LGP EVALUATION REPORT APPENDIX A:
HIM RESEARCH SUPPORT SUMMARY

a. Commercial Linear Fluorescent Lighting Pre-post Metering Research Summary
b. Furnace HIM Metering Research Summary
c. PRSV Evaluation Planning Research Summary

Commercial Linear Fluorescent Lighting Pre-post Metering Research Summary

COMMERCIAL LINEAR FLUORESCENT LIGHTING PRE-POST METERING RESEARCH SUMMARY

Summit Blue was engaged by the California Public Utilities Commission (CPUC or Commission) to conduct a statewide lighting study to gather pre- and post-retrofit field data from 200 linear fluorescent lighting, 100 high bay lighting, and 50 occupancy sensor retrofit projects (Pre/Post Study, Pre/Post, or Study) completed through various programs in the IOUs' 2006-2008 portfolio of programs. This work was a component of the high impact measure (HIM) research undertaken by Itron focusing on linear fluorescent, high bay lighting, and occupancy sensors.

This report provides a summary of the project objectives, implementation, and final disposition of the Pre/Post data collection effort. A discussion of the issues and challenges is also provided with the intent of informing similar field research efforts should these be undertaken n the future. As the field data collected through the Pre/Post was passed to Itron to be analyzed for their post-only data, there are no separate Pre/Post results presented in this memo.

Study Objectives

The primary objective of the Pre/Post Study was to collect primary energy use data for C&I linear fluorescent fixtures, high bay fixtures, and occupancy sensors to support an estimate of mean lifetime avoided cost savings associated with installing each of these three HIMs, measured with a high level of confidence.

Secondary objectives of the Study were to:

- Collect primary energy use data to support development of hourly (8,760) load shapes for each HIM, for a number of key market segments, and for a number of space types within each market segment.
- Collect contextual data about sites in the sample, including the equipment type, wattage, operating schedules, how prior equipment was used, and an assessment of the likely wattage of prior equipment; and
- Collect field data for 200 linear fluorescent lighting, 100 high bay lighting, and 50 occupancy sensor projects installed through selected programs within the IOUs 2006-2008 portfolio of programs to include inventories of lighting fixtures, customer-reported operating schedules, spot measurements of lighting fixture wattage, and actual fixture operating schedules captured by fixture time-of-use data logging.

Program and Building Type Targets

Table A-1 presents the targeted number of retrofit projects to be investigated within each IOU territory by technology type. These IOU samples were broken down further by IOU program and DEER building type and this is presented in Table A-4 at the end of this appendix.

Table A-1. Pre/Post Targets by Technology and IOU Territory

Technology	PG&E	SCE	SDG&E	Total
Linear Fluorescent	66	61	67	194
High Bay	34	33	33	100

Occupancy sensors projects were not specifically recruited for as it was expected that the targeted linear fluorescent and high bay installations would include occupancy sensors.

Field Requirements

The Pre/Post Study collected a robust set of pre- and post-retrofit data for each participant site. Generically, the data set collected by field auditors consisted of both visual observations and measurements and included:

Site information: This data included electric and gas meter numbers, basic information about the business, and basic information about the building itself. The field auditors recorded business type, ownership, and operating hours. They also recorded heating and cooling system types, total floor area, and floor area by space type.

Customer reported operating schedule: In addition to *business* operating hours, the field auditors asked the customers about the schedule for each specific lighting circuit with fixtures to be retrofit. This was recorded in detail as the percent "on" time, in each hour of every daytype.

Fixture data: Summit Blue collected detailed information for every fixture affected by the retrofit. Every unique ballast and lamp combination was defined. This information included items such as lamp manufacturer and model number, lamp quantity, lamp length and diameter (if linear fluorescent), and ballast manufacturer and model number. It also included contextual data not affecting fixture power, such as lighting application, mounting type, reflector, and floor-to-fixture height.

Lighting inventory: The final component of the field observations was the lighting inventory. This task required the field auditors to identify the lighting circuits feeding every fixture affected by the retrofit. Each lighting circuit was defined as serving one previously-defined space type, and with one customer-reported schedule. The field auditors then recorded the quantity and type of fixtures on each of these defined circuits. The information contained in the lighting inventory provided the "load" portion of determining the 8,760 load shape for the circuit. When combined with all of the other lighting circuits at the site, the load could be aggregated at both the site and space-type level.

The other task required of the field auditors was to collect actual measurements of both fixture power data and the time-of-use for each lighting circuit defined in the lighting inventory. Specifically, the field auditors conducted:

Spot measurements: The field auditors conducted spot measurements of power for as many defined fixtures as safety and time allowed. Most often, this measurement was taken at the fixture, upstream of the ballast. When fixtures could not be accessed due to height or safety issues, the field auditors took spot measurements at the point-of-control (such as the switch), or at the electrical panel. The field auditors recorded volts, power factor, amps, and watts for every measurement, and they conducted on-the-spot quality control calculations to ensure the integrity of their measurements. Finally, the field auditors recorded the perceived condition of the fixture on which they took the measurement. These spot measurements of power are applied in the Lighting Inventory to inform the actual circuit power.

Time-of-Use Data logging: This critical measurement involved leaving data loggers in place over some period of time to capture the typical usage of each defined lighting circuit, both pre- and post-retrofit. The goal was not only to determine time-of-use for the fixtures on the lighting circuit, but to also see if the usage changed from pre- to post-retrofit. Summit Blue attempted to install at least one data logger on every circuit feeding fixtures affected by the retrofit; often, a "backup" logger was also installed in case the primary logger failed. The information provided by the logger data provides the "shape" portion of determining the 8,760 load shape for this circuit. When combined with all of the other lighting circuits at the site, the shape can be aggregated at both the site and space-type level.

Two weeks of pre-retrofit data was captured. This allowed for two data points for each day type. Ideally, more data could have been captured pre-retrofit, but two weeks was a good compromise with the retrofit programs who wanted to reduce their delay in completing the retrofit. Because there was no time pressure from the lighting installers after the retrofit was complete, thirty days of post-retrofit logging was conducted.

The Pre/Post data collection forms used to record the various data elements are presented as a separate appendix to the final LGP evaluation report.

Recruitment and Scheduling

It should be noted that the Pre/Post was conducted as part of the measurement and verification of the California IOU's 2006-2008 portfolio of programs. However, because the study commenced at the end of 2008 and required recruitment of sites prior to the actual program participation, it was not possible to include sites that fell into the 2006-2008 program years.

The programs within the Pre/Post sample included IOU-run rebate and direct install programs, third-party-run direct install programs, and local government partnership (LGP) direct install programs. Each program type had unique customer recruitment and project implementation procedures, which required a customized recruitment approach for the Pre/Post. Each program type and its recruitment process are described below.

IOU-Run Direct Install. SCE manages a direct install program for small commercial customers. During 2009, SCE contracted directly with three lighting installation contractors to recruit, survey, and retrofit small commercial customers within its service territory. Each contractor was assigned a geographic location and provided a listing of eligible customers within that region by SCE. The direct install contractor sent a recruiter door-to-door to solicit program participation and conduct a lighting inventory for those customers who agreed to participate. The lighting retrofit was free of cost to the customer and covered linear fluorescent and compact fluorescent fixtures. Within a week of the audit, the direct install contractor sends an installation crew behind the recruiter to retrofit those sites that had agreed to participate.

The SCE direct install program manager agreed to cooperate with the Pre/Post study and directed their installation contractors to send the Pre/Post team customer names and contact information after the recruiter secured the customer's participation but before the retrofit took place. The Pre/Post team contacted the customer to explain the study and offer them the participation compensation. If the customer agreed to participate, the first site visit was scheduled within two to three days. The Pre/Post team agreed to complete all the pre-retrofit work, including 14 days of data logging, with no more than a 20 day delay from the time the installation contractor provided the lead. Because of this requirement, it was not possible to schedule initial site visits out more than three days in advance. The window to retrieve the loggers (site visit #2) was usually only a day or two because it had to be made after 14 days of logger data was collected but before the 20 day mark.

Third-Party and Local Government Direct Install. The Ecology Action Right Lights, East Bay Energy Watch Smart Lights, and Fresno Local Government Partnership Program run by Richard Heath and Associates operate similarly to the SCE direct install program in that they first send a recruiter into a neighborhood to canvas it for recruitment then send an installation crew through to conduct the retrofits shortly after. However, each of these programs require the customer to pay a portion of the cost for the lighting retrofit.

These programs all agreed to participate in the Pre/Post Study and provide customer leads until the target number of sites for each program was met. Each program sent leads to the Pre/Post after the customer had agreed to participate in their programs. Like the SCE Direct Install program, the Pre/Post team agreed to complete the pre-retrofit field work within 20 days of receiving the lead.

IOU Rebate Programs. The IOU rebate programs presented the biggest challenge in recruiting customers into the Pre/Post Study and, as a result, had the lowest number of participants. The rebate programs provide a prescriptive rebate for each lighting type and configuration. The customer installs the lighting retrofit first then sends their completed rebate form and proof of purchase to the IOU for the rebate check. Therefore, the IOUs are not aware of the project until after the lighting retrofit is complete.

The rebate programs are often promoted by lighting contractors who factor the rebate amount into the project financial proposals. IOU customer account managers also promote lighting retrofits and the financial incentives available through the rebate programs to their assigned customers.

The Pre/Post team approached the IOU rebate program managers for their support in recruiting customers into the Pre/Post. The IOU program managers arranged meetings and conference calls with their best and most active lighting contractors. The IOU program managers highlighted the importance of evaluation studies in maintaining a robust set of energy efficiency programs and requested that the contractors send leads to the Pre/Post. Regular follow up calls were made by the Pre/Post team to each lighting contractor reminding them of the Pre/Post Study, the available financial compensation to themselves and their customers, and requesting that they send customers leads.

Participation Compensation

All customers were offered financial compensation to participate in the Pre/Post. This amount varied from $300 to $400, depending on the program, and was intended to compensate them for their time and the disruption to their operations. As a motivation for the programs and vendors to participate, a smaller amount was offered for each lead that the Pre/Post team was ultimately able to schedule. This amount ranged from $100 to $150, depending on the program. In order to ensure the customer’s cooperation through all four site visits, their compensation was paid by check after the fourth and final site visit. Because the program and lighting vendors’ obligations were complete after the lighting retrofit, their compensation was paid, by check, after they send us confirmation that the lighting retrofit was complete.

Final Results

The Pre/Post study successfully recruited and completed pre- and post-retrofit site visits for 108 sites, most of these being linear fluorescent sites. In addition, eight sites were able to provide pre-retrofit data only, which was also useful. A summary of the completed sites is provided in Table A-2.

Table A-2. Summary of Final Pre/Post Completions

IOU	Linear Fluorescent	High Bay	Combination	Total	Complete with pre-retrofit data only
PG&E	37	2	0	39	0
SCE	66	0	0	66	6
SDG&E	0	2	1	3	2
TOTALS	**103**	**4**	**1**	**108**	**8**

A full list of the completed sites, including building type, is provided in **Error! Reference source not found.** at the end of this appendix...

Issues and Challenges

This section describes the various challenges in conducting the Pre/Post study. We've grouped the challenges into those surrounding the recruitment and scheduling of sites and those with performing the actual site data collection.

Recruiting and Scheduling

The shortfall in the number of completed sites was a result of the challenges in recruiting customers into the study, particularly through the rebate programs. The completed sites were recruited from only six programs, as follow summarized in Table A-3.

Table A-3: Pre/Post Competes by Program

Program Name	Program Number	Linear Fluorescent Site Target	Completed Linear Fluorescent Sites	High Bay Site Target	Completed High Bay Sites
East Bay LGP	PGE2020	18	16	0	0
Fresno LGP	PGE2021	3	2	0	0
Right Lights	PGE2051	17	19	0	0
Comm'l Mass Market	PGE2080	17	0	34	2
Non-Res Direct Install	SCE2511	53	66	0	0
Express Efficiency	SDGE3012[1]	4	1	18	2
Total		-	**104**	-	**4**

[1] It should be noted that the Pre/Post team was not able to secure any documentation that the projects that we monitored for the rebate programs were ultimately submitted or approved. In the case of the SDG&E programs, we're not certain which rebate program was ultimately used.

The two programs above with the lowest participation, the PG&E Commercial Mass Market and the SDG&E Express Efficiency programs, are both rebate programs. The remaining programs, the SCE Non-Res Direct Install, East Bay and Fresno LGP, and the Right Lights program all committed to work with the Pre/Post study and provide leads until the target for their program was reached. The reason for the difference in participation between the LGP and third-party direct installation programs and the lighting vendors is not entirely clear. One theory is that the LGP and third-party programs are highly engaged in the energy efficiency industry in California. Both types of programs are directly funded through the IOU under the auspices of the CPUC and have direct contracts with the IOUs. As a result, they may have felt obligated to cooperate. Alternately, although the lighting vendors benefit from the IOU rebate programs, their business activities are not directly funded through them.

In addition to the challenge of securing customer leads, the Pre/Post team encountered other issues related to recruiting and scheduling customers:

- Customers were often confused about the relationship between the program and Pre/Post study. The field auditors regularly received questions and complaints from the customers on their lighting retrofits. The field auditors were instructed to gently remind the customers that they were not affiliated with the program or vendor and to suggest that they contact the program directly.
- On several occasions, the individuals within the program coordinating with the Pre/Post did not notify their installation contactors that the site was participating in the Pre/Post and should not be retrofit until after the agreed upon date.
- Customers often complained about length and number of site visits. It should be noted that, in addition to the four site visits required by the Pre/Post, these customers also underwent a lighting retrofit that requires several site walkthroughs in addition to the retrofit.
- Coordinating the field activities was challenging because of the uncertainty of site visit length. It was not possible to schedule a team for more than one site per day for the first and third site visits because of the amount of data to be collected at the site. However, we were able to schedule two, and sometimes three logger pickups (2nd and 4th site visits) when the schedule allowed. Because the loggers had to be removed within the agreed upon 20 day window pre-retrofit, there wasn't the flexibility to hold these sites until they could be scheduled with others.
- Participation in the Pre/Post also presented challenges for the participating programs. The direct install contractors work geographically, canvassing a neighborhood with a recruitment crew, then and installation crew. Because participation in the Pre/Post delayed the installation by 20 days, the installation crew had often moved out of an area by the time the pre-retrofit logging was complete and had to send a team back to perform the retrofits. This sometimes caused the retrofit to be delayed if they could not get back to the customer site right way.
- In addition, this study was conducted during a recession and installation activity was likely below normal for many of the participating programs. During this effort the country was moving through the worst recession in several decades, with GDP falling by 6.3% in the 4th quarter of 2008, and 6.1% in the 1st quarter of 2009 as the study was moving into full production Because of the recruitment challenges stated previously, some of the programs may have been overly cautious about sharing leads with the pre/post team out of concerns that the added complexity may threaten their ability to untimely complete the project, though this was never stated explicitly.

Field Data Collection

The Summit Blue team worked through a number of significant issues related to collecting such a comprehensive set of lighting data. Many of the issues were primarily in the domain of the pre-retrofit condition, but some affected both the pre- and post-retrofit conditions. Again, these challenges can be generically lumped into two categories: challenges with the onsite observations (how to properly document peculiar equipment configurations in the pre-retrofit case), and challenges with the measurements, especially with regard to the instrumentation.

Challenges with onsite observations

Collecting robust pre-retrofit data presents several considerable challenges, the most immediate of which is the various configurations of ballasts and lamps. Anecdotal evidence from pre- site visits suggests that small commercial customers often replace inoperable lamps with whatever they have lying around, regardless of whether the ballast is rated for the particular lamp configuration. For example, the field auditors often observed lamps of multiple wattages (i.e. 40w T12 and 34w T12) powered by a single ballast. They also observed cases of both T8 and T12 lamps in the same fixture, served by the same ballast. In addition, a pre-retrofit fixture with two ballasts would often have two *different* ballasts, including cases with both magnetic and electronic ballasts in the same fixture housing.

The commonality of these various configurations of ballasts and lamps required more customization of the onsite data collection forms than originally anticipated. Previous iterations of the forms asked the field techs to record "lamp type" and "ballast type" for the fixture, thus assuming that each individual fixture would be uniform. Instead, the field forms were systematically customized to allow for each of these improper ballast and lamp configurations.

Another issue was in deciding how best to represent bi-level switched fixtures. The comprehensive and robust nature of this data collection effort required the field auditors (and the forms) to be very specific in how they characterized the lighting conditions at the site. Instead of just counting number of fixtures by space type, for example, this effort required defining actual *lighting circuits*, each with its own load (captured via spot measurements and the lighting inventory) and its own shape (captured in the data logging).

In the case of bi-level switched fixtures, a single fixture housing contains ballasts fed by different lighting circuits. Initial versions of the forms required the field auditors to define a fixture as "everything contained within the box" (i.e., the fixture housing). However, this created a problem when the field auditors went to assign this defined fixture to a lighting circuit, since there were actually two circuits feeding the fixture. This challenge was overcome with a slight modification to the forms and instructions to the field auditors. Instead of defining a "fixture" as everything inside the housing, a fixture must be defined as a *single ballast* with lamps attached. Thus a single fixture housing with two ballasts would actually be counted as two "fixtures".

Another common problem with collecting pre-retrofit data is in knowing which fixtures are going to be retrofit. Having the lighting audit from the program helped in the field, but it was not foolproof. Many times, the actual post-retrofit condition was different from that shown on pre-retrofit audit. Field auditors were instructed to collect data for all fixtures included in the audit, or that the customer believed were going to be retrofit. Unfortunately, this resulted in a few sites with more time spent on the pre-retrofit field visit than necessary in cases where the fixtures were not ultimately retrofit. In a very few cases, lighting contractors also added new fixtures to a space or changed the wiring so that new lighting circuits were created that did not exist in the pre-retrofit condition. These were handled on a case-by-case basis to ensure the integrity of the data being collected.

Challenges with measurements/instrumentation

Measuring the power of fluorescent lighting presents an interesting challenge from an instrumentation standpoint. Many quality devices on the market are easy to use and accurately measure a low to high loads. Unfortunately, the current draw of a single fluorescent lighting fixture running at 120 or 277 volts is typically *very low*, and it is best measured using a laboratory grade setup under very controlled conditions. Since this was not an option for the Pre/Post study, the solution was to amplify the current to a level that gives the reading much higher accuracy.

Summit Blue built 10 current amplifiers (or “donuts”) for field teams to use when measuring single fixtures, as shown in Exhibit A-1, presented later in this appendix. The first donut was built then tested in a laboratory to ensure that it gave accurate readings. The remainder of the donuts were tested against this first donut to ensure that each was properly calibrated. Each donut had 40 turns wrapped around a wooden core that served to hold the wraps together and also to ensure that the bundle of wraps was held in the center of the CT. The current amplifier therefore would bring a fixture drawing a nominal 0.25 amps (such as an electronic ballast with 1 32w T8 lamp) up to 10 amps, at which point the accuracy jumped significantly.

Another common problem with the fixture spot measurements was that the pre-retrofit fixture conditions were often very poor. Many had burned out lamps, lamps that were mismatched to their ballasts, or lamps that output very low lumens. The varying condition of these fixtures made it all but impossible to get an even comparison of the manufacturer-specified input power to that as measured in the field. Even in cases where most of the fixtures were nominally the same (i.e., the ballast model and lamp quantity/watts was the same), these fixtures could be drawing a wide range of power based on their years of service and other factors. The workaround to this problem was in requiring the field techs to note the as best they could the condition of the lamps/ballasts that they measured. In the end, the appropriate baseline fixture wattage will be the average of all measurements for each combination of ballast and lamps.

The instrumentation challenges stretched beyond spot measurements of power. Initially, the Summit Blue team planned to use lighting-state data loggers to gather the time-of-use data for each lighting circuit. However, there were concerns with light source pollution that would cause false readings, such as in installations near windows or when attempting to measure usage in bi-level switched fixtures. Since this data logger measures light input to its photocell, it does not discriminate between light from intended source and light from the sun (or any other ambient source).

To solve this problem, the Summit Blue team used current-activated switches as the primary logger whenever possible and especially in cases susceptible to light pollution. This device measures time-of-use in the same way as the lighting-state logger, but instead of measuring light, it measures current. When the current level is over a user-defined threshold, it records an “on”; when it is under, it registers an “off”. The device measures current by using a split-core current transformer (CT). They can be used at the lighting fixture by placing the CT around the hot wire coming into the ballast controlled by the switch of interest. These devices suffer virtually no chance of data pollution. Since an open circuit (light is off) draws exactly zero current, these devices can be set at maximum sensitivity without fear of recording false transitions.

Recommendations for Future Pre/Post Studies

The Summit Blue team recommends the following revisions to the process by which future pre/post studies are conducted:

- **Future pre/post studies should be developed as research projects rather than program verification efforts.** Customers are difficult to identify pre-retrofit, especially rebate program participants. Recruiting customers into a pre/post study is also disruptive to the program and lighting vendors who agree to participate. Although the programs that worked with the Pre/Post team were very cooperative for this study, subsequent efforts may not be met with the same level of cooperation.

- **Customers should be recruited through the general population based on desired size, building/customer type, or other desired parameters rather than trying to target through their participation in a particular program.** Vendors and IOU account representatives who work with customers participating through several different programs find it unfair that certain customers qualify for the study compensation, while others conducting their retrofits through other, untargeted programs, do not

- **Adequate time should be incorporated into the project schedule to run a set of pilot sites through the *entire f*our-site visit cycle.** Results from the pilot sites should be analyzed to identify issues that may require a change in forms, instrumentation, or field protocol. This will reduce the number of mid-project changes necessary.

Table A-4. Targets by Technology Type, IOU, Program, and Building Type

Linear Fluorescent Targets

ProgramName:	AMBAG	Bakersfield	EastBay	Fresno	Right Lights	Energy Fitness	Comm'l Mass Market	TOTALPG&E	Non-Res Direct Install	Business Incentive Program	TOTALSCE	Express Efficiency	Small Business SuperSavers	TOTAL SDG&E	GRAND TOTAL
ProgramID:	PGE2016	PGE2017	PGE2020	PGE2021	PGE2051	PGE2054	PGE2080		SCE2511	SCE2517		SDGE3012	SDGE3020		
AllCommercial	-	-	-	-	2	-	1	3	7	2	9	2	15	17	29
Assembly	-	-	-	-	-	-	-	-	1	-	1	-	3	3	4
Grocery	0	-	1	-	1	-	1	3	4	-	4	-	2	2	9
Health/Medical-Clinic	-	-	1	-	-	-	-	1	9	-	9	-	-	-	10
Health/Medical-Hospital	3	-	-	1	-	-	1	5	-	-	-	-	-	-	5
Office-Large	-	-	1	-	-	-	5	6	-	1	1	-	-	-	7
Office-Small	-	2	4	1	4	1	2	14	6	-	6	1	16	17	37
OtherIndustrial	-	-	-	-	5	-	-	5	-	-	-	-	6	6	11
Restaurant-FastFood	-	-	1	-	-	-	-	1	3	-	3	-	2	2	6
Retail-SingleStorylarge	-	1	1	-	2	-	1	5	4	1	5	-	1	1	11
Retail-Small	-	-	6	-	-	2	2	10	16	-	16	-	4	4	30
Storage-Unconditioned	-	-	1	-	2	-	1	4	-	2	2	-	12	12	18
Education-CommunityCollege	-	-	-	-	-	-	-	-	1	-	1	-	-	-	1
Education-PrimarySchool	-	-	-	-	-	-	1	1	-	-	-	-	-	-	1
Education-SecondarySchool	-	-	-	-	-	-	-	-	-	-	-	1	1	2	2
Education-University	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lodging-Hotel	2	-	-	-	-	-	1	3	-	-	-	-	-	-	3
Lodging-Motel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manufacturing-LightIndustry	-	-	1	-	-	-	1	2	1	2	3	-	-	-	5
Restaurant-SitDown	-	-	1	-	-	-	-	1	1	-	1	-	1	1	3
Retail-3StoryLarge	-	-	-	1	-	-	-	1	-	-	-	-	-	-	1

ProgramName:	AMBAG	Bakersfield	EastBay	Fresno	Right Lights	Energy Fitness	Comm'l Mass Market	TOTALPG&E	Non-Res Direct Install	Business Incentive Program	TOTALSCE	Express Efficiency	Small Business SuperSavers	TOTAL SDG&E	GRAND TOTAL
SIC20Food&KindredProducts	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Storage-Conditioned	-	-	-	-	1	-	-	1	-	-	-	-	-	-	1
Storage-Refrigerated	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTALSITES	**5**	**3**	**18**	**3**	**17**	**3**	**17**	**66**	**53**	**8**	**61**	**4**	**63**	**67**	**194**

High Bay Targets

ProgramName:	AMBAG	Bakersfield	East Bay	Fresno	Right Lights	Energy Fitness	Comm'l Mass Market	TOTAL PG&E	Non-Res Direct Install	Business Incentive Program	TOTAL SCE	Express Efficiency	Small Business Super Savers	TOTAL SDG&E	TOTAL
ProgramID:	PGE2016	PGE2017	PGE2020	PGE2021	PGE2051	PGE2054	PGE2080		SCE2511	SCE2517		SDGE3012	SDGE3020		
AllCommercial	-	-	-	-	-	-	1	1	-	8	8	1	5	6	15
Manufacturing-LightIndustry	-	-	-	-	-	-	7	7	-	9	9	-	-	-	16
OtherIndustrial	-	-	-	-	-	-	2	2	-	-	-	7	4	11	13
Retail-SingleStorylarge	-	-	-	-	-	-	5	5	-	7	7	-	-	-	12
Retail-Small	-	-	-	-	-	-	4	4	-	1	1	-	1	1	6
Storage-Conditioned	-	-	-	-	-	-	2	2	-	-	-	7	-	7	9
Storage-Refrigerated	-	-	-	-	-	-	3	3	-	1	1	-	-	-	4
Storage-Unconditioned	-	-	-	-	-	-	7	7	-	5	5	2	3	5	17
Assembly	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Education-CommunityCollege	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Education-PrimarySchool	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Education-SecondarySchool	-	-	-	-	-	-	1	1	-	-	-	1	-	1	2
Education-University	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grocery	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Health/Medical-Clinic	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Health/Medical-Hospital	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lodging-Hotel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lodging-Motel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Office-Large	-	-	-	-	-	-	-	-	-	1	1	-	-	-	1
Office-Small	-	-	-	-	-	-	1	1	-	1	1	-	2	2	4
Restaurant-FastFood	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Restaurant-SitDown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

ProgramName:	AMBAG	Bakersfield	East Bay	Fresno	Right Lights	Energy Fitness	Comm'l Mass Market	TOTAL PG&E	Non-Res Direct Install	Business Incentive Program	TOTAL SCE	Express Efficiency	Small Business Super Savers	TOTAL SDG&E	TOTAL
ProgramID:	PGE2016	PGE2017	PGE2020	PGE2021	PGE2051	PGE2054	PGE2080		SCE2511	SCE2517		SDGE3012	SDGE3020		
Retail-3StoryLarge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SIC20Food&KindredProducts	-	-	-	-	-	-	1	1	-	-	-	-	-	-	1
TOTAL	**-**	**-**	**-**	**-**	**-**	**-**	**34**	**34**	**-**	**33**	**33**	**18**	**15**	**33**	**100**

Table A-5. Pre/Post Site Disposition Table

Site Name	Utility	Program Number	Technology	Building Type	Program Installation/Contractor	Complete	Complete with pre-retrofit data	Cancelled	Comments
Site #1	PG&E	PGE2020	Linear Fluorescent	Gas Station/Auto Repair	Community Energy Services Corporation	X			
Site #2	PG&E	PGE2020	Linear Fluorescent	Insurance/Real Estate	Community Energy Services Corporation	X			
Site #3	PG&E	PGE2020	Linear Fluorescent	Gas Station/Auto Repair	Community Energy Services Corporation	X			
Site #4	PG&E	PGE2020	Linear Fluorescent	Gas Station/Auto Repair	Community Energy Services Corporation	X			
Site #5	PG&E	PGE2020	Linear Fluorescent	Mixed Use/Multi-Tenant	Community Energy Services Corporation	X			
Site #6	PG&E	PGE2020	Linear Fluorescent	Gas Station/Auto Repair	Community Energy Services Corporation	X			
Site #7	PG&E	PGE2020	Linear Fluorescent	Financial/Legal	Community Energy Services Corporation	X			
Site #8	PG&E	PGE2020	Linear Fluorescent	Specialty/Novelty Foods	Community Energy Services Corporation	X			
Site #9	PG&E	PGE2020	Linear Fluorescent	Health/Fitness Center	Community Energy Services Corporation	X			
Site #10	PG&E	PGE2020	Linear Fluorescent	Gas Station/Auto Repair	Community Energy Services Corporation	X			
Site #11	PG&E	PGE2020	Linear Fluorescent	Shop in Strip Mall	Community Energy Services Corporation	X			
Site #12	PG&E	PGE2020	Linear Fluorescent	Medical/Dental Office	Community Energy Services Corporation	X			
Site #13	PG&E	PGE2051	Linear Fluorescent	Administration and management	Ecology Action	X			
Site #14	PG&E	PGE2020	Linear Fluorescent	Insurance/Real Estate	Community Energy Services Corporation	X			

Site Name	Utility	Program Number	Technology	Building Type	Program Installation/Contractor	Complete	Complete with pre-retrofit data	Cancelled	Comments
Site #15	PG&E	PGE2051	Linear Fluorescent	Gas Station/Auto Repair	Ecology Action	X			
Site #16	PG&E	PGE2051	Linear Fluorescent	Other Retail Store	Ecology Action	X			
Site #17	PG&E	PGE2020	Linear Fluorescent	Office	Community Energy Services Corporation	X			
Site #18	PG&E	PGE2051	Linear Fluorescent	Other Retail Store	Ecology Action	X			
Site #19	PG&E	PGE2051	Linear Fluorescent	Medical/Dental Office	Ecology Action	X			
Site #20	PG&E	PGE2051	Linear Fluorescent	Table Service	Ecology Action	X			
Site #21	PG&E	PGE2051	Linear Fluorescent	Convenience Store	Ecology Action	X			
Site #22	PG&E	PGE2051	Linear Fluorescent	Agriculture/Office Building	Ecology Action	X			
Site #23	PG&E	PGE2020	Linear Fluorescent	Insurance/Real Estate	Community Energy Services Corporation	X			
Site #24	PG&E	PGE2051	Linear Fluorescent	Table Service	Ecology Action	X			
Site #25	PG&E	PGE2020	Linear Fluorescent	Manufacturing/Light Industrial	Community Energy Services Corporation	X			
Site #26	PG&E	PGE2021	Linear Fluorescent	Medical/Dental Office	Richard Heath and Associates	X			
Site #27	PG&E	PGE2021	Linear Fluorescent	Medical/Dental Office	Richard Heath and Associates	X			
Site #28	PG&E	PGE2051	Linear Fluorescent	Table Service	Ecology Action	X			
Site #29	PG&E	PGE2051	Linear Fluorescent	Specialty/Novelty Food Service	Ecology Action	X			
Site #30	PG&E	PGE2051	Linear	Specialty/Novely	Ecology Action	X			

Site Name	Utility	Program Number	Technology	Building Type	Program Installation/Contractor	Complete	Complete with pre-retrofit data	Cancelled	Comments
			Fluorescent	Food Store					
Site #31	PG&E	PGE2051	Linear Fluorescent	Fast Food Restaurant	Ecology Action	X			
Site #32	PG&E	PGE2051	Linear Fluorescent	Other Commercial (Dry Cleaning and Laundry)	Ecology Action	X			
Site #33	PG&E	PGE2051	Linear Fluorescent	Lab/R&D Facility	Ecology Action	X			
Site #34	PG&E	PGE2051	Linear Fluorescent	Other Recreational/Public Assembly	Ecology Action	X			
Site #35	PG&E	PGE2051	Linear Fluorescent	Other Commercial (Dry Cleaning and Laundry)	Ecology Action	X			
Site #36	PG&E	PGE2051	Linear Fluorescent	Administration and Management	Ecology Action	X			
Site #37	PG&E	PGE2051	Linear Fluorescent	Other Service Shop (Car wash)	Ecology Action	X			
Site #38	SCE	SCE2511	Linear Fluorescent	Other Food Service	California Retrofit	X			
Site #39	SCE	SCE2511	Linear Fluorescent	Shop in Strip Mall	FCI Management	X			
Site #40	SCE	SCE2511	Linear Fluorescent	Assembly/Light Manufacture	California Retrofit	X			
Site #41	SCE	SCE2511	Linear Fluorescent	Motel	FCI Management	X			
Site #42	SCE	SCE2511	Linear Fluorescent	Liquor Store	California Retrofit	X			
Site #43	SCE	SCE2511	Linear Fluorescent	Shop in Strip Mall	FCI Management	X			
Site #44	SCE	SCE2511	Linear Fluorescent	Administration and management	California Retrofit	X			

Site Name	Utility	Program Number	Technology	Building Type	Program Installation/Contractor	Complete	Complete with pre-retrofit data	Cancelled	Comments
Site #45	SCE	SCE2511	Linear Fluorescent	Other Service Shop	FCI Management	X			
Site #46	SCE	SCE2511	Linear Fluorescent	Unconditioned Warehouse/Low Bay	California Retrofit	X			
Site #47	SCE	SCE2511	Linear Fluorescent	Medical/Dental Lab	FCI Management	X			
Site #48	SCE	SCE2511	Linear Fluorescent	Gas Station/Auto Repair	California Retrofit	X			
Site #49	SCE	SCE2511	Linear Fluorescent	Other Retail Store	FCI Management	X			
Site #50	SCE	SCE2511	Linear Fluorescent	Convenience Store	California Retrofit	X			
Site #51	SCE	SCE2511	Linear Fluorescent	Medical/Dental Office	FCI Management	X			
Site #52	SCE	SCE2511	Linear Fluorescent	Gas Station/Auto Repair	California Retrofit	X			
Site #53	SCE	SCE2511	Linear Fluorescent	Other Retail Store	California Retrofit	X			
Site #54	SCE	SCE2511	Linear Fluorescent	Other Office	California Retrofit	X			
Site #55	SCE	SCE2511	Linear Fluorescent	Gas Station/Auto Repair	California Retrofit	X			
Site #56	SCE	SCE2511	Linear Fluorescent	Convenience Store	California Retrofit	X			
Site #57	SCE	SCE2511	Linear Fluorescent	Other Commercial	California Retrofit	X			
Site #58	SCE	SCE2511	Linear Fluorescent	Repair (Non-Auto)	California Retrofit	X			
Site #59	SCE	SCE2511	Linear Fluorescent	Other Retail Store	California Retrofit	X			
Site #60	SCE	SCE2511	Linear	Gas Station/Auto	FCI Management	X			

Site Name	Utility	Program Number	Technology	Building Type	Program Installation/Contractor	Complete	Complete with pre-retrofit data	Cancelled	Comments
			Fluorescent	Repair					
Site #61	SCE	SCE2511	Linear Fluorescent	Financial/Legal	FCI Management	X			
Site #62	SCE	SCE2511	Linear Fluorescent	Insurance/Real Estate	FCI Management	X			
Site #63	SCE	SCE2511	Linear Fluorescent	Other Retail Store	California Retrofit	X			
Site #64	SCE	SCE2511	Linear Fluorescent	Shop in Strip Mall	FCI Management	X			
Site #65	SCE	SCE2511	Linear Fluorescent	Other office	California Retrofit	X			
Site #66	SCE	SCE2511	Linear Fluorescent	Other Retail Store	California Retrofit	X			
Site #67	SCE	SCE2511	Linear Fluorescent	Other Service Shop	California Retrofit	X			
Site #68	SCE	SCE2511	Linear Fluorescent	Shop in Strip Mall	FCI Management	X			
Site #69	SCE	SCE2511	Linear Fluorescent	Administration and management	FCI Management	X			
Site #70	SCE	SCE2511	Linear Fluorescent	Insurance/Real Estate	California Retrofit	X			
Site #71	SCE	SCE2511	Linear Fluorescent	Other Retail Store	California Retrofit	X			
Site #72	SCE	SCE2511	Linear Fluorescent	Auto Sales	FCI Management	X			
Site #73	SCE	SCE2511	Linear Fluorescent	Financial/Legal	California Retrofit	X			
Site #74	SCE	SCE2511	Linear Fluorescent	Financial/Legal	FCI Management	X			
Site #75	SCE	SCE2511	Linear Fluorescent	Auto Sales	California Retrofit	X			

Site Name	Utility	Program Number	Technology	Building Type	Program Installation/Contractor	Complete	Complete with pre-retrofit data	Cancelled	Comments
Site #76	SCE	SCE2511	Linear Fluorescent	Unconditioned Warehouse/Low Bay	California Retrofit	X			
Site #77	SCE	SCE2511	Linear Fluorescent	Unconditioned Warehouse/High Bay	FCI Management	X			
Site #78	SCE	SCE2511	Linear Fluorescent	Nursing Home	FCI Management	X			
Site #79	SCE	SCE2511	Linear Fluorescent	Other Retail Store	FCI Management	X			
Site #80	SCE	SCE2511	Linear Fluorescent	Unconditioned Warehouse/High Bay	FCI Management	X			
Site #81	SCE	SCE2511	Linear Fluorescent	Unconditioned Warehouse/Low Bay	FCI Management	X			
Site #82	SCE	SCE2511	Linear Fluorescent	Unconditioned Warehouse/High Bay	FCI Management	X			
Site #83	SCE	SCE2511	Linear Fluorescent	Other Service Shop	FCI Management	X			
Site #84	SCE	SCE2511	Linear Fluorescent	Other Office	FCI Management	X			
Site #85	SCE	SCE2511	Linear Fluorescent	Specialty/Novelty Food Service	FCI Management	X			
Site #86	SCE	SCE2511	Linear Fluorescent	Administration and management	FCI Management	X			
Site #87	SCE	SCE2511	Linear Fluorescent	Conditioned Warehouse/Low-Bay	FCI Management	X			
Site #88	SCE	SCE2511	Linear Fluorescent	Community Center	FCI Management	X			
Site #89	SCE	SCE2511	Linear	Other Commercial	FCI Management	X			

Site Name	Utility	Program Number	Technology	Building Type	Program Installation/Contractor	Complete	Complete with pre-retrofit data	Cancelled	Comments
			Fluorescent						
Site #90	SCE	SCE2511	Linear Fluorescent	Bar/Tavern/Night Club/Other	FCI Management	X			
Site #91	SCE	SCE2511	Linear Fluorescent	Other Office	FCI Management	X			
Site #92	SCE	SCE2511	Linear Fluorescent	Other Office	FESS	X			
Site #93	SCE	SCE2511	Linear Fluorescent	Theatre/Performing Arts	FESS	X			
Site #94	SCE	SCE2511	Linear Fluorescent	Medical/Dental Office	FESS	X			
Site #95	SCE	SCE2511	Linear Fluorescent	Administration and Management	FESS	X			
Site #96	SCE	SCE2511	Linear Fluorescent	Shop in Strip Mall	FESS	X			
Site #97	SCE	SCE2511	Linear Fluorescent	Unconditioned Warehouse /High Bay	FESS	X			
Site #98	SCE	SCE2511	Linear Fluorescent	Gas Station/Auto Repair	FESS	X			
Site #99	SCE	SCE2511	Linear Fluorescent	Other Service Shop	FESS	X			
Site #100	SCE	SCE2511	Linear Fluorescent	Other Retail Store	FESS	X			
Site #101	SCE	SCE2511	Linear Fluorescent	Other Retail Store	FESS	X			
Site #102	SCE	SCE2511	Linear Fluorescent	Auto Sales	FESS	X			
Site #103	SCE	SCE2511	Linear Fluorescent	Shop in Strip Mall	FESS	X			
Site #104	SDG&E	SDGE3012	High Bay and Linear	Unconditioned Warehouse/High	Eco Energy Systems	X			

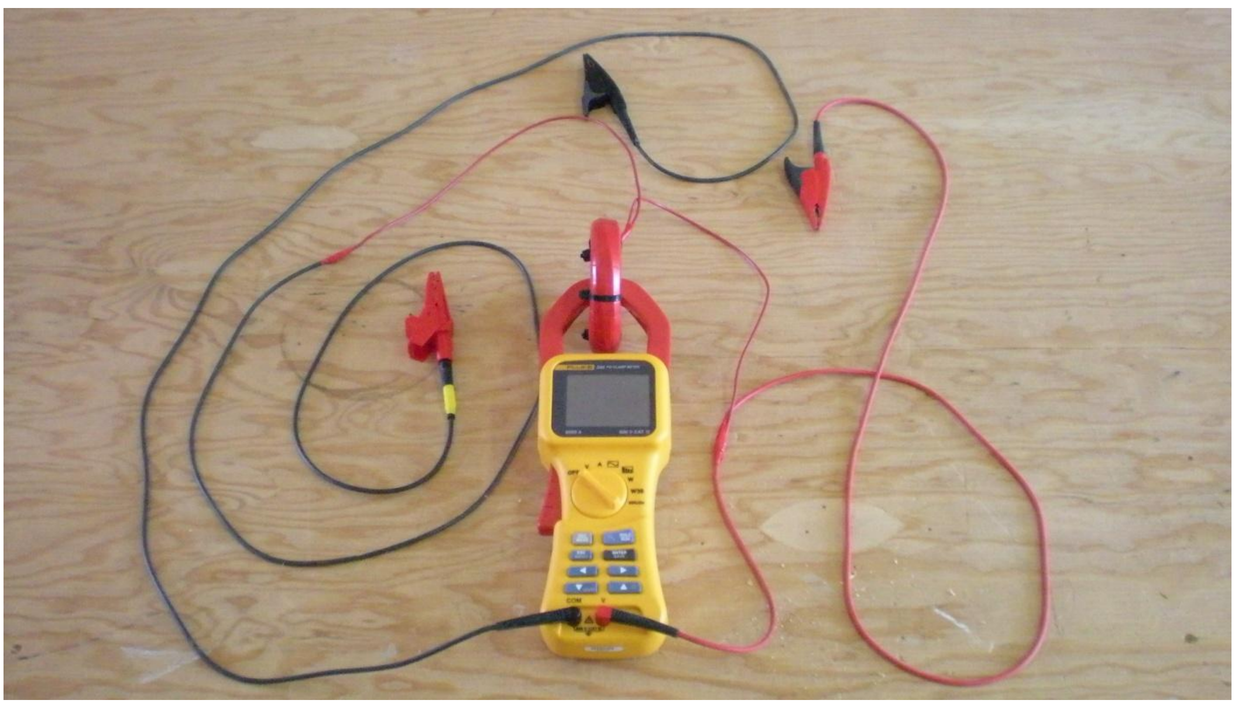
Site Name	Utility	Program Number	Technology	Building Type	Program Installation/Contractor	Complete	Complete with pre-retrofit data	Cancelled	Comments
			Fluorescent	Bay					
Site #105	SDG&E	SDGE3012	High Bay	Unconditioned warehouse/High Bay	Eco Energy Systems	X			
Site #106	SDG&E	SDGE3012	High Bay	Unconditioned warehouse/High Bay	Eco Energy Systems	X			
Site #107	PG&E	PGE2080	High Bay	Assembly/Light Manufacturing	Energy Retrofit Co.	X			
Site #108	PG&E	PGE2080	High Bay	Industrial: Truck Manufacturing	Energy Retrofit Co.	X			
Site #109	PG&E	PGE2020	Linear Fluorescent	N/A	Community Energy Services Corporation			X	Fixtures could not be logged.
Site #110	PG&E	PGE2021	Linear Fluorescent	Medical/Dental Office	Richard Heath and Associates			X	Study participation was cancelled by the customer. No logging was completed.
Site #111	SDG&E	SDGE3012	High Bay	Unconditioned warehouse/High Bay	Eco Energy Systems		X		Site withdrew from the retrofit, and thus will not participate further in the study. No post logging.
Site #112	SDG&E	SDGE3012	High Bay	Unconditioned warehouse/High Bay	Eco Energy Systems		X		Site not going forward with the retrofit. No post logging.
Site #113	SCE	SCE2511	Linear Fluorescent	N/A	FESS			X	Customer rescheduled the 1st site visit 3 times, and then did not show up for the appointment. No logging completed.
Site #114	SCE	SCE2511	Linear Fluorescent	N/A	FESS			X	Since there was only one linear fluorescent fixture at the site, project was cancelled during 1st site visit. No logging was completed.

Site Name	Utility	Program Number	Technology	Building Type	Program Installation/Contractor	Complete	Complete with pre-retrofit data	Cancelled	Comments
Site #115	SCE	SCE2511	Linear Fluorescent	N/A	FCI Management			X	Fixtures were inaccessible/hazardous. No logging completed.
Site #116	SCE	SCE2511	Linear Fluorescent	Other Service Shop	FCI Management		X		Customer is uncooperative with the retrofitters. Retrofit cancelled. No post logging.
Site #117	SCE	SCE2511	Linear Fluorescent	N/A	California Retrofit			X	Site was retrofitted before SBC completed the first site visit; no logging was completed.
Site #118	SCE	SCE2511	Linear Fluorescent	N/A	California Retrofit		X		Project was retrofitted before data loggers were removed. No post logging.
Site #119	SCE	SCE2511	Linear Fluorescent	N/A	FCI Management			X	Project was not approved by SCE. No site visit was completed.
Site #120	SCE	SCE2511	Linear Fluorescent	Shop in Strip Mall	FCI Management		X		Site was retrofitted before pre-logging was completed. No post logging.
Site #121	SCE	SCE2511	Linear Fluorescent	Insurance/Real Estate	FCI Management		X		The business is moving out of this office before SBC could finish post logging. No post logging.
Site #122	SCE	SCE2511	Linear Fluorescent	N/A	FCI Management		X		Not enough pre-retrofit logger data to continue with post-retrofit logger data collection. No post logging.
Site #123	SCE	SCE2511	Linear Fluorescent	Other Service Shop	California Retrofit		X		Lights cannot be retrofitted. No post logging.

Exhibit A-1. Current Amplifiers

Current Amplifier

Current Amplifier with Fluke



Furnace HIM Metering Research Summary

FURNACE HIM METERING RESEARCH SUMMARY

Summit Blue was engaged by the California Public Utilities Commission to conduct the field data collection portion of Cadmus' evaluation of high-efficiency residential gas furnaces (Residential Furnaces Study or Furnaces Study). High-efficiency furnaces had been deemed a High Impact Measure (HIM) for PG&E and were thus receiving an elevated level of evaluation in PG&E's service territory.[2] The study methodology was designed by Cadmus and RLW/KEMA, and Summit Blue's role in the project was to implement the methodology, collect the data in the field, and transmit the data to Cadmus for analysis.

This memorandum describes the project objectives, implementation, and final sample disposition. A discussion of the issues and challenges is also provided. Since the data collected in the field was passed directly to Cadmus for analysis, this memo will not provide the results of the Furnaces Study. Instead, the purpose of this memo is to document the tasks undertaken by Summit Blue in support of the evaluation.

Study Objectives

The principle objective of the Residential Furnaces Study was to collect primary data of therm usage for 90+ AFUE gas furnaces, installed as part of PG&E's residential gas efficiency programs. This data would support an estimate of mean lifetime avoided cost savings associated with installing 90+ AFUE furnaces, measured with a high level of confidence. Secondary objectives of the Furnaces Study were to:

- Collect primary data regarding electricity usage of VSD blower motors installed under PG&E's programs.
- Collect contextual data about residences in the sample, including basic home information and cooling system data.

Specifically, the M&V plan developed by RLW/KEMA specified that Summit Blue should collect field data at 70 sites for 90+ AFUE furnaces installed through selected programs within PG&E's 2006-2008 portfolio of programs. The field data collected included nameplate data of each new furnace, nameplate data about the any cooling systems present, basic building and occupant information, gas meter numbers and readings, and furnace time-of-use as measured by the call for heat from the thermostat.

Climate Zone Targets

Table A-6 below shows the target number of sites for data collection by climate zone. The targets were based on raw population data of 90+ AFUE furnaces installed through 11/12/2008 in PG&E's territory as part of the 2006-2008 programs. There were no targets for completing data collection by program.

[2] This measure was not a HIM for SCG or SDG&E, therefore installations in these IOUs' service territories were not included in the Furnaces Study.

Table A-6. 90+ AFUE Furnace Installations and Targeted Number of Completes by Climate Zone

Climate Zone	Number of 90+ AFUE Furnaces Installed	Percent of Total Installations	Targeted Number of Completes
CZ01	276	1%	0
CZ02	3,228	12%	8
CZ03	5,194	20%	14
CZ04	2,840	11%	8
CZ05	1	0%	0
CZ11	1,521	6%	5
CZ12	12,554	48%	35
CZ13	319	1%	0
CZ14	26	0%	0
CZ16	23	0%	0
Unknown	12	0%	0
Total	**25,994**	**100%**	**70**

*Sources: "PGE Furnace Sample – 11-12-2008.xls"; "90+ AFUE Furnace and VSD Furnace Fan MV.xls"

Field Requirements

RLW/KEMA and Cadmus developed an initial M&V plan for the Residential Furnaces Study that called for a pre and post installation billing analysis. The approach they took was based on RLW's field experiences implementing this same approach for the Residential New Construction Program. Specifically, the M&V plan called for using the request for heat from the thermostat as a proxy for determining when the furnace would be consuming gas. From the Furnaces Study proposal[3]: "RLW determined that by 'slaving' a small relay off of the heating control circuit, and logging the change of state of that relay, the run-time of the furnace could be precisely logged. The furnace nominal input Btuh is obtained from manufacturers' specifications and used to convert the run-time data to gas input."

The final metering setup consisted of a LED light attached directly to a HOBO U9-001 lighting on/off data logger. Two leads from this setup were used to swipe power from the 24V control signal coming from the thermostat during its call for heat, thus powering the LED and triggering an "on" signal in the data logger. Using this setup to measure time-of-use avoided the costly approach of direct gas metering, which would have also been limited by customer reluctance and physical constraints.[4]

Once the M&V plan was approved, Summit Blue developed a strategy for implementing it. The first step was to create a central, web-enabled database allowing for scheduling and data entry from any location with an Internet connection. Next, Summit Blue staff developed data collection forms to be used in the field. Starting with RLW's field forms for the Residential New Construction program, Summit Blue customized the form set based on the requirements of the Furnaces M&V plan. The data collected onsite included:

[3] *Cadmus_CPUC_Furnace_Study_Proposal_10242008.doc*

[4] Gas sub meters are physically large as compared to the LED logger setup, and they would be difficult to install in any tight space. The rate of customer refusal also likely would have been much higher since the installation frequently requires leaving the furnace cabinet disassembled.

- Ownership of the home, and the number and ages of people living in the home
- Year that home was built, the conditioned square footage, and any remodels since 2005
- Type and R value of any insulation added that might affect billing analysis
- Quantity and size of any natural gas appliances, as well as any appliance changes since 2005
- Heating and cooling setpoints
- Heating and cooling equipment nameplate data, including manufacturer, model numbers, capacities, and efficiencies
- Gas and electric meter numbers, and gas meter readings at logger installation and retrieval
- Time-of-use as measured by the thermostat call for heat
- Contextual data about the furnace setup at each house to inform future plans that might include combustion efficiency tests

The final, approved form set was then used to create the data-entry screens for the central database. From the form set and the M&V plan, Summit Blue developed field protocols and an easy-to-use field manual describing in detail the data to be collected onsite. Last, Summit Blue conducted multiple trainings with its field staff to ensure that all personnel were familiar with the protocols and could reliably collect the data as required.

Recruitment and Scheduling

Leads for the onsite data collection portion of the Furnaces Study were recruited through the Residential Retrofit Evaluation Team's High Impact Measure Participant Survey. The survey was conducted at the end of November through the middle of December, and it recruited 165 households that agreed to be *contacted* by Summit Blue for onsite data collection. Out of 165 recruited households, 156 were located in the climate zones targeted by this study. Table A-7 shows the number of recruits as compared to the target number of completions by climate zone.

Table A-7. Ratio of Available Recruits to Targeted Number of Completes

Climate Zone	Number of Available Recruits	Targeted Number of Completes	Ratio of Available Recruits to Targeted Completes
CZ02	19	8	2.4 : 1
CZ03	40	14	2.9 : 1
CZ04	21	8	2.6 : 1
CZ11	16	5	3.2 : 1
CZ12	60	35	1.7: 1
Others	9	0	NA
Total	**165**	**70**	**2.4 : 1**

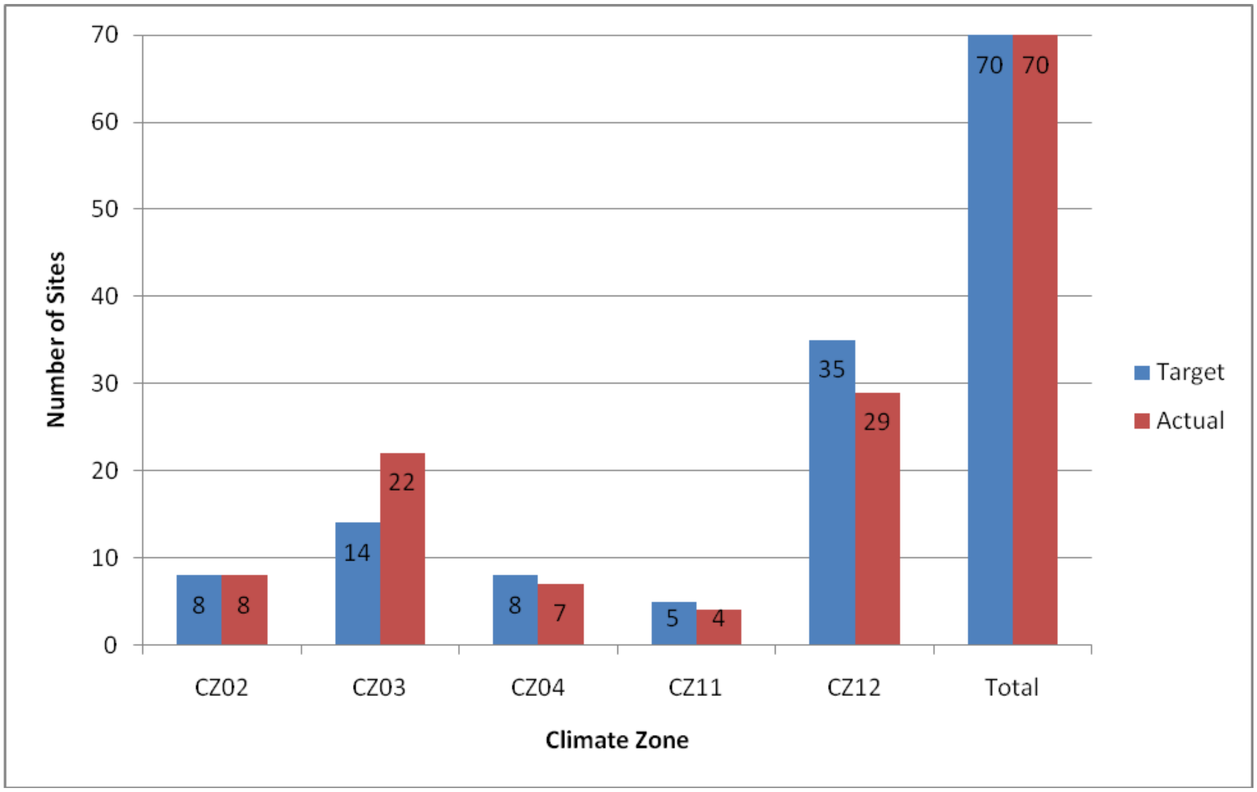
*Sources: "HIM Furnace Recruits – 20081211.xls"; Summit Blue analysis of completed sites

The list of recruits was imported to the central, web-enabled database for scheduling. Site visit scheduling was coordinated by administrative staff experienced with both calling utility customers and with grouping sites geographically to allow for easy field logistics. Recruits were offered $50 gift certificates for participating in the metering portion of the Furnaces Study. Scheduled appointments and customer comments were recorded using the central database. The database also recorded attempted customer contacts and customer refusals. Field staff could then use the database to find their scheduled appointments, print out directions to the sites, and print out the data collection forms.

Final Sample and Data Disposition

Summit Blue completed data collection at 70 sites as targeted by the M&V plan. The final number of completes by climate zone was slightly different than the target due to the relatively low ratio of available recruits to targeted completes. Figure A-1 shows a comparison of the targeted to actual number of completes by climate zone.

Figure A-1. Comparison of Targeted to Actual Number of Completes



*Source: Summit Blue analysis of targeted vs. actual completed sites

All 70 of the logger installation site visits were completed between December 8, 2008 and January 21, 2009. Of these, 63 sites (90%) were installed in December 2008. "Interim" site visits to collect partial data sets for a preliminary analysis were conducted at a small sample of sites at the end of January. The majority of retrieval site visits occurred in August 2009. Summit Blue conducted a comprehensive quality control assessment, and the final data set was delivered to Cadmus on October 13, 2009.

Issues and Challenges

The project team faced a number of significant challenges related to completing the tasks described above. For one, Summit Blue was first engaged to perform the data collection task in October, with a goal of completing all logger installations by the end of December in order to capture the bulk of the heating season. This short timeline left little time to first develop the tools necessary (i.e., the database, the onsite forms, and the protocols) to complete the job, and also little time to actually complete the installations. The problem was compounded by the busy holiday season in December, and thus having to work around both customer and field staff schedules. Summit Blue ultimately completed 90% of the targeted installations in December, and the remaining 10% in January.

Given the relatively small number of recruits, scheduling the installation site visits was also a challenge. In theory, the 165 households included in the recruitment list had already agreed in principal to participating in the metering portion of the study. However, trying to actually schedule these site visits around holiday schedules proved to be quite difficult. Many of the recruits also worked during the day, which further shortened the number of available times for completing the data collection. With a small pool to choose from within each climate zone, the scheduler had to be extra diligent in her efforts to schedule site visits. Although Summit Blue eventually scheduled and completed all of the required site visits, the actual numbers of hours for scheduling exceeded the scheduling budget by more than two times.

Perhaps the most significant overarching issue for the Residential Furnaces Study was in the methodology proposed by the HIM lead for determining the 8,760 load shape through time-of-use monitoring. An analysis of the preliminary data collected during the “interim” site visits showed that the furnace gas consumption as calculated using the methodology in the M&V plan actually *exceeded* the total gas consumption for the house as determined from the utility gas meter. After thorough deliberation, RLW suggested a second round of interim site visits to further investigate the reasons for this discrepancy. Analysis of these results led to the following findings:

- **Most of the furnaces assumed to be single-stage models were observed to operate as dual stages.** A manufacturer of a dual-stage furnace is only required to provide the high stage Btu/h on the nameplate and in the model number. Although the control boards of these furnaces have a single-stage connected to the thermostat, an internal furnace CPU actually controlled whether it was in low or high firing mode. A furnace can run in high and low stages *even if* a) there is one rated input, b) it is operated by a single-stage thermostat wired only to the W1 thermostat terminal, and c) the DIP switches look like the unit is set to single-stage. Further, many of these furnaces use a proprietary and confidential adaptive control algorithm to determine which stages to fire. As a result, logging the call for heat from the thermostat provides no information for whether the unit is firing high or low.

- **A significant delay exists between the call for heat from the thermostat and the furnace actually firing.** This “lag time” exists in order for the unit to proof the flame (thus ensuring that the gas will indeed be burned in the furnace), and to get air moving through the heat exchanger. The lag time for many furnaces has been published by the manufacturer, but the interim site visits showed that actual lag times varied substantially from published values. On average, the lag times were 144% of published values, but they were as long as 183% for one tested furnace. This delay *for each individual furnace* was also shown to vary in length based on past calls for heat. Thus logging the thermostat call for heat proved not to be a reliable indicator that furnace was indeed firing.

- **Actual in-situ firing rates are lower than rated capacity.** During the second round of interim site visits, Summit Blue installed an in-line gas meter to measure the actual gas flow rate. Full firing rates averaged 95% of the nameplate rating, and ranged from 83% to 106%. Low-fire rates were published for only three of the seven measured furnaces. The actual low firing rate averaged 96% of the published rate, with a range of 93% to 99%.

Through several meetings with the CPUC and DMQC, the group concluded that these issues with the methodology for determining the 8,760 load shape were too significant to overcome cost-effectively. Instead, the savings data would need to be based wholly on the pre- and post-retrofit billing analysis. Future efforts to measure time-of-use for furnace gas consumption should focus on either a direct gas metering approach or on measuring gas valve actuation.

Recommendations for Future Residential Gas Furnace Metering Studies

Based on the issues and challenges of this study, a few key recommendations are outlined for future furnace studies.

- **Hit the heating season earlier on.** Not only will this capture more of the heating season, but it may also help to further define shoulder months' usage. In addition, the holiday season can be avoided.

- **Allow for ample time to schedule.** While it seems likely that scheduling participants will be easy if they have already been recruited, this proved to be incorrect. Additional time for scheduling will allow for the greater likelihood of meeting targets on time. Also, more time upfront for scheduling has always ultimately saved time in the long run for the project.

- **The most accurate way to log any data is to log it directly.** Because too many assumptions were made on how efficient furnaces operated in this study, short cuts were implemented that were assumed to be cost effective. However, in this case, the most cost and time effective approach for determining accurate therm usage per home is to install an inline gas flow meter with capabilities to meter continuously over the heating season. When looking for therm usage to calculate savings, meter therm usage.

PRSV EVALUATION PLANNING RESEARCH SUMMARY

PRSV EVALUATION PLANNING RESEARCH SUMMARY

This appendix documents Summit Blue's development of an *ex-post* impact evaluation plan for energy savings from low flow pre-rinse spray valve (PRSV) retrofits. This measure was identified by the Master Evaluator Contractor Team (MECT) as a high impact measure for the 2006-2008 program cycle, based on the fourth quarter 2007 statewide measure database. The CPUC and MECT requested that Summit Blue develop an evaluation plan for this measure as part of Summit Blue's 2006-2008 Local Government Partnerships evaluation contract.

Despite large uncertainties in the magnitude of energy savings from PSRV retrofits, the CPUC/MECT ultimately decided not to pursue this evaluation due to the measure's limited presence in the final (fourth quarter 2008) measure database; the absence of PRSVs from utilities' proposed 2009-2011 program implementation plans; and the complexity and cost of conducting a rigorous evaluation of this measure.

This document includes background on the technical and regulatory aspects of PRSVs; a summary of prior research on the energy savings of PRSVs; and a proposed full-scale measurement and verification approach to ex-post PRSV gross impact evaluation, as well as two less complex alternate approaches. These proposed EM&V approaches were not implemented as part of this effort, but are intended to summarize our research and inform potential future EM&V designs on PRSV measures.

Introduction and Work History

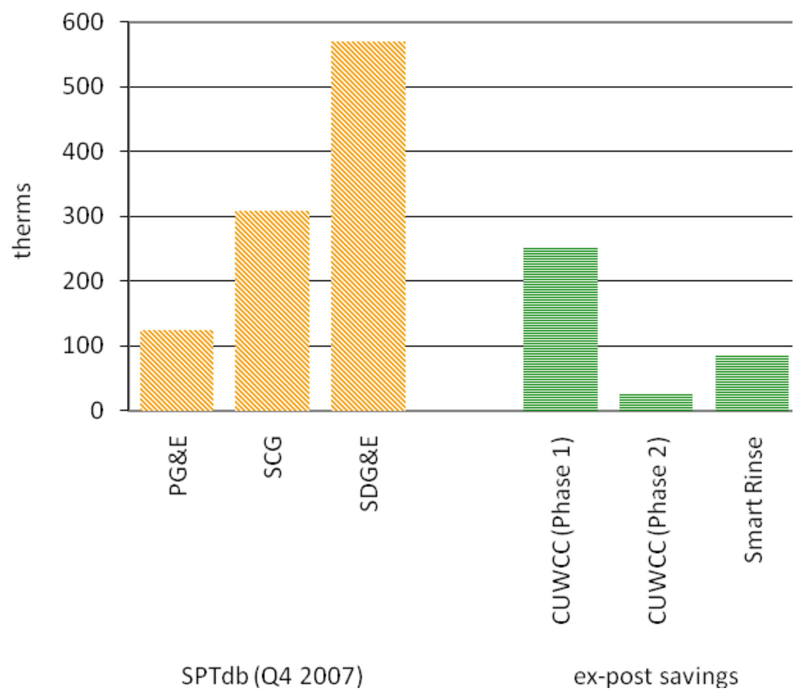
Pre-rinse spray valves (PRSV) were identified by the Master Evaluator Contractor Team (MECT) as a high impact measure (HIM) for the California Investor Owned Utility (IOU) 2006-2008 energy efficiency portfolios, based on a preliminary (fourth quarter, 2007) analysis of the CPUCs Standardized Program Tracking Database (SPTdb) (Table A-8). At that time, this measure represented more that 1% of natural gas savings at all three the gas utilities. Additionally, PG&E was claiming some electric savings from this measure.

Table A-8. PRSV savings claim summary from SPTdb, Q4 2007

	Claimed PRSV Savings			Percentage of utility Portfolio		
Utility	kW Savings	kWh Savings	Therm Savings	% kW	%kWh	% Therm
PG&E	207	1,504,504	301,265	0.05%	0.07%	1.04%
SCE	-	-	-	-	-	-
SCG	-	-	643,290	-	-	1.80%
SDGE	-	-	586,530	-	-	1.20%

Per unit savings claims in the Q4 2007 SPTdb for PRSVs ranged from 124 therms (PG&E) to 570 therms (SDG&E) per PRSV. This is in contrast to the most recent *ex-post* evaluations of PSRV savings in California, which suggest per unit annual savings of only 28 therms **(SBW 2007)**. **Figure A-2** summarizes the claimed saving per unit from the IOUs and *ex-post* savings estimates from recent evaluations.

Figure A-2. Estimated annual per-device PRSV savings from Q4 2007 SPTdb and from ex-post evaluations



The CPUC and MECT requested that Summit Blue develop an evaluation plan for PSRVs as part of the 2006-2008 Government Partnership evaluation contract. In the 2nd quarter of 2009, when the SPTdb was finalized for the 2006 – 2008 program cycle, it was discovered that the IOUs PRSV savings claims had been revised downward from the initial review of the 2007 data. The most significant reason for this decline was San Diego Gas and Electric's removal of PRSV from their claimed savings[5] and the absence of any new PRSV claims from any utility after the second quarter of 2008 (**Table A-9**),. SCG did retain a PRSV savings claim of over 1% of their portfolio, but this had been reduced by nearly 40% from the earlier tracking data. Furthermore, none of the 2009-2011 program implementation plans proposed by the utilities included PRSVs. The CPUC and MECT did not request that Summit Blue pursue an evaluation of PSRVs beyond the initial evaluation plan development efforts.

Based on the reduced savings claims and absence of PRSVs from the 2009 – 2011 portfolio, it was determined that the Summit Blue team should complete an analysis of previous evaluation efforts, identify uncertainties within those evaluations, and produce an evaluation plan that could be used in subsequent evaluations if PRSV measures are re-introduced into future portfolios.

[5] In conversation with Summit Blue, the SEMPRA representative to the evaluation contract groups for EEGA data requests suggested that there were problems with the program implementer's tracking of this measure.

Table A-9. PRSV savings claim summary from SPTdb, Q4 2008

Utility	Claimed PRSV Savings			Percentage of Utility Portfolio		
	kW Savings	kWh Savings	Therm Savings	% kW	% kWh	% Therm
PGE	211	1,522,099	327,550	0.02%	0.02%	0.40%
SCE	-	-	-	-	-	-
SCG	-	-	804,112	-	-	1.1%
SDG&E	-	-	-	-	-	-

The following sections document Summit Blue's efforts: providing background on the technical and regulatory aspects of PRSVs; summarizing prior research on the energy savings of PRSVs; and proposing evaluation plans.

Technical Description

A pre-rinse spray value (PRSV) is a handheld device that uses jets of water to remove food from dishes before they are cleaned in a dishwasher. An end user has the ability to control the flow and the temperature of the water that comes out of a PRSV. PRSVs are ubiquitous in various types of commercial kitchens including restaurants, cafeterias, and grocery stores.

Low-flow PRSVs require less water to rinse dishes than standard PRSVs and, therefore, require less energy to heat water for dish rinsing. A typical restaurant in California consumes 5,000 therms of natural gas annually to heat water for dishwashing,[6] although two thirds of this is often for a dishwasher. Low-flow PRSVs save water (and hence, energy) while maintaining equivalent cleaning performance over baseline methods.

Prior to 2006, typical PRSVs in California had a flow rate of approximately 2.5 gallons per minute (gpm).[7]. The Federal Energy Policy Act of 2005 mandates a maximum flow rate of 1.6 gpm, but does not specify a standard test method for cleanability. In 2006, California Title 20 introduced the state's first regulatory code for PRSVs: commercial PRSVs manufactured on or after January 1, 2006 must have a maximum flow rate of 1.6 gpm or less at 60 psi *and* pass the ANSI/ASTM Standard Test Method for Pre-rinse Spray Valves.[8] In 2009, typical low-flow PRSVs have a flow rate of approximately 1 gpm.[9] PRSVs (low-flow and regular) have a lifetime of approximately five years, which suggests that the market should be dominated by sub-1.6 gpm PRSVs in the near future.

Flow rates of individual PRSV units has been observed to vary over time. Fouling can cause a decrease in output over time; users have drilled holes in the face of PRSVs to increase the flow rate.

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[6] The weighted average natural gas consumption for water heating in Western region food services buildings in CBECS 2003 public micro-use data is 5,200 therms (EIA 2004)

[7] Personal communication with staff at PG&E's Food Service Technology Center.

[8] Spray valves must pass ANSI/ASTM F2324-03 Standard Test Method: "This test consists of cleaning a plate of dried tomato sauce in less than 21 seconds with 120 ± 4°F (49 ± 2°C) water at a specified distance from the plate. This test is performed at 60 ± 2 psi of flowing water pressure. The cleanability test is performed on sixty plates and the reported result is an average of the results obtained with each of the sixty plates." (CEC 2007)

[9] Personal communication with staff at PG&E's Food Service Technology Center.

Prior Research

This section reviews recent studies of low-flow PRSV savings. Annual savings per PRSV from California studies have ranged from 28 to 252 therms. Sample sizes have not been large enough to provide high levels of precision or to provide adequate distinction of savings by business type.

Summit Blue was able to locate impact evaluations of the following programs:

- City of Calgary – Detailed data collection at ten sites as part of a pilot (VCI 2005) and basic data collection for 1,201 sites participating in the program (CMISI and VCI 2008).
- California Urban Water Conservation Council (CUWCC), Phase 1, 2002-2003 – Installation of approximately 17,000 PRSVs across California. 19 of these sites were metered, although the existing equipment was not trend metered(SBW 2004).
- CUWCC, Phase 2, 2004-2005 - Installation of 16,682 PRSVs, primarily in SCG territory. Nineteen of these sites were metered in detail, 17 of which received a full post-retrofit and pre-retrofit (albeit *simulated* after the post-retrofit) examination (SBW 2007).
- SmartRinse, 2005 – Installed 4,237 PRSVs at 2,961 sites across the Redwood Empire, the Central Valley, and the Santa Cruz/Monterey area. Fifteen of these sites were selected for trend metering, ultimately, clean data for ten of these sites was available (Quantec, LLC 2006).
- Puget Sound Energy, Washington State, 2003 - 2005 – 6,809 PRSVs were installed in this program. No evaluation report was identified, only a summary of the project (Tso and Koeller 2005).
- Starbucks, Washington State, 2005 - A study of five Starbucks cafes in Washington state. No evaluation report was identified, only summary results (Tso and Koeller 2005).
- Seattle Public Utilities pre-test, 2003 – A study of four Seattle, WA sites. No evaluation report was identified, only summary results (Tso and Koeller 2005).

The two most recent California PRSV impact studies - evaluations of the SmartRinse program (Quantec, LLC 2006) and the California Urban Water Conservation Council (CUWCC) program (SBW 2007) - both used a post/pre field study approach. In this approach, program participants were first metered with their retrofit PRSVs *and then* metered with their original PRSVs, which the retrofitters had retained. While the post/pre design does measure behavioral differences between regular and low flow PRSVs, drawing conclusions about the actual "pre to post" behavior change resulting from the new PRSV is difficult because the user has already become accustomed to the retrofit PRSV when going back and using the original PRSV.

While these studies are among the most rigorous of the existing *ex-post* empirical impact evaluations, the findings are difficult to generalize to the population for several reasons:

- **Small sample size** - Complete data was collected for only 10 SmartRinse participants and 17 CUWCC participants.
- **Variation in site types** – Within the different types of commercial kitchens (e.g. cafeteria, cafe, sit-down restaurant, fast food restaurant, grocery, etc.) quantities and usage of PRSVs varies. Savings were merely reported per PRSV, not differentiated by site type, number of PRSVs per site, or size of site.

The only other publicly available study that Summit Blue could locate was the City of Calgary PRSV Replacement Program, in which 10 sites received pre/post trend metering and 1,173 sites received pre/post flow-rate spot metering. SBW has been involved in several PRSV M&V projects in Washington State: although EM&V reports are not available, results from three additional M&V efforts are summarized in “Pre-Rinse Spray Valve Programs: How Are They Really Doing” (Tso and Koeller 2005).

None of these studies have examined the persistence of savings over time. As discussed in Section 0, fouling can lead to decreases in flow rate over time, and users have been observed modifying PRSVs to increase flow rate. Controlling for this type of behavior is especially difficult and at a minimum would require a more longitudinal approach than has been used to this point.

Table A-10 summarizes the sample sizes, parameters collected, and savings estimates of all known PRSV studies in North America. Note that the *least* amount of information is known about duration (i.e., the total minutes per day) that the PRSV is in use: 46 sites from all of these studies received pre/post (or post/pre) volume trend metering, data for nine of these sites are possibly not publicly available. The reason for this sparseness of data is that collecting it requires three or four site visits and an invasive meter installation procedure: the pipe leading from the faucet to the PRSV is removed for the duration of the study and a flow metering device is installed in its place. Table A-11 shows the types of businesses sampled in each study. Table A-12 combines the information from the first two tables, but the smaller font may be difficult to read.

Table A-10. Summary of Key Measurements of Existing PRSV Studies

Study	Data collected										
	Year	Number of Sites	Savings Estimate (therms/year)	pre-retrofit PRSV flow rate (gpm or lpm)	post-retrofit PRSV flow rate (gpm or lpm)	pressure (Psi)	pre-retrofit duration (minutes/day)	post-retrofit duration (minutes/day)	mixed water temperature (degF or degC)	cold water temperature (degF or degC)	hot water temperature (degF or degC)
SmartRinse	2006	10	85				X	X	X	X	X
CUWCC Phase 1	2002-2003	171	252	X					X		X
	2002-2003	19		X	X			X	X		X
CUWCC - Phase 2	2007	145	28	X	X				X	X	X
	2007	29		X	X			X	X	X	X
	2007	17		X	X		X	X	X	X	X
City of Calgary - Pilot	2005	10	185	X	X	X	X	X			
City of Calgary	2008	1173	166	X	X	X					
Puget Sound Energy, Washington State	2006	6,809		X	X				X		X
Starbucks, Washington State	2005	5	43	X	X		X	X	X		X
Seattle Public Utilities pretest	2003	4	116	X	X		X	X			

Table A-11. Business Types and Key Assumptions for PRSV Studies

Study	Number of sites by site type								Notes
	Pub/Bar	Café	Restaurant - Full Service	Restaurant - Limited Service	Grocery	Non-grocery	Institutional	Other	
SmartRinse			10						>survey and visual verification only for 42 sites >assumed 70% gas water heater efficiency >post/pre metering order >also did post/pre dishwasher motor logging to normalize post/pre water volume
CUWCC Phase 1	???								do not have this report, only references to it did not do flow metering on pre-retrofit PRSV
CUWCC - Phase 2	???								assume water heater efficiencies: 90% for electric heaters, 70% for gas heaters
					7	21			assumed water heater efficiencies: 90% for electric heaters, 70% for gas heaters
					7	9			>Post-retrofit valve was metered first, then pre-retrofit valve was reinstalled for trend metering. >Assumed water heater efficiencies: 90% for electric heaters, 70% for gas heaters
City of Calgary - Pilot	4	2	2		2				50% hot/ 50% cold water temperature mix
City of Calgary	large variety of sites								used findings from pilot study, combined with single site visit (during retrofit) to estimate savings
Puget Sound Energy, Washington State			3672		1494		1090	385	data from Tso and Kollier, 2006 only

Study	Number of sites by site type								Notes
	Pub/Bar	Café	Restaurant - Full Service	Restaurant - Limited Service	Grocery	Non-grocery	Institutional	Other	
Starbucks, Washington State		5							data from Tso and Kollier, 2006 only
Seattle Public Utilities pretest	???								data from Tso and Kollier, 2006 only

Table A-12. Summary of PSRV Study – Full Table

Study	Year	Number of Sites	Savings Estimate (therms/year)	Data collected								Number of sites by site type								Notes
				pre-retrofit PRSV flow rate (gpm or lpm)	post-retrofit PRSV flow rate (gpm or lpm)	pressure (Psi)	pre-retrofit duration (minutes/day)	post-retrofit duration (minutes/day)	mixed water temperature (degF or degC)	cold water temperature (degF or degC)	hot water temperature (degF or degC)	Pub/Bar	Café	Restaurant - Full Service	Restaurant - Limited Service	Grocery	Non-grocery	Institutional	Other	
SmartRinse	2006	10	85				X	X	X	X	X			10						>survey and visual verification only for 42 sites >assumed 70% gas water heater efficiency >post/pre metering order >also did post/pre dishwasher motor logging to normalize post/pre water volume
CUWCC Phase 1	2002-2003	171	252	X					X		X	???								do not have this report, only references to it did not do flow metering on pre-retrofit PRSV
	2002-2003	19		X	X			X	X		X									

Study	Year	Number of Sites	Savings Estimate (therms/year)	Data collected								Number of sites by site type								Notes
				pre-retrofit PRSV flow rate (gpm or lpm)	post-retrofit PRSV flow rate (gpm or lpm)	pressure (Psi)	pre-retrofit duration (minutes/day)	post-retrofit duration (minutes/day)	mixed water temperature (degF or degC)	cold water temperature (degF or degC)	hot water temperature (degF or degC)	Pub/Bar	Café	Restaurant - Full Service	Restaurant - Limited Service	Grocery	Non-grocery	Institutional	Other	
CUWCC - Phase 2	2007	145	28	X	X				X	X	X	???								assume water heater efficiencies: 90% for electric heaters, 70% for gas heaters
	2007	29		X	X			X	X	X	X						7	21		assumed water heater efficiencies: 90% for electric heaters, 70% for gas heaters
	2007	17		X	X		X	X	X	X	X						7	9		>Post-retrofit valve was metered first, then pre-retrofit valve was reinstalled for trend

Study	Year	Number of Sites	Savings Estimate (therms/year)	Data collected								Number of sites by site type								Notes
				pre-retrofit PRSV flow rate (gpm or lpm)	post-retrofit PRSV flow rate (gpm or lpm)	pressure (Psi)	pre-retrofit duration (minutes/day)	post-retrofit duration (minutes/day)	mixed water temperature (degF or degC)	cold water temperature (degF or degC)	hot water temperature (degF or degC)	Pub/Bar	Café	Restaurant - Full Service	Restaurant - Limited Service	Grocery	Non-grocery	Institutional	Other	
																				metering. >Assumed water heater efficiencies : 90% for electric heaters, 70% for gas heaters
City of Calgary - Pilot	2005	10	185	X	X	X	X	X				4	2	2		2				50% hot/ 50% cold water temperature mix
City of Calgary	2008	1173	166	X	X	X						large variety of sites								used findings from pilot study, combined with single site visit (during retrofit) to estimate savings
Puget Sound Energy,	2006	6,809		X	X				X		X			3672		1494		1090	38 5	data from Tso and

Study	Year	Number of Sites	Savings Estimate (therms/year)	Data collected								Number of sites by site type								Notes
				pre-retrofit PRSV flow rate (gpm or lpm)	post-retrofit PRSV flow rate (gpm or lpm)	pressure (Psi)	pre-retrofit duration (minutes/day)	post-retrofit duration (minutes/day)	mixed water temperature (degF or degC)	cold water temperature (degF or degC)	hot water temperature (degF or degC)	Pub/Bar	Café	Restaurant - Full Service	Restaurant - Limited Service	Grocery	Non-grocery	Institutional	Other	
Washington State																				Kollier, 2006 only
Starbucks, Washington State	2005	5	43	X	X		X	X	X		X		5							data from Tso and Kollier, 2006 only
Seattle Public Utilities pretest	2003	4	116	X	X		X	X				???								data from Tso and Kollier, 2006 only

PROPOSED SAVINGS EVALUATION APPROACHES

This section proposes both a *full-scale* measurement and verification approach to ex-post PRSV gross impact evaluation, as well as two less complex *alternate* approaches.

The full-scale approach offers improvements over previous studies including a statistically significant sample size - stratified by business type - as well a true pre/post methodology; however, this approach would require three to four site visits per site, as well as the invasive installation of a flow meter in line with the PRSV.

The alternate approaches both leverage data collected from previous PRSV impact evaluation efforts and do not require invasive, multiple-visit field work. The first alternative method would also leverage existing data, and would conduct single-visit, non-invasive site visits to participant and non-participant sites. The second alternative method would be to aggregate data from all available PRSV studies (including 46 pre/post trend-metered sites), adjusted to California conditions, and provide an updated savings estimate.

Basis for Energy Savings

Energy savings attributable to PRSV retrofits can be calculated from the following equation:

$$ES = D\frac{(M_1 - M_2) * C * (T_M - T_C)}{\eta}$$

Where:

- ES are the annual energy savings (therms).
- D is the ratio of dishwasher usage before and after PRSV installation[10].
- M_1 is the baseline water mass flow (gallons/year).
- M_2 is the energy efficient (EE) mass flow (gallons/year).
- C is the specific heat of water (7.8×10^{-5} therms/gallon - °F).
- T_M is the mixed water temperature (°F).
- T_C is the cold water temperature (°F).
- η is the combined efficiency of the water heater and distribution system.

[10] While this is, presumably, not a function of the PRSV, there can be large variation in dish load from week to week, month to month, or season to season, which could significantly skew perceived results. This was addressed in Quantec's SmartRinse 2005 evaluation (Quantec, LLC 2006) where, in aggregate, a 12% decrease in dishwasher use was observed from the pre to the post retrofit measurement periods.

Full Pre/Post Evaluation

The most rigorous PRSV analysis would include a true pre/post evaluation, starting with spot measurements and trend metering under existing conditions (standard PRSV), and then repeating after a low flow PRSV was installed and users had become accustomed to it.

This approach might be impractically costly, given the relatively minor role that PRSV plays in the EE portfolios:

- The $(M_1 - M_2)$ term is the most costly to determine, requiring the multiple site visits and invasive instrumentation. Conducting a rigorous savings estimate, however, requires this information.
- The *D* term would also require trend metering for the duration of the study. Motor on-off loggers can be used to observe dishwasher usage. These loggers use sense vibration to determine whether the motor is on or off. The sensor is placed strategically close to the dishwasher, and is non-invasive.

Table A-13 shows the variables that are used in the savings equation and their sources.

Table A-13. Data sources for variables in the energy savings equation

Variable	Name	Source
D	Dishwasher adjustment factor	Derived from metered dishwasher loading
M_1	Baseline flow rate (gallons/ year)	Trend metered, post retrofit, and extrapolated to one year
M_2	Post-measure flow rate (gallons/year)	Trend metered, pre retrofit, and extrapolated to one year
T_M	Mixed water temperature (°F)	Trend metered and spot measured at each of the four site visits
T_C	Cold water temperature (°F)	Spot measured at each of the four site visits and adjusted for seasonal variation in mains water temperature
η	Water heater energy efficiency	Spot measured with flue gas tester or estimated from nameplate information and adjusted for distribution losses

To collect the required data, four site visits per site are proposed. The objectives of each site visit are:

- **Site Visit 1** – pre-retrofit measurement to install instrumentation and to conduct spot measurements of water temperatures and water heater efficiency.
- **Site Visit 2** – pre- retrofit measurement to retrieve trend metered flow and dishwasher loading data and to conduct spot measurements of water temperatures and water heater efficiency.
- **Site Visit 3** – post-retrofit measurement to install instrumentation and to conduct spot measurements of water temperatures and water heater efficiency.
- **Site Visit 4** – pre- retrofit measurement to retrieve trend metered flow and dishwasher loading data and to conduct spot measurements of water temperatures and water heater efficiency.

The on-site measurements are defined in detail below:

- **Bucket test -** To measure PRSV flow rate, a volume-marked bucket is filled and a stopwatch is used to time the process. Flow rate is then the volume of the bucket divided by the time to fill it. This should be done for both the baseline and the low-flow case. Although this measurement is not to be used in the savings algorithm, it is useful as part of the verification process to understand the extent to which lower flow PRSV usage is compensated by increased duration of PRSV usage per dish.

- **Water flow metering -** An inline flow meter is installed to measure the mixed water flow rate that goes through the PRSV. This will be used in the pre and post retrofit metering process. This is preferable to measuring hot water and cold water under the sink because some sinks have a toggle switch that directs the water flow between the PRSV and the sink-tap; measuring the-under-the-sink flow rates would include measurement of some water flow that is not going through sink faucet, *not* the PRSV.

- **Mixed water temperature** –Mixed water temperature is the temperature of the water coming out of the PRSV. This should be metered by installing a thermocouple on the flexible piping that transports water to the PRSV using a tee junction. Mixed water temperature will be metered and logged during both pre and post measurement periods. As a simplifying and cost cutting measure, mixed water temperatures might be spot metered only.

- **Inlet (mains) temperature -** The inlet (mains) cold water temperature will also be spot metered during each site visit at water heater inlet with a precise thermocouple. This is the temperature of the water coming from the utility and going to the water heater. This will be accomplished in a non invasive manner by attaching a thermocouple to the water heater inlet pipe, close to the water heater and wrapping it in insulation.

- **Dishwasher usage** – A motor on-off logger will be used to determine dishwasher usage. A motor on-off logger uses vibration to determine whether the motor is on or off. The sensor is placed strategically close to the dishwasher and is non-invasive.

- **Water heater efficiency -** A flue gas meter will be used to accurately measure the efficiency of water heaters. This will be done in all the four site visits. As an additional check, the nameplate efficiency of the water heater will also be noted. Nameplate efficiency alone could be used as a proxy for measured efficiency to reduce complexity of the study.

- **Secondary data collection -** Water utilities will be contacted to collect mains water temperatures. Additionally, we will also collect the rated flow rate of the PRSV and the age of these devices. This will help understand how the efficiency of the water heaters and PRSV vary with time.

Table A-14 shows the instruments requirements for this methodology, specifying the number of site visit(s) for which it is required; the number of devices needed; the price range of these devices, and the devices' function.

Table A-14. A Brief Overview of Instruments Needed for PRSV Data Collection

Instruments needed	Activity	Per site*	Per team*	Price range	Function
Volume marked bucket	1 and 3		X	$5	A bucket with measurement lines.
Stopwatch	1 and 3		X	$15- 30	Handheld accurate event time estimation device.
In-line flow meter	1 and 3	X		$200 - $500	Gives a pulse per unit of water flow (eg. 1 gallon). The number of pulses are logged
Precise temperature sensor	All		X	$100 – 300	An accurate thermometer that will be used to measure mixed water temperature.
Thermocouple	All	X		$ 4 – 10	
Motor on/off sensor	1 and 3	X		$50 – 100	This senses vibration and thus determines whether a motor is on or not.
Flue gas meter	All		X	$600 - $1400	Once placed on the exhaust of the water heater, this device reads the amount of CO, CO_2 and O_2 to determine the combustion efficiency of the water heater.
Personal computer	2 and 4		X	-	Will be used to retrieve data from the data logger.
Data logger	1 and 3	X		$ 250 - $1500 depending on storage capacity and computational ability.	This is used to log the data from the thermocouples and the inline flow meters.

*The instruments listed above can be categorized as needed on a *per site* or *per team* basis. The per-site instruments imply that these instruments would be used for metering and logging data at each individual site, hence we would need one of these instruments per PRSV. The per-team instruments will be used to do spot measurements; the same instrument will be used at multiple sites. The total cost would be based on the total number of sites included in the study, and the number of PRSVs per site.

Alternate Approaches

Given the cost of conducting the evaluation suggested in the previous section for a statistically significant sample size, less costly alternative approaches were also developed. The first alternate approach would survey sites with existing PRSV (presumably some mix of standard and low-flow PRSVs) using a single-visit approach to develop a proxy for $(M_1 - M_2)$ by estimating existing PRSV *effectiveness.* The second alternate approach would be to combine data from previous studies to create a more robust sample size.

Proxy for $(M_1 - M_2)$

The $(M_1 - M_2)$ term can be broken down further:

$$M_1 - M_2 = FR_1 t_1 Dishes - FR_2 t_2 Dishes$$

Where

- FR_1 is the flow rate of the pre-retrofit PRSV
- FR_2 is the flow rate of the post-retrofit PRSV
- t_1 is the average time it takes to wash one dish with the pre-retrofit PRSV
- t_2 is the average time it takes to wash one dish with the post-retrofit PRSV
- *Dishes* is the annual number of dishes

Previous studies have estimated the annual water consumption, $FR_1t_1Dishes$ and $FR_2t_2Dishes$, by measuring water consumption (with a flow meter) for a few weeks: once with the post-retrofit PRSV and once again with the pre-retrofit PRSV. In Quantec's 2005 SmartRinse evaluation (Quantec, LLC 2006), these consumption values were normalized by the number of dishwasher loads run during the same time, to account for differences in activity between the "post" and "pre" metering periods that were unrelated to the PRSV (i.e., more business during one of the periods – and thus more dishes – than the other period). The challenge with this approach is that the normalization must be precise to identify an accurate difference between the pre and post water consumption – it is this difference that is needed to compute energy savings; i.e., **the method requires two very precise estimates (pre and post) in order to accurately estimate a difference between the two**. The CUWCC Phase 1 study did not use this normalization, and resulted in a savings estimate (252 therms/year) that is much higher than other studies: Phase 2 used this normalization and resulted in a savings estimate that is much lower than other studies. This large variation in savings suggests an approach that may have been too sensitive to uncertain parameters.

A more theoretical approach to estimating annual "pre" and "post" water consumption would be to estimate these values based on PRSV *effectiveness*. For the purposes of this memo, *effectiveness* is defined as the *gallons required to rinse one dish*, or the term FR_it_i (the product of flow rate (gallons per minute) and time to rinse one dish (minutes per dish)). As a proxy for metering the gallons used and dishes rinsed, a field effectiveness test could be deployed using the following approach to estimate effectiveness:

1) Measure flow rate of PSRV using a bucket test (i.e. time how long it takes to fill a bucket of specified volume).

2) Rinse a standardized type of dirty dish with the PRSV and measure the time required. This test could be modeled after the ANSI/ASTM F2324-03 Standard Test Method for Pre-rinse Sprave Valves, in which dishes with dried tomato sauce are tested. This test would be repeated multiple times, with an average time per dish computed.

3) Compute effectiveness: [flow rate] x [time per dish].

The ratio of post- to pre-retrofit effectiveness provides an estimate of the percentage of water consumed by the post-retrofit PRSV, relative to the pre-retrofit PRSV. The savings percentage can be defined as

$$Savings\ Percentage = (1 - effectiveness_{post}/effectiveness_{pre)}\ x\ 100\%$$

The key pieces of information that this approach does not provide are 1) the number of dishes washed annually and 2) how much time is required to rinse a typical dish, relative to the standard test dish.

However, data from previous studies can be used to approximate a pre-retrofit water consumption (as a function of PRSV flow rate), and this can be multiplied by the Savings Percentage to estimate annual water savings from PRSV retrofit.

This savings estimation approach suggests the following methodology:

1) Single site visits to a relatively large (~100 to 200) number and variety of sites with commercial kitchens to collect the following information:

- Business type
- PRSV flow rate
- PRSV model information and nameplate flow rate, to observe variations from rated flow rate (e.g. due to differences in water pressure, fouling, or user manipulation).
- PRSV time to rinse one plate – using the standardized testing procedure
- Mixed water temperature
- Cold water temperature
- Water heater fuel type and efficiency – Fuel type will be observed, efficiency could be estimated from the nameplate data of the water heater and observed insulation of heater and pipe. If more accuracy is desired, a flue gas tester could be used for empirical water heater efficiency data.

2) If the sample does not provide an adequate number of low-flow PRSVs, conduct laboratory testing at the Food Services Technology Center (FSTC) to determine effectiveness of common low-flow PRSV models.

3) For sites in the sample, estimate the energy savings of a hypothetical PRSV retrofit, using the actual PRSV effectiveness measurement from the site, the low-flow PRSV effectiveness estimate from sites with low-flow PRSV (or FSTC testing), and annual pre-retrofit PRSV water consumption estimates from data analysis of previous PRSV studies.

Meta analysis of combine secondary data sources

The most simple approach to improving ex-ante savings estimates would be to pool observations from previous studies (adjusted for climate and fuel type) and estimate average savings within the larger group. There are data for 37 to 46 observed sites available from the previous studies mentioned in Section 0. However, the population of existing PRSV has most likely changed since these studies were conducted due to the standards introduced at the federal (2005) and state (2006) level, and this approach is not recommended.

Summary and Conclusions

Previous studies of PRSV retrofits have suffered from small sample sizes (under 20 sites) and resulted in large uncertainty in savings. Additionally, the *post/pre* methodologies employed have not been calibrated to true *pre/post* behavioral patterns.

This report summarizes three approaches to estimating savings from low-flow PRSV retrofits; ranging from a rigorous pre/post analysis to simple meta-analysis of secondary data. Ex-ante savings estimates derived from previous studies need refinement, these approaches offer solutions for a range a budgets.

PRSVs do not currently appear to be a statewide high impact measure, nor does it look like they will be in coming years. Ultimately, savings claimed from PRSVs played a smaller role in the 2006-2008 energy efficiency programs than initially observed and have not been included in program implementation plans for 2010-2012 programs. Furthermore, standards introduced federally (2005) and at the state level (2006) have reduced baseline energy consumption for PRSV installed in recent years, while the lifetime of a PRSV is only about five years.

In large part, it appears that PRSVs have disappeared from EE programs because of the low savings estimates in the most recent California study (SBW 2007) as well as the declining baseline energy consumption driven by the 1.6 gpm standards. However, PRSVs that pass standardized testing are now available at flow rates of less than 1.0 gpm; suggesting that annual savings in the range of 100 therms may still be possible. While this is less savings than IOUs previously claimed, this could be a cost effective measure, perhaps under a different delivery mechanism than the direct install programs previously implemented. Agencies might also take interest in PRSVs as *water* savings measure.

Finally, at the MECT's request, Summit Blue began an uncertainty analysis of the combined pool of secondary data in recent PRSVs studies. Distributions were assigned to assumed parameters in each study and Crystal Ball was used to determine confidence intervals on savings estimates. This research was cancelled by the MECT before completion when it became clear that this measure was discontinued at all IOUs and was losing prominence in the SPTdb.

ACKNOWLEDGMENTS

The authors would like to thank Todd Bell and Angelo Karas of the Food Service Technology Center for their help with this research.

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LGP Evaluation Report Appendix B: HIM Research Instruments

- Commercial Linear Fluorescent Lighting Pre-post Metering Data Form
- Furnace HIM Metering Data Form

Commercial Linear Fluorescent Lighting Pre-post Metering Data Form

PRE- AND POST-RETROFIT INVENTORY & RUNTIME HOUR MONITORING STUDY
C&I Linear Fluorescents, High Bay Fixtures, & Occupancy Sensors

A. Program & Customer Information *(pre-populated from online scheduling database)*

IOU:		Program Name:		EEGA Number:	
Corporate or Multi-Site Business Name:					
Customer/Business Name (Actual/Storefront):					
Service Address:		City:		Zip:	

Site Contact Names	Site Contact Title	Phone Number	Alternate Phone	Email

B. 3rd-Party Implementer Information *(pre-populated from online scheduling database)*

Implementation Contractor Business Name:					
Customer Commit Date:		Date Given to Install Contractor:		Anticipated Install Date:	

Contact Names	Contact Title	Phone Number	Alternate Phone	Email

C. Installation Contractor Information *(pre-populated from online scheduling database)*

Installation Contractor Business Name:			
Scheduled Installation Start Date:		Scheduled Installation Finish Date:	

Contact Names	Contact Title	Phone Number	Alternate Phone	Email

D. Installation Site Visit Scheduling *(pre-populated from online scheduling database)*

	PRE-RETROFIT INSTALLATION (#1)	POST-RETROFIT INSTALLATION (#3)
1. Assigned Field Work Company:		
2. Assigned Field Work Personnel:		
3. Scheduler:		
4. Scheduled Date & Time:		
Comment 1:		
Comment 2:		
Comment 3:		

E. Retrieval Site Visit Scheduling *(pre-populated from online scheduling database)*

	PRE-RETROFIT RETRIEVAL (#2)	POST-RETROFIT RETRIEVAL (#4)
1. Assigned Field Work Company:		
2. Assigned Field Work Personnel:		
3. Scheduler:		
4. Scheduled Date & Time:		
Comment 1:		
Comment 2:		
Comment 3:		

SITE INFORMATION FORM Project ID: ________ Site Name: ________________________________

Instructions: *Use this checklist for each of the 2 Logger Installation Site Visits (#1 and #3). It will help to 1) assist with pre-site visit preparation, 2) ensure that all onsite data collection activities have been completed, and 3) assist with the post-site visit QC and data entry.*

Installation Site Visit Checklists

	PRE-RETROFIT INSTALLATION (#1)			POST-RETROFIT INSTALLATION (#3)		
1. Names of Surveyors/Installers:						
2. Actual Date of Inventory & Logger Installation:						
3a. Start Time / 3b. End Time / 3c. Time Onsite:						
PRE-SITE VISIT PREPARATION:	Check	Notes		Check	Notes	
4. Data Collection Forms Printed and Packed?	☐			☐		
5. Previous Site Visit Forms and Photos Printed?	*Not Applicable*			☐		
6. Have Obtained Directions to Site?	☐			☐		
7. Have All Items on the Equipment Checklist?	☐			☐		
8. On/Off Lighting Loggers Synced to Pacific Time?	☐			☐		
ONSITE DATA COLLECTION:	Check	Notes		Check	Notes	
9. Site Information Form Complete?	☐			☐		
10. All Operating Details Forms Complete?	☐	Qty Forms:		☐	Qty Forms:	
11. All Fixture Details Forms Complete?	☐	Qty Forms:		☐	Qty Forms:	
12. All Lighting Inventory Forms Complete?	☐	Qty Forms:		☐	Qty Forms:	
13. Branch Circuit Mapping Complete *(if required)?*	☐	Qty Forms:		☐	Qty Forms:	
14. Site Metering Plan Complete?	☐	Qty Forms:		☐	Qty Forms:	
15. All Logger Installation Forms Complete?	☐	Qty Forms:		☐	Qty Forms:	
16. Project ID & Form Numbers Entered on all pages?	☐			☐		
POST-SITE VISIT ACTIVITIES:	Check	Notes		Check	Notes	
17. Online Tracking Status Updated?	☐			☐		
18. Online Data Entry Complete?	☐			☐		
19. Hard-Copy Scanned and Uploaded?	☐			☐		
20. Site Photos Labeled and Uploaded?	☐			☐		

Other Comments and Notes:

Pre-Retrofit Installation (#1) Notes:	
Post-Retrofit Installation (#3) Notes:	

SITE INFORMATION FORM

Project ID: ________ **Site Name:** ____________________________________

Instructions: *Use this checklist for each of the 2 Logger Retrieval Site Visits (#2 and #4). It will help to 1) assist with pre-site visit preparation, 2) ensure that all onsite data collection activities have been completed, and 3) assist with the post-site visit QC and data entry.*

Retrieval Site Visit Checklists

	PRE-RETROFIT RETRIEVAL (#2)			POST-RETROFIT RETRIEVAL (#4)		
1. Names of Retrievers:						
2. Actual Date of Logger Retrieval:						
3. Start Time / 3b. End Time / 3c. Time Onsite:						
PRE-SITE VISIT PREPARATION:	Check	Notes		Check	Notes	
4. Previous Site Visit Forms and Photos Printed?	☐			☐		
5. Missing Data Report Printed?	☐			☐		
6. Have Obtained Directions to Site?	☐			☐		
ONSITE DATA COLLECTION:	Check	Notes		Check	Notes	
7. All Data Logger Retrieval Tables Complete?	☐	Qty Loggers Retrieved:		☐	Qty Loggers Retrieved:	
8. All Missing Data Points Accounted For?	☐			☐		
POST-SITE VISIT ACTIVITIES:	Check	Notes		Check	Notes	
9. Online Tracking Status Updated?	☐			☐		
10. All Logger Data Downloaded to PC?	☐			☐		
11. Logger Data Uploaded?	☐			☐		
12. Logger QC Report Completed?	☐			☐		
13. Hard-Copy Scanned and Uploaded?	☐			☐		

Other Comments and Notes:

Pre-Retrofit Retrieval (#2) Notes:	
Post-Retrofit Retrieval (#4) Notes:	

SITE INFORMATION FORM

Project ID: ________ **Site Name:** ____________________________________

Instructions: *Fill out the "Electric & Gas…" and "Site & Business…" tables below. Some of the information can be collected by interviewing the customer, and some of the information will need to be observed onsite. Write "DK" for Don't Know and "NA" for Not Applicable. Electric and Gas Meter info may be taken from bill.*

Electric & Gas Meter Information

Check Box When Complete ☐

Electric Utility *(circle one)*:	PG&E SCE SDG&E OT *(if OT, thank the participant and terminate the survey)*		
E1a. Electric Meter Number:		**E1b. Does [E1a] also record electric usage from other businesses?**	Yes No
E2a. Electric Meter Number:		**E2b. Does [E2a] also record electric usage from other businesses?**	Yes No
Gas Utility *(circle one)*:	PG&E SCG SDG&E None Propane OT:______________________		
G1a. Gas Meter Number:		**G1b. Does [G1a] also record gas usage from other businesses?**	Yes No
G2a. Gas Meter Number:		**G2b. Does [G2a] also record gas usage from other businesses?**	Yes No

Site & Business Characteristics

Check Box When Complete ☐

1. Observed Business or Building Type Code *(use codes from table below)*:	
2. Is the business Independently-Owned (I), Corporate-Owned (C), or a Franchise (F)? *(circle one)*	I C F
3. What year was the business established at this location?	
4. Is the occupied space owned or leased? *O=Owned; L=Leased; OT=Other:______________________________*	O L OT
5. What year (or decade) was the majority of the facility built?	
6. What kind of a site is this? *(circle one)*:	
P=Part of a Bldg: *business occupies part of a bldg* **SM=Small Multi-Bldg**: *business occupies multiple bldgs, all of which can be surveyed* **B=Single Bldg**: *business occupies the entire bldg* **CM=Campus**: *business occupies multiple bldgs which need to be sampled* **OT=Other:** *describe in notes*	P B SM CM OT
7a. Number of stories in building / 7b. Number of stories occupied by business:	/
8. What is the total floor area of the space that the business occupies?	
9. What is the conditioned floor area of the space that the business occupies?	
10. Dominant Cooling Type for the Business *(circle one)*:	
1=None **2**=Split-System **3**=PkgRooftop **4**=PTAC/PTHP **5**=EvapCool **6**=Chiller **7**=IndivAC/HP **8**=WLHP **9**=Other:__________________	**1 2 3 4 5 6 7 8 9**
11. Dominant Heating Type for the Business *(circle one)*:	
1=ElecResist **2**=ElecHP **3**=Gas **4**=Both **5**=Propane **6**=None **7**=Other:__________________	**1 2 3 4 5 6 7**

Observed Business/Building Type Codes

Business Type	Code	Business Type	Code	Business Type	Code
Offices (Non-Medical):		**Retail Store:**		**Lodging:**	
Administration and management	011	Department / Variety Store	041	Hotel	081
Financial / Legal	012	Retail Warehouse/Clubs	042	Motel	082
Insurance/Real Estate	013	Shop in Enclosed Mall	043	Resort	083
Data Processing/Computer Center	014	Shop in Strip Mall	044	Other Lodging	084
Mixed-Use/Multi-tenant	015	Auto Sales	045	**Public Assembly:**	
Lab/R&D Facility	016	Other Retail Store	046	Religious Assembly (worship only)	091
Software Development	017	**Warehouse:**		Religious Assembly (mixed use)	092
Government Services	018	Refrigerated Warehouse	051	Health/Fitness Center	093
Other Office	019	Unconditioned Warehouse, High Bay	052	Movie Theaters	094
Restaurant/Food Service*:		Unconditioned Warehouse, Low Bay	053	Theater / Performing Arts	095
Fast Food or Self Service	021	Conditioned Warehouse, High Bay	054	Library / Museum	096
Specialty/Novelty Food Service	022	Conditioned Warehouse, Low Bay	055	Conference/Convention Center	097
Table Service	023	**Health Care:**		Community Center	098
Bar/Tavern/Nightclub/Other	024	Hospital	061	Other Recreational/Public Assembly	099
Other Food Service	025	Nursing Home	062	**Services:**	
Food Stores :		Medical/Dental Office	063	Gas Station / Auto Repair	101
Supermarkets	031	Clinic/Outpatient Care	064	Gas Station w/Convenience Store**	102
Small General Grocery	032	Medical/Dental Lab	065	Repair (Non-Auto)	103
Specialty/Ethnic Grocery	033	**Education:**		Other Service Shop	104
Convenience Store**	034	Daycare or Preschool	071	**Miscellaneous:**	
Liquor Store	035	Elementary School	072	Assembly / Light Mfg.	111
Other Food Store	036	Middle / Secondary School	073	Police / Fire Stations	112
Agricultural:		College or University	074	Post Office	113
Commercial Greenhouse	200	Vocational or Trade School	075	**Other Comm.** *Describe below*	130
Other Ag. *Describe below*	210			**Industrial:** Use SIC or NAICS code	

Notes:

SITE INFORMATION FORM

Project ID: ________ **Site Name:** ______________________________

Instructions: *Specify Business Hours for both normal and seasonal operation. Seasonal operation is a significant change in normal business hours, such as the summer break period for schools that follow a traditional schedule. Define typical operation for all Day Types listed below and specify hours in military time (8:30 am=0830, 6:30 pm=1830). For partial (i.e. not full) operation days, also indicate the approximate % of full operation as Partial Op %.* ***For Lodging sites****: Use the Seasonal Operation and PartialOp% to capture high and low season operation and occupancy rates.*

Normal Business Hours

Check Box When Complete ☐

Day Type	Business Hours (24 hr clock)	Closed All Day?	Open 24 hrs?	By Appt.	PartialOp%
Monday	from _ _ _ _ to _ _ _ _	☐	☐	☐	
Tuesday	from _ _ _ _ to _ _ _ _	☐	☐	☐	
Wednesday	from _ _ _ _ to _ _ _ _	☐	☐	☐	
Thursday	from _ _ _ _ to _ _ _ _	☐	☐	☐	
Friday	from _ _ _ _ to _ _ _ _	☐	☐	☐	
Saturday	from _ _ _ _ to _ _ _ _	☐	☐	☐	
Sunday	from _ _ _ _ to _ _ _ _	☐	☐	☐	

Seasonal Business Hours

Check Box if Either N/A or Complete ☐

Day Type	Business Hours (24hr clock)	Closed All Day?	Open 24 hrs?	By Appt.	PartialOp%
Monday	from _ _ _ _ to _ _ _ _	☐	☐	☐	
Tuesday	from _ _ _ _ to _ _ _ _	☐	☐	☐	
Wednesday	from _ _ _ _ to _ _ _ _	☐	☐	☐	
Thursday	from _ _ _ _ to _ _ _ _	☐	☐	☐	
Friday	from _ _ _ _ to _ _ _ _	☐	☐	☐	
Saturday	from _ _ _ _ to _ _ _ _	☐	☐	☐	
Sunday	from _ _ _ _ to _ _ _ _	☐	☐	☐	

Seasonal Operation Periods

Check Box if Either N/A or Complete ☐

PERIOD 1 *(describe):*			PERIOD 2 *(describe):*			PERIOD 3 *(describe):*		
Begin Month/Day:			Begin Month/Day:			Begin Month/Day:		
End Month/Day:			End Month/Day:			End Month/Day:		

Closed Holidays

Check Box if Either N/A or Complete ☐

☐ New Year's Eve	☐ Easter Sunday	☐ Columbus Day	☐ Christmas Day Celebrated
☐ New Year's Day	☐ Memorial Day	☐ Veteran's Day	☐ Casear Chavez Day
☐ New Year's Day Celebrated	☐ Flag Day	☐ Thanksgiving	☐ Other 1:
☐ Martin Luther King Day	☐ Independence Day (July 4^{th})	☐ Thanksgiving Friday	☐ Other 2:
☐ President's Day	☐ Independence Day Celebrated	☐ Christmas Eve	☐ Other 3:
☐ St. Patrick's Day	☐ Labor Day	☐ Christmas Day	**Total Closed Holidays:**

Hours and Operation Notes:

SITE INFORMATION FORM

Project ID: ________ **Site Name:** ______________________________

Instructions: *Identify a unique Area ID for each distinct Activity Area type within the space occupied by the business. A maximum of eight Activity Area types can be specified. Include all of the Activity Areas at the site, whether the lighting is part of the Lighting Inventory or not. Any area that is not part of the retrofit can be entered with Activity Area Code 098 (Non-rebated). Be sure also to record the sqft of each identified Activity Area. If the Area has large garage doors that are often open, check the box for "Area Has Windows".*

Activity Area Definitions

Check Box When Complete ☐

Area ID	Activity Area Code *(see table)*	Activity Area Description	Area Has Windows	Area Has Skylights	Area Will Be Included in Lighting Inventory	Conditioned Space Type Code	Total Sqft of Area
1			☐	☐	☐		
2			☐	☐	☐		
3			☐	☐	☐		
4			☐	☐	☐		
5			☐	☐	☐		
6			☐	☐	☐		
7			☐	☐	☐		
8			☐	☐	☐		
Total (use as a dummy-check comparison against the customer-reported value):							

Conditioned Space Type Codes				
CH = Cooled & Heated	**CL** = Only Cooled	**HT** = Only Heated	**ECH** = EvapCooled & Heated	**ECL** = Only EvapCool
NU = HVAC present but not used	**RF** = Refrigerated	**UN** = Unconditioned	**OU** = Outside	**OT** = Other (describe in comments)

AA Code	Activity Area Type Description	AA Code	Activity Area Type Description	AA Code	Activity Area Type Description
1	Auditorium/Gym	22	Guest Rooms (Hotel/Motel)	42	Religious Worship
2	Auto Repair Workshop	23	Kitchen/Break room & Food Prep.	43	Residential
3	Bank/Financial	24	Laboratory	44	Restrooms
4	Bar Cocktail Lounge	25	Laundry	45	Retail Sales/Showroom
5	Barber/Beauty Shop	26	Library	46	Smoking Lounge
6	Casino/Gaming	27	Loading Dock	47	Storage (Conditioned)
7	Classroom/Lecture	28	Lobby (Hotel)	48	Storage (Unconditioned)
8	Clean Room	29	Lobby (Main Entry and Assembly)	49	Storage (Refrigerated/Freezer), Walk-in
9	Computer Room/Data Processing	30	Lobby (Office Reception/Waiting)	50	Storage (Refrigerated/Freezer), Building
10	Comm/Ind Work (General High Bay)	31	Locker and Dressing Room	51	Surgery Rooms
11	Comm/Ind Work (General Low Bay)	32	Mall Arcade and Atrium	52	Theater (Motion Picture)
12	Comm/Ind Work (Precision)	33	Mechanical/Electrical Room	53	Theater (Performance)
13	Conference Room	34	Medical Offices and Exam Rooms	54	Unknown
14	Convention and Meeting Center	35	Office (Executive/Private)	55	Vacant (Conditioned)
15	Copy Room	36	Office (General)	56	Vacant (Unconditioned)
16	Corridor / Hallways	37	Office (Open Plan)	57	Vocational Areas
17	Courtrooms	38	Patient Rooms	**98**	**Non Rebated Area**
18	Dining Area	39	Patio Area	**99**	**Other Unlisted Activity Types**
19	Dry Cleaning	40	Pool/Spa Area		
20	Exercise Centers/Gymnasium	41	Police/Fire Station	**100**	**Outside/Outdoor Area**
21	Exhibit Display Area / Museum				

Activity Area Definition Notes:

SITE INFORMATION FORM

Project ID: ________ **Site Name:** ____________________________________

Instructions: *Use the Site Sketch to help identify data logger locations, map the circuits, or help direct how you approach the Lighting Inventory.*

Site or Circuit Sketch *(1 of 2)*

Check Box When Complete ☐

Site or Circuit Sketch Notes:

SITE INFORMATION FORM **Project ID:** ________ **Site Name:** ____________________________________

Instructions: *Use the Site Sketch for reference only – it may help locating data loggers, or it may simply help direct how you approach the Inventory.*

Site or Circuit Sketch *(2 of 2)*

Check Box When Complete ☐

Site or Circuit Sketch Notes:

SITE INFORMATION FORM

Project ID: ________ **Site Name:** ________________________________

Instructions: *Use the "Screening for Panel Monitoring" questions to confirm that panel monitoring should be attempted, or to document why it was not attempted at this site. Use the "Site Photo Log" to identify and describe all of the photos that will be uploaded to the online tool. Be sure to use the correct naming convention for the files, which is "ProjectID_PhotoID.jpg".*

Screening for Panel Monitoring

Check Box When Complete ☐

1. Are the electrical panels accessible, and will the customer allow you to get into them? *(circle one):*	Yes No
2. Are the electrical panels clean and safe to work with? *(circle one):*	Yes No
3. Are either of these true: A) the lighting is 277V; or B) you can visually trace all wiring from the Point-of-Control to the Branch Circuit?	Yes No
4. Will the customer allow you to switch lights on and off throughout the business for several minutes at a time? *(circle one):*	Yes No
If any of Q1-Q4 = NO:	*You cannot conduct any metering at the panel. You do not need to fill out the Branch Circuit Mapping Form.*
If all of Q1-Q4 = YES:	*You might possibly be able to conduct metering at the panel. Leave the hot fixture wires accessible after completing the spot measurements so that you can trace the fixture to its branch circuit at the panel. You must fill out the Branch Circuit Mapping Form.*
Notes:	

Site Photo Log

Photo ID	Site Visit Number *(circle one)*	Photo Description
1	1 2 3 4	
2	1 2 3 4	
3	1 2 3 4	
4	1 2 3 4	
5	1 2 3 4	
6	1 2 3 4	
7	1 2 3 4	
8	1 2 3 4	
9	1 2 3 4	
10	1 2 3 4	
11	1 2 3 4	
12	1 2 3 4	
13	1 2 3 4	
14	1 2 3 4	
15	1 2 3 4	
16	1 2 3 4	
17	1 2 3 4	
18	1 2 3 4	
19	1 2 3 4	
20	1 2 3 4	
21	1 2 3 4	
22	1 2 3 4	
23	1 2 3 4	
24	1 2 3 4	
25	1 2 3 4	

OPERATING DETAILS FORM

Check Box When Form is Complete: ☐

SITE VISIT TYPE *(check one)*:	☐ PRE-Retrofit ☐ POST-Retrofit	Project ID:		Site Name:	

Instructions: *Fill out Operating Details for each unique Operation Schedule to be inventoried. The values in each cell of the table should be the* ***percentage of the hour*** *multiplied by the* ***percentage of fixtures ON****. For example, if 50% of the fixtures are ON from 9:30 to 10:00, the recorded value should be 25% (50% of the fixtures x 50% of the hour). A* consistent schedule *is one in which the hours do not vary much day-to-day, such as a retail operation that begins and ends at the same times. A* variable schedule *is one in which the hours are unpredictable (checking "Variable schedule" indicates that the recorded schedule is a best-guess from the customer).*

1. Schedule ID:__________ Schedule Description:______________________________ *Check Box When Complete* ☐

1. Daytypes *(circle)*	Hour Bin	12:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00
Mo Tu We Th Fr Sa Su Hol	AM												
	PM												
Mo Tu We Th Fr Sa Su Hol	AM												
	PM												
Mo Tu We Th Fr Sa Su Hol	AM												
	PM												
Mo Tu We Th Fr Sa Su Hol	AM												
	PM												

2. Is the Normal Schedule consistent day-to-day, or is it variable?	☐ Consistent schedule ☐ Variable schedule	3. Does the Normal Operating Schedule vary during the year?	☐ No, it's the same year-round ☐ Yes, it varies by season *(describe in notes below)*

Notes:

2. Schedule ID:__________ Schedule Description:______________________________ *Check Box When Complete* ☐

1. Daytypes *(circle)*	Hour Bin	12:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00
Mo Tu We Th Fr Sa Su Hol	AM												
	PM												
Mo Tu We Th Fr Sa Su Hol	AM												
	PM												
Mo Tu We Th Fr Sa Su Hol	AM												
	PM												
Mo Tu We Th Fr Sa Su Hol	AM												
	PM												

2. Is the Normal Schedule consistent day-to-day, or is it variable?	☐ Consistent schedule ☐ Variable schedule	3. Does the Normal Operating Schedule vary during the year?	☐ No, it's the same year-round ☐ Yes, it varies by season *(describe in notes below)*

Notes:

3. Schedule ID:__________ Schedule Description:______________________________ *Check Box When Complete* ☐

1. Daytypes *(circle)*	Hour Bin	12:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00
Mo Tu We Th Fr Sa Su Hol	AM												
	PM												
Mo Tu We Th Fr Sa Su Hol	AM												
	PM												
Mo Tu We Th Fr Sa Su Hol	AM												
	PM												
Mo Tu We Th Fr Sa Su Hol	AM												
	PM												

2. Is the Normal Schedule consistent day-to-day, or is it variable?	☐ Consistent schedule ☐ Variable schedule	3. Does the Normal Operating Schedule vary during the year?	☐ No, it's the same year-round ☐ Yes, it varies by season *(describe in notes below)*

OPERATING DETAILS FORM

Check Box When Form is Complete: ☐

SITE VISIT TYPE *(check one)*:	☐ PRE-Retrofit ☐ POST-Retrofit	Project ID:		Site Name:	

Instructions: *Fill out Operating Details for each unique Operation Schedule to be inventoried. The values in each cell of the table should be the* ***percentage of the hour*** *multiplied by the* ***percentage of fixtures ON****. For example, if 50% of the fixtures are ON from 9:30 to 10:00, the recorded value should be 25% (50% of the fixtures x 50% of the hour). A consistent schedule is one in which the hours do not vary much day-to-day, such as a retail operation that begins and ends at the same times. A variable schedule is one in which the hours are unpredictable (checking "Variable schedule" indicates that the recorded schedule is a best-guess from the customer).*

1. Schedule ID:__________ Schedule Description:______________________________ *Check Box When Complete* ☐

1. Daytypes *(circle)*	Hour Bin	12:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00
Mo Tu We Th Fr	AM												
Sa Su Hol	PM												
Mo Tu We Th Fr	AM												
Sa Su Hol	PM												
Mo Tu We Th Fr	AM												
Sa Su Hol	PM												
Mo Tu We Th Fr	AM												
Sa Su Hol	PM												

2. Is the Normal Schedule consistent day-to-day, or is it variable?	☐ Consistent schedule ☐ Variable schedule	3. Does the Normal Operating Schedule vary during the year?	☐ No, it's the same year-round ☐ Yes, it varies by season *(describe in notes below)*

Notes:

2. Schedule ID:__________ Schedule Description:______________________________ *Check Box When Complete* ☐

1. Daytypes *(circle)*	Hour Bin	12:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00
Mo Tu We Th Fr	AM												
Sa Su Hol	PM												
Mo Tu We Th Fr	AM												
Sa Su Hol	PM												
Mo Tu We Th Fr	AM												
Sa Su Hol	PM												
Mo Tu We Th Fr	AM												
Sa Su Hol	PM												

2. Is the Normal Schedule consistent day-to-day, or is it variable?	☐ Consistent schedule ☐ Variable schedule	3. Does the Normal Operating Schedule vary during the year?	☐ No, it's the same year-round ☐ Yes, it varies by season *(describe in notes below)*

Notes:

3. Schedule ID:__________ Schedule Description:______________________________ *Check Box When Complete* ☐

1. Daytypes *(circle)*	Hour Bin	12:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00
Mo Tu We Th Fr	AM												
Sa Su Hol	PM												
Mo Tu We Th Fr	AM												
Sa Su Hol	PM												
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Sa Su Hol	PM												
Mo Tu We Th Fr	AM												
Sa Su Hol	PM												

2. Is the Normal Schedule consistent day-to-day, or is it variable?	☐ Consistent schedule ☐ Variable schedule	3. Does the Normal Operating Schedule vary during the year?	☐ No, it's the same year-round ☐ Yes, it varies by season *(describe in notes below)*

Notes:

FIXTURE DETAILS FORM

Check Box When Form is Complete: ☐

SITE VISIT TYPE *(check one):*	☐ PRE-Retrofit ☐ POST-Retrofit	Project ID:		Site Name:	

Instructions: *Each fixture at the site with a different combination of Points 1-7 must be given a unique Fixture ID. The only exception to this is when the Lamp Mfr/Model Number from one fixture is different from another fixture, but the nameplate **watts** are the same. If the lamps powered by a single ballast are different, record these as different lamp types in Point 6 below. **There should always only be one ballast per fixture**. For example, if a **single fixture housing** has 2 identical ballasts powering 4 identical lamps, there would be just one Fixture ID, and it would be defined as having 1 ballast and 2 lamps. However, it would be **counted** twice in the Lighting Inventory Form, even though it exists in the same physical fixture housing. If a fixture housing has 2 **different** ballasts and/or 4 **different** lamps, this would be given 2 different Fixture IDs. It would then be counted in the Lighting Inventory Form **once under each ID** (for a total of two times). Take a spot measurement for every defined Fixture ID, but **only on fixtures that are operating normally**.*

Fixture ID: _________ Fixture Description: ______________________________ *Check Box When Complete* ☐

1. Lamp Type *(circle one):* **F**=LinFluor **UT**=Utube Fluor **OF**=Other Fluor **CF**=Compact Fluor **CIR**=Circline Fluor **MV**=Mercury Vapor **MH**=Std Metal Halide **PS**=Pulse-Start MH **HPS**=High-Pressure Sodium **LPS**=Low-Pressure Sodium **LED**=LED **Q**=Quartz/Halogen **E**=Induction **IP**=Incand. PAR **IR**=Incand. Reflector **I**=Incandescent Gen Service **N**=Neon **ER**=Battery-Power Exit **OT**=Other:__________________	F UT OF CF CIR MV MH PS HPS LPS LED Q E IP IR I N ER OT
2. Lighting Application Code *(circle one):* **A**=Area **D**=Display **F**=Bldg Façade **T**=Task **S**=Security **L**=Landscape **X**=Exit **P**=Parking Lot **G**=Parking Garage **OT**=Other:_____________	A D F T S L X P G OT
3. Fixture Mounting Type *(circle one):* **H**=Hanging/Suspended **S**=Surface-Mount **F**=Ceiling Fan **R**=Recessed, Non-Can **C**=Recessed Can **PL**=Plug-in Lamp **A**=Attached to Bldg **P**=Pole **TR**=Track **OT**=Other:____________________	H S F R C PL A P TR OT
4. Reflector Type *(circle one):* **W**=White **S**=Specular/Metallic **N**=None **OT**=Other:____________________	W S N OT
5. Floor-to-Fixture Height *(measure from floor to reflector or ballast cover, and round to the nearest foot):*	

6. Lamp Types	6a. Lamp Manufacturer	6b. Lamp Model Number	6c. Lamp Length, If Applicable *(circle one)*	6d. Lamp Diameter, If Applicable *(circle one)*	Lamp Watts (LW)	Lamp Qty (LQ)	Total Lamp Watts (TW)=[W]*[Q]
Type 1:			NA 2ft 3ft 4ft 8ft OT:____	NA T5 T8 T10 T12 OT:____			
Type 2:			NA 2ft 3ft 4ft 8ft OT:____	NA T5 T8 T10 T12 OT:____			
Type 3:			NA 2ft 3ft 4ft 8ft OT:____	NA T5 T8 T10 T12 OT:____			
Type 4:			NA 2ft 3ft 4ft 8ft OT:____	NA T5 T8 T10 T12 OT:____			
Total Number of Lamps [Sum LQ] and Total Connected Lamp Wattage [Sum TW]:							

7. BALLAST INFORMATION *(if no ballast, check the "NA" box to the right and skip to Spot Measurements):*			☐ N/A
7a. Ballast Type (circle one): *E=Electronic; M=Magnetic; A=Advanced*	NA E M A DK	**7d. Does the ballast label indicate the expected lamp configurations?** *(circle one):*	NA Yes No
7b. Ballast Manufacturer:		**7e. If [7d]=Yes, does the actual lamp configuration match any of the configurations from the ballast label?** *(circle one):*	NA Yes No
7c. Ballast Model Number:		**7f. If [7e]=Yes, what is the Amps from the ballast label for the actual lamp configuration?** *(if amps not listed, then NA):*	

Spot Measurement Data – ***take ONLY on normally-operating fixtures!*** *Check Box if N/A or When Complete* ☐

S1. Measurement Device *(circle one):* *F345=Fluke 345; F43B=Fluke 43B; OT=Other:_____________*	F345 F43B OT	**S5. Measurement Location** *(circle one):* *F=At Fixture; J=At Junction Box; S=At POC; P=At Panel*	F J S P
S2. Measurement Device Serial Number:		**S6. Voltage Reading:** *N=Line-to-Neutral; G=Line-to-Ground*	N G
S3. Current Amplifier, # of Turns *(circle one):*	NA 10 20 30 40 50	**S7. Number of Fixtures Included in Measurement:**	
S4. Current Amplifier Serial Number:			

S8. MEASUREMENTS:	WITH Current Amp (1)	NO Current Amp (2)	S10. QUALITY CONTROL CALCULATIONS:	
S8a. Volts (V):			**S10a = ([Sum TW] – [S9d1]) / [Sum TW]:**	
S8b. Power Factor (PF):			*if absolute value of **S10a > 20%**, retake the measurement*	
S8c. Amps (A):			**S10b = ([7f] – [S9c1]) / [7f]:**	
S8d. Watts (W):			*if absolute value of **S10b > 10%**, retake the measurement*	
S9. CALCULATIONS:	**WITH Current Amp (1)**	**NO Current Amp (2)**	**S10c = ([S8a1] * [S8b1] * [S9c1]) – [S9d1]:**	
S9a. Actual Amps = [S8c] / [S3]:			*if absolute value of **S10b > 1 watt**, double-check readings*	
S9b. Actual Watts = [S8d] / [S3]:			***S10d. Describe condition of lamps/ballast*** *(circle all that apply):*	N L P F BO BE Z T
S9c. Amps Per Fixt = [S9a] / [S7]			***N**=Normal; **L**=Low-Lumens; **P**=Pulsing Lamp(s); **F**=Flickering Lamp(s); **BO**=Burned Out Lamp(s); **BE**=Blackened Lamp Ends; **Z**=Buzzing Ballast; **T**=Tar Leaking From Ballast*	
S9d. Watts Per Fixt = [S9b] / [S7]				

Notes

FIXTURE DETAILS FORM

Check Box When Form is Complete: ☐

SITE VISIT TYPE *(check one)*:	☐ PRE-Retrofit ☐ POST-Retrofit	Project ID:		Site Name:	

Instructions: *Each fixture at the site with a different combination of Points 1-7 must be given a unique Fixture ID. The only exception to this is when the Lamp Mfr/Model Number from one fixture is different from another fixture, but the nameplate **watts** are the same. If the lamps powered by a single ballast are different, record these as different lamp types in Point 6 below. **There should always only be one ballast per fixture**. For example, if a **single fixture housing** has 2 identical ballasts powering 4 identical lamps, there would be just one Fixture ID, and it would be defined as having 1 ballast and 2 lamps. However, it would be **counted** twice in the Lighting Inventory Form, even though it exists in the same physical fixture housing. If a fixture housing has 2 **different** ballasts and/or 4 **different** lamps, this would be given 2 different Fixture IDs. It would then be counted in the Lighting Inventory Form **once under each ID** (for a total of two times). Take a spot measurement for every defined Fixture ID, but **only on fixtures that are operating normally**.*

Fixture ID: _________ Fixture Description: ______________________________ *Check Box When Complete* ☐

1. Lamp Type *(circle one)*: **F**=LinFluor **UT**=Utube Fluor **OF**=Other Fluor **CF**=Compact Fluor **CIR**=Circline Fluor **MV**=Mercury Vapor **MH**=Std Metal Halide **PS**=Pulse-Start MH **HPS**=High-Pressure Sodium **LPS**=Low-Pressure Sodium **LED**=LED **Q**=Quartz/Halogen **E**=Induction **IP**=Incand. PAR **IR**=Incand. Reflector **I**=Incandescent Gen Service **N**=Neon **ER**=Battery-Power Exit **OT**=Other:_________________	F UT OF CF CIR MV MH PS HPS LPS LED Q E IP IR I N ER OT
2. Lighting Application Code *(circle one)*: **A**=Area **D**=Display **F**=Bldg Façade **T**=Task **S**=Security **L**=Landscape **X**=Exit **P**=Parking Lot **G**=Parking Garage **OT**=Other:_____________	A D F T S L X P G OT
3. Fixture Mounting Type *(circle one)*: **H**=Hanging/Suspended **S**=Surface-Mount **F**=Ceiling Fan **R**=Recessed, Non-Can **C**=Recessed Can **PL**=Plug-in Lamp **A**=Attached to Bldg **P**=Pole **TR**=Track **OT**=Other:____________________	H S F R C PL A P TR OT
4. Reflector Type *(circle one)*: **W**=White **S**=Specular/Metallic **N**=None **OT**=Other:____________________	W S N OT
5. Floor-to-Fixture Height *(measure from floor to reflector or ballast cover, and round to the nearest foot)*:	

6. Lamp Types	6a. Lamp Manufacturer	6b. Lamp Model Number	6c. Lamp Length, If Applicable *(circle one)*	6d. Lamp Diameter, If Applicable *(circle one)*	Lamp Watts (LW)	Lamp Qty (LQ)	Total Lamp Watts (TW)=[W]*[Q]
Type 1:			NA 2ft 3ft 4ft 8ft OT:____	NA T5 T8 T10 T12 OT:____			
Type 2:			NA 2ft 3ft 4ft 8ft OT:____	NA T5 T8 T10 T12 OT:____			
Type 3:			NA 2ft 3ft 4ft 8ft OT:____	NA T5 T8 T10 T12 OT:____			
Type 4:			NA 2ft 3ft 4ft 8ft OT:____	NA T5 T8 T10 T12 OT:____			
Total Number of Lamps [Sum LQ] and Total Connected Lamp Wattage [Sum TW]:							

7. BALLAST INFORMATION *(if no ballast, check the "NA" box to the right and skip to Spot Measurements)*:			☐ N/A
7a. Ballast Type (circle one): *E=Electronic; M=Magnetic; A=Advanced*	NA E M A DK	**7d. Does the ballast label indicate the expected lamp configurations?** *(circle one)*:	NA Yes No
7b. Ballast Manufacturer:		**7e. If [7d]=Yes, does the actual lamp configuration match any of the configurations from the ballast label?** *(circle one)*:	NA Yes No
7c. Ballast Model Number:		**7f. If [7e]=Yes, what is the Amps from the ballast label for the actual lamp configuration?** *(if amps not listed, then NA)*:	

Spot Measurement Data – ***take ONLY on normally-operating fixtures!*** *Check Box if N/A or When Complete* ☐

S1. Measurement Device *(circle one)*: *F345=Fluke 345; F43B=Fluke 43B; OT=Other:____________*	F345 F43B OT	**S5. Measurement Location** *(circle one)*: *F=At Fixture; J=At Junction Box; S=At POC; P=At Panel*	F J S P
S2. Measurement Device Serial Number:		**S6. Voltage Reading:** *N=Line-to-Neutral; G=Line-to-Ground*	N G
S3. Current Amplifier, # of Turns *(circle one)*:	NA 10 20 30 40 50	**S7. Number of Fixtures Included in Measurement:**	
S4. Current Amplifier Serial Number:			

S8. MEASUREMENTS:	WITH Current Amp (1)	NO Current Amp (2)	S10. QUALITY CONTROL CALCULATIONS:	
S8a. Volts (V):			**S10a = ([Sum TW] – [S9d1]) / [Sum TW]:**	
S8b. Power Factor (PF):			*if absolute value of **S10a > 20%,** retake the measurement*	
S8c. Amps (A):			**S10b = ([7f] – [S9c1]) / [7f]:**	
S8d. Watts (W):			*if absolute value of **S10b > 10%,** retake the measurement*	
S9. CALCULATIONS:	**WITH Current Amp (1)**	**NO Current Amp (2)**	**S10c = ([S8a1] * [S8b1] * [S9c1]) – [S9d1]:**	
S9a. Actual Amps = [S8c] / [S3]:			*if absolute value of **S10b > 1 watt,** double-check readings*	
S9b. Actual Watts = [S8d] / [S3]:			***S10d. Describe condition of lamps/ballast** (circle all that apply):*	N L P F BO BE Z T
S9c. Amps Per Fixt = [S9a] / [S7]			***N**=Normal; **L**=Low-Lumens; **P**=Pulsing Lamp(s); **F**=Flickering Lamp(s); **BO**=Burned Out Lamp(s); **BE**=Blackened Lamp Ends; **Z**=Buzzing Ballast; **T**=Tar Leaking From Ballast*	
S9d. Watts Per Fixt = [S9b] / [S7]				

Notes

BRANCH CIRCUIT MAPPING FORM

Check Box if Form is either N/A or Complete: ☐

SITE VISIT TYPE *(check one):*	☐ PRE-Retrofit ☐ POST-Retrofit	Project ID:		Site Name:	

Instructions: *This form must only be filled out if the Panel Metering Screening from the Site Information Form has been passed. If so, use this form to trace all of the Points-of-Control (POCs) to the correct Branch Circuit at the electrical panel. If a single Branch Circuit serves more than 12 POCs, use as many Branch Circuit tables as necessary to capture them all.* ***If any of Q3, Q5c, Q6c, or Q7 equals "No", you cannot conduct panel metering on the branch circuit.***

1. Branch Circuit ID:_________ Description:_________________________________ Table _____ of _____

1. POC IDs:												
2. Area IDs:												

3. Do all POC IDs have the same Area ID? *(if No, you cannot conduct panel metering on this branch circuit – skip to On/Off metering):*			Yes No
4. Total Connected Load for all POCs on this Electrical Panel Branch Circuit ID *(summed using the Lighting Inventory Form):*			
5a. Watts / 5b. Amps with all POCs Switched ON:	/	**5c. Is [5a] within ~10% of [4]?**	Yes No
6a. Watts / 6b. Amps with all POCs Switched OFF:	/	**6c. Is [6a] less than ~5% of [4]?**	Yes No
7. Can you be reasonably sure that any loads other than those identified in [1] make up less than 5% of the total branch circuit load? *(if Yes, continue with panel meter setup. If No, you cannot conduct panel metering on this branch circuit):*			Yes No
Notes:			

2. Branch Circuit ID:_________ Description:_________________________________ Table _____ of _____

1. POC IDs:												
2. Area IDs:												

3. Do all POC IDs have the same Area ID? *(if No, you cannot conduct panel metering on this branch circuit – skip to On/Off metering):*			Yes No
4. Total Connected Load for all POCs on this Electrical Panel Branch Circuit ID *(summed using the Lighting Inventory Form):*			
5a. Watts / 5b. Amps with all POCs Switched ON:	/	**5c. Is [5a] within ~10% of [4]?**	Yes No
6a. Watts / 6b. Amps with all POCs Switched OFF:	/	**6c. Is [6a] less than ~5% of [4]?**	Yes No
7. Can you be reasonably sure that any loads other than those identified in [1] make up less than 5% of the total branch circuit load? *(if Yes, continue with panel meter setup. If No, you cannot conduct panel metering on this branch circuit):*			Yes No
Notes:			

3. Branch Circuit ID:_________ Description:_________________________________ Table _____ of _____

1. POC IDs:												
2. Area IDs:												

3. Do all POC IDs have the same Area ID? *(if No, you cannot conduct panel metering on this branch circuit – skip to On/Off metering):*			Yes No
4. Total Connected Load for all POCs on this Electrical Panel Branch Circuit ID *(summed using the Lighting Inventory Form):*			
5a. Watts / 5b. Amps with all POCs Switched ON:	/	**5c. Is [5a] within ~10% of [4]?**	Yes No
6a. Watts / 6b. Amps with all POCs Switched OFF:	/	**6c. Is [6a] less than ~5% of [4]?**	Yes No
7. Can you be reasonably sure that any loads other than those identified in [1] make up less than 5% of the total branch circuit load? *(if Yes, continue with panel meter setup. If No, you cannot conduct panel metering on this branch circuit):*			Yes No
Notes:			

4. Branch Circuit ID:_________ Description:_________________________________ Table _____ of _____

1. POC IDs:												
2. Area IDs:												

3. Do all POC IDs have the same Area ID? *(if No, you cannot conduct panel metering on this branch circuit – skip to On/Off metering):*			Yes No
4. Total Connected Load for all POCs on this Electrical Panel Branch Circuit ID *(summed using the Lighting Inventory Form):*			
5a. Watts / 5b. Amps with all POCs Switched ON:	/	**5c. Is [5a] within ~10% of [4]?**	Yes No
6a. Watts / 6b. Amps with all POCs Switched OFF:	/	**6c. Is [6a] less than ~5% of [4]?**	Yes No
7. Can you be reasonably sure that any loads other than those identified in [1] make up less than 5% of the total branch circuit load? *(if Yes, continue with panel meter setup. If No, you cannot conduct panel metering on this branch circuit):*			Yes No
Notes:			

BRANCH CIRCUIT MAPPING FORM

Check Box if Form is either N/A or Complete: ☐

SITE VISIT TYPE *(check one):*	☐ PRE-Retrofit ☐ POST-Retrofit	Project ID:		Site Name:	

Instructions: *This form must only be filled out if the Panel Metering Screening from the Site Information Form has been passed. If so, use this form to trace all of the Points-of-Control (POCs) to the correct Branch Circuit at the electrical panel. If a single Branch Circuit serves more than 12 POCs, use as many Branch Circuit tables as necessary to capture them all.* ***If any of Q3, Q5c, Q6c, or Q7 equals "No", you cannot conduct panel metering on the branch circuit.***

1. Branch Circuit ID:_________ Description:____ Table _____ of _____

1. POC IDs:												
2. Area IDs:												

3. Do all POC IDs have the same Area ID? *(if No, you cannot conduct panel metering on this branch circuit – skip to On/Off metering):*				Yes No
4. Total Connected Load for all POCs on this Electrical Panel Branch Circuit ID *(summed using the Lighting Inventory Form):*				
5a. Watts / 5b. Amps with all POCs Switched ON:	/	**5c. Is [5a] within ~10% of [4]?**		Yes No
6a. Watts / 6b. Amps with all POCs Switched OFF:	/	**6c. Is [6a] less than ~5% of [4]?**		Yes No
7. Can you be reasonably sure that any loads other than those identified in [1] make up less than 5% of the total branch circuit load? *(if Yes, continue with panel meter setup. If No, you cannot conduct panel metering on this branch circuit):*				Yes No
Notes:				

2. Branch Circuit ID:_________ Description:____ Table _____ of _____

1. POC IDs:												
2. Area IDs:												

3. Do all POC IDs have the same Area ID? *(if No, you cannot conduct panel metering on this branch circuit – skip to On/Off metering):*				Yes No
4. Total Connected Load for all POCs on this Electrical Panel Branch Circuit ID *(summed using the Lighting Inventory Form):*				
5a. Watts / 5b. Amps with all POCs Switched ON:	/	**5c. Is [5a] within ~10% of [4]?**		Yes No
6a. Watts / 6b. Amps with all POCs Switched OFF:	/	**6c. Is [6a] less than ~5% of [4]?**		Yes No
7. Can you be reasonably sure that any loads other than those identified in [1] make up less than 5% of the total branch circuit load? *(if Yes, continue with panel meter setup. If No, you cannot conduct panel metering on this branch circuit):*				Yes No
Notes:				

3. Branch Circuit ID:_________ Description:____ Table _____ of _____

1. POC IDs:												
2. Area IDs:												

3. Do all POC IDs have the same Area ID? *(if No, you cannot conduct panel metering on this branch circuit – skip to On/Off metering):*				Yes No
4. Total Connected Load for all POCs on this Electrical Panel Branch Circuit ID *(summed using the Lighting Inventory Form):*				
5a. Watts / 5b. Amps with all POCs Switched ON:	/	**5c. Is [5a] within ~10% of [4]?**		Yes No
6a. Watts / 6b. Amps with all POCs Switched OFF:	/	**6c. Is [6a] less than ~5% of [4]?**		Yes No
7. Can you be reasonably sure that any loads other than those identified in [1] make up less than 5% of the total branch circuit load? *(if Yes, continue with panel meter setup. If No, you cannot conduct panel metering on this branch circuit):*				Yes No
Notes:				

4. Branch Circuit ID:_________ Description:____ Table _____ of _____

1. POC IDs:												
2. Area IDs:												

3. Do all POC IDs have the same Area ID? *(if No, you cannot conduct panel metering on this branch circuit – skip to On/Off metering):*				Yes No
4. Total Connected Load for all POCs on this Electrical Panel Branch Circuit ID *(summed using the Lighting Inventory Form):*				
5a. Watts / 5b. Amps with all POCs Switched ON:	/	**5c. Is [5a] within ~10% of [4]?**		Yes No
6a. Watts / 6b. Amps with all POCs Switched OFF:	/	**6c. Is [6a] less than ~5% of [4]?**		Yes No
7. Can you be reasonably sure that any loads other than those identified in [1] make up less than 5% of the total branch circuit load? *(if Yes, continue with panel meter setup. If No, you cannot conduct panel metering on this branch circuit):*				Yes No
Notes:				

SITE METERING PLAN

Check Box if Form is either N/A or Complete: ☐

SITE VISIT TYPE *(check one):*	☐ PRE-Retrofit ☐ POST-Retrofit	Project ID:		Site Name:	

Instructions: ***The nominal maximum quantity of loggers to install per site is 15. If the number of Points-of-Control (POCs) is sufficiently small that the number of loggers required (including backups) to monitor each POC is less than or equal to 15, all of the POCs at the site should be monitored. This form should only be used when it is necessary to prioritize the POCs for monitoring so that the logger quantity does not exceed the nominal maximum of 15 loggers.***

To fill out this form, use the data from the Lighting Inventory Forms to fill out the first part of the Site Metering Plan. All POCs in the Lighting Inventory should be represented in this plan – use more than 1 Site Metering Plan form if necessary to capture all the circuits with lighting that will be or was retrofit. Where a backup logger is needed, it should be of a different type than the primary logger. In all cases, a CT at the Panel (CTP) should be the first choice; a CT at the Fixture or POC (CTF) should be the second choice; and a Lighting On/Off Logger (LO) should be the last resort. Guidelines for deciding which POCs to monitor:

1. *Any circuit representing more than 10% of the connected load should be metered.*
2. *Any circuit representing more than 25% of the connected load needs a backup logger.*
3. *If any combination of Area ID and Schedule ID adds up to more than 10% of the connected load, then 20% of these circuits (lines) need to be metered.*

COMPLETE AFTER THE LIGHTING INVENTORY							COMPLETE AFTER BRANCH CIRCUIT MAPPING *(if applicable)*			
Index	Area ID	Sched ID	POC ID	Total Connected Load [C]	% of Connected Load [E]=C/D	Will this POC be Metered?	Branch Circuit ID *(if applicable)*	Primary Logger Type *(circle one)*	Backup Logger Type *(circle one)*	Logger Has Been Set & Recorded
1						Yes No		CTP CTF LO	CTP CTF LO None	☐
2						Yes No		CTP CTF LO	CTP CTF LO None	☐
3						Yes No		CTP CTF LO	CTP CTF LO None	☐
4						Yes No		CTP CTF LO	CTP CTF LO None	☐
5						Yes No		CTP CTF LO	CTP CTF LO None	☐
6						Yes No		CTP CTF LO	CTP CTF LO None	☐
7						Yes No		CTP CTF LO	CTP CTF LO None	☐
8						Yes No		CTP CTF LO	CTP CTF LO None	☐
9						Yes No		CTP CTF LO	CTP CTF LO None	☐
10						Yes No		CTP CTF LO	CTP CTF LO None	☐
11						Yes No		CTP CTF LO	CTP CTF LO None	☐
12						Yes No		CTP CTF LO	CTP CTF LO None	☐
13						Yes No		CTP CTF LO	CTP CTF LO None	☐
14						Yes No		CTP CTF LO	CTP CTF LO None	☐
15						Yes No		CTP CTF LO	CTP CTF LO None	☐
16						Yes No		CTP CTF LO	CTP CTF LO None	☐
17						Yes No		CTP CTF LO	CTP CTF LO None	☐
18						Yes No		CTP CTF LO	CTP CTF LO None	☐
19						Yes No		CTP CTF LO	CTP CTF LO None	☐
20						Yes No		CTP CTF LO	CTP CTF LO None	☐
21						Yes No		CTP CTF LO	CTP CTF LO None	☐
22						Yes No		CTP CTF LO	CTP CTF LO None	☐
23						Yes No		CTP CTF LO	CTP CTF LO None	☐
24						Yes No		CTP CTF LO	CTP CTF LO None	☐
25						Yes No		CTP CTF LO	CTP CTF LO None	☐
TOTAL CONNECTED LOAD [D]:										

Notes:

SITE METERING PLAN

Check Box if Form is either N/A or Complete: ☐

SITE VISIT TYPE *(check one)*:	☐ PRE-Retrofit ☐ POST-Retrofit	Project ID:		Site Name:	

Instructions: ***The nominal maximum quantity of loggers to install per site is 15. If the number of Points-of-Control (POCs) is sufficiently small that the number of loggers required (including backups) to monitor each POC is less than or equal to 15, all of the POCs at the site should be monitored. This form should only be used when it is necessary to prioritize the POCs for monitoring so that the logger quantity does not exceed the nominal maximum of 15 loggers.***

To fill out this form, use the data from the Lighting Inventory Forms to fill out the first part of the Site Metering Plan. All POCs in the Lighting Inventory should be represented in this plan – use more than 1 Site Metering Plan form if necessary to capture all the circuits with lighting that will be or was retrofit. Where a backup logger is needed, it should be of a different type than the primary logger. In all cases, a CT at the Panel (CTP) should be the first choice; a CT at the Fixture or POC (CTF) should be the second choice; and a Lighting On/Off Logger (LO) should be the last resort. Guidelines for deciding which POCs to monitor:

1. *Any circuit representing more than 10% of the connected load should be metered.*
2. *Any circuit representing more than 25% of the connected load needs a backup logger.*
3. *If any combination of Area ID and Schedule ID adds up to more than 10% of the connected load, then 20% of these circuits (lines) need to be metered.*

COMPLETE AFTER THE LIGHTING INVENTORY							COMPLETE AFTER BRANCH CIRCUIT MAPPING *(if applicable)*			
Index	Area ID	Sched ID	POC ID	Total Connected Load [C]	% of Connected Load [E]=C/D	Will this POC be Metered?	Branch Circuit ID *(if applicable)*	Primary Logger Type *(circle one)*	Backup Logger Type *(circle one)*	Logger Has Been Set & Recorded
1						Yes No		CTP CTF LO	CTP CTF LO None	☐
2						Yes No		CTP CTF LO	CTP CTF LO None	☐
3						Yes No		CTP CTF LO	CTP CTF LO None	☐
4						Yes No		CTP CTF LO	CTP CTF LO None	☐
5						Yes No		CTP CTF LO	CTP CTF LO None	☐
6						Yes No		CTP CTF LO	CTP CTF LO None	☐
7						Yes No		CTP CTF LO	CTP CTF LO None	☐
8						Yes No		CTP CTF LO	CTP CTF LO None	☐
9						Yes No		CTP CTF LO	CTP CTF LO None	☐
10						Yes No		CTP CTF LO	CTP CTF LO None	☐
11						Yes No		CTP CTF LO	CTP CTF LO None	☐
12						Yes No		CTP CTF LO	CTP CTF LO None	☐
13						Yes No		CTP CTF LO	CTP CTF LO None	☐
14						Yes No		CTP CTF LO	CTP CTF LO None	☐
15						Yes No		CTP CTF LO	CTP CTF LO None	☐
16						Yes No		CTP CTF LO	CTP CTF LO None	☐
17						Yes No		CTP CTF LO	CTP CTF LO None	☐
18						Yes No		CTP CTF LO	CTP CTF LO None	☐
19						Yes No		CTP CTF LO	CTP CTF LO None	☐
20						Yes No		CTP CTF LO	CTP CTF LO None	☐
21						Yes No		CTP CTF LO	CTP CTF LO None	☐
22						Yes No		CTP CTF LO	CTP CTF LO None	☐
23						Yes No		CTP CTF LO	CTP CTF LO None	☐
24						Yes No		CTP CTF LO	CTP CTF LO None	☐
25						Yes No		CTP CTF LO	CTP CTF LO None	☐
TOTAL CONNECTED LOAD [D]:										

Notes:

LOGGER INSTALLATION FORM

Project ID: ________ **Site Name:** ____________________________________

Instructions: *Fill out a separate Logger Installation Form for every data point to be metered. This could be a single DENT Lighting Logger, or a CT feeding one channel of a HOBO data logger.* ***It is critical that the Post-Retrofit metering data point matches the Pre-Retrofit data point****. Take a photo of the installation that shows perspective on where it was installed, and record a description of the placement in the notes. Record the serial numbers of all pieces of equipment to be installed.*

Logger Installation Site Visits

	PRE-RETROFIT INSTALLATION (#1)	POST-RETROFIT INSTALLATION (#3)
Logger Installation ***(check box when data entry complete):***	☐	☐
1a. Installation Date / 1b. Installation Time:	/	/
2. Logger Placement ***(circle one):***		
P=At the Panel **C**=At the POC **F**=At the Fixture **O**=Other:______________	P C F O	P C F O
3. Branch Circuit ID *(if P)* **or POC ID** *(if C or F):*		
4. Logger Type ***(circle one):***		
HCT=HOBO w/ CT **DCT**=DENT w/ CT **DLL**=DENT Lighting Logger	HCT DCT DLL	HCT DCT DLL
5. Logger Serial Number:		
6. Primary (P) or Backup (B) Logger?	P B	P B
7. If Logger Type = HCT, then:	☐ **N/A**	☐ **N/A**
7a. Logger Channel *(circle one):*	1 2 3 4	1 2 3 4
7b. CT Size *(circle one):*	20A 50A 100A 200A	20A 50A 100A 200A
7c. Sampling Interval *(minutes):*		
7d. CT Serial Number:		
8. If Logger Type = DCT, then:	☐ **N/A**	☐ **N/A**
8a. Logger sensitivity has been adjusted properly?	Yes No	Yes No
8b. Logger has been reset but not cleared?	Yes No	Yes No
8c. Fixture was switched on/off at installation time?	Yes No	Yes No
9. If Logger Type = DLL, then:	☐ **N/A**	☐ **N/A**
9a. Placement: *I=Inside the fixture; O=Outside the fixture*	I O	I O
9b. Was the Fiber Optic attachment used in the installation?	Yes No	Yes No
9c. Is it in a location that receives significant daylight or other light?	Yes No	Yes No
9d. Logger sensitivity has been adjusted properly?	Yes No	Yes No
9e. Logger has been reset but not cleared?	Yes No	Yes No
9f. Fixture was switched on/off at installation time?	Yes No	Yes No
10. Was a photo of the installation taken ***(circle one):***	Yes No	Yes No
11. For Post-Retrofit Installation: *do you feel reasonably confident that you are metering the same data point as in the Pre-Retrofit Installation? Describe why in the notes.*	Not Applicable	Yes No

Describe the Logger Placement and Location:

Pre-Retrofit Installation (#1):	
Post-Retrofit Installation (#3):	

Logger Retrieval Site Visits

	PRE-RETROFIT RETRIEVAL (#2)	POST-RETROFIT RETRIEVAL (#4)
Logger Retrieval ***(check box when data entry complete):***	☐	☐
1a. Retrieval Date / 1b. Retrieval Time:	/	/
2. Logger Disposition ***(circle one):***		
F=Found Intact **B**=Found Broken **M**=Missing **OT**=Other *(describe in notes)*	F B M OT	F B M OT
3. If DCT or DLL, fixture was switched on/off at retrieval time?	Yes No	Yes No
4. Does logger serial number and channel match the installation?	Yes No	Yes No
5. If [4]=No, what is actual logger serial number and channel?		

Other Comments:

Pre-Retrofit Retrieval (#2):	
Post-Retrofit Retrieval (#4):	

LOGGER INSTALLATION FORM

Project ID: ________ **Site Name:** ____________________________________

Instructions: *Fill out a separate Logger Installation Form for every data point to be metered. This could be a single DENT Lighting Logger, or a CT feeding one channel of a HOBO data logger.* ***It is critical that the Post-Retrofit metering data point matches the Pre-Retrofit data point****. Take a photo of the installation that shows perspective on where it was installed, and record a description of the placement in the notes. Record the serial numbers of all pieces of equipment to be installed.*

Logger Installation Site Visits

	PRE-RETROFIT INSTALLATION (#1)	POST-RETROFIT INSTALLATION (#3)
Logger Installation *(check box when data entry complete):*	☐	☐
1a. Installation Date / 1b. Installation Time:	/	/
2. Logger Placement *(circle one):*		
P=At the Panel **C**=At the POC **F**=At the Fixture **O**=Other:_______________	P C F O	P C F O
3. Branch Circuit ID *(if P)* **or POC ID** *(if C or F):*		
4. Logger Type *(circle one):*		
HCT=HOBO w/ CT **DCT**=DENT w/ CT **DLL**=DENT Lighting Logger	HCT DCT DLL	HCT DCT DLL
5. Logger Serial Number:		
6. Primary (P) or Backup (B) Logger?	P B	P B
7. If Logger Type = HCT, then:	☐ **N/A**	☐ **N/A**
7a. Logger Channel *(circle one):*	1 2 3 4	1 2 3 4
7b. CT Size *(circle one):*	20A 50A 100A 200A	20A 50A 100A 200A
7c. Sampling Interval *(minutes):*		
7d. CT Serial Number:		
8. If Logger Type = DCT, then:	☐ **N/A**	☐ **N/A**
8a. Logger sensitivity has been adjusted properly?	Yes No	Yes No
8b. Logger has been reset but not cleared?	Yes No	Yes No
8c. Fixture was switched on/off at installation time?	Yes No	Yes No
9. If Logger Type = DLL, then:	☐ **N/A**	☐ **N/A**
9a. Placement: *I=Inside the fixture; O=Outside the fixture*	I O	I O
9b. Was the Fiber Optic attachment used in the installation?	Yes No	Yes No
9c. Is it in a location that receives significant daylight or other light?	Yes No	Yes No
9d. Logger sensitivity has been adjusted properly?	Yes No	Yes No
9e. Logger has been reset but not cleared?	Yes No	Yes No
9f. Fixture was switched on/off at installation time?	Yes No	Yes No
10. Was a photo of the installation taken *(circle one):*	Yes No	Yes No
11. For Post-Retrofit Installation: *do you feel reasonably confident that you are metering the same data point as in the Pre-Retrofit Installation? Describe why in the notes.*	Not Applicable	Yes No

Describe the Logger Placement and Location:

Pre-Retrofit Installation (#1):	
Post-Retrofit Installation (#3):	

Logger Retrieval Site Visits

	PRE-RETROFIT RETRIEVAL (#2)	POST-RETROFIT RETRIEVAL (#4)
Logger Retrieval *(check box when data entry complete):*	☐	☐
1a. Retrieval Date / 1b. Retrieval Time:	/	/
2. Logger Disposition *(circle one):*		
F=Found Intact **B**=Found Broken **M**=Missing **OT**=Other *(describe in notes)*	F B M OT	F B M OT
3. If DCT or DLL, fixture was switched on/off at retrieval time?	Yes No	Yes No
4. Does logger serial number and channel match the installation?	Yes No	Yes No
5. If [4]=No, what is actual logger serial number and channel?		

Other Comments:

Pre-Retrofit Retrieval (#2):	
Post-Retrofit Retrieval (#4):	

Furnace HIM Metering Data Form

CPUC HIM - 90+ AFUE Residential Gas Furnaces

SECTION 1 - CUSTOMER and SCHEDULING

Customer Name(s):		Site ID:	
Site Address:		Phone 1:	
City:	Zip:	Phone 2:	
Email:		Incentive ID:	

	Logger Installation Site Visit	Logger Retrieval Site Visit
Inspector(s):		
Scheduled Date & Time:		
Actual Date & Time:		
Total Time Onsite:		

Customer and Scheduling Notes:

SECTION 2 - DATABASE RECORDS

Application ID:		Climate Zone:	Rebate Paid Date:
Furnace Measure Description:		Furnace Meas Qty:	Annual Therm Savings:
VSD Meas Desc *(if applicable)*:		VSD Meas Qty:	Annual Elec Savings:

Gas Utility Name:		Gas SAID or Acct Number:	
Electric Utility Name:		Elec SAID or Acct Number:	

Database Records Notes:

SECTION 3 - CUSTOMER INTERVIEW

3.1	What type of fuel do you use to heat your home?	☐ Gas	☐ Electric	☐ Propane	☐ Heat Pump
	*** IMPORTANT NOTE: If the Heating Fuel Type = Propane, collect data but do not install meter. If Heating Fuel Type = Electric or Heat Pump, thank the participant and move on to next site. ***				

3.2	Are your furnace and air conditioner all in one package or are they split?	☐ Packaged	☐ Split	
3.2	In what year was your home built?			
3.3	What is the conditioned square footage of your home?	*square feet*		
3.4	Have you added any insulation to your home in the last two years, or do you plan to do so in the next 4 months?	☐ Yes	☐ No	

[If 3.4 = Yes]	*What type of insulation did/will you add?*	☐ Ceiling	☐ Wall	☐ Floor	☐ Other:
[If 3.4 = Yes]	*What month and year did/will you add it?*	*What was/will be the R-value?*			

3.5	Have you replaced any of your gas appliances in the last two years, or do you plan to do so in the next 4 months?				☐ Yes	☐ No
[If 3.5 = Yes]	*What gas appliance did/will you replace? (check all that apply)*					
	☐	Water Heater	*Month and year of replacement?*	*Was the previous unit gas or electric?*	☐ Gas	☐Elec
	☐	Stove	*Month and year of replacement?*	*Was the previous unit gas or electric?*	☐ Gas	☐Elec
	☐	Dryer	*Month and year of replacement?*	*Was the previous unit gas or electric?*	☐ Gas	☐Elec
	☐	Other:	*Month/yr of replacement?*	*Was the previous unit gas or electric?*	☐ Gas	☐Elec
3.6	Why did you replace your previous furnace?	☐ Replaced on Burnout	☐ Early Replacement	☐ Other:		
[If 3.6 = Early Replacement]	*How old was the replaced unit?*			years		

Now I'd like to take a look at your thermostat, record the settings, and ask you a few questions about your setpoints.

Current Heating Setpoints

Start Month:		End Month:		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Heating Setpt 1:	*degF*	Hrs/Day at Setpt 1:								
Heating Setpt 2:	*degF*	Hrs/Day at Setpt 2:								
Heating Setpt 3:	*degF*	Hrs/Day at Setpt 3:								
Hours Per Day Unit is Turned Off:										

Current Cooling Setpoints

Start Month:		End Month:		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Heating Setpt 1:	*degF*	Hrs/Day at Setpt 1:								
Heating Setpt 2:	*degF*	Hrs/Day at Setpt 2:								
Heating Setpt 3:	*degF*	Hrs/Day at Setpt 3:								
Hours Per Day Unit is Turned Off:										

3.7	Have your heating setpoints changed significantly since your new furnace was installed?	☐ No	☐ Yes (fill out table below)

Previous Heating Setpoints *(record only if significantly different than current setpoints)*

Start Month:		End Month:		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Heating Setpt 1:	*degF*	Hrs/Day at Setpt 1:								
Heating Setpt 2:	*degF*	Hrs/Day at Setpt 2:								
Heating Setpt 3:	*degF*	Hrs/Day at Setpt 3:								
Hours Per Day Unit is Turned Off:										

SECTION 4 - HEATING EQUIPMENT

Heating Manufacturer:						
Heating Model Number:						
Heating Serial Number:						
Heating Input:		☐ kBtuh	☐ tons	Heating Output:	☐ kBtuh	☐ tons
Heating Efficiency:		☐ AFUE	☐ HSPF	Year Mfr:		

Data Logger Installation

Location	Serial Number	Installation Date & Time	Retrieval Date & Time	Notes
Heating Stage 1:				
Heating Stage 2:				
Supply Fan VSD:				

Heating Equipment Notes:

SECTION 5 - COOLING EQUIPMENT

Condenser Manufacturer:	
Condenser Model Number:	

Condenser Serial Number:								
Condenser Disposition:	☐	**Existing**	☐	**Replaced on Burnout**	☐	**Early Replacement**	***If Early Replacement, how old was replaced unit?***	**yrs.**
Refrig Type:	☐ **R-22**	☐ **R-410a**	**TXV?**	☐ **Yes**	☐ **No**	**Cooling Capacity:**	☐ **kBtuh**	☐ **tons**
Evap Coil Manufacturer:								
Evap Coil Model Number:								
Evap Coil Serial Number:								
Evap Coil Disposition:	☐	**Existing**	☐	**Replaced on Burnout**	☐	**Early Replacement**	***If Early Replacement, how old was replaced unit?***	**yrs.**
Duct Location:	☐ **Attic**	☐ **Crawl Space**	☐ **Garage**	☐ **Other:**				

	Quantity	RLA-Volts	FLA-Volts	Horsepower		
Compressor:						
Condenser Fan:						
Evap/Supply Fan:					**VSD?** ☐ **Yes**	☐ **No**
Supply Voltage:						
Cooling Equipment Notes:						

SECTION 6 - METER INFORMATION AND BUILDING SKETCH

Gas Meter Number:		**Gas Meter Reading at Logger Installation:**
Electric Meter Number:		**Gas Meter Reading at Logger Retrieval:**
Measured Conditioned Floor Area (from sketch below):		***square feet***

RES FURNACES LOGGER RETRIEVAL

Field Tech Name(s):____

Site ID:		Site Address:	

Instructions: Thoroughly fill out the questions and fields below. Take any additional notes that you deem helpful. Before leaving the site, review each table and if all fields are complete, then check the *complete* box at the top of that table.

Furnace Manual Lookups *(do this prior to arriving at the site)*

Check Box When Complete ☐

	Furnace #1	Furnace #2
L1. Furnace Manufacturer from Installation Site Visit Data:		
L2. Furnace Model Number from Installation Site Visit Data:		
L3. Was the installation or technical information manual located and printed?	Yes No	Yes No
L4. Does the manual indicate DIP switch settings? *(if yes, indicate page number):*	Yes [pg:_____] No DK NA	Yes [pg:_____] No DK NA
L5. Quantity of gas firing stages, according to manual *(circle one):*	1 2 3 DK NA	1 2 3 DK NA

Notes:

Customer Interview

Check Box When Complete ☐

C1. Do you have a gas bill that I could look at? *(if yes, record gas meter multiplier or "none"):*	Yes No DK	*Multiplier:*
C2. Has the ownership or tenancy of the home changed since 2005? *(if yes, collect as much information about the previous tenants as possible, including # of people and their ages. Record the additional details in the notes):*		Yes No DK
C3. How many people live in the home currently? *(circle one; if more than 5, record actual number):*		1 2 3 4 5 6+ [#:______]
C4. What are the ages of the people currently living in the home? *(record all)*		
C5. Has the number of people living in the home changed since 2005? *(if yes, describe changes in the notes)*		Yes No DK
C6. Have any remodels been completed since 2005? *(if yes, describe changes in notes, especially sq ft differences):*		Yes No DK

C7. Record the quantity of working appliances that use natural gas supplied by the customer's gas utility, and any changes since 2005 *(read list):*

Appliance Type	C7a. Current Qty Gas Units	C7b. Has Qty or Size of Gas Units Changed Since 2005?	C7c. If C7b=Yes, describe changes, including month/year of change, and differences in quantity, size, or fuel type.
Furnaces:		Yes No DK	
Water Heaters:		Yes No DK	
Stoves/Ovens:		Yes No DK	
Clothes Dryers:		Yes No DK	
Spa/Hot Tub Heaters:		Yes No DK	
Pool Heaters:		Yes No DK	
Indoor Fireplaces:		Yes No DK	
Outdoor Fireplaces:		Yes No DK	
Outdoor Gas Grills:		Yes No DK	
Other:__________________		Yes No DK	

Notes *(include anything else that might affect the billing analysis, such as the presence of shade trees or buildings, etc):*

RES FURNACES LOGGER RETRIEVAL

Field Tech Name(s):____

Site ID:		Site Address:	

Meter Readings and Site Observations

Check Box When Complete ☐

1M-1. [Take photograph showing the outside front of the house, including address number]:		☐ **Done** ☐ **NA** *(describe in notes)*
1M-2. Does gas meter number match that from the installation site visit? *(if no, record actual):*	Yes No DK	*Actual:*
1M-3. [Take photograph showing the gas meter number]:		☐ **Done** ☐ **NA** *(describe in notes)*
1M-4. Record the gas meter reading:		
1M-5. [Take photograph showing the gas meter reading]:		☐ **Done** ☐ **NA** *(describe in notes)*
1M-6. Does electric meter number match that from the installation site visit? *(if no, record actual):*	Yes No DK	*Actual:*
1M-7. [Take photograph showing the electric meter number]:		☐ **Done** ☐ **NA** *(describe in notes)*
Notes:		

FURNACE #1: Observations and Logger Retrieval

Check Box When Complete ☐

1F-1. Does furnace manufacturer match that from the installation site visit? *(if no, record actual):*	Yes No DK	*Actual:*
1F-2. Does furnace model match that from the installation site visit? *(if no, record actual):*	Yes No DK	*Actual:*
1F-3. [Take photograph of furnace nameplate to show manufacturer and model]:		☐ **Done** ☐ **NA** *(describe in notes)*
1F-4. [Take photograph of furnace interior showing the logger setup]:		☐ **Done** ☐ **NA** *(describe in notes)*
1F-5. Does 1st stage (W1) logger serial number match installation number? *(if no, record actual):*	Yes No NA	*Actual:*
1F-6. [Download data from logger and record file name as "SiteID_1S_LoggerSerial_RetrievalDate.csv"]:		☐ **Done** ☐ **NA** *(describe in notes)*
1F-7. Does logger data look reasonable and usable? *(qualitative assessment; if no, describe in the notes):*		Yes No DK NA
1F-8. Does 2nd stage (W2) logger serial number match installation number? *(if no, record actual):*	Yes No NA	*Actual:*
1F-9. [Download data from logger and record file name as "SiteID_2S_LoggerSerial_RetrievalDate.csv"]:		☐ **Done** ☐ **NA** *(describe in notes)*
1F-10. Does logger data look reasonable and usable? *(qualitative assessment; if no, describe in the notes):*		Yes No DK NA
1F-11. Does Watt's-Up logger serial number match installation number? *(if no, record actual):*	Yes No NA	*Actual:*
1F-12. [Download data from logger and record file name as "SiteID_WU_LoggerSerial_RetrievalDate.csv"]:		☐ **Done** ☐ **NA** *(describe in notes)*
1F-13. Does logger data look reasonable and usable? *(qualitative assessment; if no, describe in the notes):*		Yes No DK NA
1F-14. Do the actual DIP switch settings match those from the manual? *(if yes, record details of settings in the notes):*		Yes No DK NA
1F-15. [Take photograph of the DIP switches to show the settings]:		☐ **Done** ☐ **NA** *(describe in notes)*
1F-16. Quantity of gas valves in the furnace:		1 2 3 DK
1F-17. [Take photograph showing the interior of the furnace, including all gas valves]:		☐ **Done** ☐ **NA** *(describe in notes)*
1F-18. [Take photograph of any furnace maintenance tags]:		☐ **Done** ☐ **NA** *(describe in notes)*
1F-19. What percentage of the total conditioned floor area does this furnace serve?		
1F-20. Where is the furnace located? *A=Attic; CS=Crawl Space; B=Basement; CL=Closet; G=Garage; OT=Other:________*		A CS B CL G OT
1F-21. How is the blower motor controlled? *1S=Single-speed; 2S=Two-speed; EC=Electronically-commutated (variable)*		1S 2S EC DK
1F-22. Is there a previously-drilled hole in the stack available for a combustion efficiency test?		Yes No DK NA
1F-23. Where does the furnace flue expel the combustion gases? *R=Roof; G=Ground-level; OT=Other:____________*		R G OT DK
1F-24. Does the furnace share its flue with a gas water heater or other gas appliance?		Yes No DK NA
1F-25. [If 1F-24=Yes] Would it be easy to isolate the furnace gases from those of other appliances? *(describe in notes)*		Yes No DK NA

1F-26. What is the flue material? *M=Metal/Aluminum P=PVC OT=Other:___________________*	M P OT DK
Notes:	

RES FURNACES LOGGER RETRIEVAL

Field Tech Name(s):____

Site ID:		**Site Address:**	

FURNACE #2: Observations and Logger Retrieval

Check Box if N/A, or When Complete ☐

2F-1. Does furnace <u>manufacturer</u> match that from the installation site visit? *(if no, record actual):*	Yes No DK	*Actual:*
2F-2. Does furnace <u>model</u> match that from the installation site visit? *(if no, record actual):*	Yes No DK	*Actual:*
2F-3. [Take photograph of furnace nameplate to show manufacturer and model]:		☐ **Done** ☐ **NA** *(describe in notes)*
2F-4. [Take photograph of furnace interior showing the logger setup]:		☐ **Done** ☐ **NA** *(describe in notes)*
2F-5. Does 1st stage (W1) logger serial number match installation number? *(if no, record actual):*	Yes No NA	*Actual:*
2F-6. [Download data from logger and record file name as "SiteID_1S_LoggerSerial_RetrievalDate.csv"]:		☐ **Done** ☐ **NA** *(describe in notes)*
2F-7. Does logger data look reasonable? *(qualitative assessment; if no, describe in the notes):*		Yes No DK NA
2F-8. Does 2nd stage (W2) logger serial number match installation number? *(if no, record actual):*	Yes No NA	*Actual:*
2F-9. [Download data from logger and record file name as "SiteID_2S_LoggerSerial_RetrievalDate.csv"]:		☐ **Done** ☐ **NA** *(describe in notes)*
2F-10. Does logger data look reasonable and usable? *(qualitative assessment; if no, describe in the notes):*		Yes No DK NA
2F-11. Does Watt's-Up logger serial number match installation number? *(if no, record actual):*	Yes No NA	*Actual:*
2F-12. [Download data from logger and record file name as "SiteID_WU_LoggerSerial_RetrievalDate.csv"]:		☐ **Done** ☐ **NA** *(describe in notes)*
2F-13. Does logger data look reasonable and usable? *(qualitative assessment; if no, describe in the notes):*		Yes No DK NA
2F-14. Do the actual DIP switch settings match those from the manual? *(if yes, record details of settings in the notes):*		Yes No DK NA
2F-15. [Take photograph of the DIP switches to show the settings]:		☐ **Done** ☐ **NA** *(describe in notes)*
2F-16. Quantity of gas valves in the furnace:		1 2 3 DK
2F-17. [Take photograph showing the interior of the furnace, including all gas valves]:		☐ **Done** ☐ **NA** *(describe in notes)*
2F-18. [Take photograph of any furnace maintenance tags]:		☐ **Done** ☐ **NA** *(describe in notes)*
2F-19. What percentage of the total conditioned floor area does this furnace serve?		
2F-20. Where is the furnace located? *A=Attic; CS=Crawl Space; B=Basement; CL=Closet; G=Garage; OT=Other:_______*		A CS B CL G OT
2F-21. How is the blower motor controlled? *1S=Single-speed; 2S=Two-speed; EC=Electronically-commutated (variable)*		1S 2S EC DK
2F-22. Is there a previously-drilled hole in the stack available for a combustion efficiency test?		Yes No DK NA
2F-23. Where does the furnace flue expel the combustion gases? *R=Roof; G=Ground-level; OT=Other:___________*		R G OT DK
2F-24. Does the furnace share its flue with a gas water heater or other gas appliance?		Yes No DK NA
2F-25. [If 2F-24=Yes] Would it be easy to isolate the furnace gases from those of other appliances? *(describe in notes)*		Yes No DK NA
2F-26. What is the flue material? *M=Metal/Aluminum P=PVC OT=Other:___________________*		M P OT DK
Notes:		

Other Notes

LGP EVALUATION REPORT APPENDIX C:

PALM DESERT PARTNERSHIP PILOT PROGRAM EVALUATION SUPPORTING DOCUMENTS

a. Residential Early Retirement Appendix
    i. Impact Sampling
    ii. Data Collection Methodology
    iii. Data Analysis Methodology
    iv. Detailed Results
    v. Remaining Useful Life Analysis
b. Refrigerant Charge and Airflow Appendix
    i. Impact Sampling
    ii. Data Collection Methodology
    iii. Data Analysis Methodology
    iv. Detailed Results
c. Palm Desert Net to Gross Net-to-Gross Methodology and Analysis

Residential Early Retirement Appendix

1.1 Residential Early Retirement

1.1.1 Impact Sampling

The Residential Early Retirement measure, "Central AC Early Retirement (Tier 1 & 2 Adder)," was identified as a measure of interest in Palm Desert, and was selected for additional scrutiny, with a goal of achieving 90-20 confidence and precision at the program level. The intention of this decision was to contribute to achieving a high level of confidence and precision in the Palm Desert program net impact estimate, while adding as much as possible to the collective knowledge of savings from HVAC measures in hot dry climates.

There were 610 participating residential customers in the Early Retirement program. The data reveal a mean of gross savings of 921 kWh. Assuming an Ex Ante coefficient of variation (CV) of 0.70, a sample size of 34 was targeted and attained to achieve a 90/20 level of confidence and precision (see Table C-1). It was decided that stratification of the Early Retirement Impact sample would not improve the evaluation since savings are constant per unit installed.

Table C-1. Early Retirement Sample Target

Measure	Population	Ex Ante Mean Gross Savings (kWh)	Sample Size	Expected CV	Confidence Level	Precision
Early Retirement (Residential)	610	921	34	0.70	90%	20%
Note: Results displayed are *ex ante*. *Ex post* results will be reported when available.						

1.1.2 Data Collection Methodology

The Palm Desert residential air conditioning (AC) early retirement program was evaluated by Summit Blue in parallel with the statewide evaluation of AC replacement programs in California spearheaded by KEMA. The data collection methodology implemented in Palm Desert replicates the stated KEMA methodology with only minor adaptations for the specific Palm Desert effort. The data collection consisted of contextual data and measure specific data, which were adapted from the KEMA data collection methodology. What follows is an edited version of the KEMA data collection protocol.

Contextual Data

As part of the evaluation effort, appropriate site level contextual data were collected to inform eQuest site models. Thermostat operation schedules and occupant vacation schedules were collected. Other site level data included building dimensions, conditioned floor area for affected zones, building orientation, building vintage, age of replaced system if early replacement, interior wall type, wall insulation, wall height, roof material, roof insulation, window area by orientation, window glazing, and internal and external window shades. In Palm Desert, plug loads, lighting, and operating schedules were not collected onsite as it was deemed unnecessary for residential analysis. Table C-2 summarizes site contextual data collection.

Table C-2. Site Contextual Data Collection Summary

Building Parameter	Data Collection
Building Type	Observed
Total Area	Measured
Vintage	Surveyed
Area Served	Measured/Plans
Number of Floors	Measured/Plans
Number of Buildings	Measured/Plans
Window Area by Orientation	Measured/Plans
Glazing Type by Orientation	Observed/Plans
Glazing Interior and Exterior Shading by Orientation	Observed/Plans
Roof Construction	Observed/Plans
Ceiling Insulation	Observed/Plans
Occupancy Schedule	Surveyed
Heating Setpoint	Surveyed
Cooling Setpoint	Surveyed
SystemType	Observed
Cooling Efficiency	Measured

Measure Specific Data (Post Installation)

Measure specific data for the replacement AC unit was collected for early replacement sites. Collected data included: Manufacturer, model number and serial number for each condenser/compressor unit, evaporator coil, and furnace; HVAC efficiency, refrigerant type, metering device, number of compressors.

The following parameters were logged on site for 40-50 days post installation to inform eQuest models: HVAC unit input power, supply air temperature, return air temperature, mixed air temperature, ambient temperature. Spot measurements of each of these parameters were also be taken during the initial site visit to ensure the validity of the monitored data.

The measure specific data collected in Palm Desert did not include staging sequence, compressor RLA, condenser fan hp, fan FLA, supply and return fan hp, or fan control strategy. However, this data was researched if needed, by looking up online manufacturer manuals. In addition, it was determined that a logging interval of 40-50 days was sufficient to acquire accurate measured data for the peak season.

Data Accuracy and Instrumentation

The accuracy of the data logged on site was of utmost importance. We maintained quality control at each step of evaluation including collecting field data, monitoring performance data, initial data entry, post analysis and reporting. Each of these steps were carried out by qualified professionals and were cross checked by senior engineers to avoid inaccuracies.

Different time series data loggers were used to record various performance parameters of the HVAC system. Spot watt measurements were carried out for all the logging input parameters to cross verify the accuracy of the loggers. The following instruments were used to measure the performance of the HVAC units.

Instrument Specifications: A WattNode with two 30-50 amp current transformers was used to meet our power measurement criteria. This meter outputs a stream of pulses whose frequency is proportional to instantaneous power and whose count is proportional to watt hour. A pulse input adapter along with a Hobo Microstation were used to record the pulse output from the wattnode. Every pulse from the WattNode corresponds to a fixed amount of energy. Watt-hour per time stamp was calculated by multiplying the Wh/pulse conversion factor corresponding to the size of current transformer used by the numbers of pulses per time stamp. Return and supply air temperature and humidity were measured with a 12-bit temp/Rh smart sensor and this sensor also used a Hobo Microstation to record the data. The details of various data loggers and their accuracies are described in Table C-3.

Table C-1. Summary of Logging Equipment

Function/Data Point to Measure	Equipment Brand//Model	Qty Req'd	Rated Full Scale Accuracy	Accuracy of Expected Measurement	Metering Duration	Planned Metering Interval
Power	Wattnode/WNB-3D-240-P	1	± 0.5%	± 0.04%	40-50 days	1 Minutes
Power	Hobo Microstation with pulse adapter	1	45µs ±10 %	45µs ±10 %	40-50 days	1 Minutes
Supply/Return Temperature / RH	Hobo Microstation with 12 Bit Temp/RH	2	±0.36 ºF/ ± 2.5 %RH	±1 ºF/ ± 4.0 RH%	40-50 days	5 Minutes
Indoor Temperature / RH	Hobo U10-003	1	±0.36 ºF/ ± 3.5 %RH	±1 ºF/ ± 5.0 RH%	40-50 days	5 Minutes
Ambient Temperature	Hobo Microstation with S-TMB-M002smart sensor	1	±0.36 ºF	±0.30 ºF	40-50 days	5 Minutes
Airflow	True flow meter & DG700 pressure gauge	1	± 7% CFM ± 1% Pa	± 12% CFM	40-50 days	Instant

Data loggers and sensors used for power measurement were placed inside the air conditioner cabinet where possible. In many cases, the microstation was placed outside the cabinet. Two voltage leads were directly connected to the two incoming terminals. Two split core current transformers were slipped onto the two phases of the incoming lines to the AC. A smart temperature sensor was mounted near the bottom of the condenser on the north (shady) side of the unit. Smart sensors along with a HOBO Microstation were used to monitor supply and return temperature and humidity while a HOBO U10 was placed on top of the thermostat.

Both sampling and recording interval for power monitoring were set for 1 minute or 90 seconds, depending on the expected metering duration. Supply and return temperature and humidity and outdoor temperature were also logged at 1 minute or 90 seconds, depending on the expected metering duration. Thermostat temperature was logged at a 5 minute interval.

Measurement Accuracy Concerns and Quality Control

Supply and Return Temperature and Humidity: After reviewing the data, some questionable supply temperatures and absolute humidities were observed. In some cases, the data from a given site had to be thrown out because this data was bad. Two theories have been postulated for the source of this problem, both revolving around poorly mixed air in the supply or return plenum.

1. When the sensor had to be placed close to the coil in a vertical closet orientation, variability in the temperature and humidity within that space created a larger effective error. If the supply temperature sensor happened to be placed directly in the center of the coil, air going between the two lobes of an A-coil would flow over the sensor, causing a high reading.
2. If a condensate drain is plugged on a rooftop unit, water can back up in the supply and return plenums without being noticed by the homeowner. If the sensor was placed low in the plenum, then evaporative cooling of the air near the bottom of such a unit would cause a high humidity level at the return sensor.

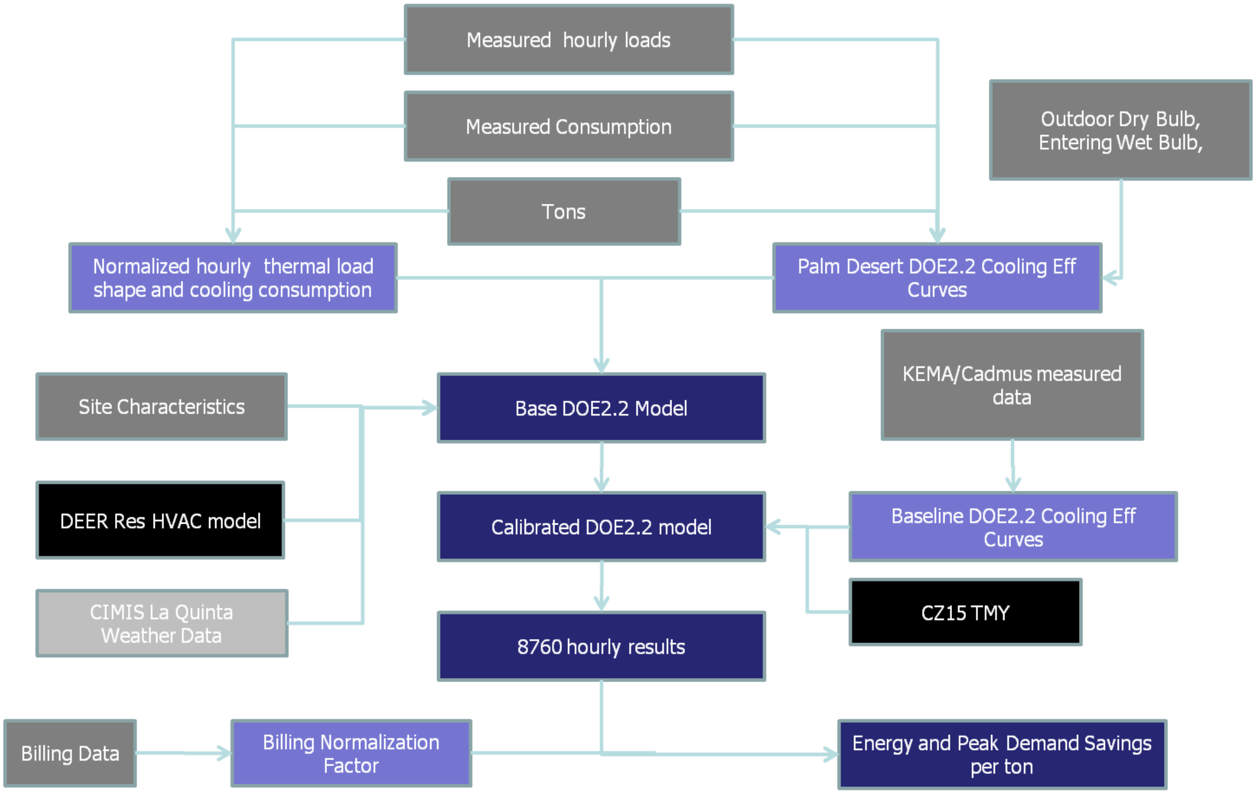
Airflow measurements: Review of the airflow measurements with energy division technical advisors raised questions about the generally low observed airflow. Summit Blue staff have extensive experience with airflow measurement and the difficulties associated with this measurement.

1.1.3 Data Analysis Methodology

Introduction

A summary of the analysis methodology is outlined below. The analysis methodology follows the same basic approach as that used by Cadmus and KEMA in their analysis, but the detailed realization of the analysis differs in the tools used, because the Palm Desert data included a high frequency of special cases and Cadmus and KEMA chose to simplify their analysis in the interest of time. Figure C-1 summarizes the flow of data from field activities to energy savings values.

Figure C-1. Early Retirement Data Flow Map



Site-level Data Aggregation and Analysis

Data Aggregation

Raw logger data files were combined and processed using the SAS software package. First, data from different loggers at the same site were combined by rounding the time for each data point to the nearest logging interval. These data included logged measurements of indoor temperature and dew point, outdoor temperature at the condenser, supply and return air temperature and dew point, and outdoor unit Wattnode pulses (proportional to energy consumption). Indoor temperature and dew point values were logged at a greater interval and were approximated using linear interpolation for data points where these values were missing.

Next, spot measurements of indoor unit fan power and airflow rate from FACT (SBC's online field database) were combined with the logger data. Where airflow measurements were taken at a remote return filter slot, numbers were scaled up by 4% to account for duct leakage, as recommended by the manufacturer. Relevant site and logger installation data were also extracted from FACT, including the logger deployment and retrieval dates, the size of the current transducers (CTs) connected to the Wattnode, and whether the unit is a packaged rooftop unit or a split system. Based on this data, the points from the installation and retrieval days were thrown out, and the Wattnode pulses were converted to energy consumption using the conversions in Table C-4 below:

Table C-2. WattNode Pulse Conversion Factors

WattNode Model	CT Size (Amps)	Conversion (Wh/Pulse)
WNB-3D-240-P	30	0.75
WNB-3D-240-P	50	1.25
WNB-3D-240-P	70	1.75
WNB-3D-240-P	100	2.50
WNB-3D-480-P	70	4.04

For six sites, field staff were unable to take airflow measurements; in these cases, airflow was assigned based on the average airflow per ton for all other sites, 300 CFM/ton. For nine sites, indoor unit fan power was not able to be measured, so a linear regression relating fan power to airflow and tons rated capacity was derived based on the sites which had both airflow and fan power measurements:

$$FankW = 0.000308 * Airflow + 0.149 * Size - 0.233$$

Where:

- *FankW* is the indoor unit fan power, in kW
- *Airflow* is the airflow rate in CFM
- *Size* is the outdoor unit rated capacity, in tons

Logged values of supply and return air temperature and dew point were used to calculate the change in specific enthalpy across the evaporator coil and the return air specific volume using equations from the ASHRAE Handbook of Fundamentals, assuming standard pressure at 500 feet elevation:

- Equation for the partial pressure of water vapor at saturation
- Equation for the humidity ratio
- Equation for Total Enthalpy
- Equation for Sensible Enthalpy
- Equation for Specific Volume

Return wet bulb temperature was approximated for each point by creating a lookup table of wet bulb values by 2 ^{o}F increments of dry bulb and dew point, using a NOAA online calculator (NOAA, 2009). Wet bulb values were approximated using a two-dimensional interpolation of actual values of dry bulb and dew point.

Site Data Analysis

In order to accurately characterize equipment operation, each data point was assigned a mode value to reflect whether it the unit was off, running in low or high stage, or a combination of the two. In the latter category, which has been termed the "shoulder" points, the logged energy consumption indicated that the unit ran for part of the logged interval. Shoulder points were determined as follows:

1. First, all data points showing consumption equivalent to 300 W or less were thrown out.

2. If the previous or next data point showed zero energy consumption, the point was determined to be a shoulder.

3. Additionally, if the consumption of a point was less than 80% of the previous or next point, that point was determined to be a shoulder.

The remaining points were divided into "high" and "low" stage points as follows:

1. The energy consumption time series data was plotted for each site, and each site was individually inspected.

2. If no sign of two-stage operation was present, all remaining points were labeled "high".

3. For two-stage units, a regression of average energy consumption against outdoor temperature was determined, and scaled up by 20%. This was plotted against observed energy consumption, and determined to be adequate in separating high from low-stage operation for all but two units. For the other two, a line of simple average energy consumption served this function. Points above the line were high stage operation, and below the line were low stage.

These mode assignments were then cleaned up to account for irregularities in the data. If multiple shoulder points were assigned on the beginning or end of an "on" period, all but the shoulder closest to the "on" point were changed to off points. Additionally, "on" periods with two or less data points were assumed to be "off" points as well.

Next, airflow and indoor unit fan energy use were determined for each point as follows:

- For points in high stage, full measured airflow and fan energy were assigned.

- For points in low stage, airflow and fan energy were scaled based ratios from manufacturers' data for the specific indoor units monitored.

- For shoulder points, airflow and fan energy of the adjacent point with the highest energy use were scaled by the ratio of the shoulder point energy use to that of the adjacent point.

- For two-stage units with variable speed evaporator fans, the airflow and fan energy were further adjusted based on the "ramp up" schedule of the specific indoor unit, as shown in Table C-5 below. This ramp up schedule is followed when switching from "off" to either stage, or from one stage to the other. Fan power was adjusted by the airflow adjustment raised to the 2.5 power.

Table C-5. Variable-Speed Evaporator Fan Ramp-Up Schedules by Manufacturer

Indoor Unit Manufacturer	Initial Ramp Up – 50% Airflow	Secondary Ramp Up – 80% Airflow	Full Airflow Operation	Post Operation Ramp Down – 50% Airflow
Lennox	30 sec	7.5 min	Until set point	30 sec
American Standard	1 min	7.5 min	Until set point	3 min

Compressor energy consumption was calculated by subtracting out 1.7 W continuous power draw for the WattNode, and subtracting out the fan energy consumption if the unit was a packaged rooftop unit (for which the fan was on the monitored circuit).

Load and sensible load were calculated by first calculating the total air mass for the logging interval (airflow*interval/specific volume), then multiplying that by the change in total or sensible enthalpy measured across the coil. Load and sensible load for the leading shoulder point were re-calculated using the average EER for a given run period, to account for the fact that the enthalpy measured was likely erroneous due to sensor lag.

Finally, the data for each site was aggregated to the hourly level. Outdoor and indoor temperatures were averaged over all points, supply and return temperatures were averaged over only the "on" points, and energy consumption and loads were summed over the "on" points. Additionally, fraction of time "on" and fraction of time in high stage were calculated for each site for each hour.

Load Shape Aggregation

From the hourly site data, an aggregate load and energy consumption shape was calculated for the monitored period. Because eQuest deals with gross loads in the systems model, fan heat was added to the sensible and total loads for each hour (assumed to be 100% conversion of the fan energy used). First, the total number of sites logging was determined for each day. Days were separated into "good" days, in which it was determined that enough sites were represented (22) to create a representative load shape, "bad" days for which that was not true (10 to 21 sites), and "unacceptable" days for which less than 10 sites were present. The load shape and energy consumption for the good days was taken by summing the loads and energy consumption for each hour, and dividing by the total available tons capacity. Consumption and load in the "bad" weeks were determined by taking load and EER scalars for each site by hour of day, representing the load/consumption of that site at that hour relative to the group of sites present during the "good" days, and scaling consumption and load in the "bad" weeks with these site-specific factors.

Load Shape Aggregation

From the hourly site data, an aggregate load and energy consumption shape was calculated for the monitored period. Because eQuest deals with gross loads in the systems model, fan heat was added to the sensible and total loads for each hour (assumed to be 100% conversion of the fan energy used). First, the total number of sites logging was determined for each day. Days were separated into "good" days, in which it was determined that enough sites were represented (22) to create a representative load shape, "bad" days for which that was not true (10 to 21 sites), and "unacceptable" days for which less than 10 sites were present. The load shape and energy consumption for the good days was taken by summing the loads and energy consumption for each hour, and dividing by the total available tons capacity. Consumption and load in the "bad" weeks were determined by taking load and EER scalars for each site by hour of day, representing the load/consumption of that site at that hour relative to the group of sites present during the "good" days, and scaling consumption and load in the "bad" weeks with these site-specific factors.

Equipment Model Derivation

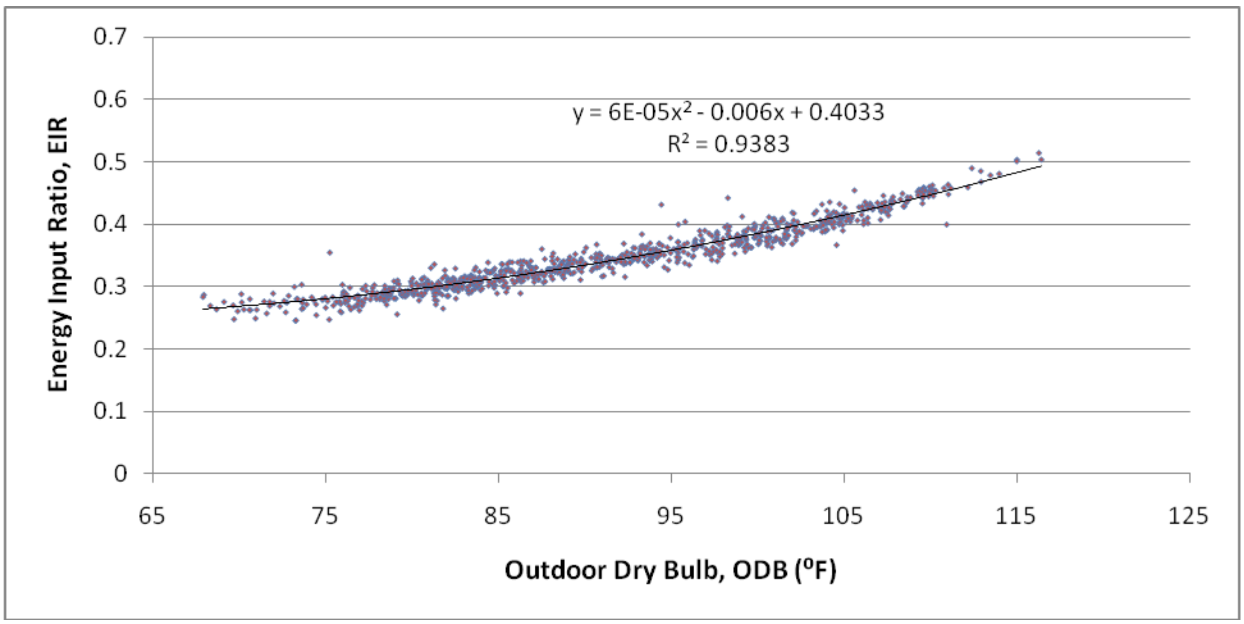
Data was aggregated from site-level hourly data to aggregate hourly data for the "good" days only. A unit was determined to be "on" in a particular hour if it had runtime of 5% or more. Runtime fraction and outdoor drybulb (ODB) were averaged over all points, while high stage fraction, energy input ratio (EIR) and coil entering wet bulb (EWB) were averaged just for the "on" units. High stage fraction (HSF) was calculated for all "on" units, assuming an HSF of 1 for single stage units. Run time fraction (RTF) was calculated for all "on" units as the fraction of time in an hour that the units were running. A typical manufacturer's value of 0.6 was used for the ratio of low stage capacity to high stage capacity (LHR). Capacity (CAP) for "on" units was calculated from the system load (LOAD), using the following equation:

$$CAP = LOAD * \frac{HSF + \frac{1 - HSF}{LHR}}{RTF}$$

Sensible heat ratio and runtime were also calculated for "on" units. These calculated variables were plotted against each other in an effort to test for correlation between variables, with the ultimate objective of deriving a mathematical equipment model similar in form to the DEER DOE2 equipment curves for EIR and capacity.

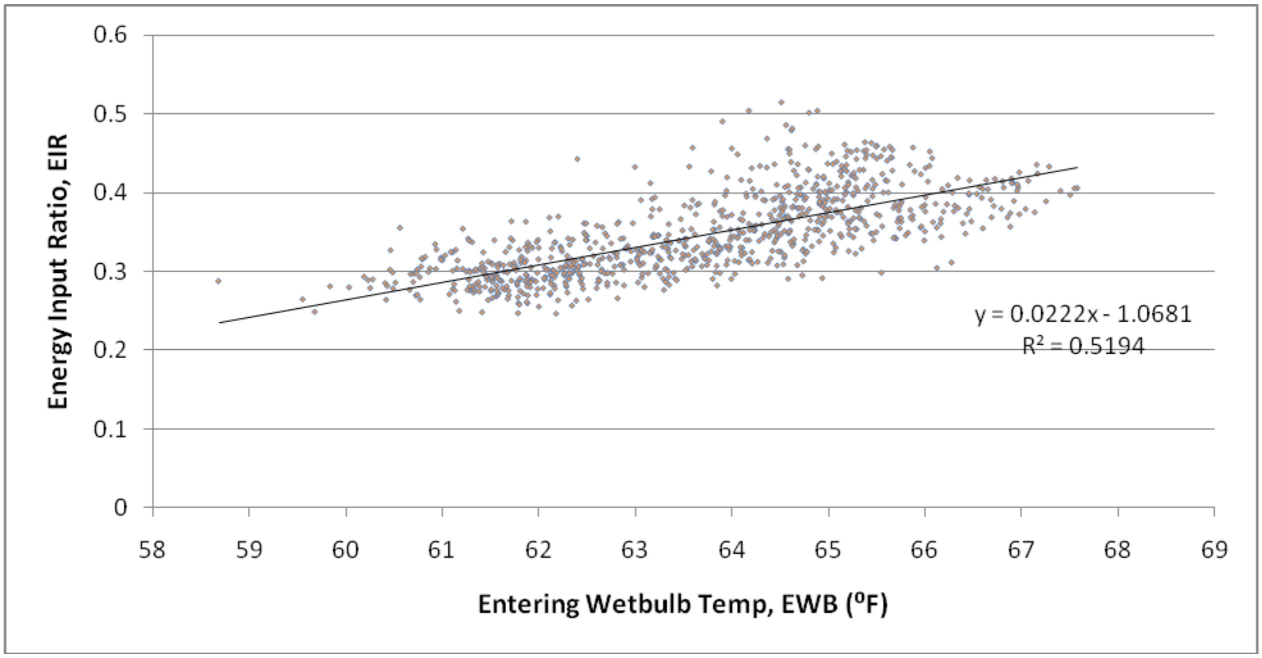
The DEER curve for EIR uses part load ratio (PLR), ODB, and EWB. EIR was plotted against ODB. Figure C-2 shows a strong correlation and surprisingly good fit between EIR and ODB.

Figure C-2. Measured EIR vs. ODB



Energy input ratio was also plotted against entering wet bulb. Figure C-3 shows a relatively weak correlation between EIR and EWB.

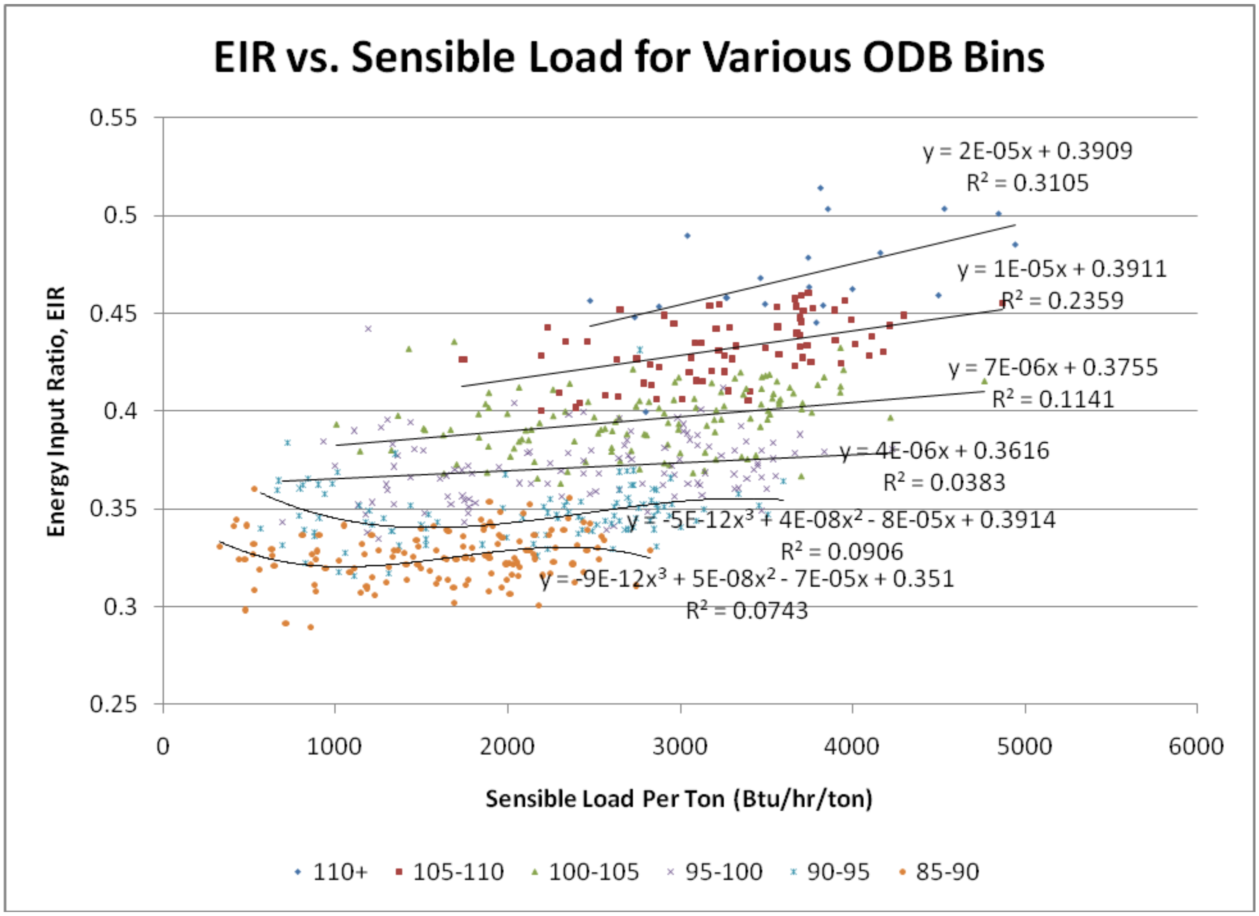
Figure C-3. Measured EIR vs. EWB



The results of Figure C-2 and Figure C-3 can be interpreted to show that outdoor dry bulb appears be the primary driver of unit efficiency in Palm Desert. That is not the whole story, since almost all of the other driving variables in the DOE2 model are also correlated to outdoor dry bulb, including run time fraction, part load ratio, and entering wet bulb. In Palm Desert, operation over a wide range of outdoor dry bulb was observed (75-115 deg F), while there was not very much variation in entering wet bulb temperature (60-67 deg F). What variation there was in entering wet bulb temperature was strongly correlated to outdoor dry bulb, as higher outdoor dry bulbs increased return temperatures in systems where there were significant gains to the return ducts.

An attempt was made to separate part load effects from outdoor dry bulb effects by binning outdoor dry bulb and observing relationships among data points within those bins. Figure C-4 shows entering input ratio graphed against outdoor dry bulb, with points grouped in five degree increments of outdoor dry bulb. At low-medium temperatures, there is almost no correlation between sensible load and EIR. At higher temperatures, there is a weak correlation, but the data is also sparser than at medium temperatures, so this correlation may not be significant.

Figure C-4. EIR vs. Sensible Load for Various ODB Bins



For completeness, additional data plots of variables considered for regression analysis follow in Figure C-5 to Figure C-8.

Figure C-3. RTF vs. ODB

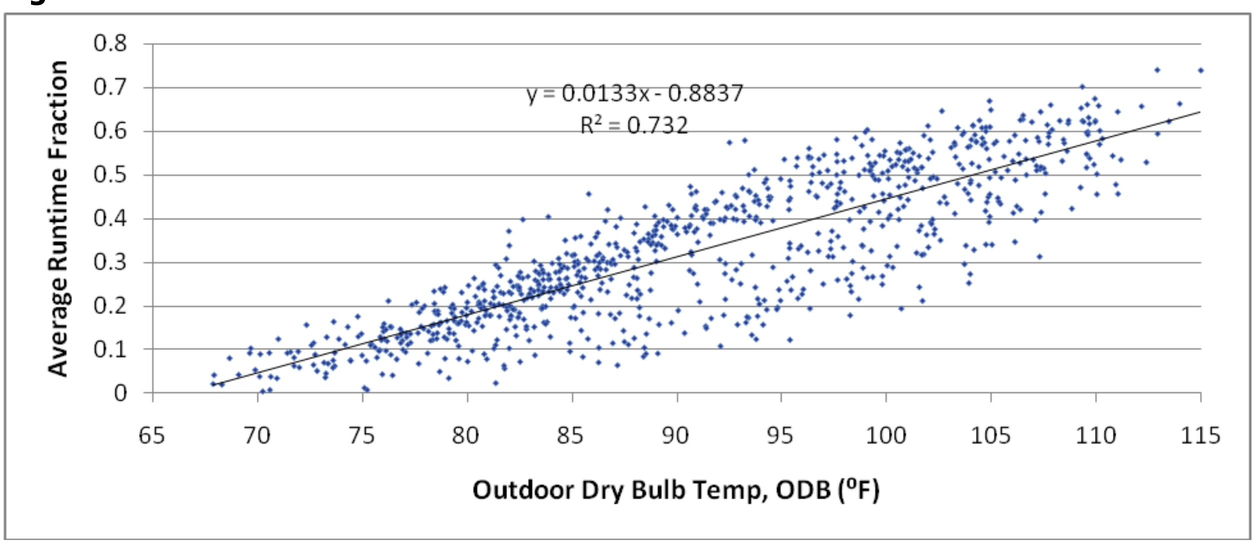


Figure C-4. Fraction of AC tons Running vs. Average Sensible Load per Ton

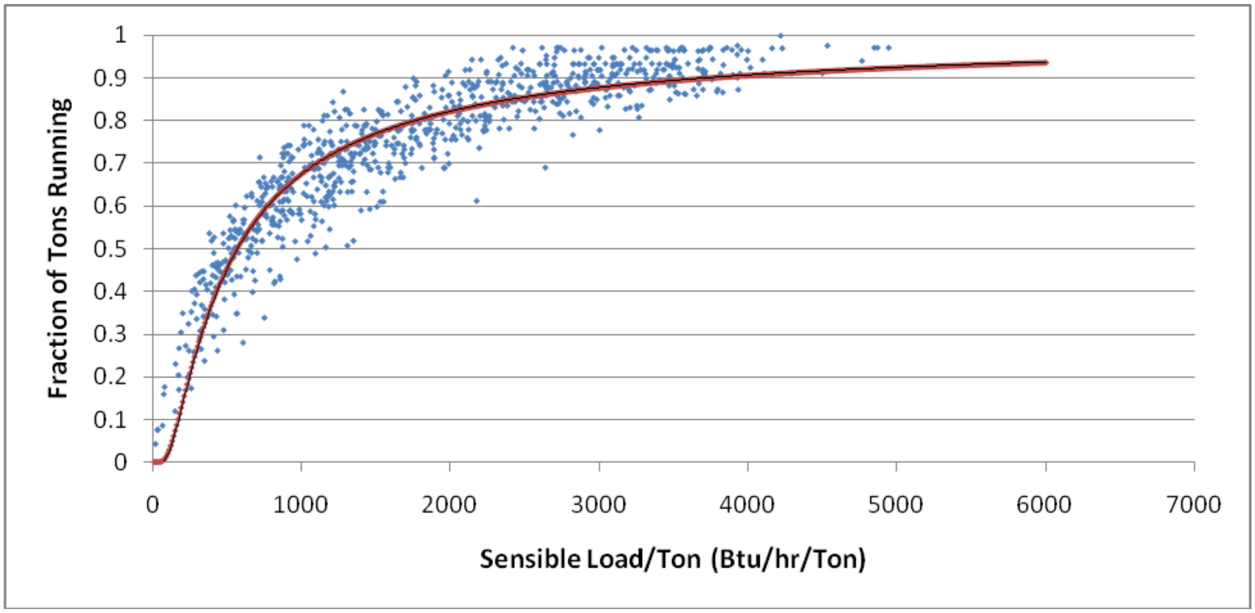


Figure C-5. Sensible Load per Ton vs. ODB

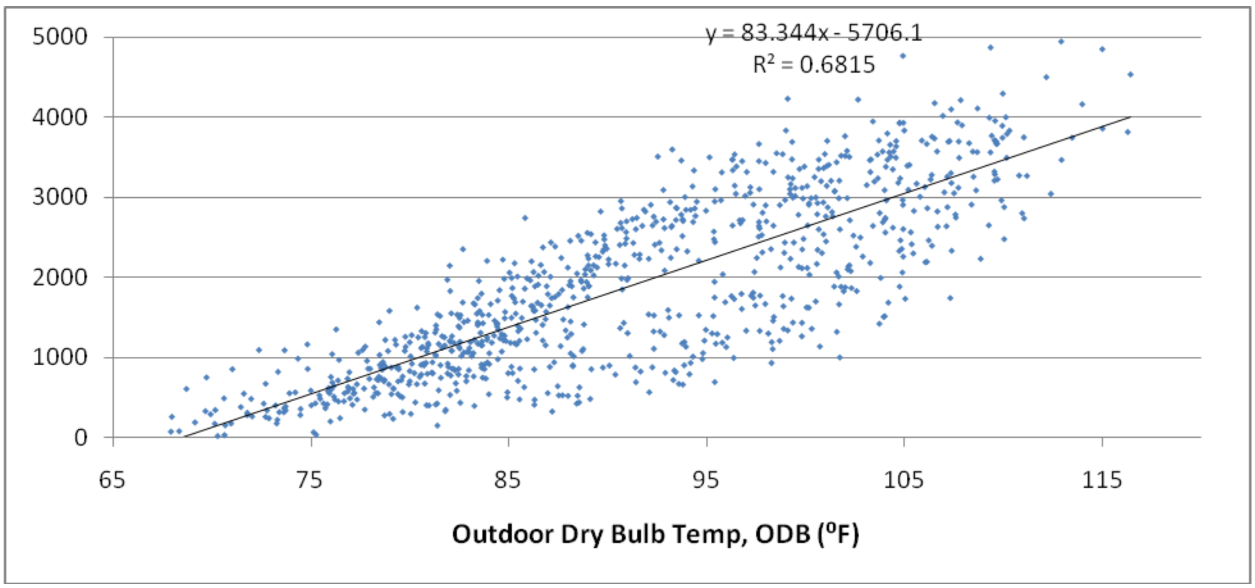
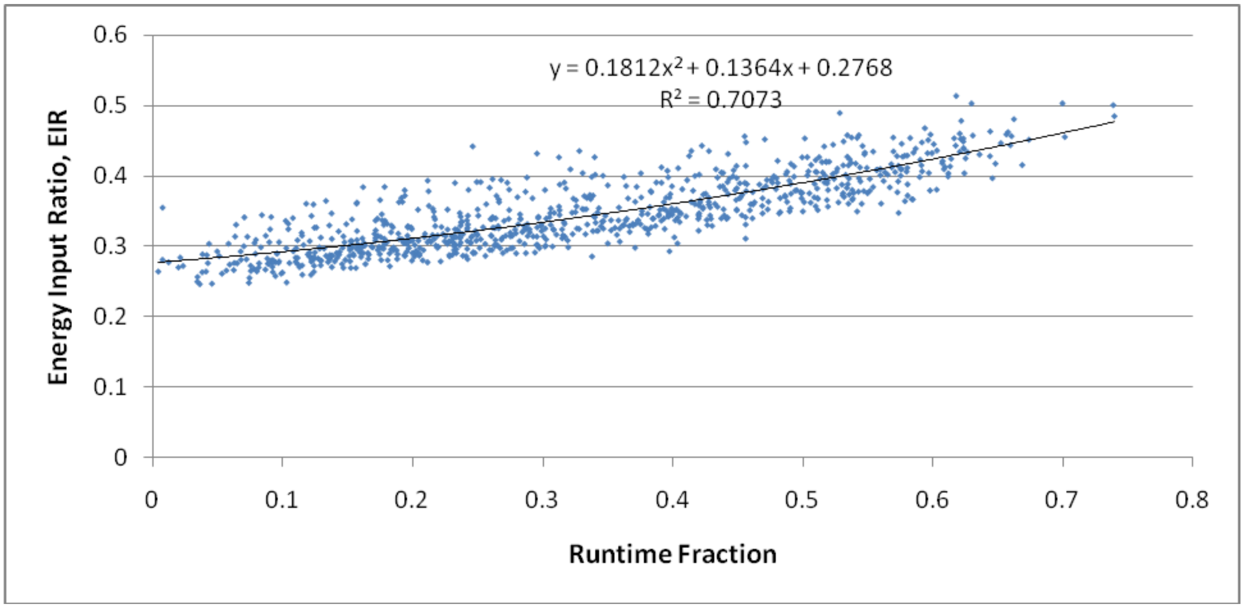


Figure C-6. EIR vs. Runtime Fraction



All of these graphs show strong correlation between outdoor dry bulb and part load variables. As a result of this strong correlation between outdoor dry bulb and part load variables and the weak correlation when the effects of part load are isolated, the evaluation team decided to create a model that did not include part load impacts on energy input ratio.

EIR curve fit regression

A least-squares regression was done for EIR against ODB and EWB and for EIR against ODB only. The results of these regressions are shown in Table C-6.

Table C-6. Regression of Capacity Against ODB and EWB

	ODB only	ODB & EWB
R-Squared	0.9379	0.9406
Average % Error in EIR	2.89%	2.84%
Total % Error in Energy Use	2.52%	2.49%

The results show that there is no significant improvement in the quality of the curve fit when using ODB and EWB as opposed to using ODB only. The evaluation team decided to use ODB only in its final EIR curve model. This equation had the form:

$$EIR = EIR_{base} * (A + B * ODB + C * ODB^2)$$

EIR_{base} is equal to the EIR at the reference ARI rating conditions.

It should be noted that this curve includes any part load or coil entering wet bulb impacts that were found in the underlying data. Because part load and entering wet bulb are correlated with outdoor dry bulb, it was difficult to separate out their impacts, given the limited range of observed operation and noise in the data.

Two baseline equipment efficiency curves were developed using data from other contract groups. For the pre-installation baseline, in-situ logged performance measurements from a sample of post-corrected RCA sites in KEMA's sample, all with nominal SEER 10, were used to derive an estimate of efficiency as a function of outdoor temperature. For the SEER 13 code-minimum baseline, in-situ logged performance measurements from SEER 13 units in the specialized commercial early retirement sample were used. The resulting equation and coefficients are shown in Table C-7.

Table C-7. Coefficients for EIR = f(ODB)

Compressor/Condenser: $EIR = EIR_{base} * (A + B * ODB + C * ODB^2)$					**Supply Fan**
	EIR_{base}	**A**	**B**	**C**	**W/cfm**
High Efficiency measured	0.358	1.365	-0.0217	0.000188	0.586
SEER 10 measured baseline	0.545	1.004	-0.0121	0.000128	0.600
SEER 13 measured baseline	0.385	0.881	-0.0105	0.000123	0.586

The Palm Desert high efficiency measured EIR function constitutes a very good fit of the available data.

Figure C-9. Distribution of Percent Error in EIR = f(ODB)

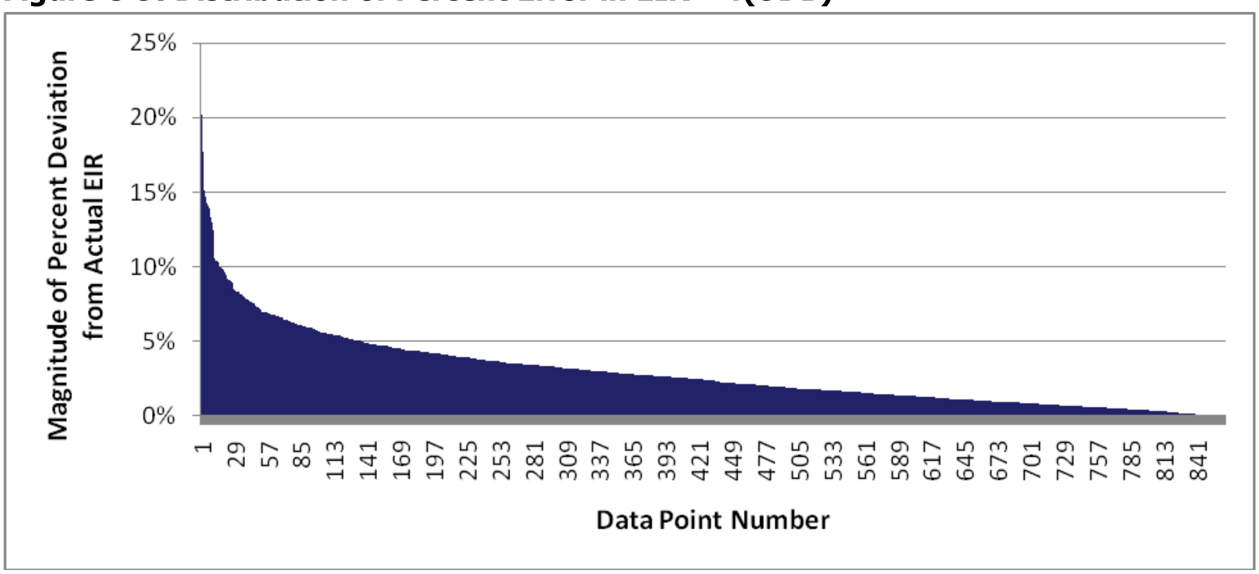
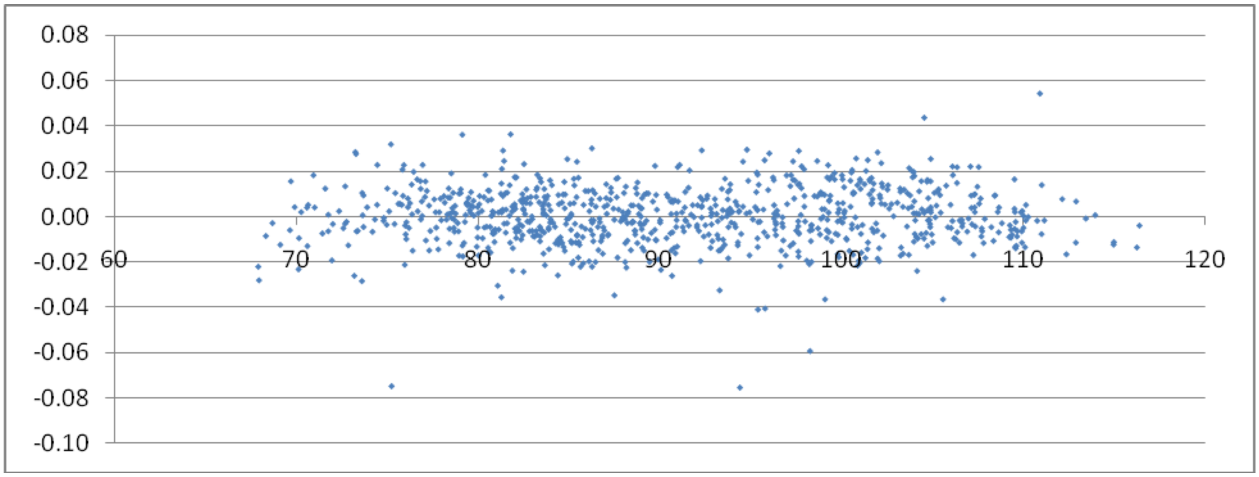
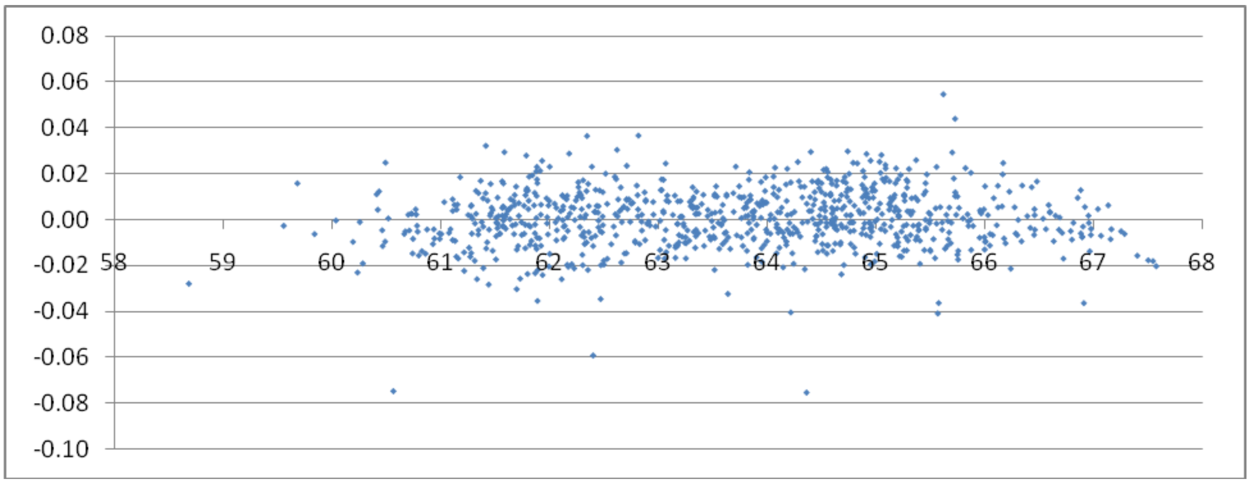


Figure C-7. Residuals by ODB for EIR = f(ODB)



The residuals, which are plotted against ODB and EWB in Figure C-10 and Figure C-11 respectively, show no obvious pattern, which indicates there are no major components missing from our curve fit. The coefficients and form of the equation for EIR = f(ODB) indicated in Table C-7. Coefficients for EIR = f(ODB)Table C-7 constitute a high quality fit that is unlikely to get appreciably better with the addition of more parameters.

Figure C-8. Residuals by EWB for EIR = f(ODB)



Capacity curve fit regression

Because the measured part load impacts on HVAC EIR were found to be small and hard to decipher, the capacity curve fit did not have as large an impact on the results of modeling. The primary impact of the capacity curve in this case is to calculate runtime, which only impacts the amount of duct system loads on the system if there are no efficiency impacts. There are problems with the measured capacity at low runtimes, because the two-stage equipment have blowers with ramping schedules during start-up and after finishing that cause relatively low capacity per time on, but increase efficiency. As a result, the fit was focused on higher capacity hours, which is also where the capacity will have the largest impact on energy consumption. The capacity regression did not reveal a strong correlation, but this will not introduce as much uncertainty as if there were significant part load impacts on efficiency.

Table C-9. Capacity = f(EWB, ODB)

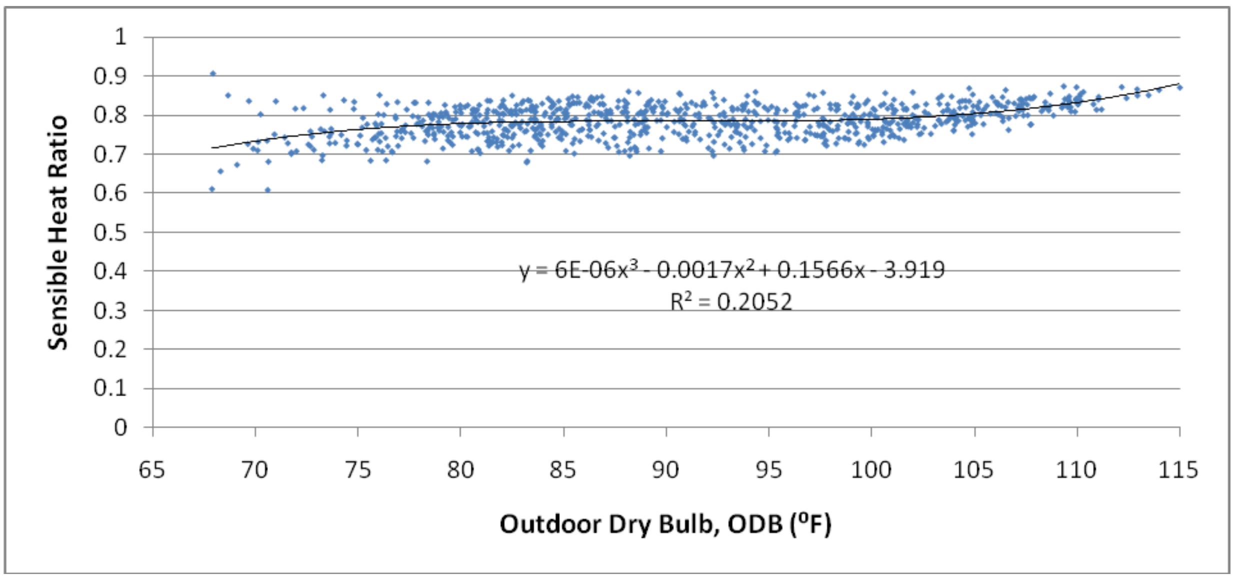
$$CAP = CAP_{base} * (A + B * EWB + C * EWB^2 + D * ODB + E * ODB^2 + F * EWB * ODB)$$

CAP_{BASE}	A	B	C	D	E	F
8304	0.803	-0.0635	0.000622	0.0416	-0.000162	-0.0001289

Sensible Heat Ratio

The average sensible heat ratio was investigated to determine if there was any significant variation that should be captured. The average sensible heat ratios were surprisingly low and did not vary as much as one might expect. Figure C-13Figure C-10 shows sensible heat ratio vs. outdoor dry bulb. The sensible heat ratio stays roughly in the range between 0.7 and 0.85. As a result, the model used zeroed out most variability in the sensible heat ratio, leaving some bypass factor adjustment for entering return temperature in place.

Figure C-10. Sensible Heat Ratio vs. ODB



Building Energy Simulation Model Creation and Calibration

A building energy simulation model was built in eQuest, starting with the 1985 vintage single family DEER 2008 model from climate zone 14. The following changes were made to the DEER model to match contextual data collected on site:

- Increase in ceiling insulation (R-23)
- Increase in wall insulation (R-14)
- Change roof construction to tile
- Used only single story
- Used increased wall area, actual floor area

- Use actual window area/orientation, window U-value and shading coefficient updated
- Increased contents mass to 15 lb/ft2, to reflect prevalence of tile floors
- Increased solar coupling with mass to 40%, to reflect prevalence of tile floors
- A diversity multiplier of 0.93 was used to reflect 2 out of 28 sites being on vacation or using evaporative cooling in lieu of central AC for most of the time

A 2009 local weather file was created using CIMIS data from La Quinta. CIMIS data includes horizontal solar radiation. The DOE2 weather file converter from doe2.com was used to convert the CIMIS data into an hourly weather file for use in DOE2.

Hourly Simulation Calibration Results

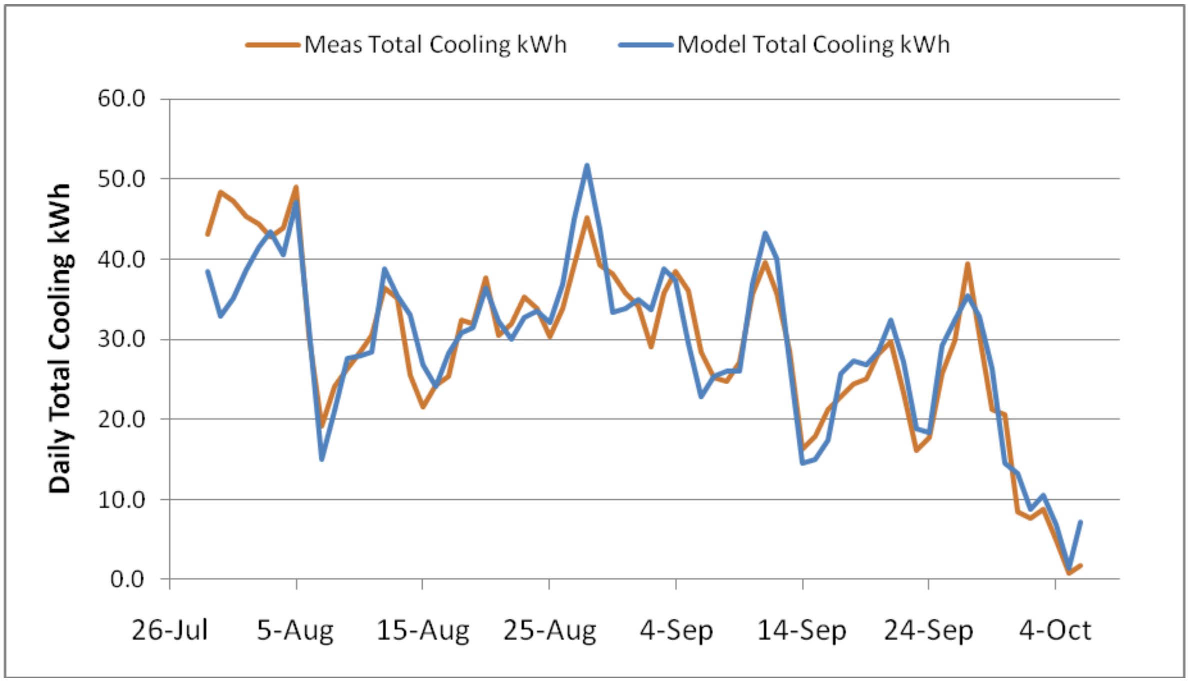
The model was calibrated to actual energy consumption per ton, with primary objectives of minimizing error in total measured period consumption and peak demand consumption. The secondary objectives were to attain a reasonably good approximation of the variation observed in daily total consumption and average consumption by hour of the day. The model was calibrated to within 1% of measured peak demand and cooling energy consumption, as shown in Table C-8.

Table C-8. Model Calibration Results

	Energy (kWh/ton)	Peak Demand (kW/ton)
Measured	421.6	0.681
Modeled	422.5	0.687
Error	-0.2%	-1.0%

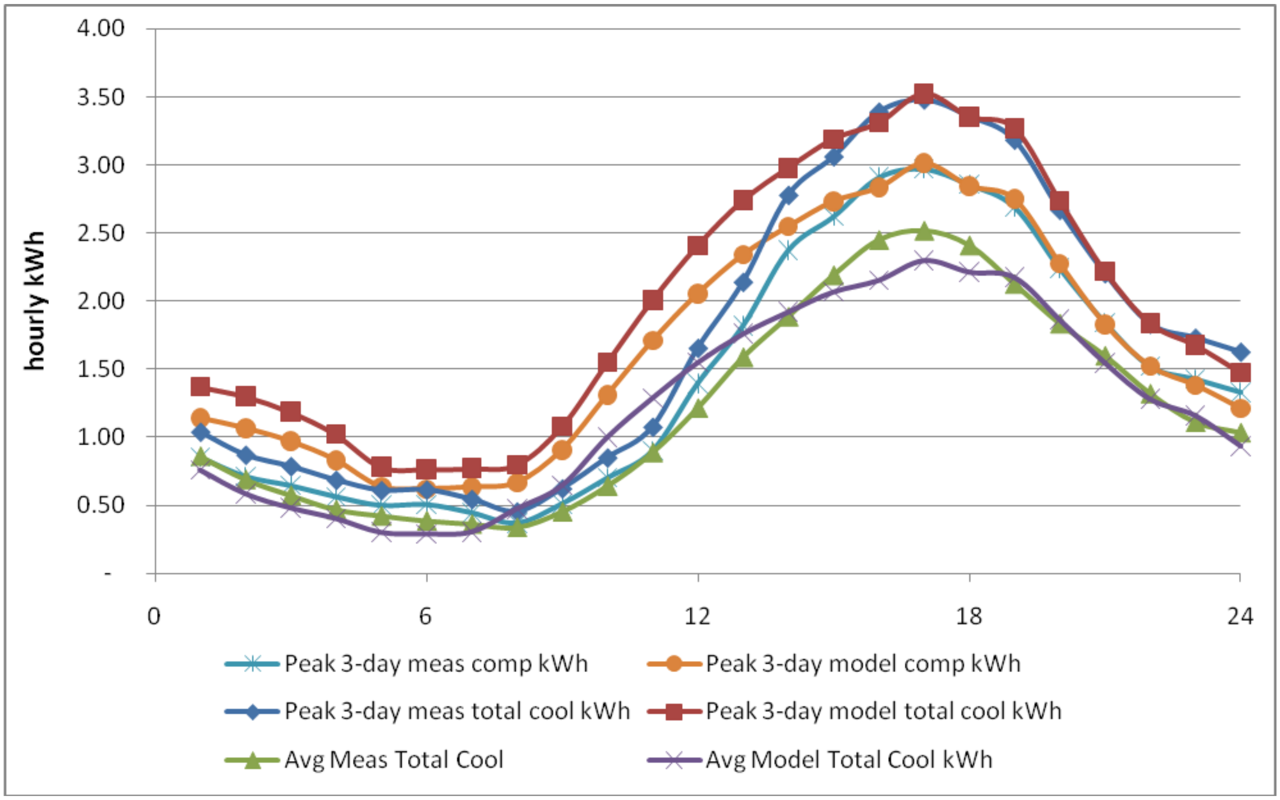
The model does a very good job of tracking day- to-day variation in cooling energy consumption, as shown in Figure C-14.

Figure C-11. Calibration Results: Daily Cooling Energy Consumption



Average and peak days consumption by hour of the day are shown in Figure C-15. The model was calibrated to make the peak hours match up better, which explains why the match is best around the peak day peak hours. The model consistently leads the measured data during the morning ramp up in cooling loads, even with the large amount of mass in the model.

Figure C-15. Average and Peak Days Hourly Consumption Calibration

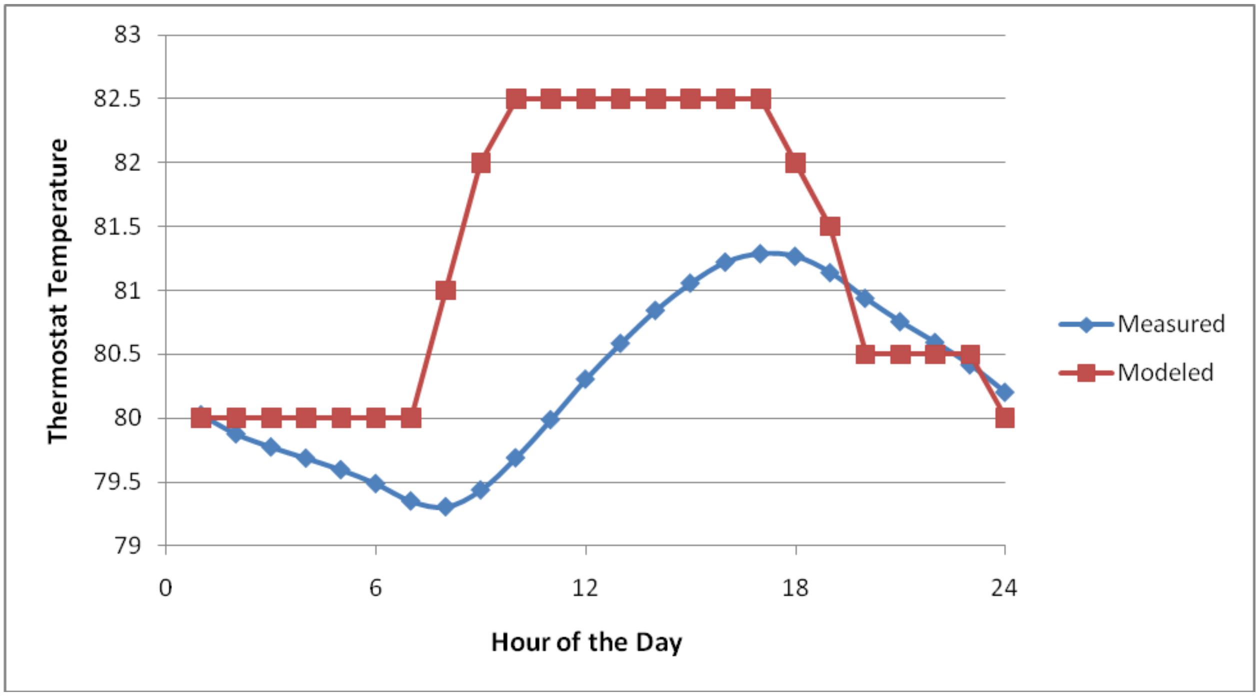


The calibration knobs in the model were chosen on the basis of there being uncertainty in some driving building characteristic and/or ease of manipulation during the calibration process:

- Natural Ventilation – Turned on
- Internal gains – Adjusted lighting consumption as proxy for all internal gains (plug loads are probably more uncertain); total is 6680 kWh equipment and lighting consumption
- Duct leakage/gains – Reduced duct leakage to 9% total leakage, 1.5% return leakage; Reduced Supply UA to 60 Btu/hr/deg F, Return UA to 10 Btu/hr/deg F
- Building contents mass – Set building mass to 15 lb/ft^2
- Thermostat cooling schedule – Used as final tuning parameter (See Figure C-16)

The thermostat cooling schedule was used as the final tuning parameter, with the shape being subtly manipulated to give the best final result without straying too far from the measured temperatures at the thermostat.

Figure C-16. Measured Temperature at Thermostat vs. Model Thermostat Setpoint



Billing Analysis

An analysis of the billing records from the participants in the Palm Desert program was done in order to find out if the sample that received site visits have a significantly different cooling shape than the participant population. The time period that was looked at was 2004 to 2006, before any of the program measures had been installed. A three year period was chosen to account for possible variations by year.

The first step in the analysis was to combine billing records, tracking data, and sample data to get a complete data set. The steps taken were:

1. Identify and extract the billing records only for participants that received a residential AC early retirement.
2. Import billing, tracking, and sample data into SAS
3. Delete any records for years 2007 and after
4. Calculate average daily kWh per month (kWh divided by billing days) for each billing entry
5. Delete any outliers that have very large or very small average daily kWh values (less than 5 kWh/day or more than 100 kWh/day) as these are not reasonable values for normal residential bills.
6. Delete any records for customers in a year that has less than 12 months of data
7. Add Service Account Number to the data

8. Merge in program tracking data, combining the data according to the Service Account Number

9. Merge in sample data, combining by site ID and SCE Account Number.

The second step was to extract average daily kWh per customer for annual, seasonal, and monthly time ranges. The data was first separated into two groups – those that received site visits and those that didn't – and then the statistical analysis was performed on each group individually.

In the third step, participants that received the Early Retirement measure were isolated and kept, as these are the ones receiving a load shape analysis.

Finally, the monthly consumption of the early retirement participants was used to generate estimates of heating and cooling energy by calculating a base consumption from the month with the lowest consumption and subtracting that base consumption from the consumption in other months.

Billing Analysis Results

Annual: The annual average energy use for sites and non-sites is very close (within 2%) and not significantly different. Results are shown in Table C-9.

Table C-9. Average Annual Particant Energy Use

	Non-Sampled Participants			Sampled Participants		
Year	Average Annual kWh	Average Days/year	Average Annual kWh/day	Average Annual kWh	Average Days/year	Average Annual kWh/day
2004	10,232	355	28.82	9,645	345	27.96
2005	10,418	365	28.54	10,429	366	28.49
2006	10,526	362	29.08	10,489	364	28.82
Average over 2004-2006	10,392	361	28.81	10,188	358	28.42

Seasonal: The seasonal average energy use for sites and non-sites was also close, differing the most in Winter months (December, January and February) and the least in the summer months (June, July and August). Sites showed a higher average usage than non-sites in general. Seasonal results are summarized in Table C-10.

Table C-10. Average Seasonal Energy Use For Participants

		Non-Sampled Participants		Sampled Participants		Comparison
Season	Days in Season	kWh/day	Total kWh	kWh/day	Total kWh	Difference
Winter	90	19.3	1,737	17.6	1,584	-9%
Shoulder	183	25.8	4,721	24.3	4,447	-6%
Summer	92	43.7	4,020	46.9	4,315	7%
Total			10,479		10,346	-2%

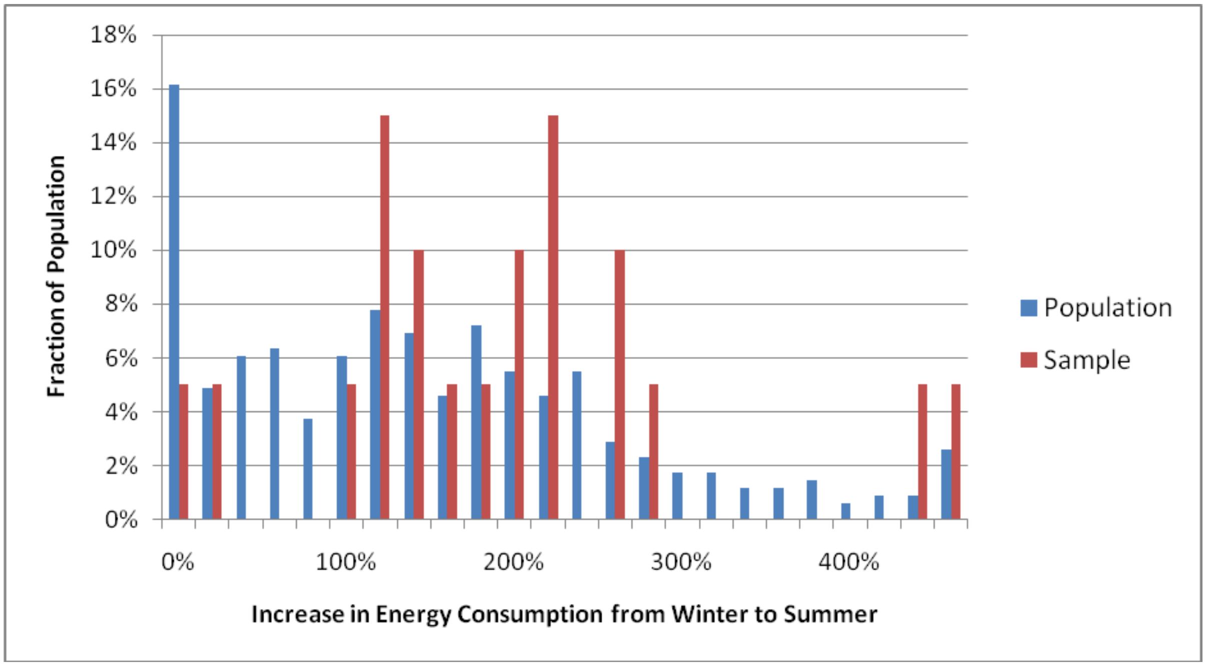
Monthly: The monthly average energy use for sites and non-sites were significantly different in the months February through May, but within 11% of each other in all the other months. These results are shown in Table-C-11.

Table C-11. Average Monthly Energy Use For Participants

	Non-Sampled Participants			Sampled Participants				
Month	**Average kWh/ day**	**Total KWh per Month**	**Estimated Cooling/ Heating Load**	**Average kWh/ day**	**Total KWh per Month**	**Estimated Cooling/ Heating Load**	**% Difference in Total Load**	**% Difference in Heating/ Cooling Load**
jan	19.4	601.4	55.4	18.9	585.9	107.1	-3%	93%
feb	19.5	546.0	0.0	17.1	478.8	0.0	-12%	0%
mar	20.9	647.9	101.9	18.1	561.1	82.3	-13%	-19%
apr	23.0	690.0	144.0	19.5	585.0	106.2	-15%	-26%
may	31.0	961.0	415.0	30.8	954.8	476.0	-1%	15%
jun	40.0	1200.0	654.0	43.7	1311.0	832.2	9%	27%
jul	50.0	1550.0	1004.0	55.8	1729.8	1251.0	12%	25%
aug	46.8	1450.8	904.8	51.9	1608.9	1130.1	11%	25%
sep	34.0	1020.0	474.0	38.3	1149.0	670.2	13%	41%
oct	22.1	685.1	139.1	22.6	700.6	221.8	2%	59%
nov	18.9	567.0	21.0	17.8	534.0	55.2	-6%	163%
dec	19.6	607.6	61.6	19.7	610.7	131.9	1%	114%
Total		**10,527**			**10,810**			

In addition to total use, an estimate of heating and cooling load was done by subtracting total load in the lower use month, which was February, from the other months. This gives an estimate of the variable energy use in the participants' homes (i.e. non baseload) which is almost always related to heating and cooling. This estimate showed that heating and cooling represented a significantly different percentage of total load for the two groups (38% for non-sites and 48% for sites). When the variable energy use was compared, the greatest differences were in the summer months. Over the cooling months (March through October), average differences in total energy use and variable energy use (likely all cooling during those months) were 5% and 20% respectively. This difference in estimated cooling energy use was used to create the billing normalization factor, equal to the estimated cooling energy use of the non-sampled participants divided by the estimated cooling energy use of the sampled participants. The most likely explanation for this difference between sampled and non-sampled parti is that the significant snowbird population was participating in the program but did not respond to recruitment during the summer. The figure below shows that the sample has fewer members with small increases from winter to summer than the population.

Figure C-17. Distribution of Population by Seasonal Change in Energy Consumption



To conclude, this analysis shows that the energy use before the program started was not significantly different when comparing sampled participants and non-sampled participants, on an annual and seasonal basis. However, when heating and cooling use is examined there are significant differences between the two groups. Different on-site recruitment rates from year-round and seasonal residents appears to account for the discrepancy. The results of this analysis were used to normalize the savings measured in the sample to the overall population, by multiplying the measured savings by 80% to account for the difference in estimated cooling energy between sampled participants and non-sampled participants. The billing normalization factor is 80%, with a 90% confidence interval of 67% to 100%.

1.1.4 Detailed Results

Once the building energy simulation model was calibrated, the model was rerun with the climate zone 15 typical meteorological year, with the various baseline and efficient cases. The savings results from the calibrated model produced the following sample unit energy savings (UES), shown in **Error! Reference source not found.**, for an early retirement, defined as upgrading from a nominal SEER 10 vintage unit to a new high efficiency unit.

Table C-12. Sample Unit Energy and Demand Savings

Unit Energy Savings (kWh/ton)	Peak Demand Savings (kW/ton)
490	0.30

The results of the billing analysis, showing a billing normalization factor of 0.80 between sample and non-sample participants, were used to scale the sample UES to the full participant population UES, which is shown in Table C-13.

Table C-13. Population Unit Energy and Demand Savings

Unit Energy Savings (kWh/ton)	Peak Demand Savings (kW/ton)
394	0.24

These unit energy savings were then multiplied by the sample tons to give a comparison of the *ex ante* claimed savings and *ex post* verified savings. These results and the gross savings realization rates are shown in Table C-14.

Table C-14. Derivation of Gross Savings Realization Rates

	kWh	kW
Ex Ante Sample Gross Savings	34946	22
Ex Post Sample Gross Savings	60302	37
Gross Realization Rate	173%	169%

1.1.5 Remaining Useful Life Analysis

Objective

Calculating the lifetime savings of residential air conditioning (A/C) units that were retired early under the Palm Desert program requires an estimation of the remaining useful life (RUL) of the A/C units at the point of retirement. The purpose of this analysis is to estimate the average remaining useful life of residential air conditioner units retired in this program.

Approach

This analysis uses a two-pronged approach to estimate the remaining useful life of residential central air conditioners. First, a generic mortality curve "shape factor" was estimated using regression analysis of retirement data from five different residential appliances (excluding air conditioners). Second, a System Dynamics model was developed to estimate both the mean life and mortality shape factor for residential central air conditioning units given data regarding the stock of A/C units in the U.S. and A/C unit shipments over a 27-year period. The two approaches complemented each other in that the estimated mortality shape factors from both approaches (across six different appliances) were very close, indicating that a common shape factor can be applied to many residential appliances, even those with differing EULs, with minimal uncertainty.

Estimation of a Generic Shape Factor for Residential Appliances

While different residential appliances have a range of Effective Useful Lifetime (EULs), their mortality probabilities tend to follow a pattern that is well described by a Weibull distribution. As a result, this distribution is commonly used for lifetime analysis. Unfortunately, detailed mortality data for residential air conditioners were not available to facilitate this analysis. However, related technologies often follow a similar "shape" of failure even if their EULs are different. Thus, it was postulated that if data from multiple residential appliances were available, a generic shape factor, or reasonable range of likely shape factors, could be calculated that could facilitate estimation of an RUL for a given appliance EUL.

Mortality Data from Five Appliances

Natural Resources Canada, Energy Efficiency Office, sponsored a Survey of Household Energy Use (SHEU)[1] that was published in 2003. Among other data, this survey collected information regarding the age of various appliances at the point of their retirement. Detailed data were gathered for five key residential appliances: dishwashers, refrigerators, freezers, clothes washers, and clothes dryers. These data are provided in the tables below.

Table C-15. SHEU Dishwasher Mortality Data

Dishwasher Data			
Retirement Age	Number of Instances	Fraction	Cumulative Fraction
5 years old or less	78,987	0.12	0.12
6 to 10 years old	154,724	0.24	0.36
11 to 15 years old	206,158	0.32	0.67
16 to 20 years old	140,685	0.22	0.89
21 years old or more	72,948	0.11	1.00
Total	***653,502***	***1.00***	

Table C-16. SHEU Refrigerator Mortality Data

Refrigerator Data			
Retirement Age	Number of Instances	Fraction	Cumulative Fraction
3 years old or less	221,771	0.05	0.05
4 to 5 years old	107,860	0.03	0.08
6 to 10 years old	423,032	0.10	0.18
11 to 15 years old	1,007,062	0.24	0.41
16 to 20 years old	1,206,398	0.28	0.70
21 years old or more	1,294,104	0.30	1.00
Total	***4,260,227***	***1.00***	

Table C-17. SHEU Freezer Mortality Data

Freezer Data			
Retirement Age	Number of Instances	Fraction	Cumulative Fraction
10 years old or less	90,810	0.16	0.16
11 to 15 years old	87,372	0.16	0.32
16 to 20 years old	145,186	0.26	0.58
21 to 25 years old	106,914	0.19	0.77
26 years or more	126,841	0.23	1.00
Total	*557,123*	*1.00*	

[1] Natural Resources Canada, Office of Energy Efficiency, "Survey of Household Energy Use (SHEU), Detailed Statistical Report." 2003 - http://oee.nrcan.gc.ca/publications/statistics/sheu03/pdf/sheu03.pdf

Table C-18. SHEU Clothes Washer Mortality Data

Clothes Washer Data			
Retirement Age	Number of Instances	Fraction	Cumulative Fraction
5 years old or less	168,646	0.07	0.07
6 to 10 years old	323,521	0.13	0.20
11 to 15 years old	650,238	0.26	0.46
16 to 20 years old	1,150,056	0.46	0.92
21 years old or more	192,466	0.08	1.00
Total	***2,484,927***	***1.00***	

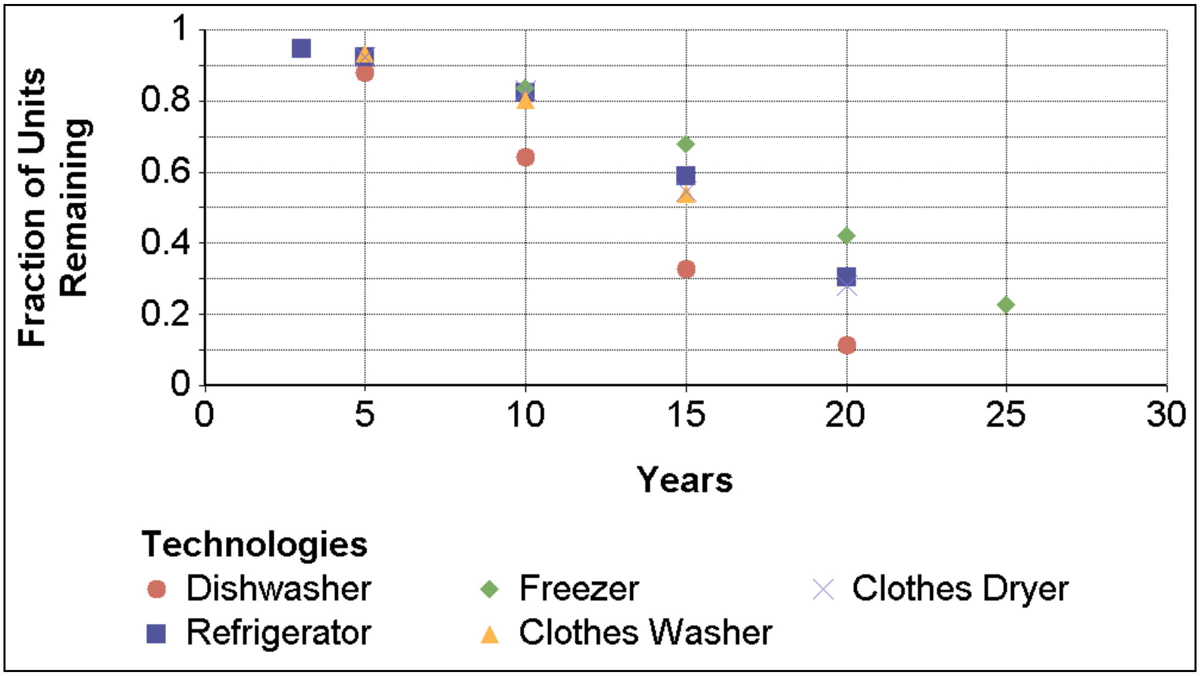
Table C-19. SHEU Clothes Dryer Mortality Data

Clothes Dryer Data			
Retirement Age	Number of Instances	Fraction	Cumulative Fraction
5 years old or less	112,794	0.077	0.077
6 to 10 years old	139,308	0.095	0.172
11 to 15 years old	416,435	0.284	0.456
16 to 20 years old	386,880	0.264	0.720
21 years old or more	410,668	0.280	1.000
Total	***1,466,085***	***1.000***	

Figure C-18 illustrates the appliance retirement data for the five residential appliances reviewed[2].

[2] The 20-year data point for clothes washers was discarded as an outlier in this analysis.
[3] A numerical methods approach was chosen for simplicity, as compared with attempting to derive an analytical solution to the RUL equation for a Weibull distribution.

Figure C-18. Appliance Retirement Data



Fitting the Retirement Data with a Weibull Distribution

The Weibull distribution was selected for fitting the retirement data to a curved based on its excellent ability to characterize lifetime behavior and common usage in this type of survival analysis. The Weibull distribution has the following characteristics:

Probability Density Function (PDF) = $(k/\lambda)(x/\lambda)^{k-1}e^{-(x/\lambda)^k}$

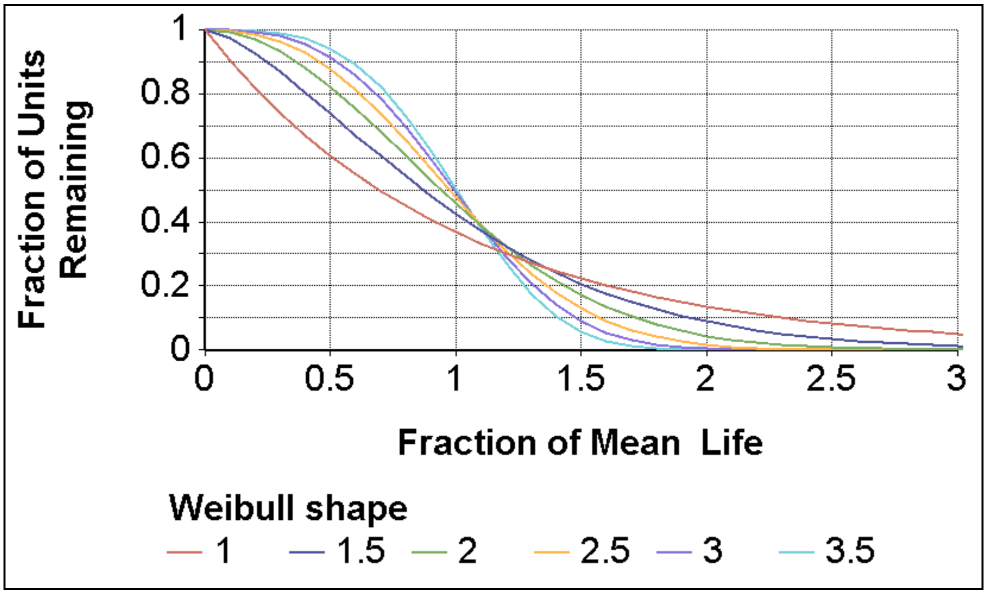
Cumulative Distribution Function (CDF) = $1 - e^{-(x/\lambda)^k}$

Fraction of Units Remaining = 1 - CDF

Mean Lifetime $(\mu) = \lambda\Gamma(1 + 1/k)$; k = shape factor, λ = scale factor

An illustration of the fraction of units remaining as a function of the fraction of mean life of a technology is provided below for various Weibull shape factors.

Figure C-19. Illustration of Various Weibull Shapes on Fraction of Units Remaining



Data for each appliance was fit with a Weibull distribution adjusting the scale and shape factors using least-squares regression. The regression results are summarized below in Table C-20.

Table C-20. Parameter Results from the Weibull Regression for Various Appliances

Weibull Regression Results			
Appliance	Shape factor (k)	Scale parameter (λ)	Mean Life (μ)
Dishwasher	2.18	14.22	12.59
Refrigerator	2.15	18.76	16.62
Freezer	2.46	21.36	18.95
Clothes Washer	2.31	18.63	16.51
Clothes Dryer	2.57	18.26	16.21
Average	***2.34***		

The figures below show the Weibull curves fit to each set of data.

Figure C-20. Dishwasher Retirement Data and Weibull Curve Fit

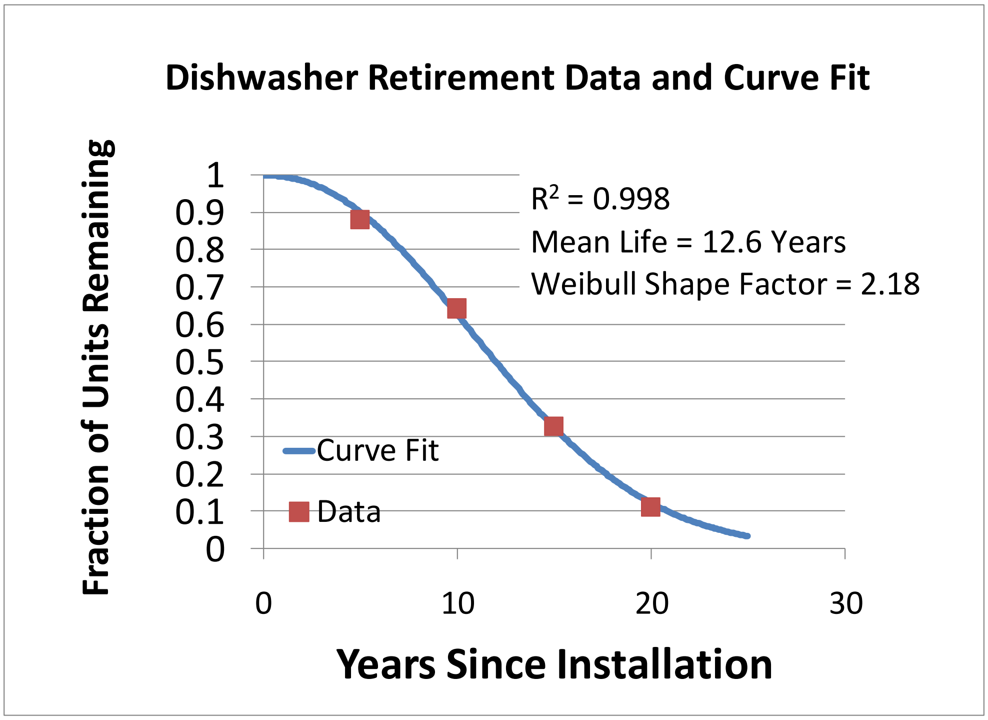


Figure C-21. Refrigerator Retirement Data and Weibull Curve Fit

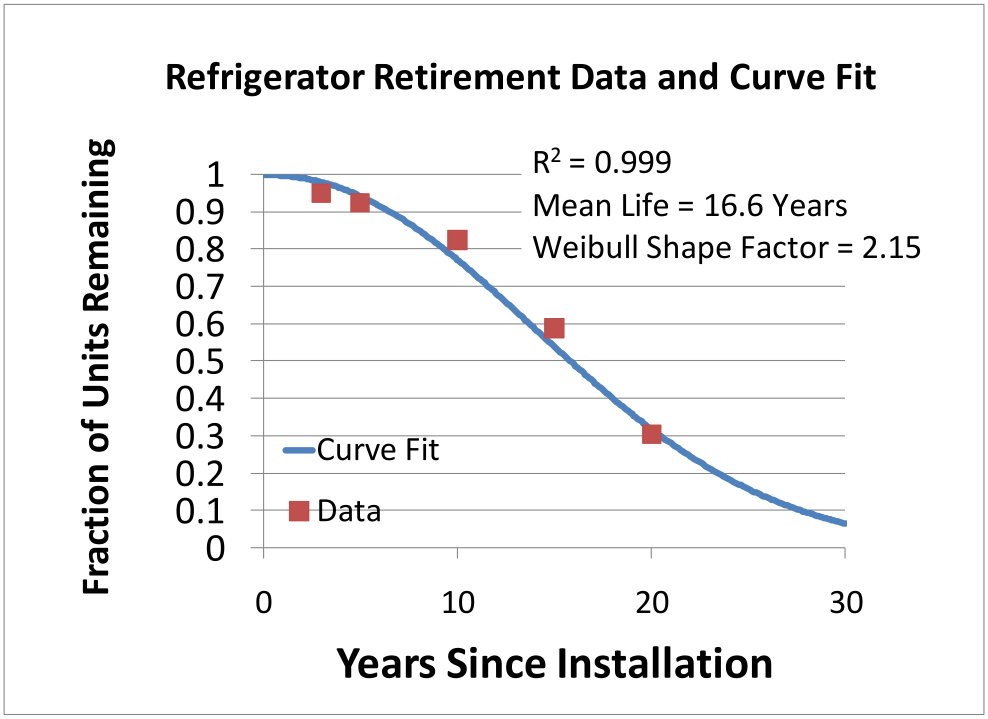


Figure C-22. Freezer Retirement Data and Weibull Curve Fit

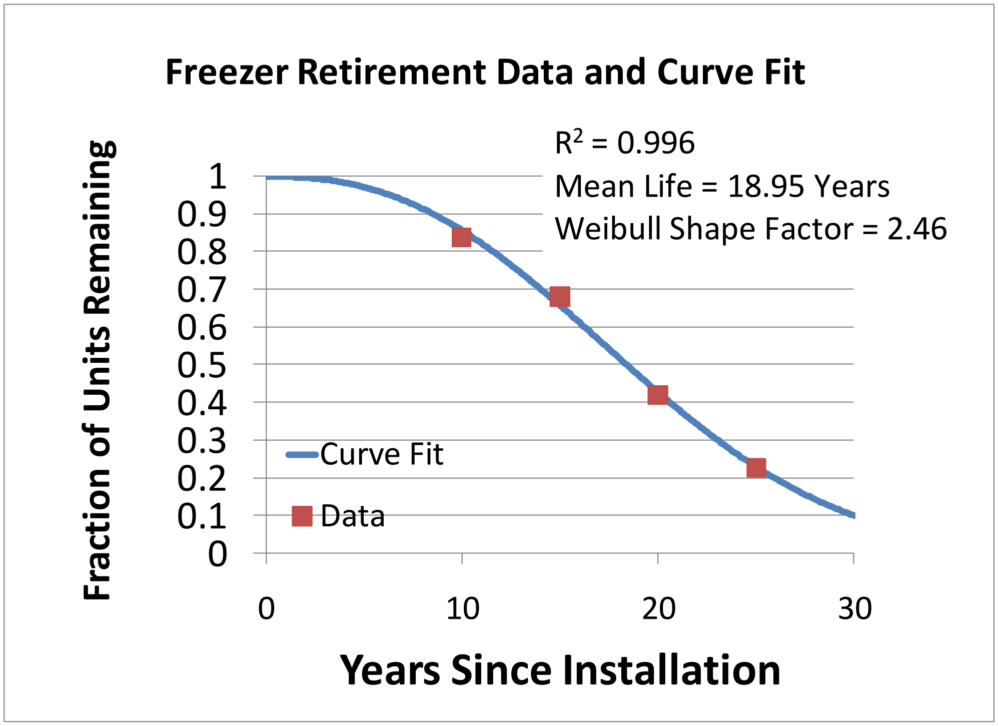


Figure C-23. Clothes Washer Retirement Data and Weibull Curve Fit

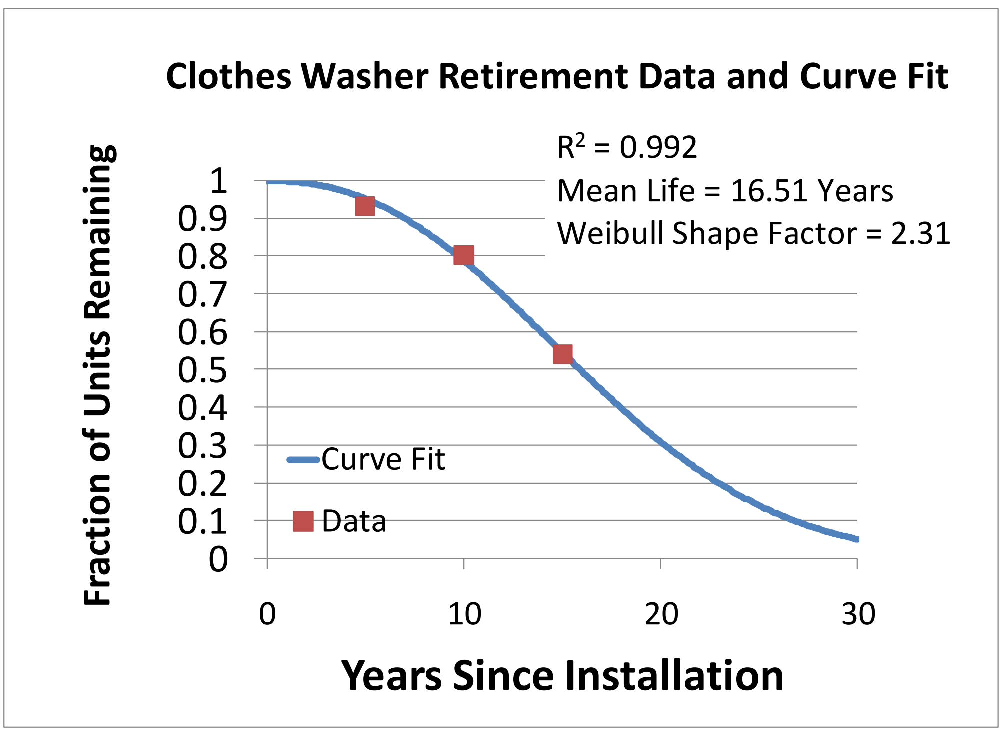
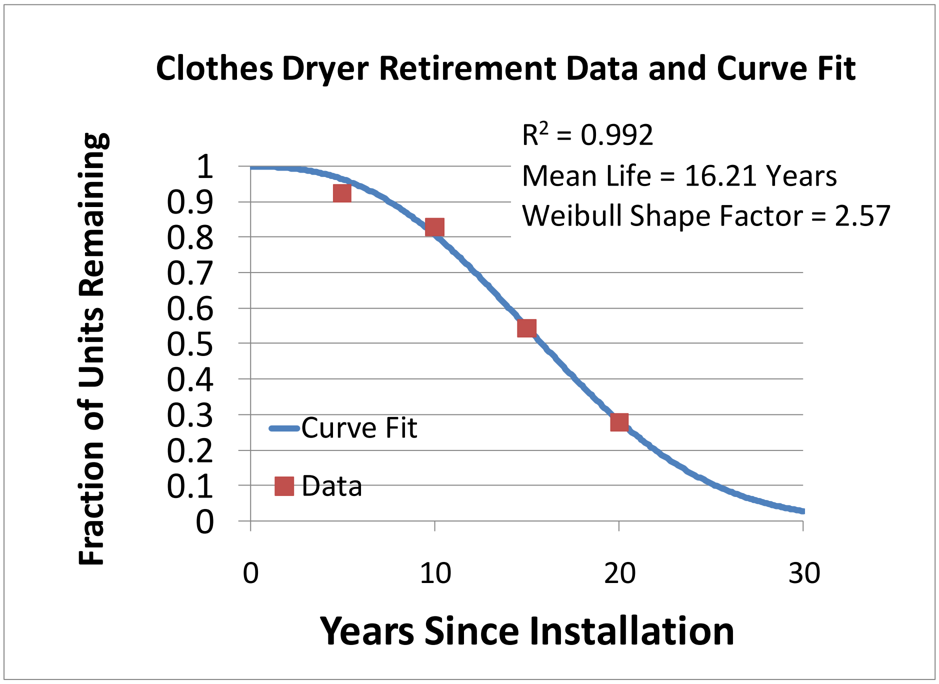
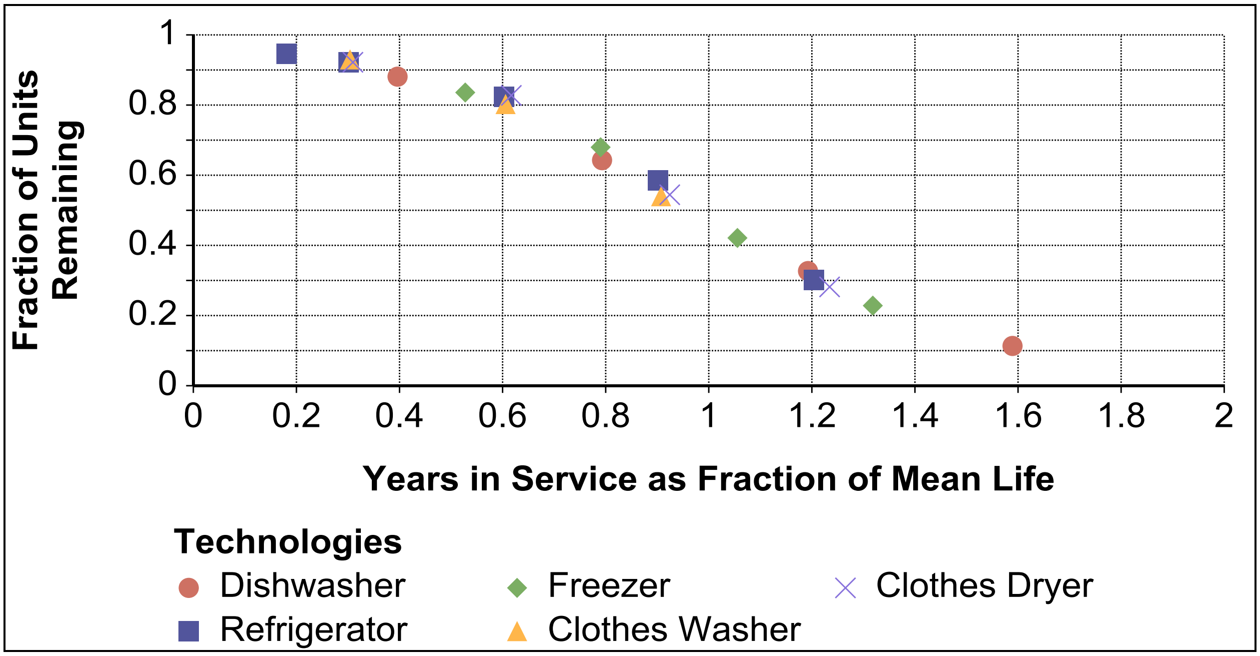


Figure C-24. Clothes Dryer Retirement Data and Weibull Curve Fit



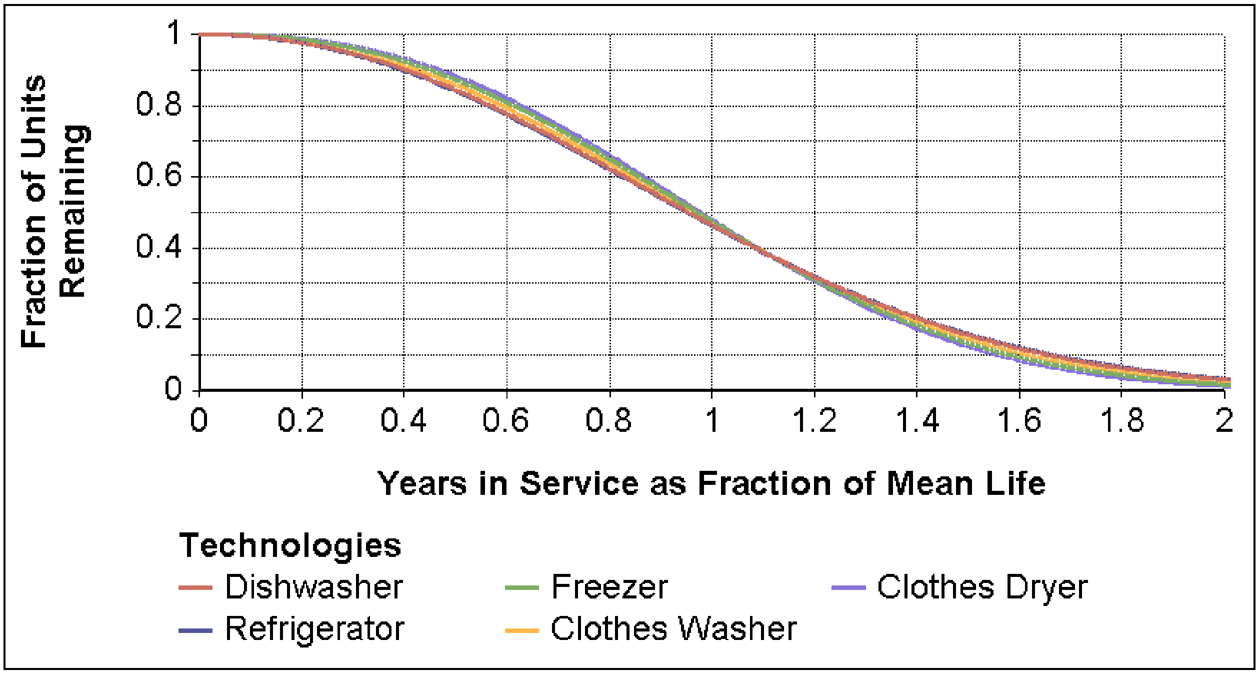
As seen in the above figures, the Weibull distribution appears to be a good choice curve-fitting to appliance retirement data. The data were normalized by mean lifetime to illustrate the similarity in the *shape factor* of the mortality curves across these appliances. Figure C-25 below shows that appliance mortality behaves in a very consistent manner across multiple residential appliances, when normalized by mean lifetime.

Figure C-25. Appliance Retirement Data Normalized as a Fraction of Appliance Mean Life



When the normalized appliance mortality data are regressed with a Weibull distribution, the outcome is a tightly constrained range of shape factors across appliance types. Figure C-26 shows the extent of the range of Weibull curve fits to the normalized data.

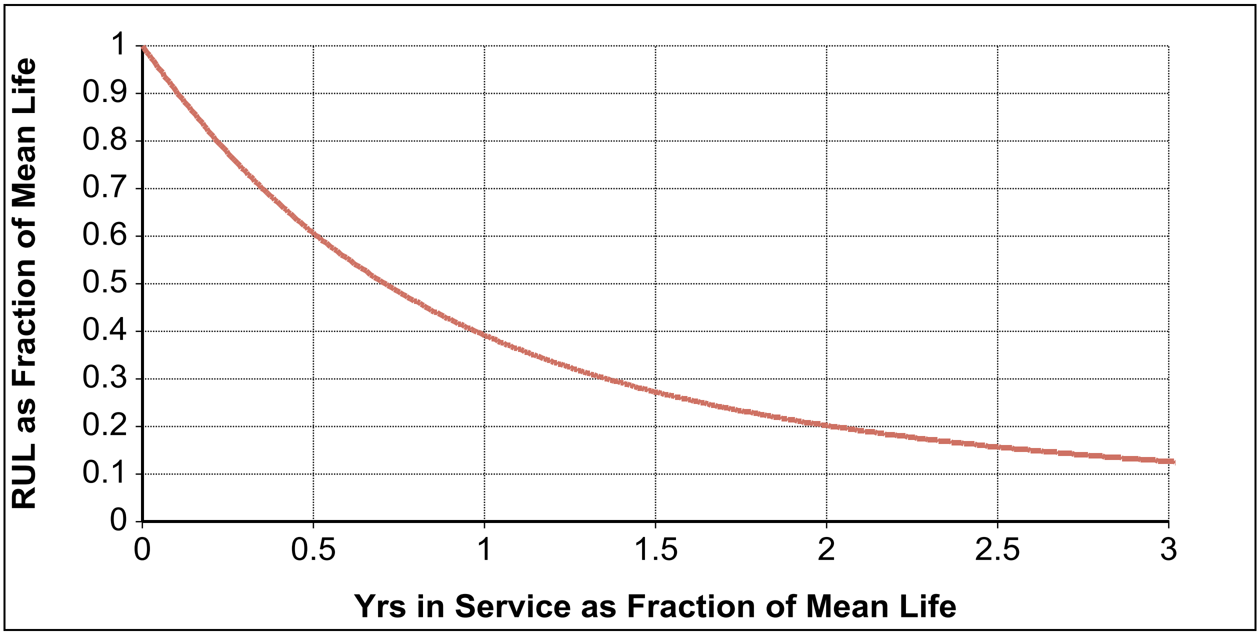
Figure C-26. Normalized Weibull Curve Fit to Appliance Data



The implication of the above figure is that it the tight range of shape factors across multiple residential appliances indicates that a common, or average, shape factor might be used for residential appliance retirement estimation given data regarding the EUL of a particular appliance. Therefore, in this analysis, the average shape factor of 2.34 was selected as that which reasonably characterizes residential appliances. This value will later be compared with a shape factor estimated specifically for residential central A/C units using a different approach.

With an assumed shape factor of 2.34 for the Weibull distribution, one can calculate using numerical methods[3] the remaining useful life for an appliance as a function of the years the appliance has been in service. This result is illustrated below for a shape factor of 2.34 with both the x and y axes normalized by the mean lifetime of the technology.

Figure C-27. RUL vs Years in Service (Weibull Shape Factor = 2.34)



Using the above curve, one can see for instance that if a product has an EUL of 10 years and has been in service for 10 years, it would be expected that the product would last for roughly an additional 3.9 years (or 0.39 x 10 years, where 0.39 is the y-axis value read at the x-axis value of 10/10 = 1). Likewise, if the product were in service for 20 years (or 2 x EUL), it could still be expected to last an additional 2 years (or 0.2 x EUL).

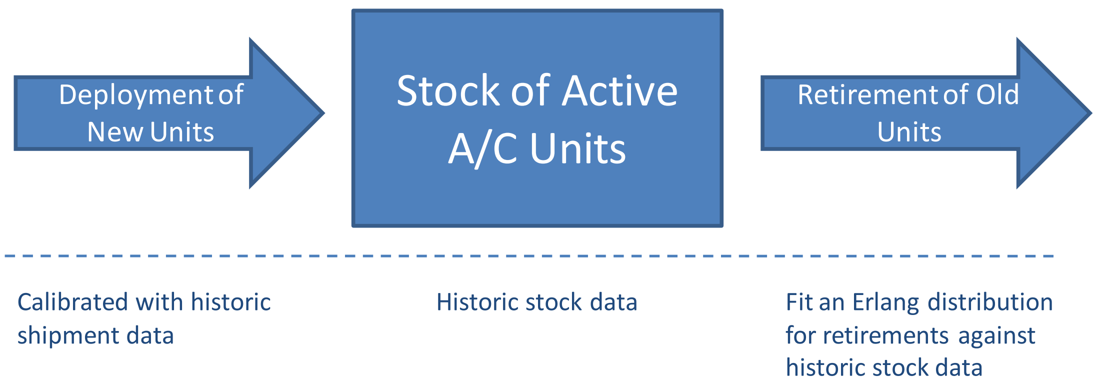
Estimating the EUL and Shape Factor for Residential Central A/C Units using a System Dynamics Approach

As mortality data were not available for residential A/C units, the team opted to use a System Dynamics approach to estimate the EUL and the mortality shape factor of residential A/C units. This approach was feasible given there were data available estimating the shipment of A/C units into the U.S. [4] and data

[3] A numerical methods approach was chosen for simplicity, as compared with attempting to derive an analytical solution to the RUL equation for a Weibull distribution.
[4] Air-Conditioning, Heating, and Refrigeration Institute, Equipment statistics, Central Air Conditioners and Air Source Heat Pumps, Domestic 10/21/2009

permitting the team to estimate the total stock of A/C units in the U.S. over a 27-year period[5]. The retirement of units was simulated using an Erlang[6,7] distribution, which is similar in shape to a Weibull distribution. The mean life and Erlang shape parameters for retirement were optimized in the Analytica software platform by minimizing the sum of the differences between the A/C unit stock data and the simulated stock of A/C units. A conceptual illustration of the stock/flow model is provided in the figure below.

Figure C-28. Conceptual Illustration of the Stock & Flow Dynamic Model Used to Estimate EUL and the Retirement Shape Factor



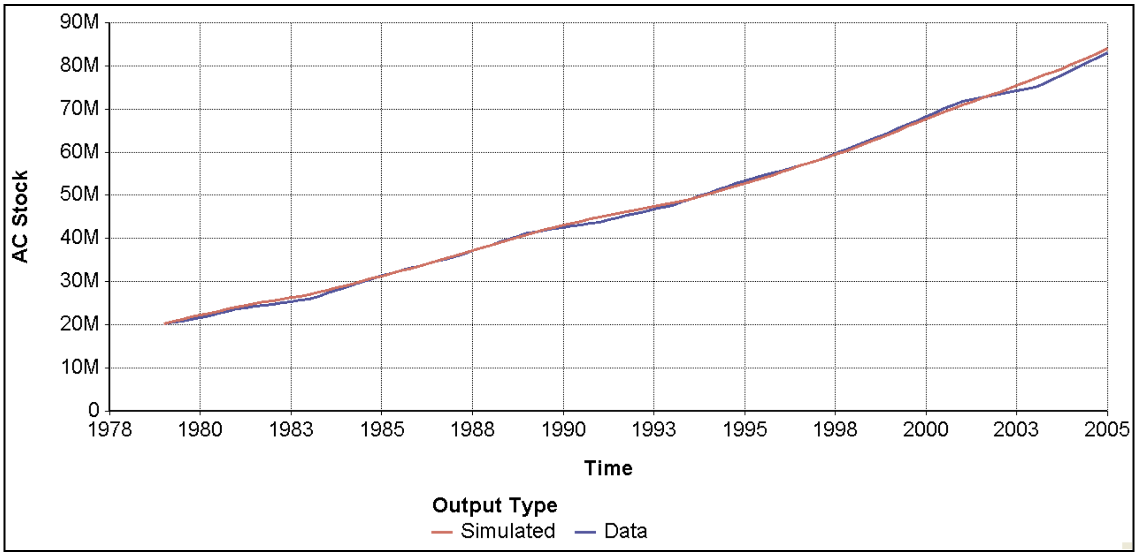
As illustrated below in Figure C-29, an excellent fit of the A/C stock data and simulated A/C stock was obtained with an EUL (mean lifetime) of 15.46 years and an Erlang shape factor of 5. For comparison, the value for mean life of residential central air conditioners used by the Database for Energy Efficient Resources (DEER) is 15 years, a close match.

[5] Based on data from the Energy Information Administration, Residential Energy Consumption Survey (RECS), Housing Characteristics (1980- 2005); and Air-Conditioning, Heating, and Refrigeration Institute, Industry Statistics, Distribution Statistics 10/21/2009

[6] The Erlang distribution was chosen based on alignment with the system dynamic approach to modeling aging chains as an integer (k) number of separate stocks.

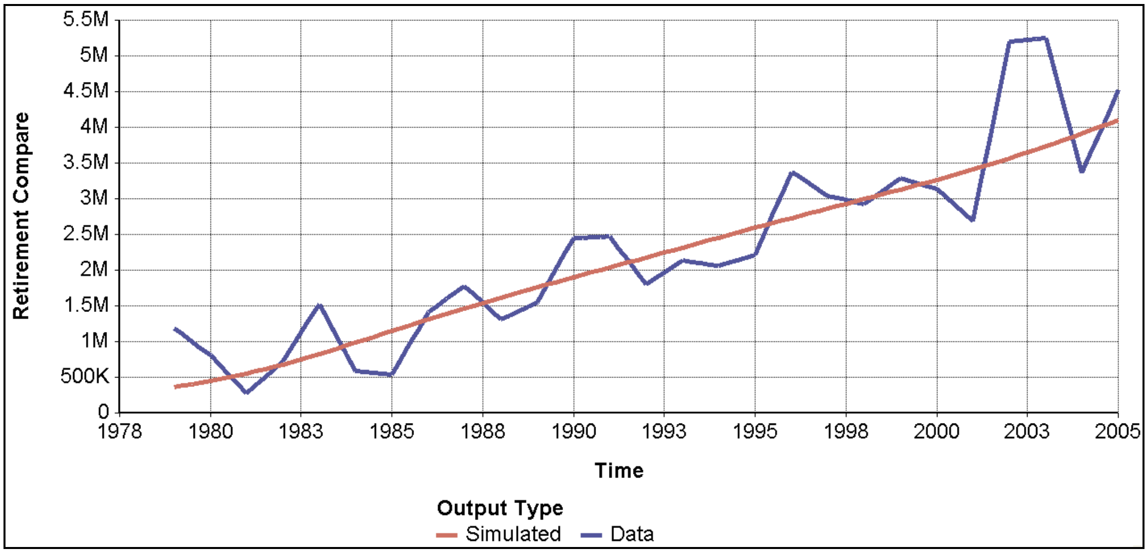
[7] PDF = $\lambda^k x^{k-1} e^{-\lambda x}/(k-1)!$; CDF = $\gamma(k, \lambda x)/(k-1)!$; $\mu = k/\lambda$; k = shape factor, λ = scale factor

Figure C-29. Fit of Simulated Stock to Historical Stock of Active Units with Erlang Shape Parameter = 5 and EUL = 15.46 years.



Although the A/C unit retirements were not used in the objective function for optimizing the parameters (only the stock data were fit with the simulated stock), a comparison was made between the simulated retirements of A/C units and the calculated retirements of A/C units based on the A/C unit stock and shipment data as a cross-check of the modeling approach. While the retirement data are quite "noisy", in general there appears to be a good fit, on average, of the simulated retirements vs. the retirement data.[8]

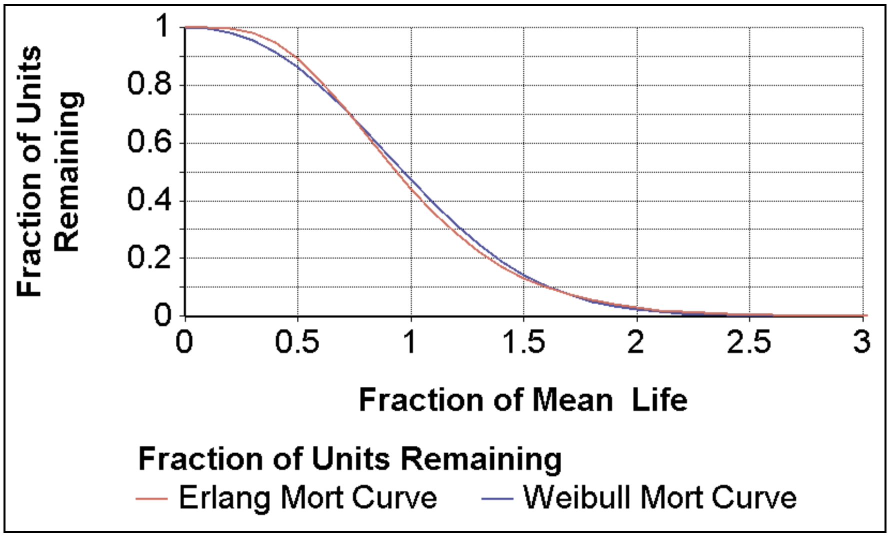
Figure C-30. Fit of Simulated Retirements to Historical Retirements Using an Erlang Distribution with Shape Parameter = 5 and EUL = 15.46 years



For direct comparison with the first analysis method, the optimized Erlang shape factor of 5 is compared with the average Weibull shape factor of 2.34 calculated in the previous section. As can be seen in the figure below, these mortality curves are quite similar in shape.

[8] The retirement data are noisy largely due to having to calculate retirements from the available stock data and shipment data over time.

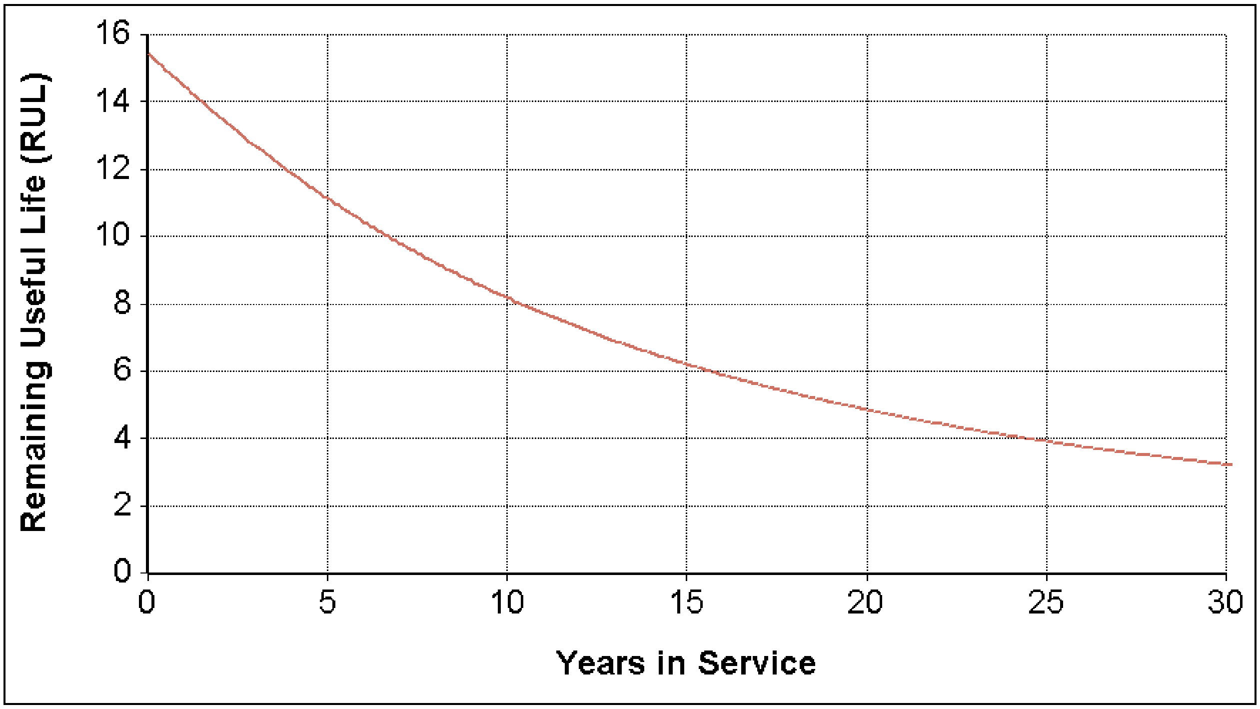
Figure C-31. Comparison of Weibull Mortality Curve (Shape Factor = 2.34) with an Erlang Mortality Curve (Shape Factor = 5)



The above figure indicates that a second, independent, method for estimating the retirement shape factor yielded very similar results to the first method for estimating the shape factor for a number of residential appliances. This result strengthens the contention that a common Weibull shape factor can be used to reasonably estimate the RUL of a residential appliance given a particular EUL and years in service of the appliance. Thus, for the purpose of calculating an RUL for residential central A/C units, a Weibull distribution with a shape factor of 2.34 (the average calculated in Section 0) with an EUL of 15.46 years (the value calculated by optimizing the mean life in the System Dynamics model) was used in this RUL analysis.

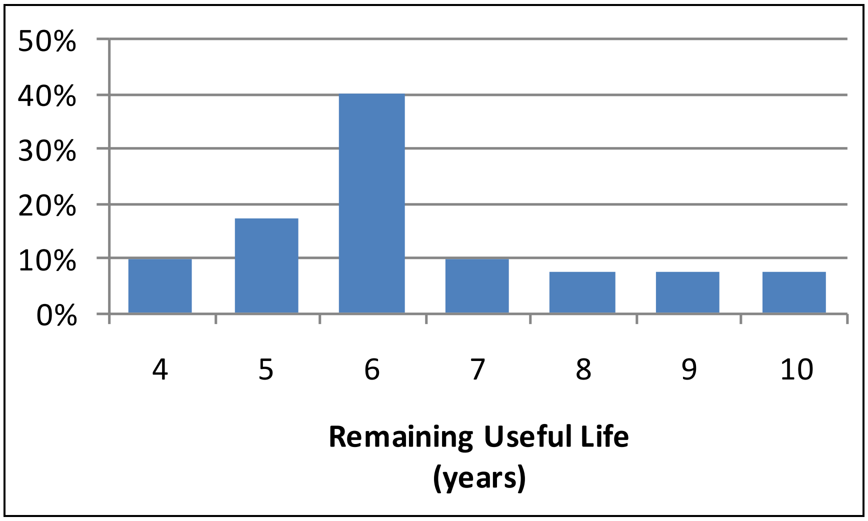
The resulting RUL curve when applying a Weibull shape factor of 2.34 and a mean life of 15.46 years is shown in the figure below. As can be seen in this figure, in the event that an air conditioner unit has not been retired by its EUL (15.46 years), it should be expected to continue running for about 6 more years.

Figure C-32. Remaining Useful Life of Air Conditioners



The estimated air conditioner RUL curve was applied to a sample of 30 air conditioner units that were retired early in the Palm Desert program, as the number of years in service was collected as part of the field activity. The distribution of the remaining useful life of this sample is shown in the figure below. The mean RUL of this sample is 5.9 years, which will be used in the determination of lifetime energy savings for this early retirement program.

Figure C-33. Distribution of RUL of Early-Retired AC Units from the Palm Desert Partnership Program



Refrigerant Charge and Airflow Appendix

1.2 Residential and Commercial Refrigerant Charge and Airflow

1.2.1 Impact Sampling

The Refrigerant Charge and Airflow (RCA) Measure, "HVAC DIAGNOSTICS AND REPAIR BY THE UNIT OF THE TON." was also identified as a measure of interest in Palm Desert, and was selected for additional scrutiny, with a goal of achieving 90/20 confidence and precision at the Program level. Impact sampling for this measure will be first discussed for Commercial customers, and then for Residential.

RCA Commercial Impact Sampling

The 427 total items with Commercial RCA reveal a gross savings mean of 5,015 kWh. Assuming an Ex Ante coefficient of variation (CV) of 0.50, a sample size of 20 was targeted and attained, which falls within a 90/19 level of Precision/Reliability. Results will be updated once Ex Poste results are available.

Table C-21. Commercial RCA Impact Sampling Target Summary

Measure	Population	*Ex ante* Mean Gross Savings (kWh)	Sample Size	Expected CV	Confidence Level	Precision
RCA (Commercial)	427	5,015	20	0.50	90%	19%
Note: Results displayed are *ex ante*. *Ex post* results will be reported when available						

Stratification was done by savings, each stratum contributing to 33% of total savings:

- The 1st stratum is composed of 1 participant,
- The 2cd stratum is composed of 18 participants,
- The 3rd stratum is composed of 212 participants.

Typically, each participant in the sample will receive an "on-site" evaluation, consisting of one building where verification is performed and one unit is logged. However, entities that are very large can be targeted for multiple on-sites, meaning that multiple buildings may be logged. Therefore, in Stratum 1, 7 buildings were targeted, and in Stratums 2 and 3, 6 buildings were targeted.

All participants in the 1st and 2cd strata were attempted, and then participants were recruited as needed from the 3rd to obtain a total of 20. Because of difficulties in recruitment in the 1st and 2cd strata, the sample was shifted as necessary to the 3rd. As a result, 3 logger installs were made in the first stratum, 4 in the second, and 13 in the third, still maintaining a total of 20.

RCA Residential Impact Sampling

There are 1,703 total items with Residential RCA. The data reveal a mean gross savings of 2349 kWh. Assuming a CV of 0.50, a sample size of 20 was targeted and attained to fall within a 90/19 level of confidence and precision (see Table C-23.). There was no stratification, as verification is independent of building type since there is expected to be no variation between single-family, multi-family or mobile homes in this analysis. Results will be updated once *ex post* results are available.

Table C-23. Residential RCA Impact Sampling Target Summary

Measure	Population	*Ex ante* Mean Gross Savings (kWh)	Sample Size	Expected CV	Confidence Level	Precision
RCA (Residential)	1,703	2349	20	0.50	90%	19%

1.2.2 Data Collection Methodology

The refrigeration charge and airflow (RCA) data collection methodology implemented in Palm Desert replicates the stated KEMA methodology for spot measurements and verification, but without the pre-post data logging. Post-only data logging of commercial sites was completed using the same methodology as the residential early retirement data logging. The following methodology was adapted directly from KEMA's data collection plan.

Contextual Data

Measured conditioned square footage, building vintage, envelope characteristics, and thermostat and occupancy schedules were used to characterize the buildings in the Palm Desert sample. The contextual data collected is listed in Table C-24.

Table C-24. RCA Contextual Data Collection

Building Parameter	Data Collection
Building Type	Observed
Total Area	Measured
Vintage	Surveyed
Area Served	Measured/Plans
Number of Floors	Measured/Plans
Number of Buildings	Measured/Plans
Window Area by Orientation	Measured/Plans
Glazing Type by Orientation	Observed/Plans
Glazing Interior and Exterior Shading by Orientation	Observed/Plans
Roof Construction	Observed/Plans
Ceiling Insulation	Observed/Plans
Occupancy Schedule	Surveyed
Heating Setpoint	Surveyed
Cooling Setpoint	Surveyed
SystemType	Observed
Cooling Efficiency	Measured

The only connected load and schedule measured or captured during data collection onsite in Palm Desert was for the air conditioner.

Measure Specific Data

Weather dependence:

The refrigerant AC charge tests are weather dependent. It is accepted that the minimum ambient temperature for testing and adjustment of refrigerant charge is fifty-five degrees Fahrenheit. However most AC manufacturer performance curves do not allow extrapolation of performance below seventy-five degrees. As a result, data was collected during July, August, and September, when temperatures were consistently at least 75 degrees by 9 AM.

Data collected

The following AC nameplate information was taken: A/C manufacturer, model and serial #. Instantaneous site measurements included: electric power input, supply and return temperature, supply and return relative humidity, suction pressure, liquid line pressure, suction temperature, liquid line temperature, condenser entering air temperature, and air flow.

At commercial sites, the following parameters were logged for 40-50 days post-installation: return and supply air temperatures and RH, temperature at the mixing chamber, outdoor temperature entering the coil, and AC power consumption. Seasonal variations on both the load profile as well as the operating hours of the AC will be accounted for in eQuest.

Data Accuracy and Instrumentation

Table C-25 outlines the instruments used in post-installation logging and metering.

Table C-25. Post-installation Logging and Metering Devices

Function /Data Point to Measure	Equipment Brand/Model	Qty Req'd	Rated Full Scale Accuracy	Accuracy of Expected Measurement	Metering Duration	Metering Interval
Power	Wattnode/WNB-3Y-480-P	1	± 0.05%	± 0.45%	40-50 days	1 min
Power	Hobo Microstation with pulse adapter	1		±0.4	40-50 days	1 min
Supply Temperature/RH	Hobo Temp/ RH smart sensor	1	±2.5-3.5 RH	±3.5	40-50 days	1 min
Return temperature/RH	Hobo Temp/ RH smart sensor	1	±2.5-3.5 RH	±2.5	40-50 days	1 min
Condenser Entering Temp	Hobo Temp smart sensor	1	±2.5-3.5 RH	±2.5	40-50 days	1 min
Thermostat temperature/RH	Hobo temp/RH logger	1	± 7% CFM ± 1% Pa	+5%-15%CFM	Instant	

Table C-26 describes instrumentation used to calibrate the data logging sensors and used for post-only verification site visits.

Table C-26. RCA Spot Measurement and Calibration Devices

Function/Data Point to Measure	Equipment Brand/Model	Qty Req'd	Rated Full Scale Accuracy	Accuracy of Expected Measurement	Metering Duration	Metering Interval
Suction and discharge pressure	Testo 556-1	1	0.5%	0.5%	15 Minutes	5 Seconds
Suction and liquid line temp	Testo pipe clamp probes	2	0.5%	0.5%	15 Minutes	5 Seconds
Ambient temp	Testo radio probes	2	0.5%	0.5%	15 Minutes	5 Seconds
Temperature	Vaisala H41	1	1 °F, 2% RH	1 °F, 2% RH	15 minutes	5 minutes
Wet bulb/dry bulb temp	Vaisala H41	1	1 °F, 2% RH	1 °F, 2% RH	15 minutes	5 minutes
RMS Power	Fluke 345	1	2.5%	2.5%	10 minutes	5 minutes
Air handler pressure/CFM	TrueFlow Air Handler Flow Meter Kit	1	± 7% CFM	+5%-15%CFM	Instantaneous	
Pressure	DG700 digital pressure gauge	1	1%		Instantaneous	

1.2.3 Analysis Methodology

This section explains the methodology used to arrive at ex- post savings. The methodology outlined here is common for both residential and commercial RCA tests. The analysis uses data provided by the implementer and field data to determine whether a unit has had (a) refrigerant charge added to it and (b) is in proper charge state at the time of field tests. The major steps involved in the analysis are:

1. Analyze program installation forms to determine if a significant change in refrigerant charge occurred. This step is referred to as **documentation review.**
2. Verify on-site that the unit is still in use and did not receive significant repair including refrigerant charge after the initial installation and verify that the unit has correct charge at time of the field test. This step is referred to as **field data analysis.**
3. Calculate the overall verification rate as the fraction of claimed tons passing all three of the above criteria to obtain **final results.**

Documentation Review

Documentation review was done to insure that the measure was implemented appropriately. Documents detailing implementation were sent by the program implementer in the form of installation forms.

Data about the amount of refrigerant charge added or removed was frequently unavailable on installation forms. As a result, the evaluation team calculated an installation rate using a significant change in refrigerant pressures recorded on the installation form as a proxy for a significant change in the refrigerant charge having been made. This was done in following manner,

1. A difference in pre and post suction pressure was calculated. If there was proof that the suction pressure increased, then the equipment was said to pass the suction pressure test,

2. Difference between pre and post discharge was calculated, If there had been a minimum decrease of 10 psi, then the equipment was said to pass the discharge pressure test.

3. Installation forms were scanned for alternate proof/ documentation of refrigerant charge change. This was in the form of notes such as *"10 oz of refrigerant added"*. If there were notes documenting refrigerant charge change, the equipment was said to pass the alternate proof test,

4. If a particular equipment passed any of the above three tests, it was said to pass the documentation review.

Field Data Analysis

The objectives of this step were to (a) verify on-site that the unit is still in use and did not receive significant repair including refrigerant charge after the initial installation and (b) verify that the unit has correct charge at the time of field testing. These steps are explained in the following section.

On-site Installation Verification

On-site verification was done using the following checks:

- Verifying equipment details as specified in program tracking data and installation forms.

- Speaking with customers to make sure they have not replaced the unit or had repair work done on the unit after the RCA measure was implemented.

If equipment had met these criteria then it was considered to have a verified installation.

Refrigerant Charge Calculation

Once the measure installation had been verified on-site, tests were carried out to ascertain whether the equipment has correct refrigerant charge or not. These tests were:

- A **Superheat Test** was performed on systems that did not have a thermal expansion valve (TXV). This test determined if a system was meeting its target superheat. The first step in doing this was to determined the difference between the actual and target superheat, given by:
  SD = (AS – TS)

where:

SD = Super heat difference (F).

AS = Actual Superheat (F)

TS = Target superheat as specified by the manufacturer.

Equipment passed the superheat test if the absolute values of SD was less than 5 degrees F[9].

- A **Sub-cooling Test** was done on systems that had a TXV. This test determined if a system was meeting its target sub-cooling as specified by the manufacturer. The first step in doing this was to determine the difference between the actual and target sub-cooling, given by:
  SCD = (ASC – TSC)

  Where:

  SCD = Sub-cool difference.

  ASC = Actual sub-cooling achieved by the equipment

  TSC = Target sub-cooling as specified by the manufacturer.

  Equipment passed the sub-cooling test if the absolute value of SCD was less than 3 degrees F[10].

Final Combination of Tests

The final test was done to calculate the actual savings realized by each system due to RCA correction. This was done using results from documentation and onsite tests and fourth quarter 2008 program tracking data.

- To carry out the final combination of tests, a database of systems sampled was created. This database included the following fields:
- Gross energy savings claimed
- Gross demand savings claimed
- Size of each system (tons) per program tracking data
- Documentation review test results
- On site installation test results including field verified size of equipment
- On site RCA test results

If a system passed the on-site RCA and the documentation review test it is given ex-ante energy and demand savings given by the following quations:

VD = kW * (SV)/ (SC)

VE = kWh * (SV)/ (SC)

The variables in the equations above are defined and sourced according to Table C-27.

9 This target temperature difference was specified by Energy Division Technical Advisors.
10 This target temperature difference was specified by Energy Division Technical Advisors.

Table C-27. Sources for Verified Energy and Demand Savings Calculation

Variable	Meaning	Units	Source
VD	Verified demand savings	kWh	Calculated
VE	Verified energy savings	kW	Calculated
kWh	Claimed energy savings	kWh	Program tracking database
kW	Claimed demand savings	kW	Program tracking database
SV	Equipment size verified on site	Tons	Verified on site
SC	Equipment size claimed in the program tracking database	Tons	Program tracking database

1.2.4 Detailed Results

This section presents results and explanation of results for residential and commercial RCA measurement and verification (M &V) work. The realization rates computed for residential and commercial RCA are 14 % and 6 % based on energy respectively.

This section is divided in three stages of analysis, including,

- Results of the documentation review process, where verification was done on measure installation based on documents provided by the implementer.
- Field findings based on data collected on the field.
- Realization rate calculated based on both field and desk review activities.

Documentation Review

Table C-28 shows the results of the documentation review for the residential RCA analysis. For each unique piece of equipment sampled, implementer documentation was studied to determine whether there was proof of (a) added refrigerant charge, (b) an increase in suction pressure, or (c) a significant decrease in discharge pressure. If the equipment met any of the three criteria, it was considered to have passed the documentation review.

Table C-28. Results of Documentation Review for Residential RCA

Site ID	Equipment ID	Size (Tons)	Refrigerant charge added?	Suction pressure increase?	Significant discharge pressure decrease?*	Desk review result
6195	85	4				Fail
6317	74	-				Fail
6779	79	5				Fail
6934	88	-				Fail
8169	80	3				Fail
8169	81	3				Fail
11700	77	5				Fail
11784	75	4				Fail
11784	76	3				Fail
11869	91	5		X		Pass
12938	87	3.5				Fail
13045	62	3.5				Fail
13074	-	-				Fail
13146	52	4				Fail
13171	86	5	X	X		Pass
14880	82	3.5		X		Pass
15189	61	6	X	X		Pass
15780		3	X			Pass
15784	78	3				Fail
15806	90	-				Fail
15897	-	5		X		Pass

As seen in Table C-29, 6 of 22 units passed the documentation review. They represented 23.5 tons of the 96.5 tons sampled for residential RCA measures. Table C-30 shows results from the documentation review of commercial RCA measures.

Table C-29. Results of Documentation Review for Commercial RCA

Site ID	Equipment ID	Size (Tons)	Refrigerant charge added?	Suction pressure increase?	Significant discharge pressure decrease?*	Desk review result
1351	69	-				
1352	70	3.5				
1353	89	3.5				
1800	48	2		X		X
2005	34	2				
2005	95	4				
2055	31	5				
2055	55	4				
2169	49	8				
2171	45	4				
3604	43	3.5				
4868	40	3				
4871	41	5				
10923	38	5				
10923	56	4				
10923	57	0				
10924	39	0				
10924	59	5				
10926	32	5				
10927	36	3				
11038	67	3.88			X	X
11039	35	5				
11114	50	3			X	X
11115	6	6			X	X
11125	42	6				
1355	-	4.2				

Only four of 27 equipment passed the documentation review phase for the commercial RCA measure.

Field Data Analysis

Field data collected were used to determine superheat and sub-cooling temperatures being realized by equipment. These were compared to the target superheat and sub-cool temperatures as specified by the manufacturer. A system was deemed to pass the field data set if the superheat temperature being attained was within 5 degrees of manufacturer specification or if the sub-cool temperature was within 3 degrees of target sub-cool temperature (for systems with thermal expansion valves/ TXV).

The results of this analysis for residential RCA systems are shown below in Table C-31.

Table C-3 Field Data Analysis Results for Residential RCA measures

Site ID	Equipment ID	Field Verified Size (Tons)	TXV Present?	Superheat target met?	Sub-cool target met?
6195	85	4		X	
6317	74	3			
6779	79	5			
6934	88	4		X	
8169	80	3		X	
8169	81	3			
11700	77	5			
11784	75		X		
11784	76	4	X		
11869	91	3		X	
12938	87	5	X		
13045	62	3.5		X	
13074	-	3.5			
13146	52	-			
13171	86	4	X		
14880	82	5		X	
15189	61	4			
15780		5			
15784	78	3.5	X		
15806	90		X		
15897	-				

Six of twenty two units passed the field data analysis test for residential RCA. They represented 28 tons out of 96.5 for which savings were claimed. No unit with a TXV was able to pass the sub-cool test. Data was not collected on the field for five units as threeof those units had been replaced after RCA had been performed and two units had further work done on it to insure proper charge.

Table C-32. Field Data Analysis Results for Commercial RCA Measures

Site ID	Equipment ID	Field Verified Size (Tons)	TXV Present?	Superheat target met?*	Sub-cool target met?
1351	69	-			
1352	70	3.5			
1353	89	3.5			
1800	48	2			
2005	34	2			
2005	95	4			
2055	31	5			
2055	55	4		DK	
2169	49	8	X		
2171	45	4			
3604	43	3.5		DK	
4868	40	3		DK	
4871	41	5			
10923	38	5	X		X
10923	56	4		DK	
10923	57	0		DK	
10924	39	0	X		
10924	59	5		DK	
10926	32	5			
10927	36	3			
11038	67	3.880000114			
11039	35	5			
11114	50	3			
11115	68	6		X	
11125	42	6		DK	
1355	-	4.2			

*DK signifies that there was a lack of data to calculate test results.

Two units representing 11 out of a possible 99 tons passed the onsite field review test. There was lack of data to calculate results for 7 units representing 25.5 tons.

Final Results

The results of the desk review were combined with field data analysis to get final realization rates and *ex-post* savings estimates. These results are shown in Table C-34.

Table C-34. Combine desk Review and Field Work to Obtain Ex-Post Savings Estimate for Residential RCA

Site ID	Equipment ID	Size (Tons)	Pass desk review?	Pass field review?	Field Verified Size (Tons)
6195	85	4	X		4
6317	74	4			3
6779	79	5			5
6934	88	4	X		4
8169	80	3	X		3
8169	81	3			3
11700	77	5			5
11700	-	5			
11784	75	4			4
11784	76	3			3
11869	91	5	X	X	5
12938	87	4			3.5
13045	62	4	X		3.5
13074	-	4			-
13146	52	4			4
13171	86	5		X	5
14880	82	3.5	X	X	4
15189	61	6		X	5
15780		4		X	3.5
15784	78	3			
15806	90	5			
15897	-	5		X	
Totals					

Only two units pass both desk review and field data analysis. Table C-35 shows results for the final combination of tests for commercial RCA sites.

Table C-35. Combine Desk Review and Field Work to Obtain Ex-Post Savings Estimate for Commercial RCA

Site ID	Equipment ID	Size (Tons)	Pass desk review?	Pass field review? *	Field Verified Size (Tons)
1351	69	-			-
1352	70	3.5			3.5
1353	89	3.5			3.5
1800	48	2	X		2
2005	34	2			2
2005	95	4			4
2055	31	5			5
2055	55	4		DK	4
2169	49	8			8
2171	45	4			4
3604	43	3.5		DK	3.5
4868	40	3		DK	3
4871	41	5			5
10923	38	5		X	5
10923	56	4		DK	4
10923	57	0		DK	0
10924	39	0			0
10924	59	5		DK	5
10926	32	5			5
10927	36	3			3
11038	67	3.88	X		3.88
11039	35	5			5
11114	50	3	X		3
11115	6	6	X	X	6
11125	42	6		DK	6
1355	-	4.2			4.2

*DK signifies that there was a lack of data to calculate test results.

It is important to note that none of the systems that lacked data for a conclusive on site test passed the documentation review.

Palm Desert Net-to-Gross Methodology and Analysis

1.3 Palm Desert Net-to-Gross Introduction and Methods

This appendix summarizes the methods, bias corrections and results of the Net-to-Gross (NTG) analysis for the Palm Desert LGP Program. The Palm Desert Program is marketed to residential and commercial customers under the "Set to Save" brand name. This program seeks to achieve maximum energy and demand savings through the combined efforts of the City of Palm Desert, The Energy Coalition, Southern California Gas Company and Southern California Edison. A goal of 30% reduction in energy usage and demand has been set for the City of Palm Desert. This multi-faceted pilot program has many components and, as a pilot program, is used to test and refine a number of innovative programs and marketing techniques. This evaluation is concerned with the direct install offerings of the Palm Desert LGP Program that are marketed to the residential and small commercial sectors.

The Summit Blue team adopted the question structure and syntax approved by the NTG subcommittees, described as follows.

One objective of the California energy efficiency program evaluations is to identify the portion of savings directly attributable to the Program effort and to properly account for those effects that would have occurred in the absence of the program. California reporting protocols for the 2006-2008 program require the discounting of savings by a "free-ridership factor" in the estimation of net program savings by applying this net-to-gross ratio (NTGR). The 2006 Evaluation Protocols allow for the use of a participant self-report approach (SRA) to estimate the net-to-gross ratio for the basic level of rigor and with additional participant-specific documentation for the standard level of rigor.

The Energy Division(ED) convened a committee of evaluators to develop a standard framework for the measurement of net-to-gross ratios for residential and small commercial programs in a systematic and consistent manner using the SRA approach. The approach was designed to fully comply with the Evaluator Protocols. The ED developed the Guidelines for Estimating Net-To-Gross Ratios Using the Self-Report Approaches in October 2007 as more detailed guidance than was available in the California Evaluator Protocols.

Participants who were involved in the decision-making process at each participating household or small commercial site were interviewed to measure the program's influence on respondents' decision-making. The survey obtained highly structured responses concerning the probability that the household or firm would have installed the same measure(s) at the same time in the absence of the program. The survey also included open-ended and closed-ended questions that focused on the household's or firm's motivation for installing the efficiency measure. These questions covered all the requirements provided in the Guidelines, such as multiple questions; efficiency level; likelihood of adoption; timing and quantity; and consistency checks.

The NTGR algorithm derived four separate measurements of free-ridership from different inquiry routes. The first measurement consisted of responses to a series of yes/no questions that measured the impact of the program on the quantity, efficiency, and timing of the purchase. The second measurement consisted of a 0-10 scale that asked the likelihood that the respondent would have purchased the same exact high efficiency measure in the absence of the program. The third measurement combined responses to the quantity and timing questions with responses to a 0-10 scale that asked the respondents' agreement with the statement that, in the absence of the program, they would have paid the additional rebate amount to buy the high efficiency equipment on their own. The final measurement combined responses to the quantity and timing questions with responses to a 0-10 scale that asked respondents' agreement with the statement that the program was a critical factor in their decision to purchase the high efficiency equipment. In the few cases where responses were inconsistent among the four measurements, the analyst did not recode or adjust NTG estimates.

These four measurements were combined to derive the final free-ridership estimate at the measure level. Prior to finalizing the NTGR algorithm, the committee conducted iterative testing with a partial dataset. This testing contributed to the reliability of the algorithm and its computer coding.

Section 1.9 of this Appendix explains the methods used by PA Consulting who conducted the surveys to minimize non-responses. Algorithms to generate NTG ratios for residential and small business programs were developed by PA Consulting in SAS, approved by the CPUC and posted on their website, were used in these analyses.

1.4 Palm Desert Net-to-Gross Results

In this section, the residential and commercial NTG ratios are presented along with their corresponding confidence and precision levels.

NTG ratios were estimated for two measures of particular interest in Palm Desert: RCA and Early Retirement/HVAC, in addition to the NTG ratios for the remaining groups. Thus, the following Program NTG ratios were estimated:

- Early Retirement/HVAC (Residential) NTG
- RCA (Residential and Commercial) NTG
- Residential Program Excluding Early Retirement and RCA NTG
- Commercial Program Excluding RCA NTG

Results are first discussed for the Residential measures and then for the Commercial. Then, spillover is discussed.

1.4.1 Residential NTG

Early Retirement (Residential) NTG

Of special interest in the Palm Desert measure offerings was the HVAC Early Retirement measure. Residential HVAC Early Retirement participants were sampled separately to ensure a sufficient sample size for a separate NTG analysis. All Early Retirement customers also had one of the following 3 HVAC measures installed:

- Central AC Tier 1
- Central AC Tier 2
- Central AC Super High Performance

Therefore, results for all of these measures were considered together to obtain a NTG result, since just one decision was made. There were 610 participating residential customers of the Central AC Early Retirement Program. Sixty-four completed surveys with Early Replacement participants were planned and 69 surveys were completed. The Early Retirement NTG ratio was estimated to be 0.74.

RCA (Residential) NTG

The RCA (Refrigerant Charge and Airflow Adjustment) measure was also of special interest to the Summit Blue team conducting on-site measurements for the impact study. To facilitate on-site recruitment, an oversample of RCA participants was planned as a subset of the population survey of residential program participants. Thirty-eight residential customers participating in the RCA sub-program were surveyed. The NTG ratio for the RCA residential program was estimated to be 0.76.

Residential Program Excluding Early Retirement NTG

The savings-weighted NTG ratio for the group of Residential Program Measures Excluding Early Retirement/HVAC and RCA was estimated to be 0.69, with a sample size of 56..

1.4.2 Commercial NTG

RCA (Commercial) NTG

To facilitate on-site recruitment, an oversample of RCA participants was planned as a subset of the population survey for commercial program participants. Data from 19 surveys completed with commercial customers participating in the RCA sub-program were used. The NTG ratio for the RCA measure is 0.70.

Commercial Program Excluding RCA NTG

The savings-weighted NTG ratio for the group of Commercial Program Measures Excluding RCA was estimated to be 0.85.

1.5 Spillover

In keeping with CPUC directives, participant spillover will be measured and reported in this evaluation report, but not included in the program accomplishments credited to the IOUs toward goal attainment.

Forty percent of residential and 31% of commercial customers reported they had installed some type of energy efficient equipment outside of the utility program. Table C-37 displays the types of spillover and corresponding percentages. Spillover lighting was installed by 28% of residential customers and 23% of commercial customers participating in the Palm Desert LGP Program.

Table C-37. Spillover from Palm Desert Program

Residential/ Commercial	Type of Spillover	Percent of Customers
Residential	Installed lighting outside utility program	16%
	Installed other measure outside a utility program	12%
	Installed both lighting and other measure outside utility program	12%
	No spillover	60%
Commercial	Installed lighting outside utility program	10%
	Installed other measure outside a utility program	8%
	Installed both lighting and other measure outside utility program	13%
	No spillover	69%

1.6 Summary of NTG Results

Table C-38 summarizes the NTG ratios estimated for the Palm Desert Program. This table also includes sampling information, and levels of confidence and relative precision reached[11].

[11] Calculations for relative precision (for measure, sector and program level NTG values) applied T Values according to sample size at the 90% confidence level, and did not apply a finite population correction factor.

Table C-38. Palm Desert NTG Ex Post Summary

Level	Sector	Measure(s)	Sample Size	NTG	CV	Confidence Level	Relative Precision
Measure	Residential	All Measures Excluding Early Retirement/HVAC	56	0.69	0.4	90%	13%
Measure	Residential	Early Retirement/HVAC	69	0.74	0.4	90%	11%
Measure	Residential	RCA	38	0.76	0.4	90%	14%
Measure	Commercial	All Measures Excluding RCA	74	0.85	0.3	90%	7%
Measure	Commercial	RCA	19	0.70	0.2	90%	11%

1.7 Maximizing Response Rates and Minimizing Non-response Bias

For the Palm Desert Impact and NTG Sampling, several methods were employed to maximize response rates and minimize non-response bias. These included:

- varying calling times,
- making multiple attempts to each record,
- leaving messages,
- refusal conversion attempts, and
- close sample management.

Telephone interviewing with residential customers was conducted Monday-Friday evenings (5:00pm–9:00pm), Saturday mornings and afternoons (10:00am–2:00pm), and Sunday evenings (4:00pm–8:00pm) (all times local). Commercial calling was conducted during daytime hours on weekdays (8:00am–5:00pm). Follow-up attempts were varied across times of the day and days of the week to maximize response among hard-to-reach customers. Standard procedures use seven attempts (six follow-ups) per sample point over a 2- to 4-week period to ensure a high response rate.

Interviewers left messages with an 800 number so respondents could call back at their convenience which also allowed reaching more respondents. For those who hang up or initially say they are not interested in participating in the call, an interviewer experienced in refusal conversion was assigned to call them back after a predetermined amount of time.

Another important technique that was been used to reduce non-response bias is careful sample management. The minimum amount of sample that was necessary to complete the study was initially set up. The sample was then tracked closely to determine whether the initial sample was adequate to complete the study. Additional replicates were released as soon as it was determined they were necessary, to ensure that the sample was released early enough in the calling period so that the minimum number of attempts across a variety of times and days of the week could be made. In addition, quotas were assigned and tracked within the CATI system and data was exported frequently to check data for representativeness (including kWh savings coverage).

1.8 Self-Report Free Ridership Stability Indicators

For the Palm Desert NTG effort, Table C-39 displays the Self-Report Free Ridership Stability Indicators.

Table C-39. PROGRAM HIM Free Ridership Stability Indicators for Palm Desert

4 Separate Free Ridership Measurements Possible – Number of Respondents Having___*	
Zero FR Measurements	0%
One FR Measurements	59%
Two FR Measurements	37%
Three FR Measurements	4%
Four FR Measurements	0%
Proportion of respondents with an extreme FR ratio	
Proportion with 0 - 0.1 FR ratio	46%
Proportion with 0.9 - 1 FR ratio	4%

Number and proportion of respondents where changes were made to the FR ratio due to inconsistent responses**	
Number	NA
Proportion	NA
FR Ratio without those that had inconsistent responses corrected	
NA	NA%
Respondents answering they already had installed measure before they learned of the program**	
N = 46	Final average FR for these: 21%
Respondents answering they never would have even purchased equipment type without the program (efficient or inefficient)**	
N = 97	Final average FR for these: 16%
** These are included in the calculation of that respondent's free ridership and the overall weighted free ridership estimates as stipulated in the algorithm.	

LGP EVALUATION REPORT APPENDIX D:
UC/CSU PARTNERSHIP EVALUATION SUPPORTING DOCUMENTS

a. USC/CSU Net-to-Gross Analysis
b. UC/CSU Lighting Data Logger Study Lighting Load Shapes

A. USC/CSU NET-TO-GROSS ANALYSIS

1 INTRODUCTION AND METHODS

This Appendix summarizes the UC/CSU Program and the methods, data sources, questions and scoring algorithm, data analysis and results for the NTG effort for the UC/CSU Program. Of the NTG levels of free-rider analysis, the UC/CSU Program falls under the Standard – Very Large protocols, the most detailed of the three analysis protocols. While the calculation of the NTGR score is based on quantitative self-report data, multiple data sources, some of them qualitative, are integrated to produce an estimated NTG score. At least two analysts review the quantitative and qualitative data under the Standard Very Large NTG protocol.

1.1 Overview of the UC/CSU LGP

The University of California (UC), California State University (CSU), and Investor-Owned Utility (IOU) Energy Efficiency Partnership is a unique, statewide energy efficiency program achieving cost-effective immediate and persistent peak energy and demand savings. Moreover, it establishes a permanent framework for a sustainable, long-term, comprehensive energy management program at the thirty three (33) UC and CSU campuses served by California's four large IOUs (PG&E, SDG&E, SCE and SoCalGas).

The UC-CSU Partnership Program was established to help UC and CSU campuses achieve higher levels of energy efficiency in both existing buildings and new construction. The Program was conceived of and designed by a working group including senior executives from both the utilities and university systems. The purpose of the Program is to stimulate energy efficiency upgrades in the existing building stock and new buildings at UC and CSU campuses that, due to capital limitations (or limitations related to technical capabilities), would otherwise not be implemented.

Established in 2004-05, the UC/CSU Program significantly exceeded its goals, saving approximately 32 million kilowatt-hours and 1.5 million therms of gas. Peak demand savings were also targeted and achieved. As a result of this success, the program was renewed for 2006-08. Funding levels for the renewed program more than doubled on an annual basis, and energy savings goals increased approximately four-fold.

The program employs four key strategies to meet its goals: energy efficiency retrofits, monitoring based commissioning (MBCx), emerging technology demonstrations, and training and education. This multifaceted approach delivers comprehensive savings, fulfills key elements in UC and CSU sustainability policies, and contributes to California’s national leadership in energy efficiency and climate change.

The Partnership capitalizes on the vast resources and expertise of UC, CSU and California’s IOUs. It is funded by California’s investor owned utility customers through Public Goods Charges (PGC) and administered by the utility companies under the auspices of the California Public Utilities Commission.

University of California

The University of California opened its doors in 1869, and today, the UC system includes more than 220,000 students and more than 170,000 faculty and staff. UC has ten campuses - Berkeley, Davis, Irvine, Los Angeles, Merced, Riverside, San Diego, San Francisco, Santa Cruz and Santa Barbara.

The Partnership Program will provide an estimated $178 million to help fund energy efficiency projects for 2009-11, which are expected to reduce the university's annual utility costs by $36 million. UC faces significant challenges as it seeks to meet dramatically increasing utility costs, maintain its facilities and implement its sustainability policy goals. As a system, UC's campuses report a combined purchased utilities deficit of $40 million.

In late 2008, UC completed a Strategic Energy Plan for nine of its 10 campuses and four medical centers. (The facilities at the Merced campus and the new UCLA Medical Center were recently constructed consistent with prevailing university energy efficiency standards.) The plan identified opportunities for increasing energy efficiency across the system and prioritized the full array of projects and energy-efficiency initiatives available.

Based on the SEP, campuses on the UC system shared a portfolio of potential projects with California electric utility companies to determine eligibility for their incentive programs. UC has been the beneficiary of prior, customized incentive grants distributed under the auspices of Statewide Energy Partnership programs since 2004.

Program benefits at UC include:

- *Cost savings:* UC's purchased utility costs totaled $372 million in fiscal year 2007-08. The program is expected to reduce the university's annual utility cost by $36 million (in 2008 dollars).
- *Energy savings:* The program will save the UC system an estimated 187 million kilowatt-hours in electricity use (11% of the university's total system-wide use), and 10.8 million therms in natural gas use (eight percent of total system-wide use). These savings are the equivalent of UC Berkeley's entire annual electricity consumption and the equivalent of all natural gas used at the UC Davis Medical Center's Sacramento campus. It is comparable to the electricity yearly used in 17,000 homes and the annual heating needs in 18,000 residences, according to PG&E figures. The savings will result from a campus- and medical center-selected project portfolio using parameters set by the Strategic Energy Plan. The portfolio includes 900 projects for 2009-11. Typical projects cover heating, ventilation and air-conditioning (HVAC) and control upgrades, motor replacements, variable speed drive installations, lighting system upgrades and replacements, and monitoring-based building recommissioning. Individual project costs range from $3,000 to $1.4 million, with an average cost of $275,000.
- *Improved sustainability:* The program will greatly advance UC's efforts to meet its sustainable practices policy goals to reduce energy consumption to 10% below 2000 levels by 2014 and greenhouse gas emissions from purchased utilities by more than 100,000 metric tons per year.
- *Renewing facilities:* Given the extremely limited funding available for capital renewal and deferred maintenance, the portfolio of energy projects includes, where possible, projects that will address both energy efficiency and capital renewal and deferred maintenance needs.

Total project costs for 2009-11 are estimated at $247.4 million, of which $61.4 million will be covered by utility incentive payments and $186 million by the university (including approximately $8 million from campus and auxiliary sources). The $178 million in external financing, through 15-year revenue bonds, will be made available to campuses to finance their energy projects.

Other Program highlights (for the University of California) during the 2006-2008 Program cycle include:

- Number of projects completed: 92

- Total kW reduction: 5,987
- kWh reduction: 48,108,168
- Therm reduction: 3,695,037
- Incentive funding provided: $14,297,074.13

Table D-1. Program Activity, Savings, and Funding, by UC Campus

Campus	Projects Completed	kW	kWh	Therms	Incentive funding
UC Berkeley	11	801	6,839,680	189,771	$1,467,557
UC Davis	20	1,123	7,103,695	2,156,048	$3,639,047
UC Irvine	15	1,029	11,792,602	143,085	$2,703,129
UC Office of the President	4	95	647,135	8,649	$76,672.0
UC Riverside	1	-	-	178,695	$243,920
UC San Diego	7	1,362	10,094,697	199,392	$2,441,117
UC San Francisco	11	694	5,952,357	516,473	$1,954,599
UC Santa Barbara	8	644	4,108,834	87,245	$985,731
UC Santa Cruz	14	240	1,569,168	26,037	$500,837
UCLA	1	-	-	189,642	$284,463

Source: Personal Communication, Carmen King, Energy Analyst, Newcomb|Anderson|McCormick, November 9, 2009.

California State University (CSU)

The California State University is the nation's largest university system, with 23 campuses and seven off-campus centers, almost 450,000 students, and 47,000 faculty and staff. The CSU system was created in 1961 under the state Master Plan for Higher Education.

Program highlights (for the California State University system) during the 2006-2008 Program cycle include:

- Number of projects completed: 61
- kW reduction: 5,054
- kWh reduction: 30,431,973

- Therm reduction: 1,125,569
- Incentive funding provided: $8,324,407.73

Table D-2. Program Activity, Savings, and Funding, by CSU Campus

Campus	Projects Completed	kW	kWh	Therms	Incentive funding
Bakersfield	2	64	205,076	2,714	$53,289
Chico	2	65	842,011	22,780	$228,252
East Bay	3	499	3,380,580	170,873	$866,876
Fresno	1	-	412,445	10,519	$187,786
Fullerton	3	44	758,076	-	$181,938
Humboldt	1	3	26,525	-	$3,696
Long Beach	6	1,480	4,477,392	-	$1,053,420
Los Angeles	2	-	-	66,250	$99,375
Monterey Bay	6	266	2,665,211	126,751	$636,802
Pomona	4	105	1,351,954	41,806	$286,135
Sacramento	3	-	-	71,697	$71,697
San Bernardino	4	1,187	3,971,924	135,600	$1,188,355
San Diego	2	490	3,403,478	58,660	$871,878
San Francisco	5	136	1,790,450	178,552	$594,888
San Jose	5	193	1,283,335	129,951	$514,394
San Luis Obispo	3	114	529,745	5,877	$108,798
San Marcos	4	68	2,920,081	96,668	$790,671
Sonoma	5	341	2,413,690	6,871	$586,156

Source: Personal Communication, Carmen King, Energy Analyst, Newcomb|Anderson|McCormick, November 9, 2009.

Comparative Overview: UC and CSU Systems

Comparing the Program results for the UC and CSU systems yields interesting results (see Table D-3). The average project costs were similar for both systems in the 2006-2008 Program cycle, but capacity (kW) savings on the UC side were quite a bit more expensive (on an average, per/kW basis) than on the CSU side. Energy (kWh) savings had similar costs (on an average, per kWh basis), but were also a bit more expensive on the UC side. Therms, on the other hand, were much less expensive to save on the UC side (during this Program cycle).

Table D-3: Comparative Program Results: 2006-2008 Program

System	$/Project	$/kW	$/kWh	$/therm
UC System-wide Average	$ 155,403	$ 2,388	$ 0.297	$ 3.869
CSU System-wide Average	$ 136,466	$ 1,647	$ 0.274	$ 7.396

Source: Personal Communication, Carmen King, Energy Analyst, Newcomb|Anderson|McCormick, November 9, 2009.

1.2 Vendor Role

Campus level decision makers did not view vendors as a party in their decision making. A few rated highly the importance of vendor recommendations, but pointed out that vendors provide primarily technical assistance and guidance, and not guidance on the decision-making process.

1.3 NTG Methods

As part of the evaluation of the 2006-08 energy efficiency programs, the Energy Division of the California Public Utilities Commission (CPUC) formed a nonresidential net-to-gross ratio working group to develop a standard methodological framework, including decision rules, for integrating in a systematic and consistent manner the findings from both quantitative and qualitative information in estimating net-to-gross ratios. The Large Non-Residential NTG Method described in this section was developed to address the unique needs of Large Non-Residential customer projects. This method relies exclusively on the Self-Report Approach (SRA) to estimate project and domain-level Net-to-Gross Ratios (NTGRs), since other available methods and research designs are generally not feasible for large nonresidential customer programs. This approach is designed to fully comply with the California Energy Efficiency Evaluation: Protocols: Technical, Methodological, and Reporting Requirements for Evaluation Professionals (Protocols) and the Guidelines for Estimating Net-To-Gross Ratios Using the Self-Report Approaches (Guidelines). See Appendix H for guidance documents.

1.4 Case Study Methodology

The Net Impact Approach for the UC/CSU/IOU Energy Efficiency Partnership evaluation was originally assigned a “Basic” level of rigor. However, the evaluation opted to apply a “Standard – Very Large” level of rigor to improve the quality of findings. This was triggered because the UC/CSU Program targets campuses that tend to have a unique and complex decision making environment, may be a large energy user, and implement custom retrofit and new construction capital investment projects. Therefore, the UC/CSU Program falls under the Standard – Very Large protocol standards. These protocols direct use of a case study methodology, as stated in the Guidelines:

“It is important to inquire about the decision-making process and the roles of those involved for those cases with relatively large savings and with multiple steps or decision-makers. If the customer has a multi-step process where there are go/no-go decisions made at each step, then this process should be considered when using the responses to estimate the firm’s NTGR. There have been program evaluations whose estimates have been called into question when these factors were not considered, tested, and found to be important.”

The UC/CSU/IOU Energy Efficiency Partnership met these criteria in that decisions on energy efficiency investments were often made, or at least initiated, at a high level within large and complex organizations. This suggested a strong correlation and causal linkage between multiple projects, both on the same campus and, to some extent, across campuses.

As an example, program incentives may have influenced the Chancellor’s Office or Office of the President to issue directives to the individual campuses to investigate opportunities for energy efficiency. Thus, the program influence (or, conversely, any free ridership) at the Chancellor’s Office could come down to the individual campus decisions. In turn, decisions by the administrations of each different campus could influence or determine individual project decisions. Even if a project’s site manager had not considered specific projects or measures prior to the program, free ridership identified at the higher levels of decision making would need to be estimated and integrated with free ridership rates for individual projects.

1.5 Survey Design and Implementation

The Standard – Very Large Survey was used to gather NTG information from site facility site managers and campus energy managers. Utility program manager discussion guides were similar to those developed by Itron for the PG&E/3rd Party Industrial, Southern California Industrial Program Evaluation. Utility program manager discussion guides and vendor and non-participant surveys were also patterned on those used in previous NTG evaluations involving large customer decision makers. Discussion guides for university system representatives and committee members were largely based on the utility program manager discussion guide. See Appendix H for samples of survey instruments.

Interviews and surveys were conducted by Summit Blue’s professional executive interviewers. The interrelationships between the different levels of decision makers required experienced and knowledgeable personnel to conduct the interviews and that the same interviewers conduct the multiple surveys that were required at all levels of a project. Large customer surveys were designed to be administered via telephone using a CATI system to aid in data collection. Summit Blue staff resources were used to program the surveys online using Lime Survey, an open source programming tool. The more open-ended discussion guides for program managers and university decision makers were input using Survey Monkey, another survey programming tool.

1.6 Data Sources

There are five sources of free-ridership information in this study. Each level of analysis relies on information from one or more of these sources. Table D-4 shows the data sources that are used in each of the three levels of free-ridership analysis. Although more than one level of analysis may share the same source, the amount of information that is utilized in the analysis may vary. For example, all three levels of analysis obtain core question data from the Decision-Maker survey.

Table D-4: Information Sources for Three Levels of NTGR Analysis

Three Levels of NTGR Analysis	Decision-Maker Survey Core Question	Decision-Maker Survey Supplemental Questions	Utility & Program Staff Interviews	Office of the Chancellor and District Staff Interviews	PIPs, Quarterly Reports and Web Sites
Basic NTGR	√		√		
Standard NTGR	√	√	√		
Standard NTGR - Very Large Projects	√	√	√	√	√

Decision-maker survey core questions, decision-maker survey supplemental questions, utility and program staff interviews and interviews with district staff and representatives from the Chancellor's/President's Offices were the sources for the UC/CSU LGP Program NTGR calculation. Campus level decision makers did not view vendors as a party in their decision making.

1.7 Minimizing Non-Response

To minimize non-response in the UC/CSU surveys, the executive interviewer used several methods including:

- Sending out introductory emails advising potential respondents of survey intent and request convenient interview times
- Calling and leaving messages at multiple times and days – every potential respondent was contacted up to 5 attempts or refused
- Following up immediately with any survey respondents who did call back and scheduling interviews and their convenience.

The sample was managed closely and the status was reported during weekly meetings with the LCG team.

For this survey, non-response is not an issue. There were 32 projects provided on the sample, and Summit Blue completed decision-maker surveys on 19.

1.8 NTG Questions and Scoring Algorithm

The NTGR is calculated as an average of three scores. Each of these scores represents the highest response or the average of several responses given to one or more questions about the decision to install a program measure.

1. A **Timing and Selection** score that reflects the influence of the **most important** of various program and program-related elements in the customer's decision to select the specific program measure at this time. If vendor recommendation was important, then they could be incorporated in this score. However, vendor recommendations were not important in the UC/CSU Program.
2. A **Program Influence** score that captures the perceived importance of the program (whether rebate, recommendation, training, or other program intervention) relative to non-program factors in the decision to implement the specific measure that was eventually adopted or installed. This score is determined by asking respondents to assign importance values to both the program and most important non-program influences so that the two total 10. The program influence score is adjusted (i.e., divided by 2) if respondents say they had already made their decision to install the specific program qualifying measure before they learned about the program.
3. A **No-Program** score that captures the likelihood of various actions the customer might have taken at this time and in the future, if the program had not been available (the counterfactual). This score also accounts for deferred free-ridership by incorporating the likelihood that the customer would have installed program-qualifying measures at a later date if the program had not been available.

When there are multiple questions that feed into the scoring algorithm, as is the case for both the **Timing and Selection** and **No-Program** scores, the maximum score is always used. The rationale for using the maximum value is to capture the most important program element in the participant's decision making. Thus, each score is always based on the strongest influence indicated by the respondent. However, high scores that are inconsistent with other previous responses trigger consistency checks and can lead to follow-up questions to clarify and resolve the discrepancy.

For the Standard - Very Large Program algorithm, the missing score was excluded from the analysis based on advice provided by ITRON. For the UC/CSU program, all of the situations where the missing score was excluded from the analysis were caused by missing data on the No Program score.

The self-reported core NTGR is simply the average of the Timing and Selection, Program Influence, and No-Program Scores, divided by 10 or the average of the Timing and Selection and Program Influence score divided by ten.

1.9 Data Analysis and Integration

The calculation of the Core NTGR is fairly mechanical and is based on the answers to the closed-ended questions. However, the reliance of the Standard NTGR – Very Large on more information from so many different sources requires more of a case study level of effort. The SRA Guidelines point out that a case study is one method of assessing both quantitative and qualitative data in estimating a NTGR. A case study is an organized presentation of all these data available about a particular customer site with respect to all relevant aspects of the decision to install the efficient equipment. In such cases where multiple interviews are conducted eliciting both quantitative and qualitative data and a variety of program documentation has been collected, all of this information is integrated into an internally consistent and coherent story that supports a specific NTGR.

Sometimes, *all* the quantitative and qualitative data clearly pointed in the same direction while, in others, the *preponderance* of the data pointed in the same direction. Other cases were more ambiguous. In all cases, in order to maximize reliability, it was essential that two analysts were involved in analyzing the data. Each person analyzed the data separately and then compared and discussed the results. Important insights emerged from the different ways in which two analysts looked at the same set of data. Ultimately, differences were resolved and a case made for a particular NTGR. Careful training of analysts in the systematic use of rules was essential to insure inter-rater reliability.[1]

Once the individual analysts completed their review, they discussed their respective findings and presented their respective rationales for any recommended changes to the Calculator-derived NTGR. The outcome of this discussion is the final NTGR for a specific project. In disputed cases, a third analyst was consulted to moderate the final NTGR score.

1.10 Weighting of NTGR Scores for Program NTG

The measure level adjusted NTGR scores for the campuses in the UC/CSU sample were weighted by the ex-ante measure savings to calculate the program level NTGR. The project level NTG ratio is weighted by the number of projects with kWh, kW and therm savings resulting in a slightly different NTG ratio for each. This analysis was conducted in Excel.

[1] Inter-rater reliability is the extent to which two or more individuals (coders or raters) agree. Inter-rater reliability addresses the consistency of the implementation of a rating system.

2 UC/CSU NTG SUMMARY OF RESULTS

This section summarizes the NTG results for both the qualitative discussions (with Utility Program Managers, University System and Campus Representatives, and Decision-Makers), and for the quantitative analysis (with Decision-Makers).

The quantitative and qualitative results both indicate that, for every project or measure analyzed, there were multiple factors that influenced the decision to go forward. The Decision-Makers were asked to weigh the different factors which influenced their decision to implement specific efficiency measures in the time period when they did, including the need to replace old or failing equipment, the availability of the rebate, etc. Table D-5, below, summarizes a number of the factors that were tested during the executive interviews, along with the average rating associated with each factor given by campus-level decision-makers for the specific measures installed (on a 0-10 scale, with 10 signifying very strong influence). The availability of the rebate and the payback on investment were the two most influential factors.

Table D-5. Factors of Influence on UC/CSU Decision-Making

Factors of Influence	Average Rating
Payback on the investment	9.2
Availability of the program rebate	8.8
Age or condition of the facility	6.3
Previous experience with PROGRAM	6.2
Corporate policy or guidelines	6.0
Information provided through program audit	4.6
Information provided through program related feasibility study	4.5
Previous experience with MEASURE	4.4
Previous experience with MEASURE	4.4
A recommendation from an auditor or consulting engineer	3.6
Standard practice in your industry	3.2
Recommendation from a vendor	2.6
Information from UTILITY or program training course	2.6
Endorsement or recommendation by UTILITY Account Rep	2.2
Information provided through other technical assistance provided through &PROGRAM	2.0
Recommendation from PROGRAM staff	1.8
Information from UTILITY or program marketing materials	1.1

2.1 Summary of UC/CSU Qualitative NTG Results

Summit Blue conducted executive interviews with Utility Program Managers and UC and CSU campus-level facility managers who oversaw the implementation of energy efficiency projects that were funded by the UC-CSU Energy Efficiency Partnership Program. These interviews are summarized in "Section 3. UCCSU Qualitative Summary," of this appendix. There was general agreement among those interviewed that there had been very little free-rider ship in the 2007-2008 Program cycle because projects get vetted closely (and are not eligible to free-riders) and because most campuses lacked sufficient funds to do projects without external financing.

In the interviews with the Decision-Makers, very little to zero free-ridership was indicated from discussions about projects implemented on the 2007-2008 time frame. There were a few examples of partial free-ridership among this group of projects (meaning the campus likely would have installed some of the measures in the same year or in future years), and a few examples of true free-ridership, both captured by the quantitative treatment of these issues (described below).

The key qualitative findings about free-ridership and spillover captured from the executive interviews with decision-makers are:

- Most of the projects would not have been completed without Partnership Program funding, in whole or in part (partial free-ridership).
- Lack of funding has been the major barrier to implementing projects, followed by lack of expertise/staff to focus on this issue.
- The Partnership Program has helped fund viable, energy-saving projects that would otherwise not have been implemented and has brought energy efficiency to the attention of diverse campus-level decision-makers who need to be part of the decision.
- There was no spillover indicated in the qualitative portion of the executive interviews. There was no efficiency project implemented that was not funded by the Program. In fact, one campus has a policy that efficiency projects must be co-funded by a utility or government program.

2.2 Calculated and Analyst-Adjusted NTG Results

The UC-CSU NTG effort for the LGP Program was evaluated using the case study method from the Standard Extra Large customer as developed by ITRON for use by all evaluators in the 2006-2008 program cycle. Summit Blue staff reviewed the Program Implementation Plans (PIPs), available quarterly reports and campus websites.

An executive interviewer completed interviews with nine utility representatives, four UC-CSU System staff (two from the UC Office of the President and two from the CSU Chancellor's Office), seven University or College representatives, and 8 on-site campus decision-makers (Facility or Campus Energy Managers) for 19 projects. While utility Program Managers and campus representatives generally claimed that free-ridership was close to zero, the more quantitative data derived from the decision-maker surveys found free-ridership levels ranging from 0% to 60%. These levels were obtained by entering the decision-maker data into the NTGR calculator to generate preliminary scores. These free-ridership levels represent NTGRs ranging from 0.4 to 1.0. Then, two evaluators, one the executive interviewer, independently reviewed the NTGR scores and adjusted them based on the qualitative information gleaned from the in-depth interviewers with program staff, campus representatives and decision-makers during the survey. Then, the evaluators determined a collaborative adjustment. Adjustments were made to almost half of the scores, and overall NTG ratios were slightly decreased from an un-weighted average of 0.80, to an un-weighted average of 0.76. Thus, free-ridership was deemed to be slightly higher than estimated in the calculator. Table D-6 displays the results.

Table D-6. NTG Ratios for UC/CSU (Calculated and Adjusted)

ID	Campus	Measure	Calculated NTGR	Adjusted NTGR
29	CSU-San Bernadino	Campus-wide lighting retrofit	0.67	0.68
27	CSU- San Marcos	PC Power Management	0.75	0.70
28	CSU- San Marcos	Heating Hot Water System Improvements	1.00	1.00
38	CSU - San Diego	Student Services West: Upgrade fans to VSD	0.78	0.78
39	CSU - San Diego	HP Steam Trap Survey and Replacement	0.93	0.92
40	CSU - San Diego	LP Steam Trap Replacement - campus wide.	0.93	0.93
16	UC Berkeley	Retrofit Steam Traps	0.87	0.80
24	UC Davis	Steam Trap Retrofit	1.00	1.00
8	UC Davis	Central Plant - Absorber to Chiller Upgrade	0.60	0.60
30	UC Irvine	Replace existing stairwell lighting with bi-level technology	0.90	0.70
31	UC Irvine	CRT Monitor replacement and PC Power Management	0.60	0.55
32	UC Irvine	Upgrade to Low Pressure Drop/High Efficiency HVAC Filters	0.90	0.80
35	UC Irvine	Reduce air changes in Teaching Labs by installing dampers, controls, and occupant sensors	0.50	0.50
36	UC Irvine	Replace fans on AHU 1 and 3, install VFDs, remove sound attenuators	0.40	0.40
37	UC Irvine	Install Aircuity	0.96	0.93
22	UCLA	MSB Fume Hood Conversion Project	0.81	0.81
19	UCSF	Lighting Garages (M6549) - MU/ACC	0.87	0.80
20	UCSF	HVAC Retrofits - Kalmanovitz Library	0.93	0.87
34	UCSF	Library - Install and Commission New VFDs, Correct Start/Stop Controls	0.73	0.73

2.3 Spillover

There was no spillover indicated in the executive interviews with the UC and CSU campus-level decision-makers. Each respondent was clear that there had been no energy efficiency projects, stimulated by their experience with an efficiency measure through the Partnership Program, that had been implemented but which received no utility or government funding. In fact, each campus decision-maker claimed that there had been no efficiency projects implemented that were unfunded in the 2007-2008 time frame, stimulated by the Partnership Program or not.

CPUC directives require that participant spillover be measured and reported in the evaluation reports, but not included in the program accomplishments credited to the IOUs toward goal attainment. Therefore, Program Spillover percents are not estimated for Program impacts.

2.4 Program NTG

The adjusted NTG ratios for each project in the UC/CSU Program was weighted based on the proportion of kWh, kW or therm savings they contributed to the total savings in the sample to created a kWh, kW or therm savings weighted NTG ratio. The NTG ratios for the UC/CSU Program are presented in Table D-7. The table also presents levels of relative precision.[2]

The population of projects from the population was xx. Completed NTG surveys were conducted on 20 measures at 8 universities. Cooperative campus decision makers were asked to complete the Net-to-Gross questions on multiple campus projects.

A Program NTG ratio of 0.69 was estimated for kWh, which was based on 11 projects and had a confidence and precision level of 90/12. A Program NTG ratio of 0.75 was estimated for kW, with confidence and precision of 90/8, from a sample size of 8 projects. The Program NTG ratio for therms had a score of 0.72 and confidence and precision of 90/13, from a sample size of 13 projects.

The confidence and precision level goals of 90/20 was met for KWh, kW and therm fuel types.

Table D-7. Program NTG, Sampling, Confidence and Precision Results for UC/CSU

Savings Type	NTG Sample Size	% Free Riders	NTGR % (1-%FR)	CV	Confidence	Precision
kWh	11	31%	69%	.23	90%	12%
kW	8	25%	75%	.12	90%	8%
Therm	13	28%	72%	.26	90%	13%

[2] Calculations for relative precision applied T Values according to sample size at the 90% confidence level, and did not apply a finite population correction factor.

3 UC/CSU NTG QUALITATIVE SUMMARIES

This section summarizes the results of in-depth interviews with Utility Program Managers, Campus System Representatives, and Vendors affiliated with the UC/CSU Program.

3.1 Summary of Interviews with Utility Program Managers

This document summarizes the interviews with utility staff members. Summit Blue interviewed nine UC/CSU Program Managers from PG&E, SCE, Sempra and Socal Gas, using the survey instrument "Utility Program Manager: PROGRAM MGR 2009-07-20.doc." Though the same interview guide was used for each in-depth interview with utility Program Managers , Summit Blue focused on specific topics with different Program Managers to deepen the level of information and gain more visibility on certain Program features.

Program Description

The Program was conceived of and designed by a working group including senior executives from both the utilities and university systems. The purpose of the Program is to stimulate energy efficiency upgrades in the existing building stock and new buildings at UC and CSU campuses that, due to capital limitations, would otherwise not be implemented. The Program targets numerous efficiency measures in HVAC, lighting, building envelop, server-room and IT-related, etc.

Program Implementation, Outreach, and Decision-Making Processes

The Program Managers agree that the interactive nature of the Partnership Program typically guarantees that projects get studied and vetted very thoroughly before applications get submitted - first to the Management Team, then to the Chancellor's Office and the Office of the President, and ultimately to the utilities. The utilities therefore deny very few applications.

The spirit of the partnership was captured well by another utility Program Manager: "We involved our customers in the decision-making process by making them part of the Management Team. Therefore we have a shared goal/objective. The goal was created from input from the customer and progress was tracked by Program Administrative Manager selected by Management Team to act as administrator and coordinator for the entire team. By working with decision-makers at Office of President and the Chancellor's Office, we reached a high level of support to be able to complete projects on the campus level."

The utility Program Managers have a very uniform vision of the Program goals, outreach methods, metrics and measurements of success, how project-specific decisions are made, and roles of various parties and Teams. There is obvious common thinking and unified implementation strategies about the Partnership Program.

Program Marketing

The utilities have done some marketing of the Program, but report that most of the marketing was done by the UC Office of President and the CSU Chancellor's Office.

Non-Energy Benefits

The respondents also identified several other non-energy benefits from the program including:

- Awareness of energy efficiency
- Improved occupant comfort
- Market transformation
- Creation of partnerships

Free-Ridership

There was general agreement that there had been very little free-rider ship in the 2007-2008 Program cycle because projects get vetted closely and because most campuses lacked sufficient funds to do projects without external financing.

Project Results

The Program Managers generally agree that the Program is functioning according to the Program Implementation Plan (PIP), and that no major revisions were needed in the field.

Summit Blue asked the utility Program Managers whether the utility is reaching, exceeding, or falling short on various targets (i.e., spending, energy saved, kW saved and therms saved). Most utility Program Managers believed, as of the fourth quarter of 2008, that their programs were on target or exceeded targets for spending. About one-third believed their programs had fallen short of spending targets. Regarding targets for energy (kWh) saved, the utility Program Managers were split. About one-third believed they were on target for energy saved, another third believed they were exceeding targets, and another third believed they were behind targets. Regarding targets for capacity (kW) saved by the program, about half believed their utility was on target, and a third felt they were falling short of expectations. Regarding therms saved, 80% believed they were on target.

A key point made during the qualitative interviews is that university school years and utility calendar years are incongruous. The university fiscal year begins in September and the utilities follow a January-December calendar year. The universities are often challenged to complete projects by the end of the calendar year for a variety of reasons (e.g., most major renovations on campus can only be done during the summertime), meaning a lot of program-related kWh savings and program spending get deferred to the following calendar year. A number of utility Program Managers suggested that, though targets were not being met for the fourth quarter of 2008, they believed they would be meeting or exceeding Program goals by the end of 2009.

One utility Program Manager summarized the benefits of the Partnership Program very succinctly: "By virtue of being a Partnership, we are able to work together, look at a variety of solutions, share information, and this is all done in a relationship-building, on-going format. We get to know the campuses very well, and they get to know the program very well."

The biggest barrier identified by Program Managers is the lack of funding at the college and university campuses for implementing energy efficiency measures. This was seen to be more acute for the CSU system, but both the CSU and UC systems have been hampered by lack of capital for energy efficiency investments.

One individual expressed that they think the electricity side of the Program was getting more attention than the gas side. Also, the high cost of the gas projects (relative to the savings) is a large barrier on the gas side.

The fact that the Partnership Program had been on a two-year cycle (during 2007-2008) was a barrier because it did not align with the three to five year planning horizon universities often require for major projects. "If we wanted larger more sustainable projects, such as central plants or new construction, we should move to a five-year program rather than a three-year program." Another manager stated: "We're held to a year-end goal and based on whether we meet that goal our funding are set for the following year. Projects often get delayed into the following year, and our budgets can get reduced. Delays shouldn't be punished like that."

3.2 Summary of Interviews with University System Representatives

Summit Blue interviewed four Partnership Program staff at both the UC Office of the President and CSU's Chancellor's Office, using the survey instrument "University System Representatives: UNIVERSITY SYSTEM REP 2009-07-20.doc." These interviews were conducted with senior staff members from the UC Office of the President and the CSU Office of the Chancellor.

Application Process

The campuses work with the Chancellor's Office and Office of the President. Once an application gets approved by one of the system offices, it gets submitted to the Management Team. The Management Team has approval power. If a project application is approved, the university works with Newcomb Anderson to finalize the application, and then Newcomb Anderson files the application to the utility. They develop the Incentive Agreement, which is a contract called the "Retrofit Project Campus Payment (RPCP) form." This gets signed by the utility and the individual campus, and the project has been officially approved.

Role of University System Representatives

The Office of the President and the Chancellor's Office see themselves as central players driving this Program's success. The Program is largely managed and marketed through these two offices to the respective campuses, and these offices both work closely with the Program Administrator to manage and track Program activity. These two offices were also very involved in negotiating the Master Agreement that governs the relationships between the universities and the investor-owned utilities who implement the Program.

The Management Team is responsible for the day-to-day operations of the program, tracking projects, reviewing-approving applications, etc. The Executive Team works on policy, larger Program issues that come up, etc. There is a new Master Agreement for the 2010-2012 program cycle, but it is not that different from previous Master Agreements. The Master Agreement is the enabling contract signed by the investor-owned utilities and the UC and CSU system executives, which governs the Partnership Program and designates how the Program shall be coordinated between the universities and utilities. It was renegotiated for the new Program Cycle (2010-2012), and a few senior Program executives commented that think it is now "a very workable contract."

Program Results

Overall, Program Managers from all host organizations rated the Program, in the 2006-2007 time period, very positively. Though there may have been programmatic improvements needed in earlier cycles, the Program is now very integrated into the business practices of the investor-owned utilities and is very familiar to campus-level facility managers. Most campus-level decision-makers had experience with the Program before, which was seen as a driver to new projects. “Having worked with the program before gave our group, and other offices on campus, the confidence that it was worth giving attention to.”

Lengthening the Program cycle from two years to three years is also seen a very positive step forward, as stated by a few Program Managers . “Most institutional customers require three to five years to plan, implement, and complete large-capital, improvement projects,” said a utility Program Manager. By extending the length of the cycle, “campus managers are given a longer runway” to scope and budget for projects and to submit formal project applications.” It also gives utilities more time to respond to project applications and do field inspections.

One of the important features of the Program, for a few campuses, was the energy audits that were provided. A few campus energy managers commented that the audits helped “bring projects to light” and “get them on our radar screens.” This project identification and validation helped them win the interest of other campus decision-makers.

On the UC side, an enormous effort was recently undertaken (using funds from a lawsuit against Enron) to develop the *Strategic Energy Plan*, or SEP, which identified over 700 energy efficiency projects across all UC campuses, and prioritized them based on calculated costs, potential energy savings and potential ROIs. The *SEP* enabled facility managers to sell the idea of capital improvements internally to the Office of Budget and helped the UC system to release a bond issue to fund over $200 million of energy efficiency improvements. The CSU system does not have a similar “master feasibility study” which identifies and validates project concepts. CSU system executives told Summit Blue that, unlike the UC system, the CSU was also not successful in issuing a bond, meaning that the problem of limited budgets for energy efficiency improvements has not been mitigated on the CSU system.

The University System Representatives believe the Program suffered across the board due to a series of economic downturns in California, which seems to have negatively impacted the CSU side more than the UC side, because the CSU system’s Annual Capital Outlay Program (ACOP) is directly tied to the State of California’s budget.

The biggest barriers Representatives identified are serious capital constraints at the campuses and lack of technical expertise to identify and implement energy efficiency projects. These barriers were both addressed on the UC side, as described above, by the Strategic Energy Plan (SEP), which identified and prioritized projects and the recent issuance of a large bond that has created a capital fund for energy efficiency measures. The CSU side is still hampered by these barriers.

Free-Ridership

The University System program officers maintain that there is very little, and possibly zero, free-ridership among the projects funded by the Partnership Program at the university and college campuses. Their comments echo what many of the utility Program Managers said, which is that: (a) lack of funding on campus id the largest barrier to project initiation and (2) the project concepts and applications get reviewed and vetted by so many different staff members, and then again by the Program Administrator, that by the time the applications get submitted to the Chancellor’s Office or the Office of the President, those applications are only for valid (non-free-rider), viable projects that really will save energy and/or capacity, but could not be funded with other campus budget monies.

Program Challenges

Key quotes from these Representatives provide insight into some of the key challenges that Program participants have faced in the past and some of the distinct differences between the two systems:

"The UC system's budget for FTEs in facility management is 3 times larger than CSU's. So the attendance of UC staff at training seminars is 2-3 times larger. These training seminars are very important conveyors of Program information. The CSU side just doesn't have the people to send. The UC side has a lot more hospitals and laboratories (which are self-funding or bring in financing). The CSU side's facility overhead costs are much lower; even though it has two times as many campuses, they are smaller in size."

"The two systems have similar concerns, similar facilities, but the delivery of energy efficiency is different form an organizational standpoint and a financing standpoint. The UC has the SEP which really raised the visibility of the Program. The CSU side is less of a 'one big consolidated effort', but each campus is still submitting project ideas (that get floated up the Chancellor's Office)."

3.3 Summary of Interviews with University Campus Representatives

Summit Blue interviewed seven UC-CSU-CCC Partnership Program Campus Representatives from six college and universities involved in the program, using the survey instrument "University Campus Representatives: CAMPUS ENERGY MANAGER 2009-07-20.doc." Seven University Campus Representatives were interviewed from the following campuses:

- CSU Santa Barbara
- UC Davis
- UC San Francisco
- UC Berkeley
- UC San Diego

Decision-Making Process

On the UC side, the Strategic Energy Plan helps identify and define the scope of work for many projects. The campuses have different preferred payback thresholds. At UCSF, for example, they focus (first) on projects identified in the SEP with paybacks less than eight years.

The Campus Representatives explained that each campus is different and that there are multiple decision-makers on each campus. For example, the core, state-owned buildings are under one set of decision-makers. The "auxiliary buildings" (housing, food courts, transportation/parking, recreational buildings, etc.), which generate their own funding, are operated by other facility managers.

For any given project, there are multiple decision-makers involved, from various departments, which have to review the project application and approve, including: Facilities Management, the Design and Construction Department, Contracts and Procurement, the Budget Office, the Planning Department, Housing Director, etc. It can take time and be somewhat complicated. Once the campus-level decision-makers have approved the application, it gets submitted by the Campus Representative to either the CSU Chancellor's Office or the UC Office of President, where it gets further scrutinized.

Utility Role

The Campus Representatives claim that the utilities have varying roles in the project cycles. These two verbatim comments reflect the differences reported about utility roles:

- "The utilities provide design/development assistance, they provide funding/resources to conduct pre- and post-project audits. They review the applications, help execute the funding agreements. For MBCX projects, the application itself is reviewed by in-house engineering and there isn't always a physical audit prior."
- "The utilities don't do much on the front end to help scope and define projects, and they have big resources for that kind of thing. It might be nice if they were a bit more pro-active in making people know these resources are available and bringing them to the table."

Program Results

The Campus Representatives view the Program overall very favorably and believe the Program has helped them identify, fund and implement numerous energy-saving and capacity-saving measures (which they otherwise could not have implemented). In many cases, they described building equipment that was many years, even decades old, that needed to be upgraded. The Program funds helped campuses install new building equipment with a higher level of energy efficiency than they otherwise could have done.

To a large measure, the campus decision-makers did not see great value in the Program's training/education and technical assistance mechanisms; in some cases, however, the Program-related audits helped the campuses identify projects and move forward on implementing energy efficiency measures. (This is not uniformly true across all campuses; some campuses take advantage or need technical assistance more than others). They also think the Program Administrator, Newcomb Anderson McCormick, is effective at tracking projects and assisting with application completion. Some university decision-makers expressed some desire for the utilities to step forward and use their internal resources more aggressively to help identify and validate projects.

Projects sometimes get slightly modified after construction has begun, but usually only in minor ways, due to certain architectural/design constraints that get identified after tearing down walls. However, sometimes other reasons emerge for modifying the project after it has been approved: "We change the scope of a project because priorities change, new technologies are available, additional site assessment results in additional energy savings opportunities being identified, funding abilities change, schedules may change due to weather, campus activities, etc."

These other verbatim comments also provide insight into how the Campus Representatives perceive the value of the Partnership Program:

- "The Program came at an ideal time in terms of renovations that were needed, right when the UC deferred maintenance budget got slashed to zero. It opened my world to all kinds of new projects, with $10 million worth of projects in the current three-year cycle."
- "In the first two cycles (2004-2006 and 2006-2008), the university used a traditional financing approach (using capital funds). The program was not very successful in the first couple cycles because the budgets just weren't there. It was a battle to get any projects built. The Office of President couldn't dictate policy or specific actions to the campuses. The bond issues were never enough. There was always some money for energy efficiency, but it was very limited."

Free-Ridership

The Campus Representatives also claim that there are very few, if any, examples of free-ridership with the Program's funding. They maintain that budget constraints have prevented projects from going forward (before the Program offered support).

4 UC/CSU NTG CALCULATOR

This section contains the NTG Calculator used to compute NTG ratios based on results from the Decision-Maker survey. As explained in Section 1 of this appendix, "Introduction and Methods," these scores were then adjusted and weighted to compute the final NTG ratios.

The UC/CSU LGP Program was evaluated using the case study method from the Standard Extra Large Customer protocol as developed by ITRON for use by all evaluators in the 2006-2008 program cycle. As explained in the standard language document for Large Non Residential Programs:

"The Energy Division of the California Public Utilities Commission (CPUC) formed a nonresidential net-to-gross ratio working group that was composed of experienced evaluation professionals. The main purpose of this group was to develop a standard methodological framework, including decision rules, for integrating in a systematic and consistent manner the findings from both quantitative and qualitative information in estimating net-to-gross ratios." [3]

"The methodology described in this section was developed to address the unique needs of Large Nonresidential customer projects developed through energy efficiency programs offered by the four California investor-owned utilities and third-parties. This method relies exclusively on the Self-Report Approach (SRA) to estimate project and domain-level Net-to-Gross Ratios (NTGRs), since other available methods and research designs are generally not feasible for large nonresidential customer programs. This methodology provides a standard framework, including decision rules, for integrating findings from both quantitative and qualitative information in the calculation of the net-to-gross ratio in a systematic and consistent manner."

To meet the requirements of the Standard –Very Large CPUC evaluation standard, Summit Blue staff reviewed the Program Implementation Plans (PIPs), available quarterly reports and campus websites. An executive interviewer completed interviews with 7 utility representatives, 4 University representative and 7 Campus representatives. In addition, Summit Blue staff surveyed decision-makers on 19 projects which were also selected for the on-site impact study. Decision-maker data was entered into the NTGR calculator to generate the calculated NTGR scores in the UC/CSU NTG Calculator.

The calculated NTGR score is an average of the Timing and Selection, Program Influence and No Program scores. The survey questions and scores are presented in Table D-8 (1-3). One change was made to the algorithm to account for the following missed question: "When do you think you would have done this (installed the same energy efficient equipment)?" This question was collapsed with the following question on the number of months to installation of the same equipment. These free-ridership levels represent NTGRs ranging from 0.4 to 1.0.

[3] Large Nonresidential NTG Methods Language 110509, ITRON Consulting via email.

Table D-8. Decision Maker NTG Scoring Worksheet – 1

Campus	UC Berkeley	UCSF	UCSF	UCLA	UC Davis	CSU San Marcos	CSU San Marcos	CSU San Bernadino
Measure Installed	**Retrofit Steam Traps**	**Lighting Garages - MU/ACC**	**HVAC Retrofits - Kalmanovitz Library**	**MSB Fume Hood Conversion Project**	**Steam Trap Retrofit**	**PC Power Management**	**Heating Hot Water System Improvements**	**Campus-wide lighting retrofit**
SCORING CATEGORY								
Timing and Selection Score	**10**	**9**	**10**	**8**	**10**	**10**	**10**	**8**
Please rate the importance of each of the following in your decision to implement this specific [MEASURE] at this time.								
Age or condition of the facility ?	10	2	2	2	7	8	4	7
Availability of the program rebate	10	9	10	5	10	10	8	8
Information provided through program related feasibility study	10				10	9	10	0
Information provided through program audit	10				10	9	10	0
Information provided through other technical assistance provided through &PROGRAM						5	10	0
Recommendation from a vendor	8	0	0	10	0	3	7	0
VENDOR VMAX Score times Vendor Rec. score if Vendor Rec.>5	0	0	0	0	0	0	0	0
Previous experience with MEASURE	10	0	0	6	0	0	8	8
Previous experience with PROGRAM	5			7	8	8	0	5
Information from UTILITY or program training course				8	5	7	7	6

Campus	**UC Berkeley**	**UCSF**	**UCSF**	**UCLA**	**UC Davis**	**CSU San Marcos**	**CSU San Marcos**	**CSU San Bernadino**
Measure Installed	**Retrofit Steam Traps**	**Lighting Garages - MU/ACC**	**HVAC Retrofits - Kalmanovitz Library**	**MSB Fume Hood Conversion Project**	**Steam Trap Retrofit**	**PC Power Management**	**Heating Hot Water System Improvements**	**Campus-wide lighting retrofit**
SCORING CATEGORY								
Information from UTILITY or program marketing materials	7					0	0	1
A recommendation from an auditor or consulting engineer		5	9		7	0	9	8
Standard practice in your industry	8			8	0	0	10	
Recommendation from PROGRAM staff					7	0	3	
Endorsement or recommendation by UTILITY Account Rep					7	4	2	
Corporate policy or guidelines	9		3	0	0	8	7	7
Payback on the investment	10	10	10		10		10	10
Other, such as non-energy benefits					Occupancy comfort.	Reduced number of servers. Great capital cost benefit!	Equipment needed to be right-sized to save energy.	Also wanted to upgrade the old original lighting
Importance of other factor					6	9	10	8
Program Influence Score (reduced by half if learned after decision)	**7**	**8**	**9**	**7**	**10**	**6**	**10**	**8**
Did you first learn about the CCC Program BEFORE or AFTER you first began to think about implementing the measure ?	AFTER	BEFORE	BEFORE	BEFORE	BEFORE	BEFORE	BEFORE	AFTER
Did you learn about the program BEFORE or AFTER you decided to implement MEASURE?	BEFORE							BEFORE

Campus	UC Berkeley	UCSF	UCSF	UCLA	UC Davis	CSU San Marcos	CSU San Marcos	CSU San Bernadino
Measure Installed	Retrofit Steam Traps	Lighting Garages - MU/ACC	HVAC Retrofits - Kalmanovitz Library	MSB Fume Hood Conversion Project	Steam Trap Retrofit	PC Power Management	Heating Hot Water System Improvements	Campus-wide lighting retrofit
SCORING CATEGORY								
The overall importance of the Program versus the most important of the non-program so that the two importance ratings total 10								
The overall importance of the CCC PROGRAM in your decision to implement MEASURE	7	8	9	7	10	6	10	8
The overall importance of other factors in your decision to implement MEASURE	3	2	1	3	0	4	0	2
No-Program Score	9	9	9	9	10	7	10	4
If the &PROGRAM had not been available, what is the likelihood that you would have installed exactly the same item/equipment	1	1	1	1	0	4	0	6
Number of months				24		12		6
NTGR SCORE =	**0.87**	**0.87**	**0.93**	**0.81**	**1.00**	**0.75**	**1.00**	**0.67**

Table D-8. Decision Maker NTG Scoring Worksheet – 2

Campus	**UCSF**	**UC Davis**	**San Diego State**	**San Diego State**	**San Diego State**
Measure Installed	**Library - Install and Commission New VFDs, Correct Start/Stop Controls**	**Central Plant - Absorber to Chiller Upgrade**	**Upgrade fans to VSD**	**HP Steam Trap Survey/ Replacement**	**LP Steam Trap Replacement - campus wide**
SCORING CATEGORY					
Timing and Selection Score	10	8	10	10	10
Please rate the importance of each of the following in your decision to implement this specific [MEASURE] at this time.					
Age or condition of the facility ?	6	7	9	8	8
Availability of the program rebate	10	8	10	10	10
Information provided through program related feasibility study	5	3			
Information provided through program audit	5	1		10	8
Information provided through other technical assistance provided through &PROGRAM	0	3	7	1	1
Recommendation from a vendor	3	7	0	0	0
VENDOR VMAX Score times Vendor Rec. score if Vendor Rec.>5	0	0	0	0	0
Previous experience with MEASURE	3	7	7	9	7

Campus	UCSF	UC Davis	San Diego State	San Diego State	San Diego State
Measure Installed	**Library - Install and Commission New VFDs, Correct Start/Stop Controls**	**Central Plant - Absorber to Chiller Upgrade**	**Upgrade fans to VSD**	**HP Steam Trap Survey/ Replacement**	**LP Steam Trap Replacement - campus wide**
SCORING CATEGORY					
Previous experience with PROGRAM	0	7	8	8	8
Information from UTILITY or program training course		0	7	0	2
Information from UTILITY or program marketing materials		0	5	2	0
A recommendation from an auditor or consulting engineer	7	0	999	999	999
Standard practice in your industry		6			
Recommendation from PROGRAM staff		0	6		3
Endorsement or recommendation by UTILITY Account Rep		2	0	4	7
Corporate policy or guidelines	5	3	7	7	6
Payback on the investment	7	9	9	10	10
Other, such as non-energy benefits	Occupancy comfort	Energy savings is an investment issue	Occupant comfort		
Importance of other factor	3		10		
Program Influence Score (reduced by half if learned after decision)	2	4	3.5	8	8

Campus	**UCSF**	**UC Davis**	**San Diego State**	**San Diego State**	**San Diego State**
Measure Installed	**Library - Install and Commission New VFDs, Correct Start/Stop Controls**	**Central Plant - Absorber to Chiller Upgrade**	**Upgrade fans to VSD**	**HP Steam Trap Survey/ Replacement**	**LP Steam Trap Replacement - campus wide**
SCORING CATEGORY					
Did you first learn about the CCC Program BEFORE or AFTER you first began to think about implementing the measure ?	AFTER	BEFORE	AFTER	AFTER	BEFORE
Did you learn about the program BEFORE or AFTER you decided to implement MEASURE?	AFTER		AFTER	BEFORE	
The overall importance of the Program versus the most important of the non-program so that the two importance ratings total 10					
The overall importance of the CCC PROGRAM in your decision to implement MEASURE	4	4	7	8	8
The overall importance of other factors in your decision to implement MEASURE	6	6	3	2	2
No-Program Score	10	10	10	10	10
If the &PROGRAM had not been available, what is the likelihood that you would have installed exactly the same item/equipment	0		0	0	0
Number of months					
NTGR SCORE =	0.73	0.60	0.78	0.93	0.93

Table D-8. Decision Maker NTG Scoring Worksheet – 3

Campus	**UC Irvine**	**UC Irvine**	**UC Irvine**	**UC Irvine**	**UC Irvine**	**UC Irvine**
Measure Installed	**Replace existing stairwell lighting with bi-level technology**	**CRT Monitor replacement and PC Power Management**	**Upgrade to Low Pressure Drop/High Efficiency HVAC Filters**	**Reduce air changes in Teaching Labs by installing dampers, controls, and occupant sensors**	**Replace fans on AHU 1 and 3, install VFDs, remove sound attenuators**	**Install Aircuity**
SCORING CATEGORY						
Timing and Selection Score	10	10	10	7	4	10
Please rate the importance of each of the following in your decision to implement this specific [MEASURE] at this time.						
Age or condition of the facility ?	8	10	5	0	10	
Availability of the program rebate	10	10	10	5	1	10
Information provided through program related feasibility study	0	0	0	7	4	
Information provided through program audit	0	0	0		0	
Information provided through other technical assistance provided through &PROGRAM	0	0	0		0	0
Recommendation from a vendor	0	0	0	0	0	10
VENDOR VMAX Score times Vendor Rec. score if Vendor Rec.>5	0	0	0	0	0	0
Previous experience with MEASURE	0	0	0	0	8	0
Previous experience with PROGRAM	8	8	8	8	8	8

Campus	**UC Irvine**	**UC Irvine**	**UC Irvine**	**UC Irvine**	**UC Irvine**	**UC Irvine**
Measure Installed	**Replace existing stairwell lighting with bi-level technology**	**CRT Monitor replacement and PC Power Management**	**Upgrade to Low Pressure Drop/High Efficiency HVAC Filters**	**Reduce air changes in Teaching Labs by installing dampers, controls, and occupant sensors**	**Replace fans on AHU 1 and 3, install VFDs, remove sound attenuators**	**Install Aircuity**
SCORING CATEGORY						
Information from UTILITY or program training course	0	0	0	0	0	0
Information from UTILITY or program marketing materials	0	0	0	0	0	0
A recommendation from an auditor or consulting engineer	0	0	0	8	5	0
Standard practice in your industry	0	0	0	0	3	0
Recommendation from PROGRAM staff	0	0	0		0	0
Endorsement or recommendation by UTILITY Account Rep	0	0	0		0	0
Corporate policy or guidelines	10	10	8		6	8
Payback on the investment	10	10	10		2	8
Other, such as non-energy benefits					We would have done the basic part of this project anyway	
Importance of other factor						
Program Influence Score (reduced by half if learned after decision)	8	2	8	4	4	9

Campus	**UC Irvine**	**UC Irvine**	**UC Irvine**	**UC Irvine**	**UC Irvine**	**UC Irvine**
Measure Installed	**Replace existing stairwell lighting with bi-level technology**	**CRT Monitor replacement and PC Power Management**	**Upgrade to Low Pressure Drop/High Efficiency HVAC Filters**	**Reduce air changes in Teaching Labs by installing dampers, controls, and occupant sensors**	**Replace fans on AHU 1 and 3, install VFDs, remove sound attenuators**	**Install Aircuity**
SCORING CATEGORY						
Did you first learn about the CCC Program BEFORE or AFTER you first began to think about implementing the measure ?	BEFORE	BEFORE	BEFORE	AFTER	BEFORE	BEFORE
Did you learn about the program BEFORE or AFTER you decided to implement MEASURE?				BEFORE		
The overall importance of the Program versus the most important of the non-program so that the two importance ratings total 10						
The overall importance of the CCC PROGRAM in your decision to implement MEASURE	8	2	8	4	4	9
The overall importance of other factors in your decision to implement MEASURE	2	8	2	6	6	1
No-Program Score	0	0	9	4	0	10
If the &PROGRAM had not been available, what is the likelihood that you would have installed exactly the same item/equipment	10	10	3	7	10	1
Number of months	3	6	36	12	6	36
NTGR SCORE =	0.90	0.60	0.90	0.50	0.40	0.96

5 UC/CSU NTG CASE STUDIES

This section includes detailed Case Studies for the projects included in the Decision-Maker survey effort. Case Studies include background information on the campuses and projects, an assessment of free-ridership (including results from the '2 Analyst' Assessment and the Collaborative Adjustment), and conclusions made for each project.

5.1 UC Davis

Campus Description

The University of California, Davis (also known as UCD and UC Davis) is a public university and was established as a campus of the UC system in 1959. The campus is located in Davis, California, near Sacramento. It is 5,500 acres. 2,092 faculty educates 24,209 undergraduate and 7,217 postgraduates students. The university provides 102 undergraduate and 87 graduate programs. The campus is noted for its sustainability efforts. (www.ucdavis.edu)

Facility Manager

Project ID #8

Measure: Central Plant - Absorber to Chiller Upgrade

Project Description

For this project, Trane centrifugal chillers were installed in place of absorbers in the Central Plant. The project application was submitted on October 19, 2007 and the project was completed by November 28, 2007. The university received $1,246,278 in incentives.

Net-to-Gross

The NTGR calculator gave a result of 0.60, suggesting a high level of free-ridership. This was derived from a Timing and Selection score of 8 and a Program Influence score of 4. The facility manager rated the importance of the program at a 4 (out of 10), which is very indicative of other (non-program) influences bearing on the decision to implement the project.

Analyst 1 Analysis: Description and Justification of Analysis

- Payback on investment was rated very high by the facility manager (9 out of 10).
- The rebate was also rated at 8 out of 10 (in importance).
- Though the Program (compared to other factors) was only given an importance of 6 (out of 10), this does not suggest free-ridership. It suggests that there were a constellation of reasons why the project made sense, but not that they would have been able to implement the project without the funding provided by the Program.
- The facility manager made the following comment: "The financing really helped tip the scale. Turned out to be 40% of project costs. We **may** have done it anyway, because it needed to be done." This comment does suggest free-ridership.

- The facility manager made the following comment: "We had previous experience with this technology and in-house expertise." This suggests the facility managers already feel comfortable with this technology and have some momentum internally to deploy it when possible.

Analyst 1 supports a NTGR of 0.60, which is consistent with the NTGR calculator.

Analyst 2 Analysis: Description and Justification of Analysis

Analyst 2 supports a NTGR of 0.6. While the manager says that the "financing really helped tip the scale", the manager still rated the importance of the Program a 4, and claimed that they likely would have "done it anyway".

Collaborative Adjustment

Both Analysts support the NTGR calculator result of 0.6. The manager claims that Program was valued at 4 and that other, non-program factors were valued at 6.

5.2 UC Berkeley

Campus Description

The University of California, Berkeley (also known as Cal and UCB, and Berkeley) is a public university and was established in 1868. It is located in Berkeley, California, occupying 6,651 acres. The university offers more than 300 undergraduate and graduate programs. 25,151 undergraduate and 10,317 graduate students are enrolled currently. It was the first university in the UC system. In 2009, the university developed its Climate Action Plan and is actively working on sustainability issues. (Source: http://berkeley.edu)

Campus Facilities Manager

Project ID #16

Measure: Retrofit Steam Traps

Project Description

In this project, Steam Traps were surveyed and replaced. The project application was submitted on January 29, 2007 and the project was completed by March 10, 2008. The university received $57,497 in incentives (gas).

Net-to-Gross

The NTGR calculator gave a result of 0.87, suggesting a modest level of free-ridership. This was derived from a Timing and Selection score of 10, a Program Influence score of 7, and a No Program score 9. The Facilities Manager said that there was a very slight chance the campus would have implemented the project anyway (1 on a scale of 10, in terms of likelihood), had the Program not been available. However, he also gave a high rating (9 or 10 out of 10) to a number of Program effects (e.g., the rebate, technical assistance, training, etc.) in terms of Program influence.

Analyst 1 Analysis: Description and Justification of Analysis

- The Program-related scores were all very high (8-10)
- The Manager rated the importance of the Program as a 7, and the other, non-program related factors a 3.
- The Facilities Manager said that there was a very slight chance (1 on a scale of 1-10) the campus would have implemented the project anyway, had the Program not been available.
- The Facilities Manager said there are corporate policies: "We want to reduce emissions by 2014 to 1990 levels. The Office of President has the same goal - by 2020 - as required by the State - UC Berkeley opted to do it by 2014."

Analyst 1 recommends reducing the NTGR slightly from 0.87 to 0.75. On the one hand, Analyst 1 believes the Program was extremely influential, including the training and technical assistance it offers. However, the fact that the Campus Energy Manager gave 7 out of 10 "influence points" to the Program, and 3 to non-program influences, suggests some free-ridership. Thus, Analyst 1 recommends reducing the NTGR to 0.75.

Analyst 2 Analysis: Description and Justification of Analysis

Analyst 2 supports the NTGR calculator estimate of 0.87. The manager rated the importance of the Program a 7, and stated that while there is a campus-wide focus on reducing emissions and energy efficiency, they could not have implemented their projects without the rebate.

Collaborative Adjustment

Analyst 1 supports a slight downward adjustment of the NTGR calculator result of 0.87 to 0.75. Analyst 2 supports the NTGR calculator estimate of 0.87. In discussion of their findings, they concluded that the NTGR should be adjusted to 0.80.

5.3 UCSF

Campus Description

University of California, San Francisco (also known as UCSF) is a professional school founded in 1873. It is located in the Bay Area, in the city of San Francisco, California. 1686 faculty educate nearly 3,000 post-graduates. UCSF operates four major campus sites within the city of San Francisco and one in Fresno, as well as numerous other minor sites scattered through San Francisco and the Bay Area. Total size: 135 acres plus 43 acres at Mission Bay campus. The campus includes the world renowned UCSF medical center. (www.ucsf.edu)

Campus Facilities Manager

Project ID #19

Measure: HID light fixtures replaced by T8s (Millbury Union/ACC garage)

Project Description

For this project, HID light fixtures were replaced by energy efficient T8 fixtures at the Millbury Union/ACC Garage at the UC San Francisco campus. The application was submitted on January 28, 2008 and the project was completed by October 14, 2008. The campus received $171,224 in combined incentives for all garage retrofit projects.

Net-to-Gross

The NTGR calculator gave a result of 0.87, suggesting a modest level of free-ridership. This was derived from a Timing and Selection score of 9, a Program Influence score of 8, and No Program score of 9.

Analyst 1 Analysis: Description and Justification of Analysis

- The availability of the rebate and the payback on the investment were rated the highest (9 and 10, out 10, respectively) in terms of influential factors.
- The Manager rated the importance of the Program at 8, and the other, non-program related factors a 2.
- The Facilities Manager said that there was a very slight chance (1 on a scale of 1-10) the campus would have implemented the project anyway, had the Program not been available.
- The Program Manager: "We want to improve energy efficiency by 20% over Title 24. This is what we want to do, with or without the Program."
- The Facilities Manager said: "We couldn't have done this project without the extra funding (from the Program)."

Analyst 1 recommends reducing the NTGR slightly from 0.87 to 0.75. On the one hand, Analyst 1 believes the Program was extremely influential. However, the fact that the Campus Energy Manager gave 8 out of 10 "influence points" to the Program, and 2 to non-program influences, suggests some free-ridership. Also, the Facilities Manager said that there was a very slight chance (1 on a scale of 1-10) the campus would have implemented the project anyway, had the Program (and rebate) not been available. Thus, Analyst 1 recommends reducing the NTGR to 0.75.

Analyst 2 Analysis: Description and Justification of Analysis

Analyst 2 supports the NTGR calculator estimate of 0.87. The utility manager rated the overall importance of the Program an 8, and stated that if the Program had not been available that the likelihood they would have implemented the projects would have been a 1. Therefore, the manager places a high value on the Program and indicated low to modest free-ridership in the calculator estimate. From the manager's comments, it was revealed that they "couldn't have done it without the extra funding," but do have goals to "reduce energy use by 20% above Title 24." These statements, both taken into consideration, do not lead the Analyst to recommend adjusting the NTGR.

Collaborative Adjustment

Analyst 1 recommends reducing the NTGR slightly from 0.87 to 0.75. Analyst 2 supports the NTGR calculator estimate of 0.87. They agreed to adjusting the NTGR downward slightly to 0.80 after further discussion.

5.4 UCSF

Campus Description

University of California, San Francisco (also known as UCSF) is a professional school founded in 1873. It is located in the Bay Area, in the city of San Francisco, California. 1686 faculty educate nearly 3,000 post-graduates. UCSF operates four major campus sites within the city of San Francisco and one in Fresno, as well as numerous other minor sites scattered through San Francisco and the Bay Area. Total size: 135 acres plus 43 acres at Mission Bay campus. The campus includes the world renowned UCSF medical center. (www.ucsf.edu)

Campus Facilities Manager

Project ID #20

Measure: HVAC Retrofits – Kalmanovitz Library - Install and Commission New VFDs, Correct Start/Stop Controls

Project Description

In the project, HVAC Retrofits were completed at the Kalmanovitz Library; specifically, new VFDs were installed and commissioned with correct start/stop controls. The project application was submitted on November 26, 2007 and the project was completed by November 15, 2008. The university has not received any incentives yet, but proposed incentives consist of $292,059 (electric) and $138,249 (gas).

Net-to-Gross

The NTGR calculator gave a result of 0.93, suggesting a very low level of free-ridership. This was derived from a Timing and Selection score of 10, a Program Influence score of 9, and No Program score of 9.

Analyst 1 Analysis: Description and Justification of Analysis

- The availability of the rebate and the payback on the investment were rated the highest (both 10 out of 10) in terms of influential factors.
- The Manager rated the importance of the Program at 9, and the other, non-program related factors a 1.
- The Facilities Manager said that there was a very slight chance (1 on a scale of 1-10) the campus would have implemented the project anyway, had the Program not been available.
- The Program Manager: "We want to improve energy efficiency by 20% over Title 24. This is what we want to do, with or without the Program."
- There were other energy efficiency projects (new VFDs and upgrade energy management system) at the library also funded through the Partnership Program, implemented at the same time.
- "Because it ended up costing more than we thought, we ended up doing less, and the payback was a little longer than originally expected."

Analyst 1 recommends reducing the NTGR slightly from 0.93 to 0.85. On the one hand, Analyst 1 believes the Program was extremely influential. However, the fact that the Campus Energy Manager gave

9 out of 10 "influence points" to the Program, and 1 to non-program influences, suggests slight free-ridership. Also, the Facilities Manager said that there was a very slight chance (1 on a scale of 1-10) the campus would have implemented the project anyway, had the Program (and rebate) not been available. Thus, Analyst 1 recommends reducing the NTGR to 0.85.

Analyst 2 Analysis: Description and Justification of Analysis

Analyst 2 recommends a slight downward adjustment to the NTGR calculator estimate of 0.93. The manager said the campus has a goal to "beat Title 24 by 20%." Therefore, the campus would be taking measures to improve energy efficiency at some point. Analyst 2 recommends a NTGR of 0.91.

Collaborative Adjustment

Analyst 1 recommends reducing the NTGR slightly from 0.93 to 0.85. Analyst 2 recommends a slight downward adjustment to the NTGR calculator estimate of 0.93 to 0.91. After further discussion, they agreed on a downward adjustment to 0.87.

5.5 UCLA

Campus Description

The University of California, Los Angeles (also known as UCLA) is a public university located in Los Angeles, California and was established in 1919. Today, the campus includes 163 buildings across 419 acres. 4,016 faculty educate 26,928 undergraduate and 11,548 graduate students. The university offers 129 undergraduate majors. (Source: www.ucla.edu)

Facilities Manager

Project ID #22

Measure: MSB Fume Hood Conversion Project

Project Description

During this project, vent and controls were upgraded and ZP sensors were installed on fume hoods. The project application was submitted on June 5, 2007 and the project was completed on August 1, 2008. The university has not received any incentives for this project yet, however, there is $284,463 in proposed incentives.

Net-to-Gross

The NTGR calculator gave a result of 0.81, suggesting a modest level of free-ridership. This was derived from a Timing and Selection score of 8, a Program Influence score of 7, and No Program score of 9.

Analyst 1 Analysis: Description and Justification of Analysis

- The availability of the rebate was rated at 5 (out of 10) in terms of influential factors. (This was because, in the Manager's own words: "We gave it a 5 because we couldn't get the (incentive on the) electric side. Only the gas side, so we got half of what others could have.")

- There were important recommendations from the equipment provider, but assume that didn't influence the decision.
- The Manager rated the importance of the Program at 7, and the other, non-program related factors a 3.
- The Facilities Manager said that there was a very slight chance (1 on a scale of 1-10) the campus would have implemented the project anyway, had the Program not been available.
- The Program also provided important technical assistance.

Analyst 1 recommends reducing the NTGR slightly from 0.81 to 0.70. On the one hand, Analyst 1 believes the Program technical assistance was extremely influential. However, the fact that the Campus Energy Manager gave 7 out of 10 "influence points" to the Program, and 3 to non-program influences, attributable in part to the input from the equipment vendor and design engineers, suggests some free-ridership. Also, the Facilities Manager said that there was a very slight chance (1 on a scale of 1-10) the campus would have implemented the project anyway, had the Program (and rebate) not been available. Thus, Analyst 1 recommends reducing the NTGR to 0.70.

Analyst 2 Analysis: Description and Justification of Analysis

Analyst 2 supports the NTGR calculator estimate of 0.81. While the manager commented that the Program gave the university confidence, they did not give any other statements which indicate cause for adjusting the ratio outputted by the calculator.

Collaborative Adjustment

Analyst 1 recommends reducing the NTGR slightly from 0.81 to 0.70. Analyst 2 supports the NTGR calculator estimate of 0.81. After further discussion, they agreed to keep the NTGR estimate of 0.81.

5.6 UC Davis

Campus Description

The University of California, Davis (also known as UCD and UC Davis) was established as a campus of the UC system in 1959. The campus is located in Davis, California, near Sacramento. It is 5,500 acres. 2,092 faculty educates 24,209 undergraduate and 7,217 postgraduates students. The university provides 102 undergraduate and 87 graduate programs. The campus is noted for its sustainability efforts. (www.ucdavis.edu)

Campus Facility Manager

Project ID# 24

Measure: Steam Trap Retrofit

Project Description

During this project, HP steam traps were installed for blocked or leak thru (Central Plant).The project application was submitted on March 29, 2007 and the project was completed by December 15, 2007. The university received $131,588 in incentives (gas).

Net-to-Gross

The NTGR calculator gave a result of 1.0, suggesting zero free-ridership. This was derived from a Timing and Selection score of 10, a Program Influence score of 10, and No Program score of 10.

Analyst 1 Analysis: Description and Justification of Analysis

- The Facility Manager rated the importance of the Program (rebate, technical assistance, etc.) a 10 (out of 10).
- The Facility Manager said there was a zero chance they would have implemented the same project without the Program.
- Though there are corporate policies about energy efficiency, the Manager said that "These policies did not have a direct influence on these decisions."

Analyst 1 supports a NTGR of 1.0, which is consistent with what the NTGR calculator estimated, because the Facility Manager said there was a "zero chance they would have implemented the same project without the Program."

Analyst 2 Analysis: Description and Justification of Analysis

Analyst 2 supports the NTGR calculator estimate of 1.0. None of the managers extra comments given during the interview suggest adjusting the ratio downwards. The manager said that there were no corporate policies at the time of project implementation, but because of the Program they have passed policies. The manager also stated that the Program "helped me present project ideas to my superiors. It gave everyone confidence."

Collaborative Adjustment

Both Analysts support the NTGR calculator estimate of 1.0.

5.7 CSU – San Marcos

Campus Description

The California State University, San Marcos (also known as CSUSM) is a public university located in San Marcos, California, in San Diego County on 340 acres. It was established in 1989. 246 faculty educate 9,159 students. The university offers 44 undergraduate, 10 graduate and 1 doctorate programs. (Source: www.csusm.edu)

Facility Manager

Project ID# 27

Measure: PC Power Management

Project Description

During this project, PC Power Management system was installed. The project application was submitted on April 29, 2008 and the project was completed by November 2, 2008.

The received a combined $687,325(electric) and $71,813 (gas) in incentives for all HVAC/Lighting/PC Management projects.

Net-to-Gross

The NTGR calculator gave a result of 0.75, suggesting some free-ridership. This was derived from a Timing and Selection score of 10, a Program Influence score of 9, and No Program score of 7.

Analyst 1 Analysis: Description and Justification of Analysis

- The availability of the rebate was rated at 10 (out of 10) and other Program services were also rated very high, in terms of influential factors.
- The condition of the equipment was also an important influential factor. The servers needed to be replaced.
- The Manager rated the importance of the Program at 6, and the other, non-program related factors a 4.
- The Facilities Manager said that there was a good chance (4 on a scale of 1-10) the campus would have implemented the project anyway, had the Program not been available, within 12 months.
- The Program also provided important technical assistance.

The Facility Manager also made the following comments:

"The IT department had to be involved - they managed it and inherited it. It was their servers and their money. My role in that one was advisory and to review the numbers, and to submit the application."

"The equipment had to be replaced in any event. They were going to replace a lot of servers, but then they didn't need to buy nearly as many new servers."

"This is not standard practice - this is brand new technology."

"Executive Order from the Chancellor - Executive Order 987 - It orders us to conserve energy (reduce by 15% of 2003-2004's use on BTU/sq/ft basis in 5 years) and covers new construction, create an energy manager, etc."

"It allowed us to go forward without buying nearly as many servers! Great capital cost benefit!"

"The project was cost-effective - even without the rebate. But the program opened everyone's eyes."

Analyst 1 recommends reducing the NTGR slightly from 0.75 to 0.60. On the one hand, Analyst 1 believes the rebate and the Program technical assistance were extremely influential. However, the fact that the Campus Energy Manager gave 6 out of 10 "influence points" to the Program, and 4 to non-program influences suggests some free-ridership. Also, the Facilities Manager said that there was a good chance (4 on a scale of 10) the campus would have implemented the project anyway, had the Program (and rebate) not been available. Thus, Analyst 1 recommends reducing the NTGR to 0.60.

Analyst 2 Analysis: Description and Justification of Analysis

Analyst 2 supports a downward adjustment to the NTGR calculator estimate of 0.75, for the following reasons:

- The manager claimed that the project was cost-effective – "even without the rebate."
- The manager stated that the "equipment had to be replaced in any event," but did not need to buy nearly as many.
- There are regulations in order which require energy efficiency:
    - Executive Order 987: From the Chancellor, "it orders us to conserve energy (reduce by 15% of 2003-2004's use on BTU/sq/ft basis in 5 years)"
    - Executive Order AB 32: To reduce all GHGs

Analyst 2 suggests a ratio of 0.69 because of these comments, but not lower than this since they would not have made the amount of replacements that they did make. The manager said they "may have done a partial install."

Collaborative Adjustment

Analyst 1 recommends reducing the NTGR slightly from 0.75 to 0.60. Analyst 2 suggests a ratio of 0.69, but not lower. After discussion they agreed on lowering the NTGR to 0.70.

5.8 CSU – San Marcos

Campus Description

The California State University, San Marcos (also known as CSUSM) is a public university located in San Marcos, California, in San Diego County on 340 acres. It was established in 1989. 246 faculty educate 9,159 students. The university offers 44 undergraduate, 10 graduate and 1 doctorate programs. (Source: www.csusm.edu)

Facility Managers

Project ID #28

Measure: Heating Hot Water System Improvements

Project Description

During this project, there were improvements made to the heating hot water system. The project application was submitted on April 29, 2008 and the project was completed by November 16, 2008. The university has not received any incentives yet for this project; however, there are $228,925 (electric) and $24,855 (gas) in proposed incentives.

Net-to-Gross

The NTGR calculator gave a result of 1.0, suggesting zero free-ridership. This was derived from a Timing and Selection score of 10, a Program Influence score of 10, and No Program score of 10.

Analyst 1 Analysis: Description and Justification of Analysis

- The Facility Manager rated the importance of the rebate at 8 (out of 10), and other Program services (training, audit, technical assistance, etc.) a 10 (out of 10).

- The audit was very important for this project in that it made decision-makers aware of the potential savings.
- Payback on investment was rated at 10 (out of 10).
- The Facility Manager said there was a zero chance they would have implemented the same project without the Program.
- The fact that this measure is becoming standard practice was given a 10 (out of 10).

These other comments were made by the Facility Manager:

"The vendors/installers are being held responsible for the design - it was a performance-based design/build contract. We had to rely heavily on their recommendations. It had to be designed well to work - even though it is proven in some ways, we held them accountable."

"We needed to expand central plant eventually, campus needs were growing. But the equipment was not properly sized. It was inefficient at low loads (days over 75 degrees). Needed to be right-sized to save energy. The feasibility study really highlighted this potential energy savings."

"The Partnership Program and the audit made it happen - the rebate was also important, but the Program made the feasibility study happen."

"We didn't have in-house experience, but other universities and campuses - and we learned from their experience. We had been reading about this technology for a long time."

"We did not have to change out the boilers at all – we only did it because it made sense with the rebate available. We would have done no partial amount and nor would we would have adopted a less efficient solution."

Analyst 1 supports a NTGR of 1.0, which is consistent with what the NTGR calculator estimated, because the availability of the rebate really did, in this case, drive the decision to implement the energy efficiency measure.

Analyst 2 Analysis: Description and Justification of Analysis

Analyst 2 supports the NTGR calculator estimate of 1.0. The manager stated that they "did not have to change out the boilers at all – and only did it because it made sense with the rebate." The manager also confirms: they "would have done no partial amount and nor would we would have adopted a less efficient solution." Therefore, they have made it clear that there is no free-ridership with this campus.

Collaborative Adjustment

Both analysts support an NTGR of 1.0, which is consistent with what the NTGR calculator estimated, because the availability of the rebate really did drive the decision to implement the energy efficiency measure.

5.9 CSU - San Bernadino

Campus Description

The California State University, San Bernadino (also known as CSUSB) is a public university located in San Bernadino, California and was established in 1965. The San Bernadino campus is 441 acres and the

Palm Desert satellite campus is 40 acres. CSUSB currently enrolls more than 17,500 students and employs more than 2,100 faculty and staff. The university offers 100 degree, credential, and certificate programs. (Source: www.csusb.edu)

Chief Engineer/Energy Manager

Project ID #29

Measure: Campus-wide lighting retrofit

Project Description

During this project, High Efficiency Lighting Retrofits took place. The project application was submitted on April 12, 2006 and the project was completed by November 15, 2007. The received a combined $529,140 (electric) and $14,285 (gas) in incentives for all Campuswide Retrofit projects.

Net-to-Gross

The NTGR calculator gave a result of 0.67, suggesting substantial free-ridership. This was derived from a Timing and Selection score of 8, a Program Influence score of 8, and No Program score of 4.

Analyst 1 Analysis: Description and Justification of Analysis

- Though the availability of the rebate was rated at 8 (out of 10), other Program services (e.g., Program audit, technical assistance) were not rated very high, in terms of influential factors.
- The condition of the equipment was also an important influential factor. The lighting eventually needed to be replaced.
- The Manager rated the importance of the Program at 6, and the other, non-program related factors a 4.
- The Facilities Manager said that there was a good chance (4 on a scale of 1-10) the campus would have implemented the project anyway, had the Program not been available, within 6 months.

The Facility Manager also made the following comments:

"We bundled longer payback projects with shorter payback projects to bring the package down to under 13 years. This was the VP\'s target. The project also had to be self-funded. The energy savings had to pay the loan."

"It allowed us to change more lighting out than we would have."

"ESCO identified it, quantified the savings, installed the measure, but their recommendation did have a big influence. It is a guaranteed savings contract."

"We would have done 2/3 of the project without the Program, at the same level of efficiency."

Analyst 1 recommends staying with the NTGR of 0.67, as estimated by the calculator, because the Facility Manager said the campus "would have done 2/3 of the project without the Program, at the same level of efficiency" and because he also said that there was "a good chance (4 on a scale of 1-10) the campus would have implemented the project anyway, had the Program not been available, within 6 months."

Analyst 2 Analysis: Description and Justification of Analysis

Analyst 2 supports the NTGR calculator estimate of 0.67, but would also support a slightly higher ratio of 0.69 as the manager says that "it allowed us to change more lighting out than we would have." This indicates that they did perform work that they would not have otherwise done.

Collaborative Adjustment

Analyst 1 recommends staying with the NTGR of 0.67, as estimated by the calculator. Analyst 2 supports the NTGR calculator estimate of 0.67, but would also support a slightly higher ratio of 0.69. After discussion, they agreed to adjust the NTGR to 0.68.

5.10 UC Irvine

Campus Description

The University of California, Irvine (also known as UCI or UC Irvine) is a public university located in Irvine, California on 1,489 acres. The university was established in 1965. 2,685 faculty educate 22,122 undergraduate and 5,509 graduate students. UC Irvine offers 81 undergraduate and 51 Master's degree, an M.D., an Ed.D., a J.D., and 44 doctorate programs. (Source: www.uci.edu)

Campus Facilities Manager

Project ID# 30

Measure: Campus Retrofits- HVAC and Lighting: Replace existing stairwell lighting with bi-level technology - various campus wide, entire building stock - all stairwells.

Project Description

During this project, existing stairwell lighting was replaced with bi-level technology - various campus wide, entire building stock - all stairwells. The project application was submitted on November 21, 2006 and the project was completed by November 15, 2008. The received a combined $470,229 (electric) in incentives for all Campuswide Retrofit – HVAC and Lighting projects.

Net-to-Gross

The NTGR calculator gave a result of 0.9, suggesting low free-ridership. This was derived from a Timing and Selection score of 10 and a Program Influence score of 8. The No Program score was 0, meaning it was not included in the calculation.

Analyst 1 considered the following factors:

- Though the No Program score was eliminated from the calculation, because it was a 10, the data suggests the campus would have installed the same measures within 3 months."
- Though the availability of the rebate was rated at 8 (out of 10), other Program services (e.g., Program audit, technical assistance) were not rated very high, in terms of influential factors.
- The condition of the equipment was also an important influential factor. The lighting eventually needed to be replaced.

- The Manager rated the importance of the Program at 8, and the other, non-program related factors a 2.
- The Facilities Manager said that there was almost certain (10 on a scale of 1-10) the campus would have implemented the project anyway, had the Program not been available, within 6 months.

The Energy Manager also made the following comments:

"It was inefficient, but we could have lived with the existing lighting."

"There's a 50% chance we would have done the same project the same way the same year (100% of the measures, at the same level of efficiency)."

Analyst 1 recommends reducing the NTGR from 0.9 (a low level of free-ridership) as estimated by the calculator, to 0.60 (a high level of free-ridership), because the Facility Manager said the campus "would have likely installed the same measures project without the Program, at the same level of efficiency" and because he also said that it was almost certain (10 on a scale of 1-10) the campus would have implemented the project anyway, had the Program not been available, within 3 months, with the same level of efficiency."

Analyst 2 Analysis: Description and Justification of Analysis

Analyst 2 supports a lower NTGR estimate of 0. 80. While the manager says that they "could have lived with the existing lighting ," they also comments that there was a "50% chance we would have done the same project the same way the same year."

Collaborative Adjustment

Analyst 1 recommends reducing the NTGR from 0.90 (a low level of free-ridership) as estimated by the calculator, to 0.60. Analyst 2 supports lowering the NTGR estimate down to 0. 80. After discussion they agreed to an NTGR of 0.70.

5.11 UC Irvine

Campus Description

The University of California, Irvine (also known as UCI or UC Irvine) is a public university located in Irvine, California on 1,489 acres. The university was established in 1965. 2,685 faculty educate 22,122 undergraduate and 5,509 graduate students. UC Irvine offers 81 undergraduate and 51 Master's degree, an M.D., an Ed.D., a J.D., and 44 doctorate programs. (Source: www.uci.edu)

Campus Facilities Manager

Project ID #31

Measure: CRT Monitor replacement and PC Power Management

Project Description

During this project, 1,000 CRT Monitors were replaced with LCDs. The project application was submitted on November9, 2007 and the project was completed by October 22, 2008. The university has not received any incentives for this project yet; however, there are $142,981 (electric) incentives proposed.

Net-to-Gross

The NTGR calculator gave a result of 0.6, suggesting significant free-ridership. This was derived from a Timing and Selection score of 10 and a Program Influence score of 2. The No Program score was 0, meaning it was not included in the calculation.

Analyst 1 Analysis: Description and Justification of Analysis

- Though the availability of the rebate was rated at 10 (out of 10), other Program services (e.g., Program audit, technical assistance) were not rated very high, in terms of influential factors.
- The condition of the equipment was also an important influential factor (10 out of 10).
- Corporate policy was also an important influential factor (10 out of 10).
- The Manager rated the importance of the Program at 2, and the other, non-program related factors an 8.
- The Facilities Manager said that it was almost certain (10 on a scale of 1-10) the campus would have implemented the project anyway, had the Program not been available, within 6 months.

The Facility Manager also made these comments:

“We might have installed less of the PC Power Management. (This was back when you got 60% of the incentive upfront). If the partnership did not exist, we could have pursued funding elsewhere for the PC Power Management (through other SCE program).”

“Our campus probably would have installed half of the measures, at the same level of efficiency, even if the Program did not exist.”

Analyst 1 recommends reducing the NTGR from 0.6 (a high level of free-ridership) as estimated by the calculator, to 0.5 (a very high level of free-ridership), because the Facility Manager said the campus “would have likely installed the same measures project without the Program, at the same level of efficiency” and because he also said that it was almost certain the campus would have implemented half the measures in the project anyway, had the Program not been available, within 6 months, at the same level of efficiency.”

Analyst 2 Analysis: Description and Justification of Analysis

Analyst 2 supports the NTGR calculator estimate of 0.60. The manager stated that if the partnership did not exist, they “could have pursued funding elsewhere for the PC Power Management (through other SCE programs),” and thus it is believed that they would have implemented the projects. However, the manager also stated that they “might have installed less of the PC Power Management.” Therefore, the Analyst concludes by suggesting a NTGR of 0.65.

Collaborative Adjustment

Analyst 1 recommends reducing the NTGR from 0.60 (a high level of free-ridership) as estimated by the calculator, to 0.50 (a very high level of free-ridership). Analyst 2 supports the NTGR calculator estimate of 0.60. After discussion, they agreed to an NTGR of 0.55.

5.12 UC Irvine

Campus Description

The University of California, Irvine (also known as UCI or UC Irvine) is a public university located in Irvine, California on 1,489 acres. The university was established in 1965. 2,685 faculty educate 22,122 undergraduate and 5,509 graduate students. UC Irvine offers 81 undergraduate and 51 Master's degree, an M.D., an Ed.D., a J.D., and 44 doctorate programs. (Source: www.uci.edu)

Campus Facilities Manager

Project ID #32

Measure: Upgrade to Low Pressure Drop/High Efficiency HVAC Filters

Project Description

During this project, existing Low Pressure Drop/High Efficiency HVAC Filters were upgraded. The project application was submitted on November 21, 2006 and the project was completed by January 15, 2008. The received a combined $470,229 (electric) in incentives for all Campuswide Retrofit – HVAC and Lighting projects.

Net-to-Gross

The NTGR calculator gave a result of 0.9, suggesting low free-ridership. This was derived from a Timing and Selection score of 10, a Program Influence score of 8, and No Program score of 9.

Analyst 1 Analysis: Description and Justification of Analysis

- The Facilities Manager said there was some likelihood (3 out of 10) the campus would have installed the exact same set of measures within 36 months (if the Program had not been available).
- Though the availability of the rebate was rated at 10 (out of 10), other Program services (e.g., Program audit, technical assistance) were not rated very high, in terms of influential factors.
- Corporate policy was also an important influential factor (7 out of 10).
- The condition of the equipment was also an important influential factor (8 out of 10).
- The Manager rated the importance of the Program at 8, and the other, non-program related factors an 2.

These are comments made by the Energy Manager:

"We would have done more due diligence to assess the performance of the filters and been more precise rather than doing it across the board campus-wide. Probably would have installed fewer units at same efficiency level, delayed by a couple years."

"We would have likely installed 25% of the measures, at the same level of efficiency, in the same year, if the Program was not available to us."

Analyst 1 recommends reducing the NTGR from 0.9 (a low level of free-ridership) as estimated by the calculator, to 0.75 (a high level of free-ridership), because the Facility Manager said the campus "would have likely installed 25% of the same measures without the Program, at the same level of efficiency" and because he also said that it was somewhat likely (3 out of 10) that the campus would have implemented the exact same measures, had the Program not been available, within 36 months, at the same level of efficiency."

Analyst 2 Analysis: Description and Justification of Analysis

Analyst 2 supports a slightly lower NTGR of 0.85, as the manager stated that they "probably would have installed fewer units at same efficiency level, delayed by a couple years."

Collaborative Adjustment

Analyst 1 recommends reducing the NTGR from 0.9 (a low level of free-ridership) as estimated by the calculator, to 0.75, and Analyst 2 supports a slightly lower NTGR of 0.85. After discussion, they agreed to an NTGR of 0.80.

5.13 UCSF

Campus Description

University of California, San Francisco (also known as UCSF) is a professional school founded in 1873. It is located in the Bay Area, in the city of San Francisco, California. 1686 faculty educate nearly 3,000 post-graduates. UCSF operates four major campus sites within the city of San Francisco and one in Fresno, as well as numerous other minor sites scattered through San Francisco and the Bay Area. Total size: 135 acres plus 43 acres at Mission Bay campus. The campus includes the world renowned UCSF medical center. (Source: www.ucsf.edu)

Campus Energy Manager

Project ID #34

Measure: Library - Install and Commission New VFDs, Correct Start/Stop Controls

Project Description

In the project, HVAC Retrofits were completed at the Kalmanovitz Library; specifically, new VFDs were installed and commissioned with correct start/stop controls. The project application was submitted on November 26, 2007 and the project was completed by November 15, 2008. The university has not received any incentives yet, but proposed incentives consist of $292,059 (electric) and $138,249 (gas).

Net-to-Gross

The NTGR calculator gave a result of 0.73, suggesting some free-ridership. This was derived from a Timing and Selection score of 10, a Program Influence score of 2, and No Program score of 9.

Analyst 1 Analysis: Description and Justification of Analysis

- The Facilities Manager said the campus had already decided to implement the project before learning about the Program. (This is why the Program Influence score is 2).
- Though the availability of the rebate was rated at 7 (out of 10), other Program services (e.g., technical assistance) were not rated very high, in terms of influential factors.
- The audit helped bring this project concept to light.
- Corporate policy was also a somewhat influential factor (5 out of 10).
- The condition of the equipment was also a somewhat influential factor (6 out of 10).
- The Manager rated the importance of the Program at 6, and the other, non-program related factors a 4.

These are comments made by the Energy Manager:

"10% of the project might have been installed anyway, I think, based on availability of funds."

Analyst 1 recommends keeping the NTGR score at 0.73 because it reflects how, on the one hand, the campus had already decided to implement the project before learning about the Program. On the other hand, the audit played a significant role in validating the project.

Analyst 2 Analysis: Description and Justification of Analysis

Analyst 2 supports the NTGR calculator estimate of 0.73, as the manager did not make any substantive comments to indicate an adjustment to the ratio estimated.

Collaborative Adjustment

Both analysts recommend keeping the NTGR score at 0.73.

5.14 UC Irvine

Campus Description

The University of California, Irvine (also known as UCI or UC Irvine) is a public university located in Irvine, California on 1,489 acres. The university was established in 1965. 2,685 faculty educate 22,122 undergraduate and 5,509 graduate students. UC Irvine offers 81 undergraduate and 51 Master's degree, an M.D., an Ed.D., a J.D., and 44 doctorate programs. (Source: www.uci.edu)

Campus Facilities Manager

Project ID #35

Measure: Reduce air changes in Teaching Labs by installing dampers, controls, and occupant sensors

Project Description

In this project, the university reduced air changes in Teaching Labs by installing dampers, controls, and occupancy sensors in Steinhaus Hall. The project application was submitted on January 29, 2007 and the project was completed on March 15, 2008.The university received $111,352 (electric) and $39,520 (gas) incentives for this project.

Net-to-Gross

The NTGR calculator gave a result of 0.50, suggesting significant free-ridership. This was derived from a Timing and Selection score of 7, a Program Influence score of 4, and No Program score of 4.

Analyst 1 Analysis: Description and Justification of Analysis

- The Facilities Manager said the campus probably would have implemented this project without the Program (7 out of 10) within 12 months.
- The availability of the rebate was rated at 5 (out of 10), other Program services (e.g., technical assistance) were not rated very high, in terms of influential factors.
- The feasibility study, however, helped bring this project concept to light and was quite influential (7 out of 10).
- Vendor recommendation was also a very influential factor (8 out of 10).
- The Manager rated the importance of the Program at 4, and the other, non-program related factors a 6.

"We would have done this project anyway. We tacked this project on to a larger project we were already doing. This was a $150,000 change order to a 3 million contract. It got artificially accelerated. We may have waited longer if we didn't combine it (with other projects)."

"We would have done the same project in the same year (even without the Program)."

Analyst 1 recommends keeping the NTGR score at 0.50 (high amount of free-ridership) because it reflects the statements that (1) the campus "would have done this project anyway. We tacked this project on to a larger project we were already doing." And (2) the importance of the rebate was only given a 5 out of 10.

Analyst 2 Analysis: Description and Justification of Analysis

Analyst 2 supports the NTGR calculator estimate of 0.50, as the manager clearly stated that they "would have done this project anyway." The manager continued: "we tacked this project on to a larger project we were already doing… We may have waited longer if we didn't combine them."

Collaborative Adjustment

Both analysts recommend keeping the NTGR score at 0.50.

5.15 UC Irvine

Campus Description

The University of California, Irvine (also known as UCI or UC Irvine) is a public university located in Irvine, California on 1,489 acres. The university was established in 1965. 2,685 faculty educate 22,122 undergraduate and 5,509 graduate students. UC Irvine offers 81 undergraduate and 51 Master's degree, an M.D., an Ed.D., a J.D., and 44 doctorate programs. (Source: www.uci.edu)

Campus Facilities Manager

Project ID #36

Measure - Replace fans on AHU 1 and 3, install VFDs, remove sound attenuators, etc.

Project Description

In this project, fans were replaced on AHU 1 and 3, VFDs were installed, sound attenuators were removed, cooling coils and controls valves were replaced in McGaugh Hall. The project application was submitted on January 17, 2007 and the project was completed by February 13, 2008. The university received $404,520 (electric) and $32,642 (gas) in incentives for this project.

Net-to-Gross

The NTGR calculator gave a result of 0.40, suggesting very significant free-ridership. This was derived from a Timing and Selection score of 4 and a Program Influence score of 4. The No Program score was not counted, though it was a 10.

Analyst 1 Analysis: Description and Justification of Analysis

- The Facilities Manager said the campus almost certainly (10 out 10) would have implemented this project without the Program within 6 months (because they had to replace failed equipment).
- The condition of the old equipment was given an importance rating of 10 out of 10 (it was failing equipment).
- The availability of the rebate was rated at 1 (out of 10), and other Program services (e.g., technical assistance) were also rated very low, in terms of being influential factors. Payback on investment was also rated very low.
- Vendor recommendation was also a somewhat influential factor (5 out of 10).
- The Manager rated the importance of the Program at 4, and the other, non- program related factors a 6.

The Campus Facilities Manager also made the following comments:

“This was a case of failing equipment (that had to be immediately replaced).”

“Premium efficiency motors combined with VFDs in constant flow AHUs is now our standard practice.”

“We would have implemented the same project (in the same year, with the same level of efficiency).”

Analyst 1 recommends keeping the NTGR estimate at 0.40, as the comments made by the Facilities Manager validates a very high degree of free-ridership.

Analyst 2 Analysis: Description and Justification of Analysis

Analyst 2 supports the NTGR calculator estimate of 0.40, as the manager stated that they "would have done the basic part of this project anyway."

Collaborative Adjustment

Both analysts recommend keeping the NTGR estimate at 0.40.

5.16 UC Irvine

Campus Description

The University of California, Irvine (also known as UCI or UC Irvine) is a public university located in Irvine, California on 1,489 acres. The university was established in 1965. 2,685 faculty educate 22,122 undergraduate and 5,509 graduate students. UC Irvine offers 81 undergraduate and 51 Master's degree, an M.D., an Ed.D., a J.D., and 44 doctorate programs. (Source: www.uci.edu)

Campus Facilities Manager

Project ID #37

Measure: Install Aircuity (Croul Hall)

Project Description

In this Laboratory Aircuity Pilot Project, Aircuity was installed at Croul Hall. The application was submitted on November 7, 2007 and the project was completed by June 24, 2008. Thus far, the university has not been paid any incentives; however, the proposed incentives are $28,176 (electric) and $7,659 (gas).

Net-to-Gross

The NTGR calculator gave a result of 0.96, suggesting very low (almost no) free-ridership. This was derived from a Timing and Selection score of 10, a Program Influence score of 9, and No Program score of 10.

Analyst 1 Analysis: Description and Justification of Analysis

- The availability of the rebate was rated at 10 (out of 10). The payback on investment was also rated high (8 out of 10).
- The recommendation from the equipment vendor was also an important influential factor.
- The Manager rated the importance of the Program at 9, and the other, non-program related factors a 1.

- The Facilities Manager said that there was a very slight chance (1 on a scale of 1-10) the campus would have implemented the project anyway, had the Program not been available, within 36 months.
- This was not replacing old equipment - was an add-on to existing equipment.

Analyst 1 recommends slightly reducing the NTGR from 0.96 to 0.90, as there was indication that the campus may have implemented this project without the benefit of the Program within 36 months and because the Manager rated the importance of the Program at 9, and the other, non-program related factors a 1.

Analyst 2 Analysis: Description and Justification of Analysis

Analyst 2 supports the NTGR calculator estimate of 0.96, as the manager did not make any substantive comments to indicate an adjustment to the ratio estimated. The manager did state that "this was not replacing old equipment - was an add-on to existing equipment."

Collaborative Adjustment

Analyst 1 recommends slightly reducing the NTGR from 0.96 to 0.90. Analyst 2 supports the NTGR calculator estimate of 0.96. After discussion, they agreed to an NTGR of 0.93.

5.17 CSU - San Diego State University

Campus Description

San Diego State University (also known as SDSU) is a public university located in San Diego, California, and was founded in 1897. Satellite campus is located in Calexico, California. Degrees are awarded in more than 151 fields: 84 Bachelor's Degrees, 75 Master's Degrees, 15 Doctoral Degrees. More than 1,600 faculty educate 34,000 students. (Source: www.sdsu.edu)

Facilities Manager

Project ID #38

Measure: Student Services West: Upgrade fans to VSD

Project Description

In this project, fans were upgraded to VSD and lock variable vanes open in Student Services West. The project application was submitted on May 26, 2006 and the project was completed by June 11, 2008. For all 4 lighting and fan retrofit upgrades, the campus received a total of $816,835 (electric) and $122,248 (gas) incentives.

Net-to-Gross

The NTGR calculator gave a result of 0.78, suggesting some free-ridership. This was derived from a Timing and Selection score of 10, a Program Influence score of 3.5, and No Program score of 10.

Analyst 1 Analysis: Description and Justification of Analysis

- The availability of the rebate was rated at 10 (out of 10). The payback on investment was also rated high (9 out of 10).
- Technical assistance from the program was also given 7 out of 10.
- The Manager rated the importance of the Program at 7, and the other, non-program related factors a 3.
- The Facilities Manager said that there was no chance (0 on a scale of 1-10) that the campus would have implemented the project, had the Program not been available (in any foreseeable time-frame).
- The Facilities Manager said that the campus decided to implement the retrofit *before* learning about the Program.

The Facilities Manager also made the following comments:

"We knew the equipment had to be changed or do something eventually - but we were stuck until the funding came."

"Outside of a crisis, we would not have even done a partial retrofit."

Analyst 1 recommends keeping the NTGR at 0.78, as estimated by the NTGR calculator, because there is evidence of some free-ridership, but that is mitigated by the comments made that the project could not have gone forward without the Program funding.

Analyst 2 Analysis: Description and Justification of Analysis

Analyst 2 supports the NTGR calculator estimate of 0.78. The manager indicated that the equipment would need to eventually be changed, but that they would not have been able to complete the work without the Program.

Collaborative Adjustment

Both analysts separately concur that the NTGR estimated by the calculator for this project should not be adjusted.

5.18 CSU - San Diego State University

Campus Description

San Diego State University (also known as SDSU) is a public university located in San Diego, California, and was founded in 1897. Satellite campus is located in Calexico, California. Degrees are awarded in more than 151 fields: 84 Bachelor's Degrees, 75 Master's Degrees, 15 Doctoral Degrees. More than 1,600 faculty educate 34,000 students. (Source: www.sdsu.edu)

Facilities Manager

Project ID #39

Measure - HP Steam Trap Replacement - campus wide.

Project Description

The project consisted of a campus-wide HP steam trap replacement (22 traps replaced). The project application was submitted on March 29, 2007 and the project was completed by 1/31/2008. The university received $42,795 (gas) in incentives for the HP and LP steam trap project combined.

Net-to-Gross

The NTGR calculator gave a result of 0.93, suggesting very low free-ridership. This was derived from a Timing and Selection score of 10, a Program Influence score of 8, and No Program score of 10.

Analyst 1 Analysis: Description and Justification of Analysis

- The availability of the rebate was rated at 10 (out of 10). The payback on investment was also rated high (10 out of 10).
- The audit provided the Program was given 8 out of 10.
- The Manager rated the importance of the Program at 8, and the other, non-program related factors a 2.
- The Facilities Manager said that there was no chance (0 on a scale of 1-10) that the campus would have implemented the project, had the Program not been available (in any foreseeable time-frame).
- The Facilities Manager said that the campus decided to implement the retrofit *after* learning about the Program.

The facility manager also made the following comments:

"The steam traps needed to be done, and we couldn't fund it internally."

"We might have put in new equipment in the case of a steam trap failure."

Analyst 1 recommends keeping the NTGR at 0.93, as estimated by the NTGR calculator, because there is very little evidence of free-ridership. The comments made by the Facility Manager (that the project could not have gone forward without the Program funding) validates this conclusion.

Analyst 2 Analysis: Description and Justification of Analysis

Analyst 2 supports a slightly lower NTGR of 0.90. The manager stated that the replacement needed to be done but could not fund it, and indicated that they "might have put in new equipment in the case of a steam trap failure."

Collaborative Adjustment:

After discussion, both analysts agreed that the NTGR estimated by the calculator for this project should not be adjusted.

5.19 CSU - San Diego State University

Campus Description

San Diego State University (also known as SDSU) is a public university located in San Diego, California, and was founded in 1897. Satellite campus is located in Calexico, California. Degrees are awarded in more than 151 fields: 84 Bachelor's Degrees, 75 Master's Degrees, 15 Doctoral Degrees. More than 1,600 faculty educate 34,000 students. (Source: www.sdsu.edu)

Facilities ManagerProject ID #40

Measure - LP Steam Trap Replacement - campus wide.

Project Description

The project consisted of a campus-wide LP steam trap replacement (22 traps replaced). The project application was submitted on March 29, 2007 and the project was completed by 1/31/2008. The university received $42,795 (gas) in incentives for the HP and LP steam trap project combined.

Net-to-Gross

The NTGR calculator gave a result of 0.93, suggesting very low free-ridership. This was derived from a Timing and Selection score of 10, a Program Influence score of 8, and No Program score of 10.

Analyst 1 Analysis: Description and Justification of Analysis

- The availability of the rebate was rated at 10 (out of 10). The payback on investment was also rated high (10 out of 10).
- The audit provided the Program was also given 8 out of 10.
- The Manager rated the importance of the Program at 8, and the other, non-program related factors a 2.
- The Facilities Manager said that there was no chance (0 on a scale of 1-10) that the campus would have implemented the project, had the Program not been available (in any foreseeable time-frame).
- The Facilities Manager said that the campus decided to implement the retrofit *after* learning about the Program.
- Endorsement of the project by the utility account representative was given 8 out of 2 in importance.

Analyst 1 recommends keeping the NTGR at 0.93, as estimated by the NTGR calculator, because there is very little evidence of free-ridership. The comments made by the Facility Manager (that the project could not have gone forward without the Program funding) validates this conclusion.

Analyst 2 Analysis: Description and Justification of Analysis

Analyst 2 supports the calculated NTGR of 0.93. The manager commented that in the event of failure, they "would have installed the most efficient," but this statement does not suggest a lower ratio and thus, the Analyst support the calculated ratio.

Collaborative Adjustment

Both analysts separately concur that the NTGR estimated by the calculator for this project should not be adjusted.

B. UC/CSU LIGHTING DATA LOGGER STUDY LIGHTING LOAD SHAPES

LIGHTING LOAD SHAPES

Figures 1 through 16 show the plots for the statewide lighting load curves for the major space types identified by this analysis at the UC and CSU campuses. Lighting loggers were deployed in each of these spaces and information on the usage patterns is captured in these plots. The horizontal axis shows the hour of the day starting at midnight (0 hour), and the vertical axis shows the percentage of time that lights are on during that particular hour. Additionally, each space type is separated into weekday and weekend load curves. Each figure also shows how the usage patterns differ for each of the six day types identified by this analysis. The major space types include:

- Classrooms
- Common areas (including hallways and other similar high-use areas)
- Parking garages
- Laboratories
- Libraries
- Offices
- Stairs
- Storage

Each of these space types can be found at each of the seven campuses included in this analysis. These load curves also aggregate those spaces controlled by manual switching and those controlled by occupancy sensors in order to develop statewide lighting load curves. Additionally, the plots are based on weighted-averages of multiple logger deployments completed for each space type. A total of 444 control points were monitored. The weighting is based on the number of lamps associated with the same control point that the logger monitored.

It should be noted that the lighting load shape for parking garages is derived from lighting loggers deployed at UC San Francisco only. Garages were monitored to capture the realization rates for retrofit projects completed there. Similarly, the stairs load shape is derived from lighting loggers deployed at UC Irvine. This stair lighting was controlled by occupancy sensors.

Table of Figures

Figure 1 Classroom weekday load shapes for the full session, no session, and partial session time periods.

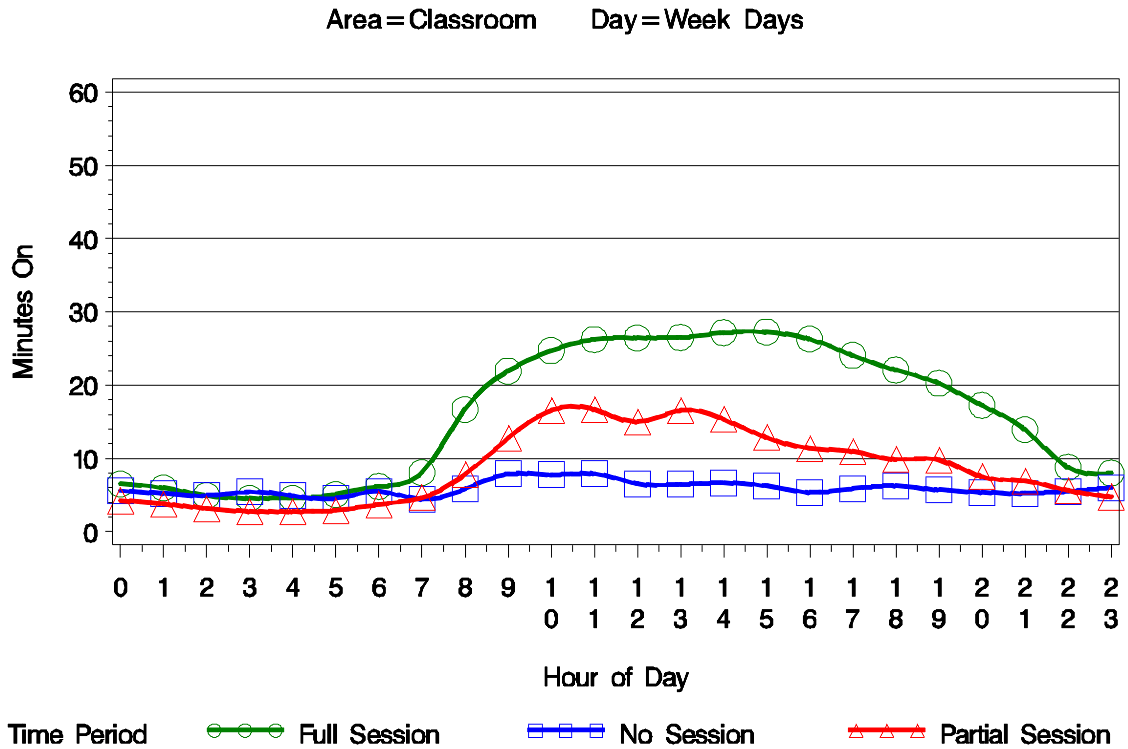


Figure 2 Classroom weekend load shapes for the full session, no session, and partial session time periods.

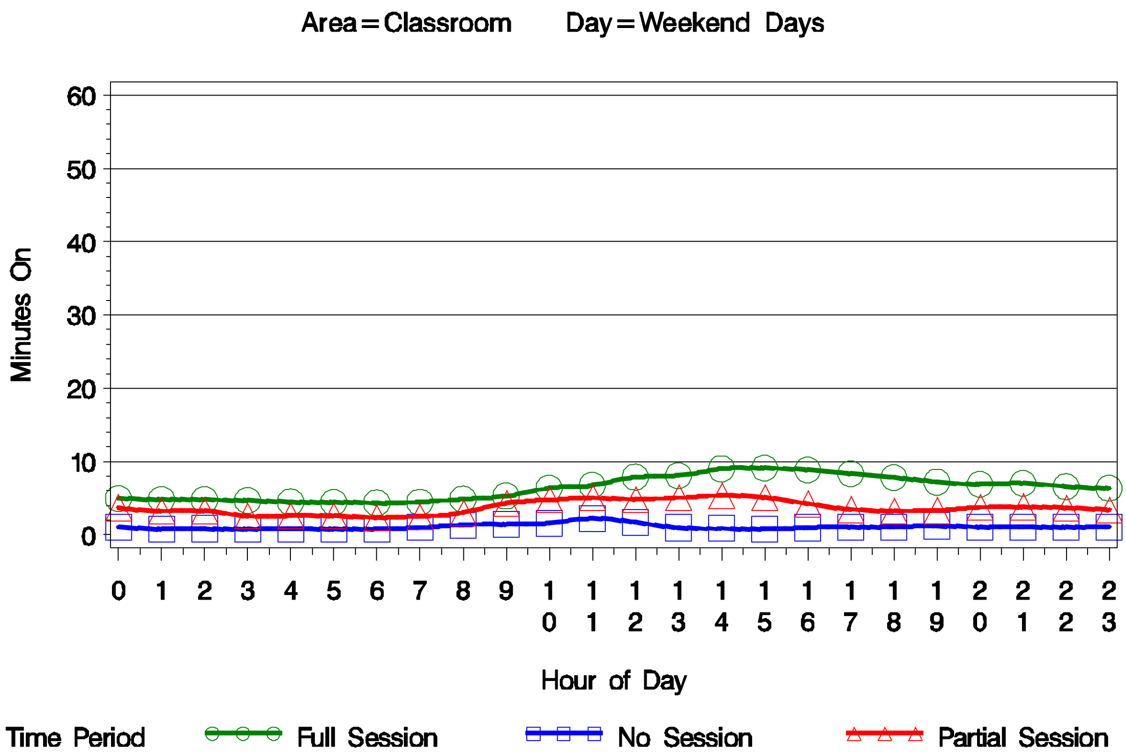


Figure 3 Common area weekday load shapes for the full session, no session, and partial session time periods.

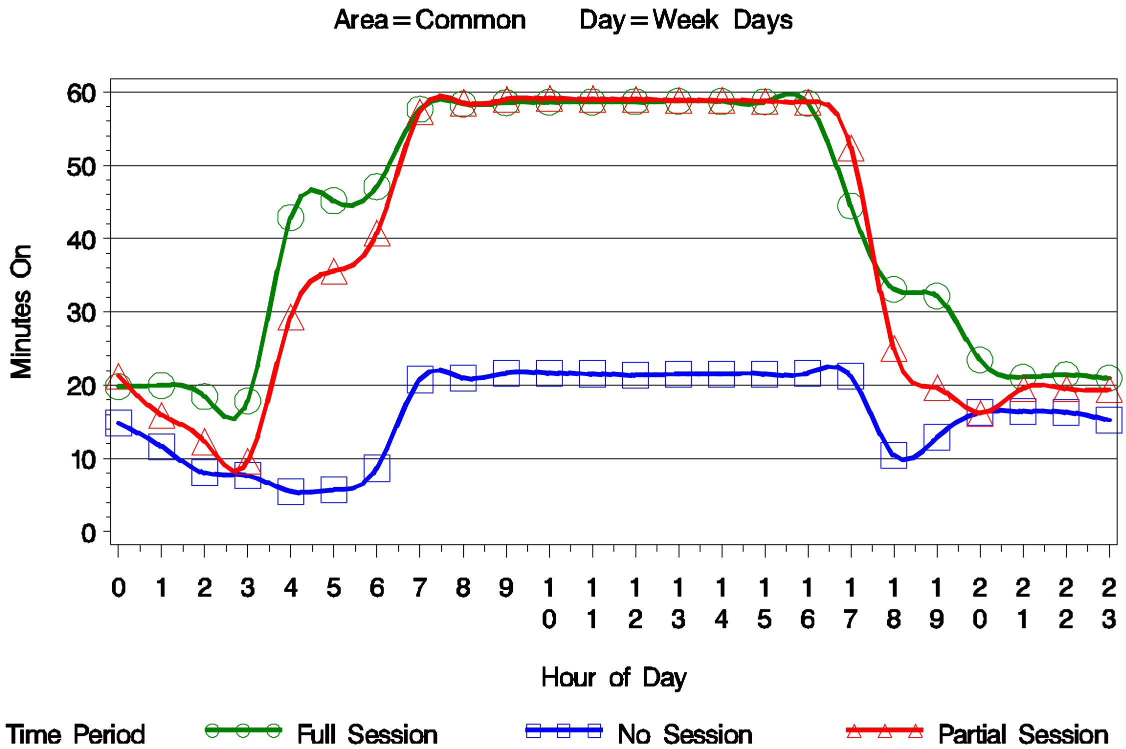


Figure 4 Common area weekend load shapes for the full session, no session, and partial session time periods.

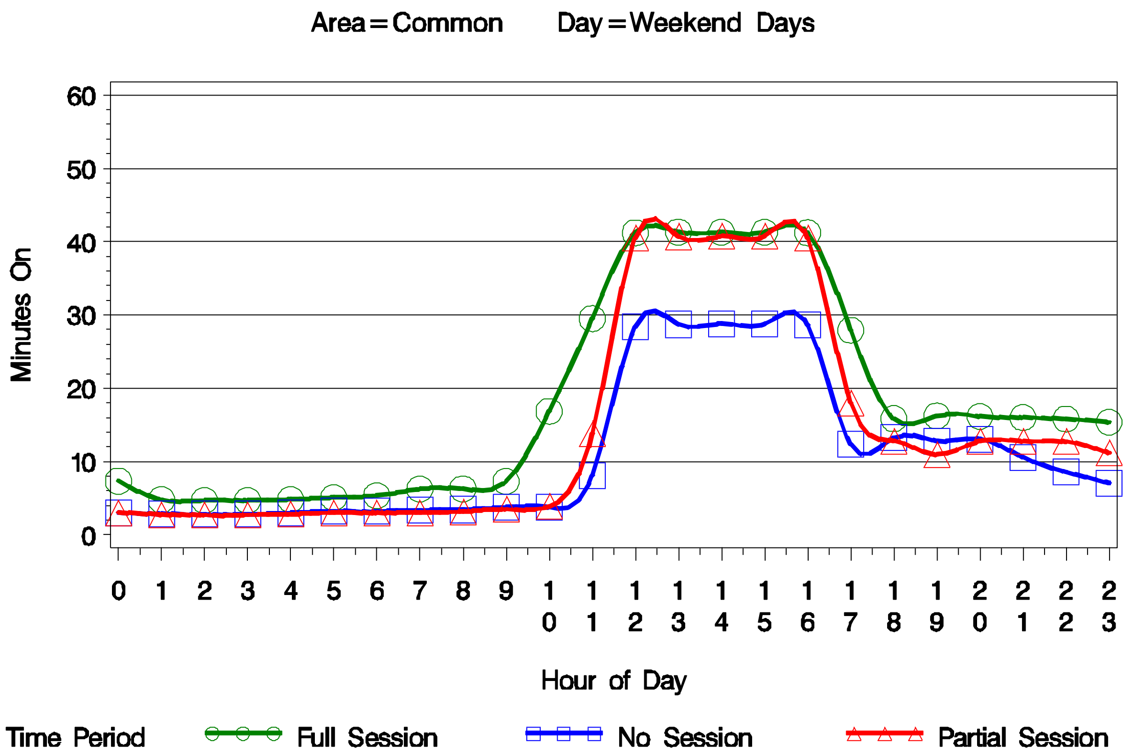


Figure 5 Parking garage weekday load shapes for the full session, no session, and partial session time periods.

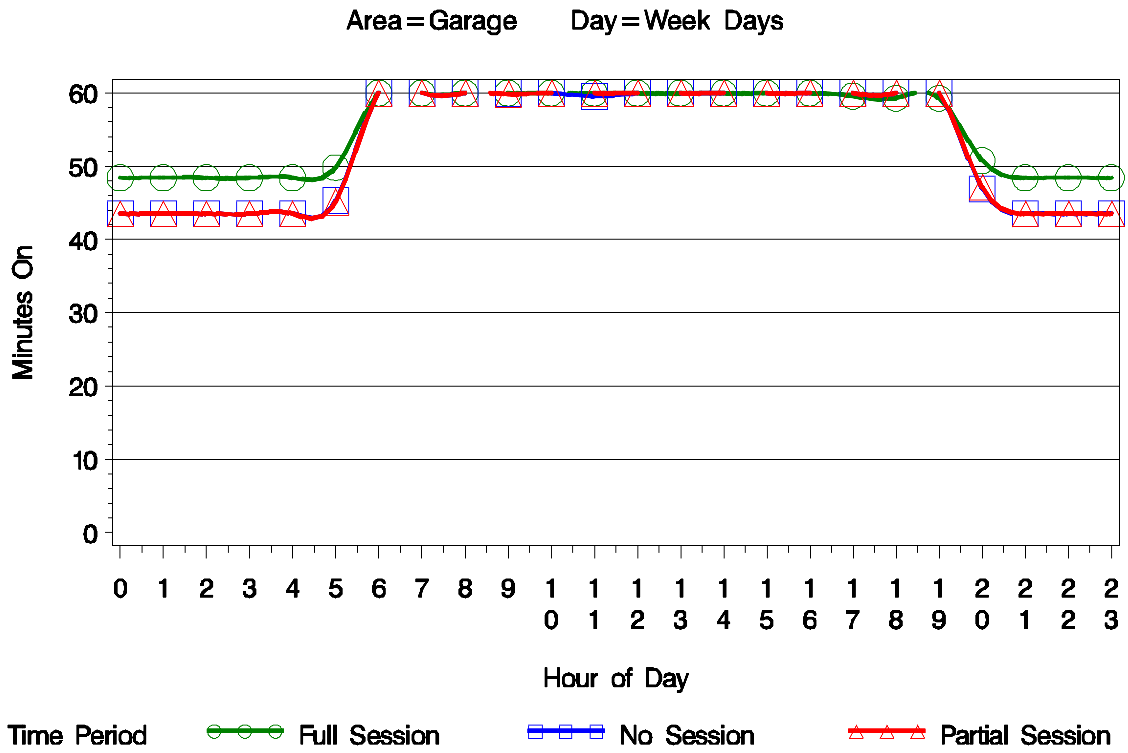


Figure 6 Parking garage weekend load shapes for the full session, no session, and partial session time periods.

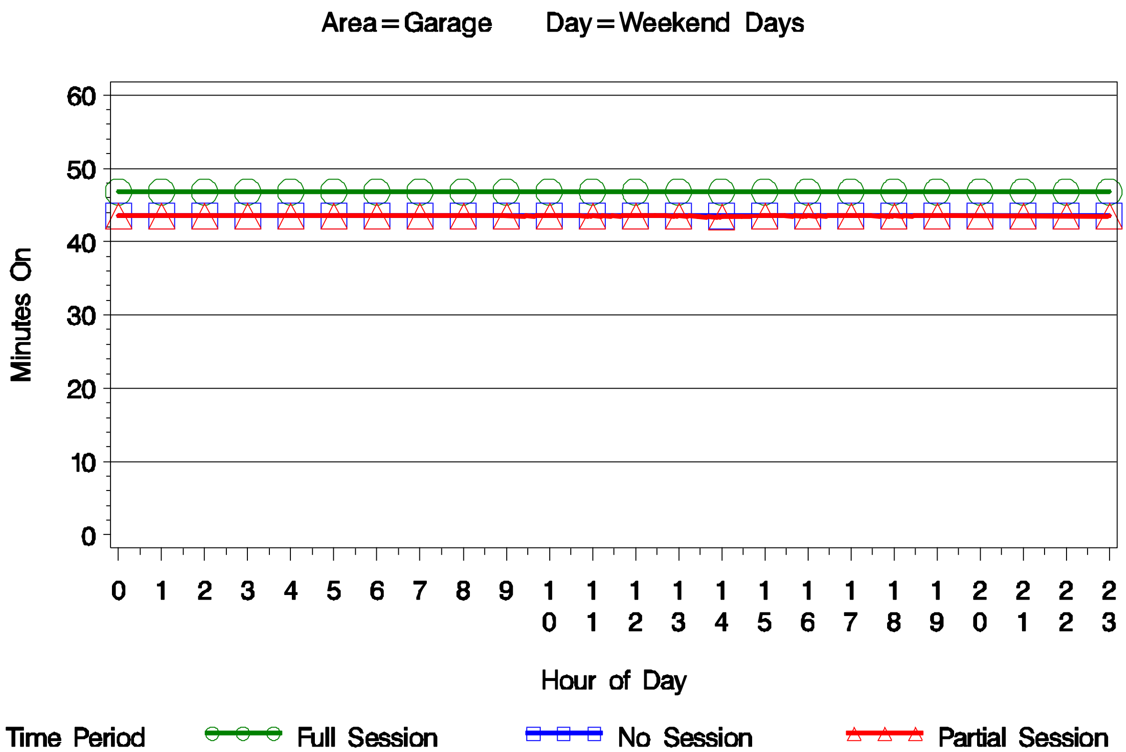


Figure 7 Laboratory weekday load shapes for the full session, no session, and partial session time periods.

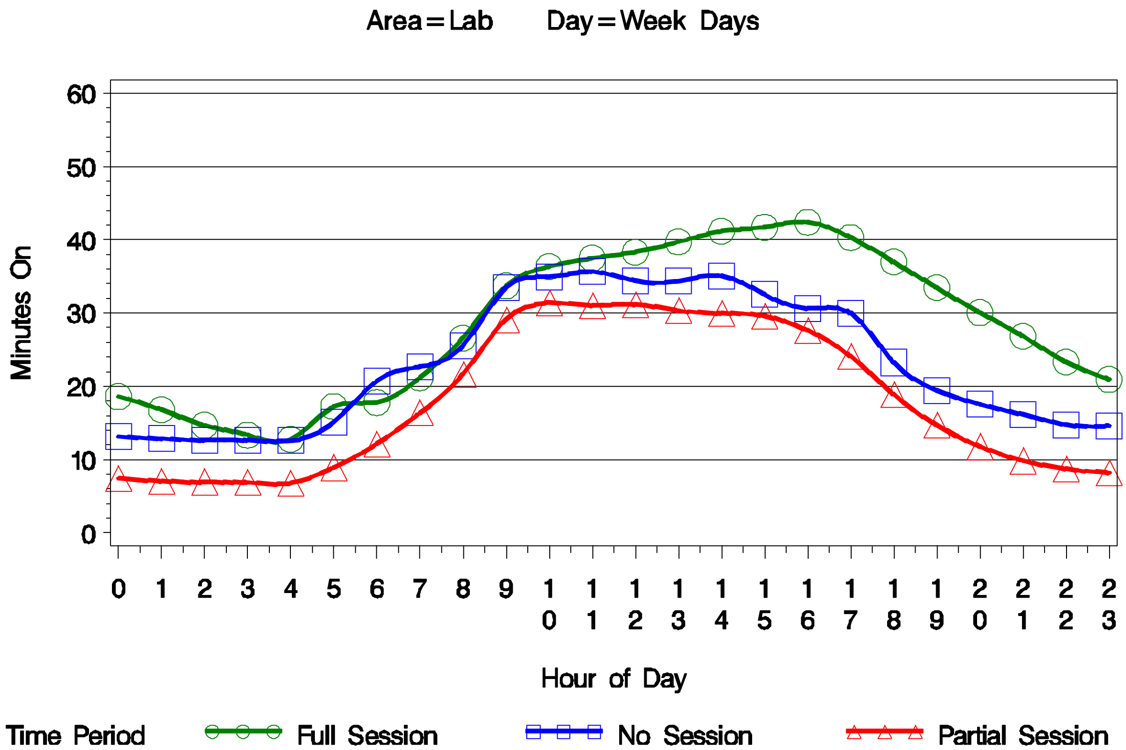


Figure 8 Laboratory weekend load shapes for the full session, no session, and partial session time periods.

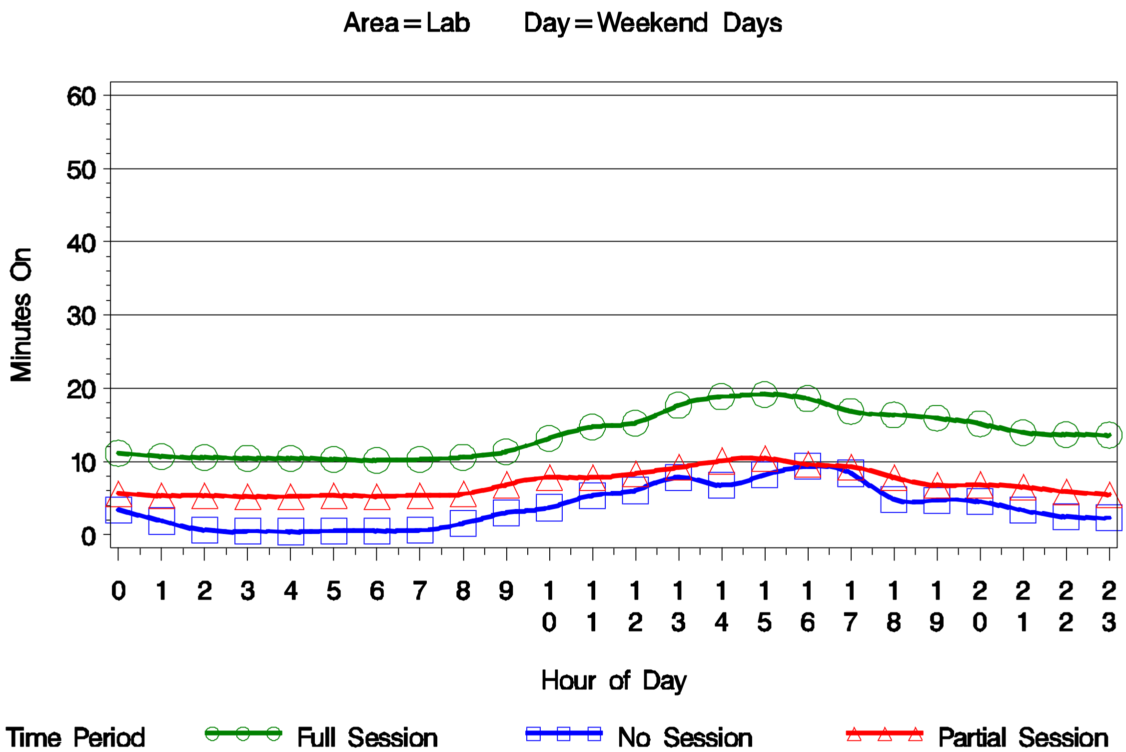


Figure 9 Library weekday load shapes for the full session, no session, and partial session time periods.

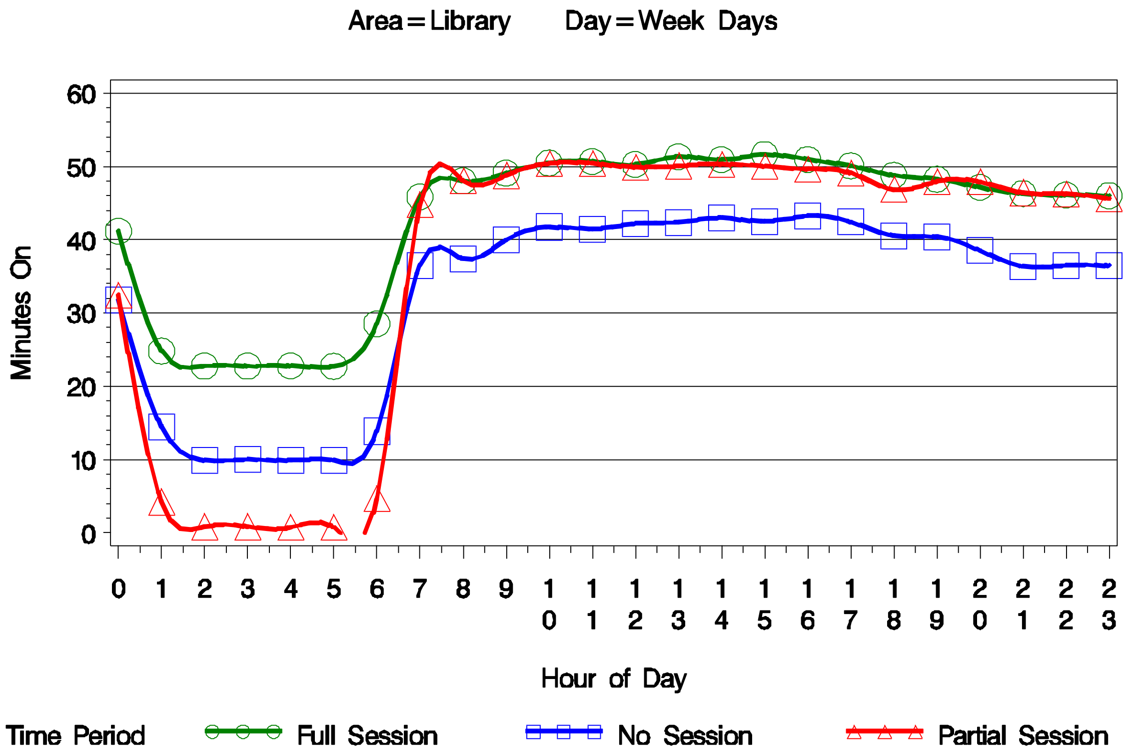


Figure 10 Library weekend load shapes for the full session, no session, and partial session time periods.

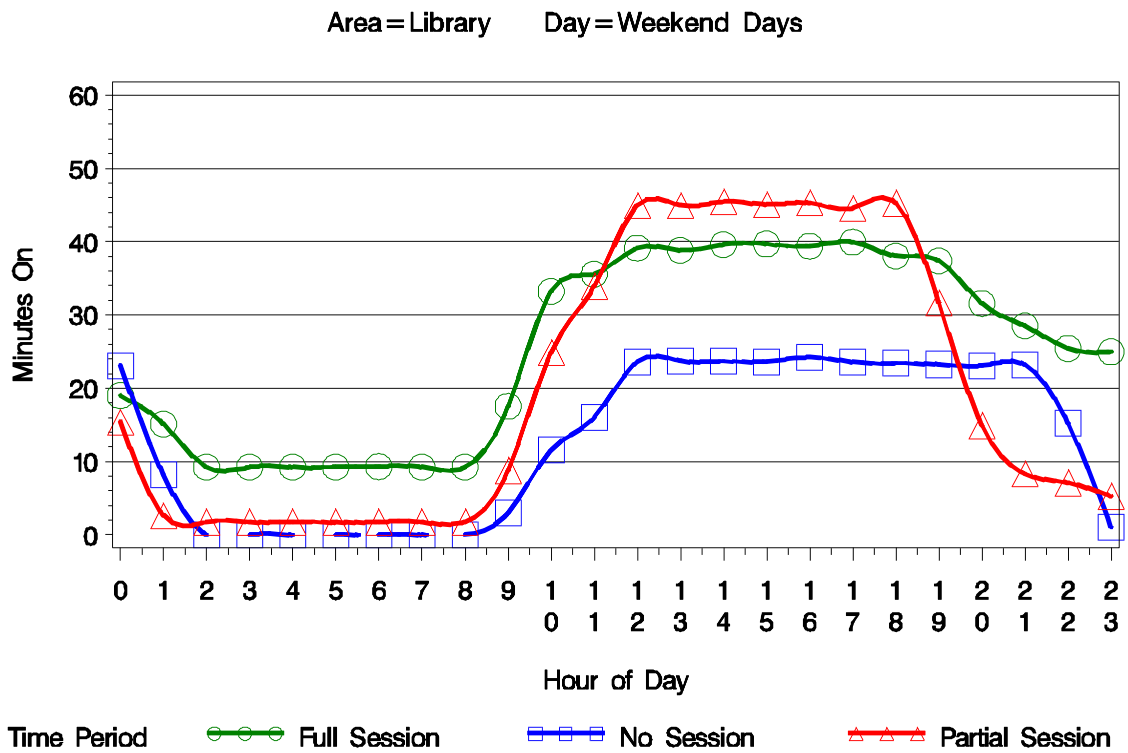


Figure 11 Office weekday load shapes for the full session, no session, and partial session time periods.

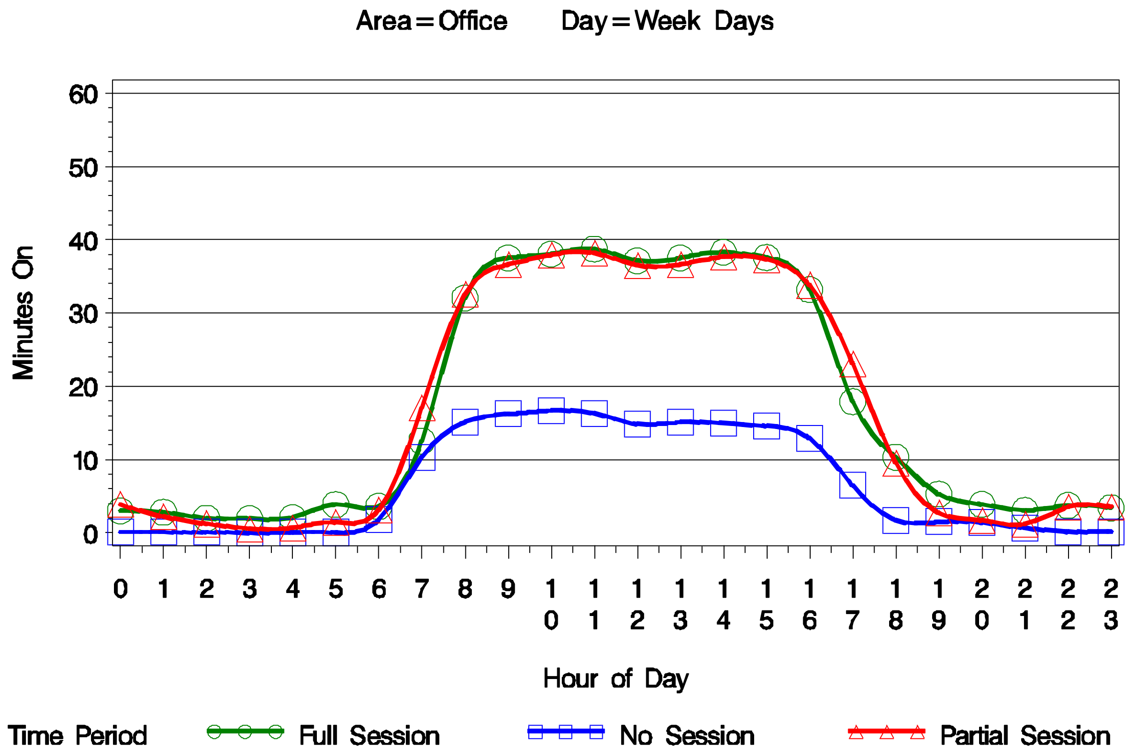


Figure 12 Office weekend load shapes for the full session, no session, and partial session time periods.

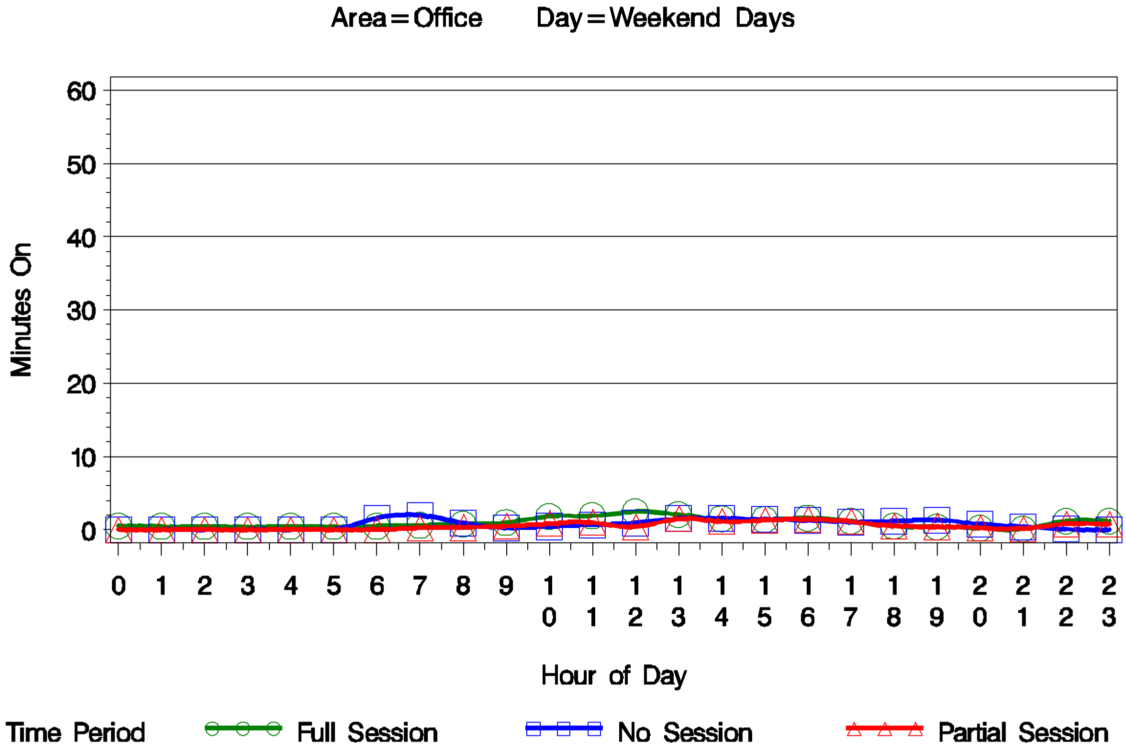


Figure 13 Stair weekday load shapes for the full session, no session, and partial session time periods.

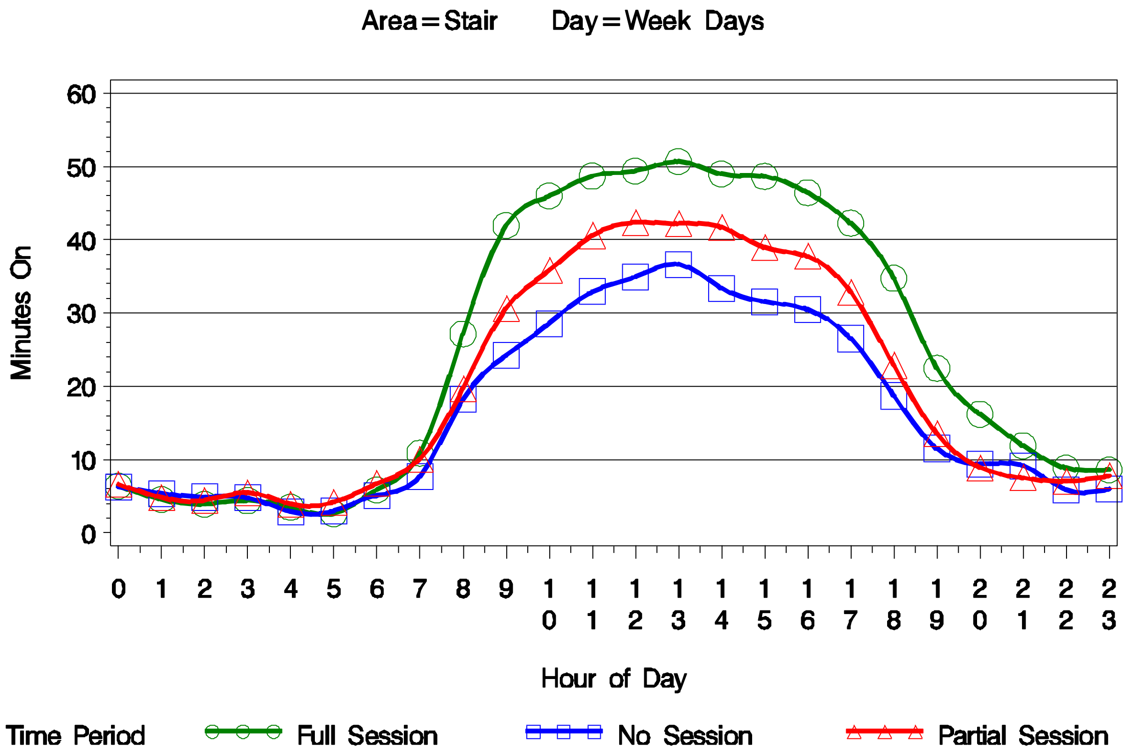


Figure 14 Stair weekend load shapes for the full session, no session, and partial session time periods.

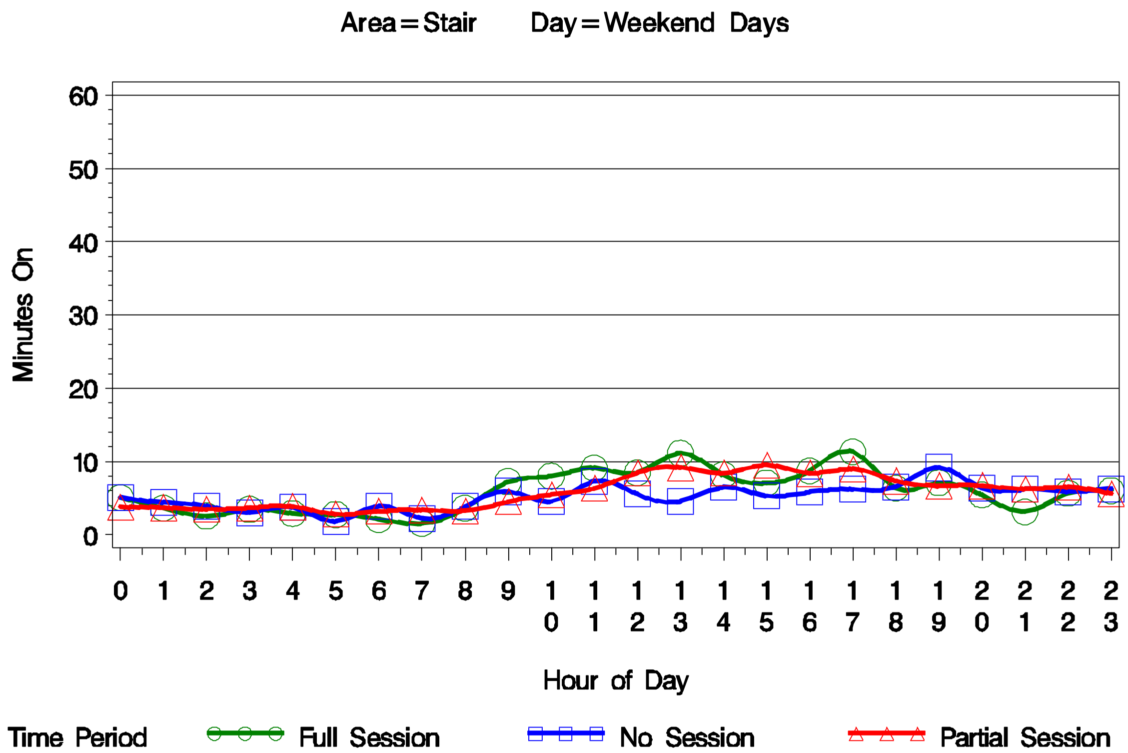


Figure 15 Storage weekday load shapes for the full session, no session, and partial session time periods.

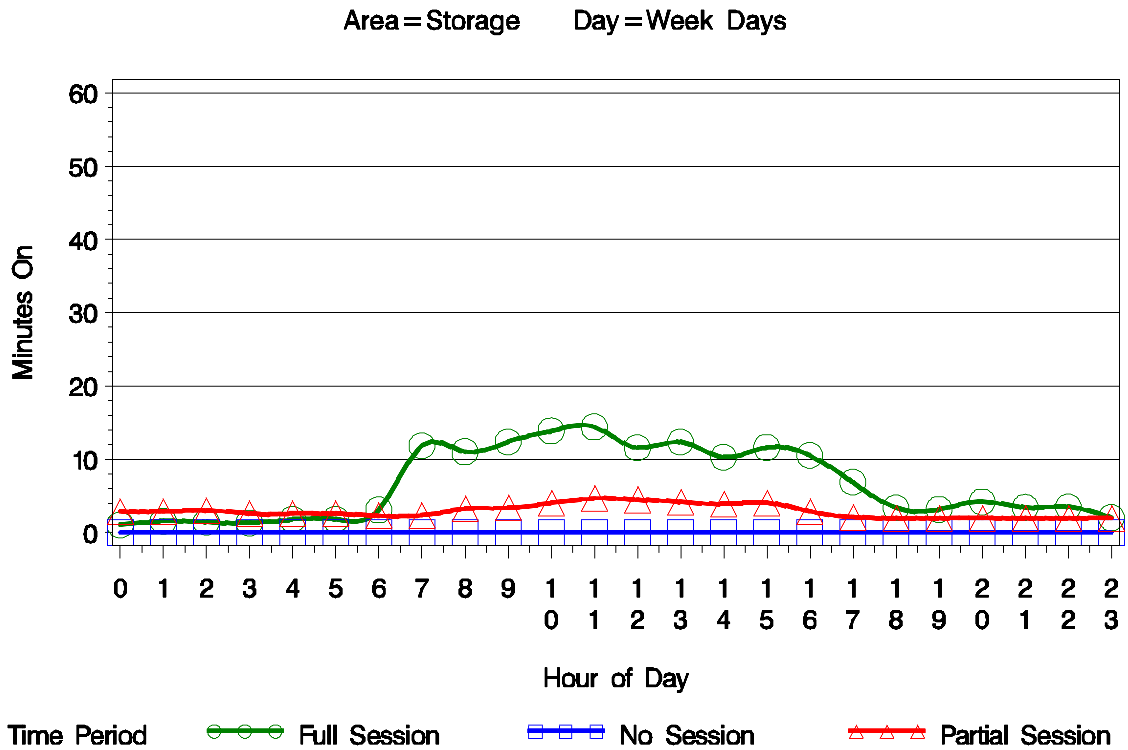


Figure 16 Storage weekend load shapes for the full session, no session, and partial session time periods.