Commercial Retro-Commissioning Program Manual for 2019

Introduction

The Commercial Retro-Commissioning Program (RCx) is designed to achieve demand and energy savings in commercial facilities. Savings are realized through the systematic evaluation of facility systems and implementation of low-cost measures targeted to improve HVAC system operation and, in many cases, improve occupant comfort.

This Program is offered to customers in the CenterPoint Energy Service Territory to enhance their facilities' comfort, productivity, and environment, while reducing energy costs by implementing low-cost measures.

This Program Manual includes detailed information about the RCx Program and guidelines for project implementation under this program.

Nexant, Inc. is the Program Administrator (PA) for this program offered by CenterPoint Energy.

CenterPoint Energy reserves the right to make modifications to this program at any time. Please check CenterPoint Energy's website for the most up-to-date information about the RCx Program: https://www.centerpointenergy.com/en-us/SaveEnergyandMoney/Pages/retro-commissioning-program.aspx

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1 Introduction

The CenterPoint RCx Program is a program for implementing low-cost /no-cost measures to optimize and enhance existing facility systems to improve performance, reduce peak demand (kW) and save energy (kWh). The program is administered by a third-party Program Administrator (PA).

1.1 Customer Eligibility

Eligible customers must be in the CenterPoint Energy service territory. Although most facilities can benefit from retro-commissioning services, sites having the following characteristics are preferred:

- Based on our interpretation of laws passed in 2007 (HB 3693), "transmission class industrials" are excluded from this program. However, "educational, government, and not-for-profit facilities" that are transmission class customers are not excluded and can participate. Based on final rulings by the Public Utility Commission (PUC), this interpretation is subject to change.
- Facilities must have a motivated in-house operations and maintenance staff that are available to support the project.
- Customers are required to commit funds of $3,000 toward implementation of identified RCx measures with simple paybacks less than 1.5 years (or the total cost of such measures if less than the $3,000 value), otherwise they are required to repay the cost of engineering services incurred ($0.04/kWh of savings identified in Investigation Phase Report).
- The building systems are free of major problems requiring costly repairs or replacements.
- All pertinent engineering mechanical systems design documentation is accessible.
- All measures incented by the program will not be eligible for CenterPoint Energy incentives under any other program.
- All projects must be implemented and verified within the agreed upon project schedule. The Owner and RCx agent will propose a schedule for each project at project kick-off. The schedule must be reviewed and approved by the PA. Typical project durations will be between 6 – 12 months.

Based on considerations such as those listed above, the PA will identify applicant facilities that have the highest perceived opportunity for savings to participate in the program and then will prioritize potential participants.

1.2 Retro-Commissioning Agents

Qualified RCx Agents are selected through a request-for-qualification process. Firms selected for the program are chosen based on a best-value ranking for performing retro-commissioning services that follow the program protocols. As part of the terms of the agreement, the RCx Agents agree to follow the guidelines set out in this program manual.

1.3 Key Changes for 2019

1.3.1 Payment Structure

The program brings back a customer incentive which is tied to certain performance metrics to maximize verified savings and to encourage quick implementation while a project is

fresh. A cap of 15% on claimed Investigation Phase savings as a percentage of total building consumption is introduced.

The $0.03/SF customer commitment is changed to a fixed not-to-exceed amount of $3,000. Customers commit to spending the lesser of $3,000 and the total identified measure bundle (measures with paybacks less than 5 years resulting in a total bundle payback of not more than 1.5 years). Customers are not only encouraged but also expected to provide input to the identified measure bundle from the very beginning of the project to ensure the measure bundle is focused on measures the customer can plan to implement.

1.3.2 Streamline Focus on Program Performance

The Preliminary Assessment phase is eliminated. The amount of building information captured on the application is reduced, and the Building Owner Agreement is combined into a single Program Application.

A list of formally excluded measures is introduced (lighting upgrades, chiller replacements, and other measures requiring large capital expenditures) to minimize time spent on these measures, which the program does not consider to be of an RCx nature.

A standard reporting template to reduce the level of effort on reporting is introduced. This will be followed by a full release of a standard measure calculator that saw limited release in 2018.

1.3.3 Promote Implementation

Quotes for all recommended measures at the Investigation Phase will be required. The expectation is that having quotes in hand instead of only estimated savings will put customers closer to initiating implementation at the end of the Investigation Phase. Measures for which obtaining quotes is difficult are measures the Program expects a customer would have a hard time implementing and are therefore less desirable for the Program.

1.4 Peak Demand Definition and Calculation Methodology

1.4.1 Definition

The peak demand reduction definition for 2019 projects meets the rules established under the TRM v6[1]. The goal is to identify the kW change of a RCM during the hours when the grid experiences a peak demand. The calculation procedure is restricted to hours of the most extreme outdoor temperatures—the warmest hours in the summer and the coldest hours in the winter. The demand to be reported is the average demand over the 20 hours of extreme temperature which occur inside the hours defined as the peak period. It is calculated as a weighted average of 20 demand values, one for each of the 20 hours, using as

[1] http://www.texasefficiency.com/images/documents/RegulatoryFilings/DeemedSavings/TRMv6.0%20Vol%201%20Overview_Final.pdf

the weights each hour's probability of the peak occurring during that hour. TMY3 data was used to predict the hours of extreme temperatures. ERCOT records were studied to find the probability values.

One value for demand savings is reported for each measure based on either the Summer or Winter Peak Period. Agents are expected to calculate energy savings based on both periods to determine the maximum possible savings and report only the higher of the two values.

1.4.2 Calculation Methodology

The following equation and example illustrates the calculation methodology that should be followed for calculating the peak period demand reduction for the program:

$$Peak\ Period\ kW\ Savings = \frac{\sum_i\ (Peak\ Probability\ Factor_i\ *\ Hourly\ kW\ Savings_i)}{\sum Peak\ Probability\ Factor}$$

Where:

Peak Probability Factor$_i$ = probability factor at the temperature bin
Hourly kW Savings$_i$ = hourly kW savings at the temperature bin
ΣPeak Probability Factor = summation of all probability factors.
Summer Peak 2019: 9.012717918
Winter Peak 2019: 4.0312842524

The peak probability factors for summer and winter are presented in Appendix A. For convenience, the factors have been combined into 5°F and 10°F bins for use in calculations.

Measures that are not weather dependent and fall within the peak period times can use the hourly kW savings as the peak period kW savings.

Example using bin temperatures:
A building has two main chillers with a smaller chiller used only for backup. Inspection of the chiller plant revealed that the smaller chiller pump (on a VFD and is10 HP) was on even though the chiller was not in use. The proposed measure will be to turn off the small chiller pump and only start it when the chiller comes online—usually during the winter time. The motor load factor is 80% and the efficiency is 90%.
To start, calculate the hourly kW savings using bin temperatures:

$$Hourly\ kW\ Savings_{100°\mathrm{F}-105°\mathrm{F}} = \frac{10\ HP * 0.746\frac{HP}{kW} * 0.8}{0.9} = 6.63\ kW$$

For 95°F -100°F bin we assume the kW is 95% of the max bin:

$$Hourly\ kW\ Savings_{95°\mathrm{F}-100°\mathrm{F}} = \frac{10\ HP * 0.746\frac{HP}{kW} * 0.8 * 0.95}{0.9} = 6.30\ kW$$

Next, use the table in Appendix A to find the probability adjusted savings for each line item. The table below shows the results.

Month	Day	Hour Ending	Hourly Temp. (°F)	Relative Probability	Hourly kW Savings	Probability Adjusted kW Savings
8	1	17	102.92	0.9294	6.63	6.1618
8	2	17	102.92	0.9294	6.63	6.1618
8	1	16	102.92	0.9189	6.63	6.0924
8	2	16	102.02	0.8657	6.63	5.7397
8	2	18	102.02	0.5754	6.63	3.815
8	12	17	98.96	0.5238	6.3	3.3002
8	5	16	98.96	0.4865	6.3	3.0648
8	29	16	98.96	0.4865	6.3	3.0648
8	1	15	100.94	0.4255	6.63	2.8211
8	2	15	100.94	0.4255	6.63	2.8211
8	1	18	100.94	0.4078	6.63	2.704
8	9	17	98.06	0.385	6.3	2.4252
8	29	17	98.06	0.385	6.3	2.4252
8	12	16	98.06	0.3502	6.3	2.2063
8	9	16	96.98	0.215	6.3	1.3546
8	8	17	96.08	0.1532	6.3	0.9654
8	27	17	96.08	0.1532	6.3	0.9654
8	28	17	96.08	0.1532	6.3	0.9654
8	26	16	96.08	0.1348	6.3	0.8494
8	12	15	98.06	0.1086	6.3	0.6842

Finally, add the probability adjusted kW savings and divide by the sum of the probability factors:

$$Peak\ Period\ kW\ Savings = \frac{58.5877\ kW}{9.0127}$$

$$Peak\ Period\ kW\ Savings = 6.50\ kW\ (summer)$$

Example without using temperature bins:
An office building is unoccupied from 5:30pm until 6:00am the next morning. The AHUs are scheduled to turn off at 8:00pm. The measure would be to turn off the AHUs at 5:30pm and save two and a half extra hours per day of runtime. The AHUs have 15 HP motors each with an efficiency of 90%. Only one AHU is affected.

$$Hourly\ kW\ Savings = \frac{15\ HP * 0.746\frac{HP}{kW} * 0.8}{0.9} = 9.95\ kW$$

This measure only has savings from 6:00pm; therefore, the probability adjusted savings for hours before 6:00pm will be zero. The table below breaks down the calculation.

Month	Day	Hour Ending	Hourly Temp (°F)	Relative Probability	Hourly kW Savings	Probability Adjusted kW Savings
8	1	17	102.92	0.9294	0	0
8	2	17	102.92	0.9294	0	0
8	1	16	102.92	0.9189	0	0
8	2	16	102.02	0.8657	0	0
8	2	18	102.02	0.5754	9.95	5.7254
8	12	17	98.96	0.5238	0	0
8	5	16	98.96	0.4865	0	0
8	29	16	98.96	0.4865	0	0
8	1	15	100.94	0.4255	0	0
8	2	15	100.94	0.4255	0	0
8	1	18	100.94	0.4078	9.95	4.0581
8	9	17	98.06	0.385	0	0
8	29	17	98.06	0.385	0	0
8	12	16	98.06	0.3502	0	0
8	9	16	96.98	0.215	0	0
8	8	17	96.08	0.1532	0	0
8	27	17	96.08	0.1532	0	0
8	28	17	96.08	0.1532	0	0
8	26	16	96.08	0.1348	0	0
8	12	15	98.06	0.1086	0	0

$$Peak\ Period\ kW\ Savings = \frac{9.7835\ kW}{9.0127}$$

$$Peak\ Period\ kW\ Savings = 1.01\ kW\ (summer)$$

1.5 Project Deliverables

Each RCx project includes two reports to be delivered to the PA by the RCx Agent– the Investigation Phase Report and final Verification Phase Report. These reports define and document the retro-commissioning activities for the project. The PA must review and accept each RCx Agent deliverable before the project may proceed to the next program phase.

Microsoft Word is the preferred format for the reports. Microsoft Excel is the preferred format for spreadsheets.

1.6 Contact Information

All applications, supporting documentation, general program inquiries, and specific project inquiries should be directed to the Program Administrator at CenterPointEnergyRCx@nexant.com.

Additional concerns may be directed to the CenterPoint Energy program manager:

Calvin Burnham, P.E., CEM
CenterPoint Energy
1111 Louisiana Street, 9th Floor
Houston, TX 77002
Phone: (713) 207-3423
Email: calvin.burnham@centerpointenergy.com

2 Program Process

The administrative process for each RCx project follows these basic program phases:

- Application Phase
- Investigation Phase (IP)
- Implementation Phase
- Verification Phase (VP)

A breakdown of each phase is presented in the following sections.

2.1 Application Screening Phase

2.1.1 Overview

The program begins with the Application Phase. Applications are completed by the facility representative and submitted to the PA, who screens projects to ensure sufficient RCx savings opportunities exist.

If an application is accepted and the facility representative does not request a specific RCx Agent, the PA will assign one based on an equitable rotation and on appropriateness of Agent qualifications and experience.

The assigned Agent will enter into a contract (Task Order) with the PA to complete services. Soon after the contracts are signed, a project kick-off meeting may be scheduled. Attendees may include representatives from CenterPoint Energy, the PA, the assigned RCx Agent, and the owner or facility representative.

2.1.2 Deliverables for Application Phase

- Application submitted to the PA or CenterPoint Energy by the owner or representative
- Project Contract (Task Order) signed by RCx Agent to commence work
- Fourteen months of utility (Electricity and Natural Gas) bills in Microsoft Excel format (Owner to provide ESI ID # in the project application to enable PA to obtain the utility information).

2.2 Investigation Phase

2.2.1 Overview

During this phase, the RCx Agent conducts detailed site-audits to identify low-cost, no-cost RCMs. It is critical to understand the program's focus on RCx measures versus capital intensive equipment upgrades and replacements. The latter are outside the scope of an RCx project, and the fee structure for agents assumes both fieldwork and analysis are focused solely on RCx measures.

The Investigation Phase Report includes a detailed description of recommended improvements, energy saving projections, equipment data, assumptions and calculations, implementation cost quotes, and a simple payback calculation. It may include one-line

diagrams and written and graphical sequences of operations for affected equipment, and verification procedures for each recommended measure. The Investigation Report must be submitted to the PA for review and acceptance. The PA will review the Investigation Phase Report submittal and accept it or make recommendations for refinement.

2.2.2 Investigation Phase Execution

During the investigation phase, the RCx Agent, with assistance from the building facility staff, will conduct a site assessment to develop an in-depth understanding of the building systems. The key investigation phase activities to be documented and included in the IP Report are (as applicable):

- Gathering data to assess equipment operation, including operational hours, building equipment data, current control sequences, etc.
- Estimating the potential peak period demand reduction (kW) and energy savings (kWh) from identified RCx RCMs, assessing the cost to implement the identified RCx RCMs, and calculating the corresponding savings to generate a simple payback period.
- Compiling the Master Findings List of low-cost RCx RCMs.
- Preparing a written sequence of operation or detailed description for any control changes and/or RCMs recommended.
- Preparing a one-line schematic of any major equipment (e.g., AHU, Central Plant) for which RCMs are recommended as applicable.

The owner may implement low-cost, no-cost measures only after sufficient information is collected to document the baseline and estimate the measures' energy savings potential. Information and test results gathered during this phase are to be included in the IP Report.

System Equipment Assessment

System assessment occurs at the equipment level and involves collecting nameplate information and conducting a minimum standard set of diagnostic tests for each system and piece of equipment included in the RCM Master Findings List. The system and equipment assessments generally include collecting the following information:

- Nameplate data (with efficiency)
- Design and operational intent
- Actual operation
- Operating parameters
- General conditions

Master Findings List

The observations made during the site assessment and detailed facility assessment form the basis for the Master Findings List. The Master Findings List identifies savings opportunities (or performance deficiencies) and recommended improvements. It summarizes all findings of the investigation phase, including the adjustments and repairs made during the course of investigation. The list includes all recommended low-cost and no-cost measures.

The Master Findings List includes the name of the system or equipment, a description of the problem or deficiency, recommended solutions, and savings category. Savings categories classify measures by the time period during which savings are anticipated. Categories include program peak-period demand savings and annual energy savings. The program peak period savings indicate the project's impact on the utility peak demand. The facility annual energy savings are to be calculated to determine the cost savings associated with each RCx measure.

For the measures recommended by the RCx Agent, the estimated annual electricity savings are calculated, implementation costs are estimated, and a simple payback period is calculated. All calculations must be submitted in detail in the IP Report, as well as any data used in support of the calculations. The PA has compiled Typical Meteorological Year (TMY3) weather data for Houston, TX and made it available for the RCx Agents to develop their calculation templates. Note that the bin data must be formatted to allow isolation of the applicable energy savings for each measure and each time period (i.e., peak period, annual, etc.).

Typical RCMs

- Turn-off unnecessary systems
- Revise equipment operating schedules
- Optimize outdoor air ventilation
- Reset supply air temperature
- Automatic reset of static pressure set-point
- Minimize simultaneous heating and cooling
- Reset chilled water supply temperature
- Air balancing
- Water balancing
- Implement chiller plant optimization
- Use variable speed drives in fans and pumps
- Eliminate leakage in air and water distribution systems
- Improve air-side economizer operation

Unacceptable RCM Characteristics

- Compromise occupant comfort
- Compromise safety
- Violates building code
- Unacceptable to owner/staff

RCMs outside RCx Program Scope

- Major equipment replacements or additions
- Chiller replacements
- Lighting retrofits

While capital-intensive measures are outside the scope of this program, Agents who identify obvious opportunities during RCx investigations are encouraged to relay this information to

facility staff and to suggest other CenterPoint programs which may be applicable for such opportunities, such as the Commercial & Industrial Standard Offer Program. However, it should be remembered that program funds are not anticipated to cover the costs of fieldwork or analysis related to non-RCx measures. Funds are expected to cover costs of fieldwork, analysis, and customer engagement necessary to understand available budgets and obtain required measure price quotes from customers and their implementation vendors.

RCx Survey Elements

The survey tasks noted in this manual are intended to provide quality assurance, streamline the RCx process, and standardize the services provided by the RCx Agents. As part of the process, the RCx Agent is requested to adhere to the RCx Survey Elements Summaries outlined below as a minimum.

The survey list is organized by system and equipment type and covers the major mechanical components typically found in commercial facilities. Table 1 provides a summary of the minimum requirements of the survey tasks.

The RCx Agent should include a simple system schematic, record a minimum set of operating parameters, and include templates for conducting functional tests to verify proper component, equipment, or system operation, as necessary. The required fields in the forms are marked by an asterisk (*). The functional tests outlined in the forms are recommendations only, and may be revised or rewritten based on the RCx Agent's judgment. The functional tests may be carried out manually by forcing system variables, or automatically by trending variables in the Energy Management and Control System (EMCS) or stand-alone logging device. It is up to the RCx Agent to determine the best method that will meet the needs for testing and be acceptable to the owner.

Table 1. RCx Survey Elements Summaries

System or Equipment	Typical Survey Requirements
Chilled Water System (Chiller and pumps)	Document sequence of operations (SeqOp)* Verify / Justify SeqOp Document actual schematic* Spot measure actual performance (kW/ton) Document setpoints* Verify temperature and pressure sensor calibration Verify thermostat calibration Document operations and maintenance (O&M) procedures
Air Handling Unit	Document SeqOp* Verify / Justify SeqOp Document system type* Document nameplate ratings* Document actual schematic Document temperature, pressure at control points* Verify economizer operation (if present) Verify damper operation and sealing Verify temperature and pressure sensor calibration Verify proper chilled water, hot water, and/or steam valve operation Measure motor/fan load, flow, pressure Identify operating point on fan curve Verify inlet guide vane / discharge damper / VFD operation (if present) Document O&M procedures
Cooling Tower	Document SeqOp* Verify / Justify SeqOp Document system type* Document nameplate ratings* Document temperature, flow at control points* Document O&M procedures
Control System	Document SeqOp for the HVAC system, integrating the equipment SeqOp s* Verify / Justify SeqOp Verify and sketch system schematic

Diagnostic Monitoring

During the RCx process, the Agent may identify problems that require short-term monitoring to understand how equipment is operating under a range of conditions or to prove the existence of suspected problems. A summary of the diagnostic monitoring activities should be submitted as part of the IP Report. Diagnostic monitoring should be performed using the existing building control system, existing sensors, and the Agent's field tools. Additional monitoring may be performed, but it will not be considered part of this program, and additional fees for this will not be included in this program.

The diagnostic monitoring plan typically lists the systems to be investigated, any simulation activity to create a desired condition, variables to be monitored, location of existing or proposed sensors (identified on associated schematic), data collection equipment, monitoring time period, sampling frequency, storage frequency, and parameter engineering units. The monitoring period must be appropriately chosen (at most, hourly intervals) to capture the desired operational characteristics.

Investigation Phase Meeting (RCM Selection)

Following delivery of the Investigation Phase Report to the owner, a meeting is to be held with the owner, the RCx Agent, and the PA to review the project recommendations. The list of measures to be implemented is agreed upon by all parties, taking into consideration factors such as comfort, safety, or liability as input by the participants in the meeting.

Owner Selection Table (OST)

After the Investigation Phase Meeting, the owner is expected to review and complete the OST. The owner will designate in the Investigation Phase OST the measures they have implemented or intend to implement during this project. The owner will sign the completed OST and return it to the PA and/or the RCx Agent.

Verification Plan Development

For each of the owner-selected measures, the RCx Agent is to develop a Verification Plan. The verification may consist of data trending, spot measurements, visual checks, and/or interviews with the party responsible for implementation. A statistically significant amount of the affected equipment for each measure implemented is required to be checked to ensure implementation took place. This plan is followed, after implementation of the completed project, with the goal of verifying that implementation was done correctly and the potential to reduce demand and energy usage exists.

In deciding the appropriate level of effort for verifying savings, the following measure characteristics should be considered:

- Estimated peak period demand and annual energy savings
- Measure complexity

The PA, as part of the verification plan review, will assess the suitability of the verification tasks for each RCM.

2.2.3 Deliverables for Investigation Phase

The Investigation Phase Report provides a summary of the investigation phase activities. Key elements to be included in the Investigation Report as appendices if applicable are as follows:

- Diagnostic tests and calculation plans
- Verification plans
- Survey forms
- Schematics of affected systems
- Written sequence of operation for affected systems or equipment
- Price quotes for all measures

2.2.4 Investigation Phase Timeline

The Investigation Phase Report must be submitted by the RCx Agent to the PA within two months of the site visit, in accordance with the approved project timeline.

2.3 Implementation Phase

Completing the implementation phase of the project is the responsibility of the building owner/facility representative. The facility owner may choose to implement the measures using in-house staff or contractors.

The facility owner keeps the RCx agent and PA up-to-date on the status of implementation of measures selected for implementation. At the completion of implementation, the owner must submit an accounting of the actual cost of the RCx project to the RCx Agent for inclusion in the Verification Report or delivery to the PA separately.

After implementation is complete, it is the facility owner's responsibility to confirm that the recommended energy conservation measures have been implemented as per the signed IP Owner Selection Table. The RCx Agent is not responsible for making the system work if it fails the construction-commissioning phase. The Owner shall promptly notify the RCx Agent upon completion of implementation, so that the RCx Agent may begin the Verification process.

2.4 Verification Phase

2.4.1 Overview

During the Verification Phase, the RCx Agent visits the site to verify that measures have been properly installed and are functioning, new control strategies are in place, repairs have been made, etc. The RCx Agent submits the Verification (Final) Report that summarizes its findings and includes revised savings estimates. The PA will review the verification report.

2.4.2 Verification Phase Execution

After implementation, the RCx Agent shall perform the verification activities as outlined in the approved Verification Plan. After the owner has completed their selected implementation, the RCx Agent shall document the verified savings in the Verification Report, which will be reviewed and approved by the PA.

Deliverables for Verification Phase

The Verification Report is prepared by the RCx Agent, and submitted to the PA after implementation verification is completed. The purpose of this report is to verify that the measures were properly implemented, provide justification for measures that were recommended but not implemented, and document verified project demand and energy savings. It shall also include concise statements of the RCx changes made to the systems and the reasons those changes were made, which may be posted on-site for the facility staff's reference.

The RCx agent is expected to brief the facility operators on the changes made to the systems and emphasize the importance of persistence with these changes.

It is essential that documented data be included in the report to support the final savings calculations, because measures may not always be implemented exactly as recommended by the RCx Agent. A template for this report can be provided upon request.

Key elements to be included in the Verification Report if applicable are as follows:

- Final Owner Selection Table
- Description of each implemented RCM
- Savings calculations
- Written sequence of operation for affected systems or equipment
- Owner's receipts/invoices for project costs

3 Customer Incentives

Table 2 shows the breakdown aimed at encouraging quicker implementation and savings alignment between IP and VP. The agent shall collaborate closely with the customer to avoid program resources spent on measures with no realistic hope of implementation. Rather than simply performing a comprehensive investigation from a technical perspective, agents will work closely with a customer to identify their specific budgets, resources, concerns, and limitations before performing their engineering fieldwork, so they concentrate on opportunities with both high savings potential and high likelihood of quick implementation.

The following table contains customer incentive rates for various VP-to-IP savings ratios and project implementation timelines.

	100+%	95-100%	90-95%	85-90%	<85%
1 mo	$0.06	$0.06	$0.05	$0.04	$0.02
3 mo	$0.05	$0.05	$0.04	$0.03	$0.02
6 mo	$0.04	$0.04	$0.03	$0.02	$0.02
9+ mo	$0.03	$0.03	$0.02	$0.01	$0.01

Table 2 Customer Bonus Structure ($-per-verified-kWh)

Values are $-per-verified-kWh. Percentages are the ratio of verified savings at VP to reported savings at IP. Durations are the time between IP report approval and customer announcement of completed implementation. Capped by customer project cost and building size: $5k, $10k, and $20k for 150k SF, 150k-500k SF, and >500k SF, respectively.

Appendix A: Probability Tables for Calculating Peak kW

Month	Day	Hour Ending	Hourly Temp. (°F)	Relative Probability
8	1	17	102.92	0.9294
8	2	17	102.92	0.9294
8	1	16	102.92	0.9189
8	2	16	102.02	0.8657
8	3	16	100.04	0.6508
8	2	18	102.02	0.5754
8	29	16	98.96	0.4865
8	1	15	100.94	0.4255
8	2	15	100.94	0.4255
8	1	18	100.94	0.4079
8	9	17	98.06	0.385
8	29	17	98.06	0.385
8	10	16	98.06	0.3502
8	10	17	96.8	0.2213
8	9	16	96.98	0.215
8	3	15	98.96	0.1764
8	8	17	96.08	0.1532
8	27	17	96.08	0.1532
8	28	17	96.08	0.1532
8	29	15	98.06	0.1086

Figure 1: Summer Peak Probability Table

Summer	
Bin Temperature (°F)	Probability Factor Sum
100-105	6.1285
95-100	2.7876
Total	8.9161

Figure 2: Summer Peak Table in Temperature Bins (5°F bins)

Summer	
Bin Temperature (°F)	Probability Factor Sum
100-110	6.1285
90-100	2.7876
Total	8.9161

Figure 3: Summer Peak Table in Temperature Bins (10°F bins)

Month	Day	Hour Ending	Hourly Temperature (°F)	Relative Probability
2	12	8	24.08	0.2003
2	12	7	24.08	0.1834
1	22	21	35.96	0.0911
1	23	8	28.04	0.0879
1	23	7	28.04	0.0795
1	11	20	39.02	0.0675
1	18	20	39.02	0.0675
1	18	19	41	0.062
1	11	21	37.04	0.0607
2	12	9	26.96	0.0575
12	20	19	39.92	0.0548
1	18	21	37.94	0.0429
1	11	8	30.02	0.0413
1	19	8	30.02	0.0413
1	19	7	30.02	0.0372
2	12	20	39.02	0.0363
2	12	10	30.92	0.0332
1	11	9	30.02	0.0327
2	12	21	37.04	0.0326
1	4	20	41	0.0314

Figure 4: Winter Peak Probability Table

Winter	
Bin Temperature (°F)	Probability Factor Sum
40-45	0.0934
35-40	0.4534
30-35	0.1857
25-30	0.2248
20-25	0.3837
Total	1.3409

Figure 5: Winter Peak Table in 5°F Temperature Bins

Winter	
Bin Temperature (°F)	Probability Factor Sum
40-50	0.0934
30-40	0.639
20-30	0.6085
Total	1.3409

Figure 6: Winter Peak Table in 10°F Temperature Bin