC10000049 | New Construction | Lighting | Systems | Prescriptive | School | The fourteen fixtures planned for installation in the greenhouse were not installed through the program. The evaluation hours of use are 25% lower than assumed in the tracking system estimate. The cooling credit increased savings by 5%. |
| UC10000049 | Retrofit | Lighting | Systems | Prescriptive | School | The savings calculated from the detail in the project file are 17% lower than those reported in the tracking system. The evaluation hours of use are 11% lower than assumed in the tracking system estimate. The cooling credit increased savings by 5%. |

## Table 33: Gas Sample Results and Reasons for Discrepancies

| DNVGL ID | Program | End Use | Measure | Program Track | Facility Type | Tracking Annual MMBtu | Eval. Annual MMBtu | Annual MMBtu Realization Rate | Primary Reasons for Discrepancies |
|---|---|---|---|---|---|---|---|---|---|
| LCG1000003 | New Construction | HVAC | Condensing Boilers, HRV, and Radiant Floor Heating | Custom | Apartments | 823 | 781 | 95% | Tracking savings are based on modeling. Using the assumptions found in the project file, the file review savings were calculated to be 1% higher than the tracking savings. The evaluation savings are 5% lower than the tracking savings due to a decrease in EFLH. |
| LCG1000006 | New Construction | HVAC | Boilers, ERVs, & Pool Dehumidifier | Custom | Other | 1,952 | 1,560 | 80% | Evaluation EFLH values are 20% lower than assumed in the prescriptive tracking savings estimate. |
| LCG1000007 | New Construction | HVAC | Heat Exchangers | Custom | Grocery | 6,825 | 4,251 | 62% | The reason for the savings variance is improper methodology, erroneous equipment performance assumptions, and general lack of detail with the savings calculations. |
| LCG1000014 | Retrofit | HVAC | Boiler Reset Controls | Custom | School | 30 | 0 | 0% | The project file did not provide any support for how the tracking savings estimate was calculated. The premise behind boiler reset controls is that maximum heating hot water temperatures are needed during the coldest times of the year. Less heat is required to maintain space temperatures as outside temperatures rise. These controls lower the hot water supply temperature accordingly. Savings come from reducing boiler short cycling and from reducing radiation losses from the boiler jacket, pipes and fittings. Monitoring at the site found that the temperature reductions are due to cycling and not the reset controls. Supply water temperatures should drop as outside air temperatures rise but the on-site monitoring actually found the opposite to be true. We are unable to tell for sure if this is a result of the installed controls but if it is, there may be negative savings for this measure. |
| LCG1000018 | Retrofit | HVAC | Steam Traps | Custom | Mfg. | 1,531 | 1,531 | 100% | No discrepancy was found. |
| LCG1000019 | New Construction | HVAC | Condensing Boilers, DHW Heaters, & Windows | Custom | Medical (Hospital) | 3,196 | 2,229 | 70% | Evaluation EFLH values are 30% lower than assumed in the prescriptive tracking savings estimate. |
| LCG1000025 | New Construction | HVAC | Condensing Boilers | Custom | Mfg. | 440 | 624 | 142% | Tracking savings uses deemed savings value. Evaluation EFLH values higher than assumed in deemed savings value. |
| LCG1000026 | Retrofit | HVAC | Condensing Boilers | Custom | Apartments | 52 | 61 | 116% | Tracking savings uses deemed savings value. Evaluation EFLH values higher than assumed in deemed savings value. |
| LCG1000040 | New Construction | HVAC | Waste Heat Recovery | Custom | Grocery | 2,888 | 3,068 | 106% | Assumed 80% of heating load would be covered by refrigeration heat recovery in tracking system. Evaluation found that 85% of heating load was covered. |
| LCG1000041 | New Construction | HVAC | Condensing Boilers | Custom | Apartments | 52 | 79 | 150% | Tracking savings uses deemed savings value. Evaluation EFLH values higher than assumed in deemed savings value. |

| DNVGL ID | Program | End Use | Measure | Program Track | Facility Type | Tracking Annual MMBtu | Eval. Annual MMBtu | Annual MMBtu Realization Rate | Primary Reasons for Discrepancies |
|---|---|---|---|---|---|---|---|---|---|
| LCG1000030 | Retrofit | HVAC | Programmable Thermostats, Attic & Basement Insulation, Air Sealing, and Low-flow Showerheads and Faucet Aerators | Custom | Apartments | 5,454 | 4,823 | 88% | The calculations drew from a selection of state TRMs from Indiana to New York and beyond. No modifications were made to customize TRM variables to conform with New Hampshire conditions. A 53°F ground water temperature was taken from the NY TRM while NH DEP data lists average NH groundwater at 55°F, for example. A lack of standardization between the measures also contributes to the savings shortfall (5,827 HDDs were used in the thermostat calculations while, on the same page, 6,294 HDDs were used for attic insulation/air sealing and 6,806 HDDs were used for basement insulation/air sealing). The HDD method is inapplicable for the basement measure as temperature differentials are a function of average ground temperature according to depth below grade rather than outside air temperatures. Also, aerator savings did not include the number of residents and was only using 2 gallons/day/apartment. |
| LCG1000031 | Retrofit | HVAC | Steam Traps | Custom | Medical (Hospital) | 1,361 | 1,361 | 100% | No discrepancy was found. |
| LCG1000042 | New Construction | HVAC | Condensing Boilers | Custom | Mfg. | 498 | 939 | 189% | The average efficiency for the monitoring period was 92.1%. Tracking savings are based upon a 90.0% installed efficiency. Plus, the tracking calculations had a calculation error. The percent improvement was calculated using an improper denominator and savings were 15.0% better than baseline rather than the 13.3% used in the tracking equation. |
| LCG1000049 | New Construction | HVAC | Heat Pumps | Custom | Medical (Hospital) | 1,117 | 1,167 | 104% | The on-site evaluation found differences between the system efficiency and set-points versus what was assumed in the tracking estimate of savings. These differences increased savings by 4%. |
| LCG1000049 | Retrofit | HVAC | Steam Traps | Custom | Medical (Hospital) | 1,615 | 1,615 | 100% | No discrepancy was found. |
| LCG1000063 | Retrofit | HVAC | Steam Traps | Custom | Mfg. | 3,591 | 3,591 | 100% | No discrepancy was found. |
| LCG1000066 | Retrofit | HVAC | Steam Traps | Custom | Medical (Hospital) | 2,511 | 2,511 | 100% | No discrepancy was found. |
| LCG1000067 | Retrofit | HVAC | Boilers, ERVs, water heaters, windows, roof & wall insulation | Custom | Apartments | 2,617 | 1,472 | 56% | The original calculated savings for this site was over 94% of the site's total usage. It appears that this error was noticed and the savings were reduced by one-third for all installed measures; leaving the calculated savings at approximately 63% of the site's total usage. It appears that the current tracking savings were prorated to be more consistent with gas usage; as new calculations supporting the tracking savings estimate could not be found. Using the data collected on-site and baseline information from the documentation, we calculate a total savings that is 56% of the tracking system estimate. |
| LCG1000069 | New Construction | HVAC | Gas Rooftop Units | Custom | Warehouse | 2,979 | 1,476 | 50% | Evaluation FLEH were 50% of what was assumed in the tracking system savings estimate. |

| DNVGL ID | Program | End Use | Measure | Program Track | Facility Type | Tracking Annual MMBtu | Eval. Annual MMBtu | Annual MMBtu Realization Rate | Primary Reasons for Discrepancies |
|---|---|---|---|---|---|---|---|---|---|
| LCG1000071 | Retrofit | Lighting Systems | Co-Gen | Custom | Mfg. | 7,693 | 8,450 | 110% | Evaluation hours of use are 10% greater than assumed in the tracking system estimate. |
| LCG1000071 | Retrofit | Lighting Controls | Co-Gen | Custom | Mfg. | 1,611 | 1,141 | 71% | Evaluation reduction in hours of use is 29% less than assumed in the tracking system estimate. |
| UC10000010 | Retrofit | Hot Water | Burner Controls | Custom | Mfg. | 9,630 | 9,478 | 98% | Tracking savings used manufacturer's prediction of the new burner control's ability to reduce excess combustion oxygen to less than 3%. The evaluation savings uses a comparison of 20-month period of pre-installed actual boiler gas consumption compared to 17-month period of post-installed boiler gas consumption. |
| UC10000018 | New Construction | HVAC | Condensing Boilers | Prescriptive | Apartments | 154 | 192 | 125% | Tracking assumes deemed savings of 77.1 MMBtu/unit. Monitored evaluation savings are 96.1 MMBtu/unit. |
| UC10000018 | New Construction | HVAC | Boiler Controls | Prescriptive | Apartments | 4 | 4 | 100% | No discrepancy was found. |
| UC10000018 | New Construction | HVAC | Thermostat | Prescriptive | Apartments | 71 | 71 | 100% | No discrepancy was found. |
| UC10000018 | New Construction | Hot Water | Water Heater | Prescriptive | Apartments | 15 | 15 | 100% | No discrepancy was found. |
| UC10000019 | New Construction | HVAC | Condensing Boilers | Prescriptive | Office | 44 | 63 | 142% | Tracking savings uses deemed value. Evaluation EFLH values higher than assumed in deemed savings value. |
| UC10000023 | New Construction | HVAC | Condensing Boilers | Prescriptive | Hotel | 1,056 | 962 | 91% | Tracking savings uses deemed savings value. Evaluation EFLH values higher than assumed in deemed savings value. |
| UC10000024 | New Construction | HVAC | Condensing Boilers | Prescriptive | Office | 44 | 29 | 67% | Tracking system uses deemed savings. The evaluation savings are based on a nameplate efficiency of 94.5%, a capacity of 106 MBH, and a metered EFLH of 907. |
| UC10000026 | Retrofit | Hot Water | Boiler Stack Economizers | Custom | Mfg. | 6,491 | 4,863 | 75% | The tracking savings calculation is based on different load assumptions for the economizers installed on two boilers. The load assumption for one is 100% which assumes that the boiler is constantly on and firing at the highest rate. The assumption for the second boiler is 50%. Actual monitored data from the site shows that the two boilers run at a 48.6% average firing rate. |

## D. End Use Level Results for FCA Purposes

Table 34 summarizes the end use level results related to the Forward Capacity Auction (FCA) that the sponsors participate in through ISO-New England. These are the key inputs for calculating summer and winter demand savings. Lighting results are broken out into several categories, which are defined as follows:

- CI Lighting All: All lighting combined (includes interior and exterior and controlled and uncontrolled)
- CI Lighting Interior All: All interior lighting that are not on controls regardless of bulb type.
  - *CI Lighting Interior LEDs: Only interior LEDs that are not on controls. Subcategory of "CI Lighting Interior All".*
  - *CI Lighting Interior non-LEDs: All non-LED interior fixtures that are not in controls. Subcategory of "CI Lighting Interior All".*
- CI Lighting OS: All interior lighting that is controlled by occupancy sensors regardless of bulb type.
- CI Lighting Parking Lot Lights: All parking lot lights regardless of bulb type.

The in-service rate and kW persistence results compare the evaluation quantity of products installed and connected kW savings to the same values that are present in the project files. The coincidence factor results represent the percent of time that program installed measures were found to be operating during the summer and winter peak periods. These coincidence factors are derived from the same data that was used in reporting the results in Table 20. The precisions associated with each input can be used in the process of calculating statistical precisions at the measure level which can then be built up to program and portfolio level precisions.

**Table 34: FCA Factor Results by End Use (Evaluation vs. Project File Savings)**

| End Use | In-Service Rate | | kW Persistence | | Connected kW Realization Rate | | Summer Coincidence Factor | | Winter Coincidence Factor | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Result | Estimated Precision at 80% CI | Result | Estimated Precision at 80% CI | Result | Estimated Precision at 80% CI | Result | Estimated Precision at 80% CI | Result | Estimated Precision at 80% CI |
| CI Lighting All | 96.4% | ±2.4% | 101.5% | ±1.8% | 97.8% | ±3.0% | 55.4% | ±17.0% | 48.6% | ±21.8% |
| CI Lighting Interior All | 97.7% | ±2.8% | 100.0% | ±6.9% | 97.7% | ±7.5% | 62.9% | ±12.9% | 50.8% | ±16.3% |
| *CI Lighting Interior LED* | *93.7%* | *±2.3%* | *103.3%* | *±19.4%* | *96.9%* | *±19.5%* | *82.7%* | *±10.1%* | *84.3%* | *±11.7%* |
| *CI Lighting Interior Non-LED* | *99.6%* | *±3.9%* | *98.5%* | *±3.0%* | *98.1%* | *±4.9%* | *60.2%* | *±8.0%* | *46.4%* | *±11.3%* |
| CI Lighting OS | 96.2% | ±6.4% | 98.6% | ±3.3% | 94.9% | ±7.2% | 40.3% | ±11.5% | 26.1% | ±18.4% |
| CI Parking Lot Lights | 100.0% | ±0.0% | 100.0% | ±0.0% | 100.0% | ±0.0% | 0.0% | - | 100.0% | - |
| Heating | 100.0% | ±0.0% | 100.0% | ±0.0% | 100.0% | ±0.0% | 0.0% | - | 60.8% | ±27.7% |
| Cooling | 100.0% | ±0.0% | 100.0% | ±0.0% | 100.0% | ±0.0% | 44.4% | ±23.0% | 0.0% | - |
| Motors & Drives | 97.8% | ±1.9% | 100.0% | ±0.0% | 97.8% | ±1.9% | 72.6% | ±7.5% | 71.8% | ±4.6% |
| Process | 73.9% | ±29.2% | 100.0% | ±0.0% | 73.9% | ±29.2% | 73.8% | ±6.8% | 57.9% | ±15.3% |
| Custom | 100.0% | ±0.0% | 100.0% | ±0.0% | 100.0% | ±0.0% | 5.9% | ±79.1% | 27.3% | ±17.5% |

## E. Select Results by End Use and Business Type

Following the delivery of the draft version of this report, the sponsors expressed interest in the energy savings realization rates by end use. Table 35 presents these results for electric measures.

**Table 35: Electric Energy Savings Results by End Use**

| Parameter/Adjustment | Lighting (n=30) | HVAC (n=8) | Motors (n=8) | Process (n=8) | Custom (n=2) | Refrigeration (n=0) | All Electric (n=42) | % Gross |
|---|---|---|---|---|---|---|---|---|
| Tracking Savings (MWh) | 15,287 | 4,854 | 3,388 | 4,900 | 1,733 | 79 | 30,242 | - |
| Documentation Adj. | -125 | -12 | -13 | -270 | 0 | 0 | -420 | -1.4% |
| Technology Adj. | 249 | 0 | 0 | 0 | 0 | 0 | 248 | 0.8% |
| Quantity Adj. | -591 | 0 | -434 | 0 | 0 | 0 | -1,025 | -3.4% |
| Operational Adj. | -432 | -991 | 458 | 1,346 | 0 | 0 | 382 | 1.3% |
| HVAC Interactive Adj. | 807 | 0 | 0 | 0 | 0 | 0 | 807 | 2.8% |
| Adjusted Gross Savings | 15,196 | 3,850 | 3,399 | 5,977 | 1,733 | 79 | 30,235 | 100.0% |
| Gross Realization Rate | 99.4% | 79.3% | 100.3% | 122.0% | 100.0% | - | 100.0% | - |
| Relative Precision | ±7.0% | ±18.1% | ±22.5% | ±11.9% | ±1.2% | - | ±5.0% | - |
| Confidence Interval | 80% | 80% | 80% | 80% | 80% | - | 80% | - |
| Error Ratio | 0.32 | 0.38 | 0.61 | 0.27 | 0.02 | - | 0.28 | - |

Table 36 presents the gas energy savings realizations rates by end use.

**Table 36: Gas Energy Savings Results by End Use**

| Parameter/Adjustment | HVAC (n=23) | Hot Water (n=3) | Co-Gen (n=1) | Process (n=0) | All Gas (n=26) | % Gross |
|---|---|---|---|---|---|---|
| Tracking Savings (MMBtu) | 64,030 | 16,279 | 9,303 | 117 | 89,730 | - |
| Documentation Adj. | -1,768 | 0 | 0 | 0 | -1,768 | -2.0% |
| Technology Adj. | -2,485 | 0 | 0 | 0 | -2,485 | -2.8% |
| Quantity Adj. | 0 | 0 | 0 | 0 | 0 | 0.0% |
| Operational Adj. | -1,927 | -1,822 | 292 | 0 | -3,457 | -4.0% |
| HVAC Interactive Adj. | 0 | 0 | 0 | 0 | 0 | 0.0% |
| Adjusted Gross Savings | 57,850 | 14,456 | 9,596 | 117 | 82,020 | 91.4% |
| Gross Realization Rate | 90.3% | 88.8% | 103.1% | - | 91.4% | - |
| Relative Precision | ±4.8% | ±0.02 | ±0.0% | - | ±3.2% | - |
| Confidence Interval | 80% | 80% | 80% | - | 80% | - |
| Error Ratio | 0.29 | 0.13 | 0.00 | - | 0.24 | - |

The lighting results are split out further by interior fixtures, exterior fixtures, and occupancy sensors in Table 37.

**Table 37: Lighting Energy Realization Rates by Measure Type**

| Lighting Type | Sample Size (# of sites) | Realization Rate | Precision at 80% CI |
|---|---|---|---|
| Energy Savings (kWh) | | | |
| Interior Fixtures | 30 | 87.5% | ±29.3% |
| Occupancy Sensors | 14 | 173.4% | ±78.9% |
| Exterior Fixtures | 5 | 97.3% | ±3.3% |

The interior fixture and occupancy sensor results are broken out by business type in Table 38 below.

**Table 38: Interior Fixture and Occupancy Sensor Energy Realization Rates by Business Type**

| | Interior Fixtures | | | Occupancy Sensors | | |
|---|---|---|---|---|---|---|
| Business Type | Sample Size (# of sites) | RR | Precision at 80% CI | Sample Size (# of sites) | RR | Precision at 80% CI |
| Retail | 6 | 82.9% | ±70.8% | 1 | 319.9% | - |
| Grocery | 5 | 110.2% | ±54.6% | 0 | - | - |
| School (K-12) | 5 | 76.0% | ±74.3% | 2 | 278.7% | ±109.2% |
| Manufacturing | 3 | 86.3% | ±21.3% | 3 | 279.8% | ±63.6% |
| Office | 3 | 99.5% | ±63.1% | 1 | 78.1% | - |
| University/College | 3 | 85.6% | ±82.0% | 2 | 130.4% | ±103.8% |
| Other | 2 | 91.7% | ±112.2% | 1 | 81.7% | - |
| Medical (Hospital) | 1 | 15.6% | - | 2 | 161.4% | ±124.9% |
| Restaurant | 1 | 76.7% | - | 1 | 83.6% | - |
| Warehouse | 1 | 115.3% | - | 1 | * | - |

* The tracking system did not claim occupancy sensor savings for this site.

The sponsors were also interested in the connected demand savings realization rates by the end use categories presented in Table 19 and Table 20. The results provided in Table 39 and the other tables in this section are case-weighted to represent the population. Table 39 compares the evaluated connected kW savings to the tracking system connected kW savings.

Results are also provided for process, cooling, and occupancy sensors after removing anomalies. Three of the four process anomalies were sites that had zero connected kW savings in the tracking system while the four was a site where all program measures had been removed. One cooling site was removed due to a tracking estimate that was more than five times higher than the evaluation savings. Eight occupancy sensor sites were removed because they had zero tracking savings, while the remaining sensors sites was removed because the tracking system estimate was only 9% of the evaluation savings.

**Table 39: Connected Demand Realization Rates by End Use (Evaluation vs. Tracking Savings)**

| | All Sites | | | After Removing Anomalies | | |
|---|---|---|---|---|---|---|
| End Use | Sample Size (# of sites) | Realization Rate | Precision at 80% CI | Sample Size (# of sites) | Realization Rate | Precision at 80% CI |
| C&I Lighting | 23 | 98.5% | ±9.3% | No Change | | |
| C&I Process | 17 | 355.3% | ±35.1% | 13 | 150.5% | ±37.5% |
| C&I Lighting OS | 14 | 254.4% | ±56.0% | 5 | 98.5% | ±14.1% |
| C&I Lighting LED | 9 | 98.9% | ±22.2 | No Change | | |
| C&I Cooling | 8 | 33.3% | ±40.4 | 7 | 76.0% | ±38.3% |
| C&I Parking Lot Lights | 5 | 100.1% | ±0.2 | No Change | | |
| C&I Heating | 3 | 122.6% | ±27.9% | No Change | | |

Table 40 shows the connected demand realization rates by business type for all C&I lighting installations. The low realization rate for medical (hospital) was caused primarily by an installed quantity reduction when comparing the tracking system estimate to the evaluation findings.

**Table 40: C&I Lighting Connected Demand by Business Type**

| Business Type | Sample Size | Total Weighted Connected Demand Savings (kW) | Precision at 80% CI |
|---|---|---|---|
| School (K-12) | 6 | 617.5 | ±56.5% |
| Retail | 5 | 414.7 | ±59.7% |
| Manufacturing | 3 | 212.2 | ±107.9% |
| Office | 3 | 456.4 | ±76.9% |
| Other | 2 | 102.6 | ±108.0% |
| Grocery | 1 | 74.3 | - |
| Medical (Hospital) | 1 | 4.5 | - |
| Restaurant | 1 | 4.4 | - |
| University/College | 1 | 179.1 | - |

# F. Measure-Level Analysis Methodology

This appendix provides the data collection and analysis methodology for the measures that were most frequently encountered in this evaluation. These measures accounted for nearly 90% of the measures and savings in the sample.

## Lighting

***Monitoring.*** Time-of-use (TOU) lighting loggers were installed to measure lighting hours of use for a minimum period of four weeks. These small devices use a photocell sensor to sense and record the dates and times that a light fixture turns on and off. The lighting logger data was used to create 8760 profiles from which annual hours of use and summer and winter peak savings could be calculated.

Factors that drove the number of installed loggers included the number of unique schedules at the site, the anticipated level of variation among the schedules within a particular space type, and the type of controls installed on the lighting.

***Verification*.** A detailed inventory is performed for each lighting measure. This inventory includes a verification of the quantity and technologies installed from the program. The types of heating and cooling systems serving the areas of the installed lighting are recorded for the calculation of interactive HVAC effects.

***Analysis.*** After the logger data is downloaded from each logger, hourly percent on-time values were calculated for each day of the week and for holidays during the monitoring period. Site hours of operation were gathered; including holidays and changes in operation that may occur throughout the year (due to seasonal, occupancy, production variations, etc.). Using these adjustments as necessary, the hourly monitored percent on-times were applied to similar days (including holidays) and hours that occurred outside of the monitoring period.

Annualized trend data and field verified equipment and quantities are entered into a lighting spreadsheet. NSTAR database values will be used for fixture wattages with site verified modifications as needed. The analysis spreadsheet calculates annual kW and kWh savings for the installed system as compared with the baseline equipment. Associated heating and cooling impact are from the variance in connected loads.

The savings were calculated as line-by-line comparisons of pre- and post-retrofit electrical use. Pre and post retrofit energy estimates were developed for each line item within each measure. The appropriate 8760 schedule is then applied to each line to calculate savings.

Lighting Analysis Summary:

- Review file documentation
- Identify lighting types, fixture counts, and control strategies by area
- Install TOU loggers to obtain operational representative sample of equipment/operation
- Perform field walk-through to identify technologies and counts
- Conduct interview with site personnel
- Verify baseline assumptions with key decision maker at the site
- Verify heating/cooling equipment by area
- Retrieve TOU loggers after monitoring period
- Download logger data and review annualization factors
- Enter annualized operation and field verified lighting technologies into spreadsheets

## Chillers

***Monitoring.*** For measures that affect cooling equipment operation, system electrical demand usually varies as a function of indoor and/or outdoor temperature, or machine loading. In some cases, sufficient information can be obtained without direct monitoring in the form of EMS trend reports or comprehensive plant operating logs and schedules. These detailed logs often provide hourly performance data over the

entire operating season. This information, along with manufacturer data, permits accurate analysis of loads and performance.

Where monitoring is performed, system electrical usage is quantified either by direct current or power monitoring, or by time-of-use monitoring supported by spot power measurements. Current and/or power loggers are installed to trend the operation of key tower fans and pumps to determine usage patterns and measure capacity. When possible, extensive use is made of data accumulated in existing facility energy management systems. These systems have the ability to trend such variables as chilled water temperature, condenser water temperature, space temperature, space humidity, cooling tower scheduling and set points, equipment run times, and other key variables. As available, this data is incorporated into all analyses and combined with the data trended in the field.

***Verification*.** Chillers and ancillary equipment are verified during the site visit. Data collection includes quantity and size of chillers, operating schedules, seasonal usage, system temperatures and control settings, and free cooling options. Chiller and facility operations will be discussed with site personnel to identify problems in operation and note changes in operation that may have occurred since measure installation.

***Analysis.*** Cooling measures are analyzed in 8,760-hour spreadsheets, since system electrical demand usually varies as a function of indoor and/or outdoor temperature or machine loading. System electrical usage is calculated for each hour of the year using the schedule, power, temperature, and other variables collected at the site. The result of this analysis is an annualized estimate of energy use that considers variation with temperature.

Prescriptive chillers, however, are often reduced to line-item calculations for like comparison to the tracking system calculations. In these instances, care is taken to compensate for loading and operational variations by employed integrated part load values (IPLV) for chiller efficiency and full load equivalent hours (FLEH) in simplified calculations. Evaluators refine these estimates through more complex power vs. temperature and hourly analyses and then fold these revised parameters into the original calculations for ease of comparison.

Chiller Analysis Summary:

- Review file documentation
- Identify baseline and new construction chiller efficiencies
- Identify free-cooling and ancillary equipment changes
- Install power loggers to obtain operational representative sample of equipment
- Obtain chiller logs and operating documentation
- Conduct interview with site personnel
- Verify baseline assumptions with key decision maker at the site
- Perform field walk-through to verify chiller and cooling equipment
- Obtain total dynamic head for pumping loop(s)
- Determine chilled water flow for loop(s)
- Identify chilled water supply temperature
- Obtain chiller lead lag sequencing schedules
- Identify chiller load reset temperature schedules
- Obtain space temperatures and humidity
- Calculate tower water and approach temperatures
- Retrieve loggers and download data
- Compile site information and logger data and perform bin analysis

## Compressed Air

***Monitoring*.** Direct power measurement or trending is employed to measure the performance of compressed air systems. In lieu of power monitoring, modern air compressors often have integral meters that monitor amperage, kW, or part/full load hours that can be employed to develop a reasonable proxy for power monitoring. Spot power measurements, operating logs, pressure set points and readings, and CFM demand profiles are also useful sources of information for expressing the operational characteristics of a compressed air system.

***Verification*.** Compressed air equipment is verified during the site visit. Data collection includes quantity and size of equipment, operating schedules, seasonal usage, and control settings. Compressed air and facility operations will be discussed with site personnel to identify problems in operation and note changes in operation that may have occurred since measure installation. The site visits verifies equipment installation. Facility operation and any changes that occurred since construction are discussed with site personnel, and baseline equipment is also reviewed at that time.

***Analysis*.** Once equipped with representative energy and demand estimates, compressed air systems are assessed in 8,760-hour spreadsheets. The energy usage of the baseline system is modeled by hour for a typical year at the same pressure/flow profile. The difference between these annual estimates is the normalized annual energy savings for the installation. It is particularly important to consider the entire compressed air system as a whole to capture the interactive effects between multiple air compressors, refrigerated air dryers, and even space conditioning.

Compressed Air Analysis Summary:

- Review file documentation
- Identify baseline and new construction equipment and calculation methodology
- Conduct interview with site personnel
- Verify baseline assumptions with key decision maker at the site
- Perform field walk-through to identify equipment and operation
- Determine if any ancillary equipment – such as air dryers – could add to savings
- Install power loggers to obtain operational representative sample of operation
- Obtain additional performance measurements from in-house monitoring
- Retrieve power loggers after monitoring period
- Download logger data and enter monitored operating trends along with field verified data into spreadsheets

## Variable Speed Drives

***Monitoring.*** Power loggers and current loggers are typically used to monitor VSD operation. These loggers provide two valuable inputs – average power draw of the system and its operating schedule. Loggers are installed to assure coverage on a representative sample of VSD applications. Sometimes the scope of the project, the scattered location of the VSDs, or availability of monitoring equipment does not permit high sample rates for power monitoring, so MVA for VSDs often accommodates additional data sources to supplement measured data. This can include data obtained from control panel readouts and trend reports from energy management systems. Since most VSD applications vary with an external input like a process cycle, outdoor temperature, static duct pressure, or return water temperature, evaluators will identify these parameters and monitor them as appropriate.

***Verification*.** Equipment and systems will be verified during the site visit. This includes verifying motor data, confirming that the VSD is operational and not in manual override, and recording speeds on the VSD digital display. System and facility operations are discussed with site personnel to identify problems in operation and note changes in operation that may have occurred since measure installation.

***Analysis.*** Variable speed drive measures are analyzed in 8,760-hour spreadsheets which allows for the calculation of demand at each hour using the conditions monitored during the site evaluation. Temperature and air enthalpies are the most common variables. Variable speed fans and pumps on HVAC systems tend to trend with ambient dry-bulb or wet-bulb temperature. Process machinery may be expressed by a mean demand across a repeating profile, or an analysis may be performed on a manufacturing process in bins of percent full speed. In VSD measures involving cyclic manufacturing processes, a single average demand will be used in a line-item calculation. Where possible and appropriate, the same methodology employed in the tracking system gross estimate was used to develop on-site savings estimates. Key parameters to this analysis are either an operating profile or mean demand, and the number of operating hours at each condition. The demand profile of the equipment can be either spot measured and averaged or current/power monitoring equipment can be deployed to track equipment energy consumption over time. In either case, spot power measurements are performed. If the VSDs are installed in electrically conditioned

space, then it is appropriate to calculate interactive HVAC effects (cooling benefit or heating penalty) for the measure.

When the baseline condition is well defined, those values are employed as the baseline. But baseline power and flow of VSD equipped systems is not always measured or well documented. In lieu of this data, such as in systems where the CFM airflow through a fan is modulated by inlet guide vanes (IGV) in the baseline scenario, evaluators will default to empirical relationships. Using power curves established by fan law theory and calibrated to actual monitored data, mathematical relationships can be developed to facilitate the derivation of IGV/VSD power or flow from known quantities. Such formulae are applied to each measured, fifteen-minute interval kW reading to derive associated estimates for the baseline fan flow/power under IGV control.

While the theoretical relationship between flow and power is cubic, many contractors use a degraded exponent such as 2.5 or 2.6 to adjust for actual performance. It is not uncommon for these 'fan laws' to be misapplied. In reviewing VSD measures in the past, DNV GL has encountered a variety of calculations and assumed relationships between flow and power. Using this standard curve as the default for evaluation work serves to normalize these sometimes-disparate engineering estimates, reduce calculation bias, and improve the precision of the adjusted gross estimates.

Variable Speed Drive Analysis Summary:

- Review file documentation
- Identify VSD quantities and applications
- Install power loggers to obtain operational representative sample of VSD operation
- Conduct interview with site personnel
- Verify baseline assumptions with key decision maker at the site
- Perform field walk-through to verify VSD installation and controlled equipment
- View drive readings at local control panel
- Obtain facility data including:
    - motor horsepower by unit
    - total system capacity (CFM/GPM)
    - outside air percentage
    - ventilation control strategies, temperatures
    - shell data
    - operating schedules
    - fan/pump curves
    - minimum fan/pump system speeds
    - remaining data required for simulation spreadsheet calculations
- Retrieve power loggers after monitoring period
- Download logger data
- Enter monitored operating trends along with field verified data into simulation spreadsheets

## Energy Management Systems

***Monitoring.*** Due to the number and complexity of controlled points, monitoring can be a challenge for energy management systems. Often, it is most practical and valuable to obtain the operating schedules directly from the central system or head end. In some instances, if the controlled equipment or spaces were not clearly defined or accessible, monitoring can be employed to confirm the existence of computer control. Furthermore, one cannot always trust that an EMS is actually performing its programs controls, so monitoring serves to validate the connectivity of the system. Because of the diversity of control system applications, the analysis techniques vary greatly, often including either multiple 8,760-hour analyses or computer building simulations.

When possible, time-of-use loggers, Elite power loggers, and temperature/RH loggers are installed. The data collected by these loggers can then be compared to the EMS trends to calibrate the two data sources and confirm the accuracy of EMS trends.

***Verification.*** The first step in an analysis of EMS performance is a review of mechanical and electrical as-built prints that identifies the systems in the facility. Schedules of equipment are reviewed and all design

factors are noted. These include motor horsepower, brake horsepower, total CFM and ventilation capacities, rated heating and cooling capacities, chiller data, and all information required to effectively model building performance. Evaluators strive to review test-and-balance reports and other documents that show how the specified units may have changed since installation. One important goal is to identify the installed equipment and to understand how it relates to the space served.

The next step is a detailed review of the energy management system at the head end. The installed points and operating routines are reviewed screen-by-screen for each system, and all points of control are noted. Key pages are printed that show occupied/unoccupied schedules, temperature set points, and other parameters used in EMS savings calculations.

The EMS system is checked for the ability to generate warnings and flag conditions that are out of pre-set operating ranges. Copies of past printed warnings are reviewed to determine the frequency and magnitude of these conditions. Evaluators inquire with EMS operators whether the system has trending capacities. A trend of performance over time can be used in lieu of, or in conjunction with, field-installed monitoring equipment. Historical data is obtained whenever possible.

As part of the facility walk-through, engineers typically identify control override conditions and test end-to-end continuity. *Just because an EMS screen shows that a start/stop routine is in place does not mean that it is working in the field*. The walk-through identifies if units are in the "hand" or manual override position, or other conditions that will bypass EMS commands. Unless an override warning is sent back to the console end, there is no way to verify EMS operation other than field verification. Monitoring of the controlled system is performed when adherence to the EMS schedule is questioned.

Operation of the facility is discussed with plant personnel. This uncovers control and operational issues that can affect system performance. Spot readings are taken during the walk-through. These can be from digital displays on VSD panels, inline thermometers, pressure gauges, or other devices. The data obtained from the walk-through establishes the performance of the equipment and any special operating issues that must be addressed. Where useful to supplement this comprehensive data collection effort, data and power recorders are installed at this time.

***Analysis.*** For most EMS measures, the information gathered from the site visit is entered into a comprehensive building modeling spreadsheet. The existing equipment is entered into an equipment section of the spreadsheet. When new components such as air handlers or pumps are changed in conjunction with the EMS installation, a separate equipment section is created to account for that difference from base case assumptions. The building construction is used to create the thermal performance of the structure. Internal gains are calculated for lighting, plug loads, equipment in the conditioned air stream, and occupants. Separate levels of gains are calculated for both occupied and unoccupied periods. Solar gains are calculated using monthly ASHRAE data according to building orientation.

DNV GL employs an 8,760-hour spreadsheet that calculates energy usage for each hour of a typical meteorological year (TMY). The spreadsheet models a base case scenario using the equipment, thermal profile of the structure, internal gains, solar gains, efficiencies, temperature set points, and schedules. Different operating schedules are used for heating, cooling, mechanical ventilation, and internal gains. These multiple schedules permit variances in operation that is part of an operating profile. Heating and cooling hours may vary according to season, and some mechanical systems may operate at different schedules from the heating set points. Internal gains occur during a different schedule from heating and cooling reflecting warm-up and cool-down strategies.

Accurate representation of the baseline condition is critical for EMS evaluation. In project documentation, analysis generally flows from an analytical representation of the baseline system, which is then used as the template for the proposed condition. In evaluation, often the opposite proves more practical; evaluators 'reverse engineer' the baseline operation by revising the installed model with characteristics stated or evidenced to be the baseline. In either case, analysis takes care to ensure that the 'before' and 'after' scenarios reflect consistent building loads and space conditions as appropriate. Where practical, the simulation is compared and calibrated to energy billing histories. Ultimately, EMS analysis compares baseline operation with installed operation and represents savings as the annualized difference.

Energy Management System Analysis Summary:

- Review file documentation
- Identify baseline and new construction control strategies

- Identify systems and equipment under EMS control
- Install data loggers to expand or refine operation (if needed)
- Conduct interview with site personnel
- Verify baseline assumptions with key decision maker at the site
- Review EMS screens and sequence of operations
- Conduct facility walk through to identify control in manual or override conditions
- Obtain facility data including:
    - motor horsepower by unit
    - total system capacity (CFM/GPM)
    - outside air percentage
    - ventilation control strategies, temperatures
    - shell data
    - operating schedules
    - fan/pump curves
    - minimum fan/pump system speeds
    - chiller data
    - ancillary cooling equipment – pumps, tower fans, etc.
    - remaining data required for simulation spreadsheet calculations
- Retrieve power loggers after monitoring period
- Download logger data
- Enter monitored operating trends along with field verified data into 8,760-hour spreadsheets

## About DNV GL

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16,000 professionals are dedicated to helping our customers make the world safer, smarter and greener.