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IMPACT AND PROCESS EVALUATION FINAL REPORT

for

QUEST'S
2004-5 BUILDING TUNE-UP PROGRAM

(SCE Program #1117-04; PG&E Program #1119-04)

Submitted to

CALIFORNIA PUBLIC UTILITIES COMMISSION, Sacramento, CA

Submitted by

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Background

The main goal of the 2004-5 Building Tune-Up Program (BTU Program) was to provide cost-effective, long-lasting energy and demand savings through retrocommissioning (RCx) of existing medium and large nonresidential buildings in the service areas of Pacific Gas and Electric (PG&E) and Southern California Edison (SCE). For each participating building, the program implementer, QuEST, performed a comprehensive audit of all energy consuming systems at a facility to identify potential cost-effective, low-cost improvements in building operations and related hardware to reduce energy use while maintaining comfort and health objectives. In addition, the program recommended operations and maintenance, as well as capital, improvements that would improve energy efficiency.

The evaluation, measurement, and verification effort described in this report was designed to accomplish multiple objectives for the California Public Utilities Commission (CPUC), including assessing energy savings achieved, measuring program cost-effectiveness, providing feedback on program implementation, and assessing overall performance, success, and continuing need for the program.

Methodology

This evaluation relied on a variety of techniques and data sources to assess the net energy savings and effectiveness of the program. These included telephone surveys, as well as short-term metering, one-time measurements, customer records, and observations at a sample of sites with installed measures. They also include developing and revising engineering calculations and building simulations. The impact portion of the EM&V effort is consistent with the requirements of IPMVP[1] Option B (Retrofit Isolation), in that it bases savings on performance measurements of the affected equipment, systems, or buildings, as appropriate, for a random sample of 17 of the 36 completed projects. These projects accounted for a substantial portion of the overall savings claimed by the program.

For each sampled project, the evaluation team reviewed documents and calculations provided by the program, developed an appropriate evaluation plan, collected data and performed the requisite analysis to estimate gross energy savings and their effective useful life. In response to program implementer comments on the draft report that questioned some of the evaluated savings results, the CPUC requested a follow-up study of several critical projects with high levels of savings uncertainty. The results of this follow-up work were subsequently incorporated into the original results.

In conjunction with the impact evaluation effort, the evaluation also reviewed the program process and assessed the level of freeridership among participants. The latter tasks required reviewing program data and records; designing interview questionnaires; conducting in-depth interviews with program administrators, consulting firms, participants and non-participants; and analyzing and reporting results.

Results

The stated goals of the program were to enroll 150 participants, and thereby obtain net annual savings of about 37 million kWh and 1.3 million therms of electric and natural gas energy, respectively, as well as reduction in average peak electrical demand of 10.1 MW. Savings were to be split almost equally between PG&E and SCE service territories. In the end, the program claimed 36 participants, whose

[1] International Performance Measurement and Verification Protocol.

cumulative claimed net savings comprised 64% of the kWh goal, 31% of the therm goal, and 11% of the kW goal.

PG&E projects overall had evaluated gross realization rates of 32% (kWh), 161% (kW), and 166% (therms), while SCE projects overall had gross realization rates of 73% (kWh, with kW not applicable) and 100% (therms). Note that across the board, evaluated peak kW reduction was significantly higher than the program estimates, which tended to be conservative. Evaluated gas savings were higher than the program claimed, while electric savings was appreciably lower.

To estimate the net program impacts based on the evaluated gross savings, we applied the net-to-gross ratios (NTGRs) developed for energy type and utility. These ranged from 0.74 to 1.00, indicating that levels of freeridership were fairly low in this program. Overall, they reduced the gross electric savings by 11%, demand reduction by 12% and therm savings by 16%. The combined net evaluated savings from the BTU program are 7.3 million kWh/year of electric savings, 1.6 MW of average peak demand reduction, and 503,000 therms of natural gas savings. Evaluated PG&E net savings represent 35% and 84% of the electric and gas goals, respectively. Evaluated SCE savings represent 4% and 9% of the electric and gas goals, respectively. Overall, the program achieved 19% of its net electric savings goal, 16% of its demand reduction goal, and 47% of its natural gas savings goals.

The key reasons why the program failed to meet its goals vary dramatically between utility service areas and fuel savings types. The program was able to exceed its kWh goals for PG&E projects according to their savings claim, but most of these savings fell away because they were not ultimately realized. The situation was reversed for kW and therm savings for PG&E projects: the program was unable to get enough projects implemented to meet these goals, but those that were implemented actually provided more savings than the program had hoped for. For SCE projects, the reason for the savings shortfall was overwhelmingly because of inability of the program to garner enough projects. Comparatively speaking, the impact of freeridership was fairly small.

We estimated the effective useful life of program savings to be 5.7 years for PG&E projects, and 12.4 years for SCE projects. The significant difference between the two utility service areas occurs because of the varying mix of implemented measures between projects in each. By comparison, the PIP cost-effectiveness calculations for this program assumed an effective useful life of eight years.

The table below compares the benefit-cost ratios and net benefits originally proposed by the program with the final evaluated results. These indicate that the BTU program was not cost-effective in either the PG&E or SCE service areas. Although the evaluated TRC costs were lower than projected in the PIP workbooks (particularly for the SCE portion of the program), the corresponding TRC benefits were considerably lower, so that the benefit-cost ratios fell well below one.

	PG&E		**SCE**		**Combined**	
Total Resource Cost (TRC) test parameter	Program implementation plan (PIP)	Evaluated	Program implementation plan (PIP)	Evaluated	Program implementation plans (PIP)	Evaluated
TRC Costs	$4,962,437	**$4,221,942**	$4,904,534	**$1,393,537**	$9,866,972	**$5,615,479**
TRC Benefits	$9,490,617	**$3,380,452**	$9,490,617	**$593,407**	$18,981,233	**$3,973,860**
TRC Net Benefits	$4,528,179	**($841,490)**	$4,586,082	**($800,130)**	$9,114,262	**($1,641,620)**
TRC Ratio	1.91	**0.80**	1.94	**0.43**	1.92	**0.71**

The process portion of the evaluation examined administrative effectiveness, program delivery, and customer satisfaction. Overall, it found many positive aspects. For instance, program administrators had clearly understood the market for retrocommissioning services and incorporated those lessons into the program design. Participants also expressed high levels of satisfaction with all areas of the program. They reported that program representatives, with a few exceptions, were courteous and professional. The best aspect of the program for participants was the free engineering analysis, while the worst was the length of time it took to complete the engineering analysis. The main reasons respondents gave for not participating in the program were lack of funds, and insufficient opportunities for improvements.

There were mixed opinions on other aspects of the program. Those associated with the program felt education about commissioning was a significant accomplishment, although most program participants stated they were already aware of the concept and its benefits. Similarly, program administrators and consultants thought the program should offer implementation services through a pool of contractors, while participant customers felt this would be of limited interest to them. Both administrators and consultants mentioned the program's memorandum of understanding (MOU) as a barrier to participation, though few participants shared this concern.

Conclusions

Overall, this evaluation found that the 2004-2005 BTU program was not cost-effective. Key reasons for this include difficulties recruiting participants, challenges persuading customers to implement measures by the program incentive deadline, and measures that underperformed and thus did not provide sustained savings. Adding the effects of measures that the program recommended, but that customers implemented after the evaluation deadline, could improve the cost-effectiveness somewhat. These effects fell beyond the scope of this evaluation.

Most participants were satisfied with the program, though there is clearly room for improvement. The evaluation effort revealed a number of refinements that can improve savings estimates and the quality of recommended measures. We feel that further study of this type of program is warranted in the future to provide better confidence in the persistence of program savings, and determine the best means to maintain these savings. These conclusions are discussed in more detail below.

A. The program was not cost-effective.

Weighing the total resource cost (TRC) benefits from the realized net savings against the actual program TRC costs yielded a TRC ratio of 0.71. This indicates that the BTU program was not cost-effective. This was true for both utility service areas, as the evaluated TRC ratios for the PG&E and SCE service areas were 0.80 and 0.43, respectively. As a point of comparison, the evaluated TRC ratio for a prior building tune-up program, Oakland Energy Partners (OEP), was 0.89[2]. The latter evaluation used a similar methodology to the BTU evaluation. We speculate that the higher TRC for OEP may reflect the more relaxed program schedule, which allowed more participants to complete projects.

The BTU program TRC results reflect the ultimate fact that the program was unable to meet its savings goals. The program achieved 19% of the electric savings it had hoped to get. Of this 81% discrepancy, 36% occurred because of insufficient projects, that is, the program was unable to recruit enough, or those recruited did not implement in time. Another 42% of the shortfall occurred because realized savings were much lower than the program claimed. Lack of sufficient projects was the main reason the program only captured 16% of the electric demand savings and 47% of the natural gas

[2] Obtained from supporting calculations for the *Oakland Energy Partners Large Commercial Tune-Up Program Impact Evaluation*, Itron, Inc. and SBW Consulting, Inc., March 31, 2006.

savings it had sought, since the realized savings for these quantities were somewhat better than the program claimed.

One factor that may mitigate these results is that our evaluation focused on energy impacts soon after the program was complete. We feel fairly certain that the program will yield additional impacts, in the form of RCx measures the program recommended that participants completed after the evaluation. While these additional impacts may be significant, it is not known if they will suffice to make the program cost-effective.

B. <u>Getting customers to implement measures in a timely manner was problematic, and completed measures frequently underperformed.</u>

The program saw a high attrition rate among initially recruited projects, a minority of which ultimately was successfully completed. Those that were completed often only tackled a small number of the recommended measures. These facts illuminate some of the difficulties inherent in executing a particularly challenging program concept over a relatively short two-year timeframe. Providing more time to recruit participants and guide them to project completion, as the current 2006-2008 program cycle does, should be helpful in this regard. Future programs should build in ample schedule cushion to accommodate customer decision-making and implementation timelines.

Predicting savings for commissioning measures can be inherently difficult, since the measures are often complex, and the effects subtle. Building operations are generally quite dynamic. "Commissioning the retrocommissioning" is an important step for programs to include, since system changes do not always work as intended. This step did not always happen in the BTU program. In many cases at the evaluated projects, measures were only partially or ineffectively implemented, or were negated by subsequent changes. In some cases, customers attempted to implement measures (such as retrofitting constant volume HVAC systems with variable speed drives and reducing fan speeds), but changed the measures back after getting complaints from building occupants. A number of projects did not investigate the interrelationship between measures and recommended repairs, so when the customer did not complete the repairs, it prevented the measures from yielding recommended savings. These observations point to the care that must be taken balancing energy savings from RCx against proper building function and comfort.

C. <u>The program satisfied most participants, although certain aspects need refinement.</u>

The process evaluation revealed that program administrators learned many useful lessons for streamlining participant recruitment and analysis. Customers for the most part responded well to the program and were satisfied with the results, and several of them reported that the program exceeded their expectations. Some, though, pointed out areas for improvement, such as a slow building analysis process, excessive paperwork, lack of administrative attention, and need to vet the proposed measures better. Clearly, too, the poor participation in SCE territory points to significant marketing and management problems.

The program was found to have a strong influence on customers implementing energy saving measures, with only a few cases of freeridership reported by participants. General recommendations that came forth from the process interviews include:

1. Update tracking database regularly.
2. Streamline investigation process.
3. Discuss HVAC concerns with customers up front.
4. Forego providing approved contractor lists.

D. Future program savings estimates should be improved.

As the wide range of measure realization rates found in this study suggests, accurately estimating savings from common tune-up measures can be very challenging. Savings estimation can be confounded by difficulties collecting reliable data and challenges trying to predict how a facility might actually implement measures. To improve predicted and realized savings estimates, it is critical to capture baseline conditions thoroughly, use best possible measurements and assumptions to estimate ex ante savings, and take post measurements to verify performance and help estimate as-built savings. Some specific steps for doing so include:

Prior to measure implementation

1. Discuss proposed measures in detail with building operators and engineers.
2. Verify the operation of baseline equipment.
3. Adopt a consistent approach to estimating average peak demand reduction.
4. Rely less on assumed values when determining power draw for electrical loads.
5. Perform short-term monitoring for large-saver measures that affect variable loads.

After measure implementation

1. Post-implementation inspections should not just check for measure implementation, but collect sufficient information to adequately re-estimate as-built savings.
2. Verify that actual measure performance meets the original design intent as proposed.
3. Ensure the facility engineering team understands how to properly maintain implemented measures.
4. More work is necessary to verify if the savings last, and if not, determine how to make them last. In this vein, future evaluations may need to incorporate at least two rounds—one right after the program ends, and one at least two years out—to assess savings persistence and spillover effects with more confidence.

1. Introduction

This report describes the results of an impact and process evaluation of the Building Tune-Up Program (BTU Program) operated in the service areas of Pacific Gas and Electric (PG&E) and Southern California Edison (SCE) during 2004 and 2005. This evaluation was conducted by SBW Consulting, Inc. and Itron, Inc. (henceforth referred to collectively as the "evaluation team" or the "evaluators.").

1.1 Program Description

The primary goal of the BTU Program was to provide cost-effective, long lasting energy and demand savings through retrocommissioning (RCx) of existing medium and large nonresidential buildings in PG&E and SCE service territories. For each participating building, QuEST and their subcontractors (referred to in this report as the "program implementer"), identified and implemented changes in building operations and related hardware to reduce energy use while maintaining comfort and health objectives. The program achieves long-term persistence of savings by emphasizing "hard" measures (e.g., via hardware that must be installed with tools, repositioning control points, and software changes that require specialized skills that cannot be easily reversed) and by providing monitoring tools, operator training, and building system manuals. In addition the program maximized the installation of all appropriate cost-effective measures by providing an independent, in-depth assessment of opportunities, coupled with consistent customer support throughout the entire project development and installation process. This approach is very similar to the Oakland Energy Partnership Building Tune-up Program that was part of the 2002-3 program cycle.

The BTU Program targeted commercial buildings in the PG&E and SCE service areas that have at least 100,000 square feet of conditioned space with an operating energy management and control system. The program provided a no-cost engineering investigation and analysis to identify and recommend improvements in building operations, such as control strategies and schedules that would increase energy efficiency. In addition, financial incentives were available to building owners who implemented the program's recommendations.

After recruiting a customer, the BTU program first provided an initial walk-through of the building to determine if sufficient energy savings potential existed. If sufficient potential was found and the customer agreed to continue, a Memorandum of Understanding (MOU) was signed by the customer, and the program allocated money for the project. Usually 60 to 70 percent of the budget for any one building was allocated for the engineering analysis, and the remainder was allocated for financial incentives for the customer. A team of professional engineers was assigned to the project to perform a comprehensive analysis of the building's energy use and to develop an Energy Management Plan. The latter outlines additional cost-effective retrofit opportunities beyond the low- and no-cost options associated with the core RCx element.

This comprehensive engineering investigation and analysis was funded entirely by the BTU program. It included an analysis of data obtained from the customer's control system, such as supply air temperature, chilled water temperature, and ambient wet and dry bulb temperatures for HVAC systems. The investigation could be time-consuming. The result of the investigation was a set of recommended measures for increasing building energy efficiency that was presented to the customer in a comprehensive written report. The project team presented the findings to the customer, and individuals attending the presentation might have included the customer's chief engineer, the property manager, and the financial manager.

Financial incentives were offered to the customer for implementing the recommendations, and these incentives may vary per measure according to the payback period. The amount of the financial incentive was intended to buy back the measure to a one-year payback. Sometimes the amount of the incentive was negotiated with the customer.

Program objectives for the PG&E/SCE Building Tune-Up Program are summarized in Table 1-1.

Table 1-1: Program Objectives

Utility service area	Number of buildings	Total building area (sq. ft.)	Net annual kWh saved	Net average peak demand reduction (kW)	Net annual therms saved
Pacific Gas & Electric (PG&E)	75	18,000,000	18,356,872	5,034	664,359
Southern California Edison (SCE)	75	18,000,000	18,647,980	5,114	620,925
ALL	**150**	**36,000,000**	**37,004,852**	**10,148**	**1,285,284**

1.2 Program Theory

The large commercial building market has been conditioned to respond to price signals through simple reduction of demand for services (i.e. shorter operational hours, thermostat adjustments) or by upgrading individual pieces of equipment. In addition, maintenance and operations tasks are initiated primarily through occupant complaints or simple scheduled equipment maintenance. In-house facilities staff generally does not have the skills, budget or time to perform in-depth evaluations of system integrity.

As part of a comprehensive audit of all energy consuming systems at a facility, the BTU program identifies O&M strategies previously not implemented and determines optimization strategies beyond routine end user control techniques. By providing detailed technical assistance to the participant at little or no initial cost, the program results in retro-commissioning and retrofit savings that otherwise would not have occurred.

1.3 EM&V Objectives

Our Evaluation, Measurement, and Verification (EM&V) effort for the 2004-5 Building Tune-Up Program was designed to meet the objectives listed in the California Public Utility Commission Energy Efficiency Policy Manual[3]. These objectives, and the manner in which we achieved them, are as follows:

1. **Measuring level of energy and peak demand savings achieved.**

   The primary objective was to verify electric and gas energy savings and peak electric demand reductions[4] from this program for each energy utility service territory. This was accomplished by collecting pre- and post-implementation data consistent with the International Performance Measurement and Verification Protocol (IPMVP), Option B – Retrofit Isolation, which calls for short-term metering at the device level. We also performed detailed reviews of the implementer's data collection and analyses of savings for a sample of the participating projects, including

[3] Version 2, prepared by the Energy Division, and released in August 2003.

[4] Defined as the average kW reduction during the period Monday-Friday 12 p.m. – 7 p.m., during the months of June through September (consistent with the *CPUC Energy Efficiency Policy Manual, Version 2*).

inspections to confirm implementation of recommended RCx improvements, and revised savings estimates as appropriate.

2. **Measuring cost-effectiveness.**

   We developed measurement-based estimates of verified energy and demand savings, so that the program implementer could re-assess program cost-effectiveness—that is, compute new total resource cost (TRC) values using the workbook developed for the program implementation plan (PIP).

3. **Providing ongoing feedback, corrective/constructive guidance regarding implementation of programs.**

   The impact evaluation provided verified savings estimates as soon as they become available for each sampled project. In theory, this would allow the implementer to make improvements as the program proceeds, although in practice, the timing was such that this feedback did not occur. The process evaluation provided feedback on program delivery, although again the timing did permit mid-course adjustments.

4. **Providing up-front market assessments and baseline analysis.**

   Results from the Oakland Energy Partnership Building Tune-up Program helped establish baseline conditions for this PG&E/SCE building tune-up program. The EM&V effort for the latter further refined estimates of typical baseline conditions. In addition, the final assessment of customer satisfaction and RCx penetration levels helps illuminate future markets for such services.

5. **Measuring indicators of effectiveness of the specific programs, including testing of the assumptions that underlie the program theory and approach.**

   The process evaluation assessed program effectiveness, customer satisfaction, and obstacles to implementing recommended measures to test the program theory and provide recommendations for improving the program.

6. **Assessing the overall levels of performance and success.**

   Our evaluation of program savings and cost-effectiveness provides a complete assessment of the program's performance and success from an energy perspective.

7. **Informing decisions regarding compensation and final payments.**

   To the extent that the CPUC finds these EM&V results to be useful, the EM&V efforts satisfy this objective.

8. **Helping to assess whether there is a continuing need for the program.**

   The results of this evaluation provide information about potential savings, customer satisfaction, and market barriers that might exist in subsequent phases, thus helping the CPUC assess whether continuing the program would be worthwhile.

1.4 Report Overview

The report is organized as follows:

Chapter 2 - Methodology	Describes the evaluation approach for selecting the sample, analyzing gross and net savings, assessing the program process, and extrapolating results to the entire program.
Chapter 3 - Results	Presents evaluation findings on gross and net savings for sampled projects and the program overall, as well as savings life and program cost-effectiveness. Also documents process interview results.
Chapter 4 - Conclusions	Provides conclusions based on the analysis results.
Chapter 5 - Appendix	Contains survey instruments, detailed evaluation analysis results, and an official record of comments on the draft version of this report.

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2. Methodology

2.1 Overview

This evaluation relied on a variety of techniques and data sources to assess the net energy savings and effectiveness of the program. These included telephone surveys, as well as short-term metering, one-time measurements, and observations at a sample of sites with installed measures. They also include revising engineering calculations and building simulations. The impact portion of this EM&V plan is consistent with the requirements of IPMVP Option B: Retrofit Isolation. We based savings on performance measurements of the affected equipment, systems, or buildings, as appropriate, for a random sample of projects.

The evaluation methodology was designed to answer the following questions:

1. What is the total program savings (gas and electric energy and peak demand) for each utility? The EM&V team adjusted savings estimates for measures implemented at sampled projects if there was strong evidence that the actual savings were different from the amount determined by the implementer. These differences formed the basis for calculating savings realization rates, which were applied to other completed projects not included in the sample. We thereby estimated total realized program savings.

2. What is the program's cost-effectiveness? We entered the realized program savings in the program implementer's PIP workbook and calculated new TRC values to determine actual cost-effectiveness.

3. Will the RCx projects yield additional benefits not fully captured through a first-year impact evaluation? The process evaluation asked participants about aspects of the program that they liked, in an attempt to identify any additional non-energy benefits important to them.

4. What mid-stream corrections can the program make to improve savings estimates and participant satisfaction? Both the impact and process evaluations were to provide the program with results for each sampled project as they became available, so the program could improve savings estimates for future projects. As the program and evaluation unfolded, however, the timing precluded any meaningful mid-course feedback.

5. To what extent has the program achieved its goals? Both the impact and process evaluations assessed progress made towards program goals. The impact evaluation assessed accomplishments made towards the energy savings goals while the process evaluation addressed accomplishments from the perspective of customer satisfaction, marketing effectiveness, overcoming barriers to participation and other customer perceptions.

6. What obstacles exist to the success of the program and how can they be overcome? The process evaluation specifically addressed market barriers and the success of the program in overcoming them. In cases where program procedures presented obstacles, we recommended ways to address these issues.

7. To what extent are customers satisfied with the program and its various components? The process evaluation specifically addressed participant satisfaction and dissatisfaction with various elements of the program. For areas where significant dissatisfaction was noted, recommendations were made to increase satisfaction for future offerings.

8. To what extent are the various program components (tracking, marketing, assessment, customer interaction and education, etc.) effective? The process evaluation addressed the effectiveness of all major program components through detailed telephone interviews with a sample of participants.

2.2 Sampling Approach

Sampling projects for project-specific data collection and the analysis portion of the EM&V effort was complicated by the desire to collect pre-implementation baseline data, as well as the fact that project implementation dates are distributed over a long period of time. In addition, we expected project-level savings estimates to highly variable, and in fact, skewed toward a small number of large cases. This latter fact would normally argue for optimizing the sample selection—that is, defining sampling strata using the savings estimates and placing more evaluation resources in the strata with larger savers. This would improve the precision of the mean realization rate estimates. The optimized approach in this situation, however, would require that we have good estimates of savings for all cases before any of them reached their implementation date. The unpredictability expected in recruiting, analyzing, and implementing measures for the RCx projects made this highly unlikely. Therefore, we adopted a simple, rather than optimized, random selection approach.

We originally proposed an interval sampling approach, in which we stipulated an interval (say, every seventh project), and sampled every project that fell on the interval. In actuality, though, projects progressed in the program database in large batches towards the end of the program, so we needed to adjust our approach. We replaced interval sampling with simple random sampling within the batches—essentially the same sampling principle with a different mechanism. As part of the sampling procedure, we also randomly selected replacements for the numerous sites that ultimately fell out of the program. The three major sample selection efforts can be summarized as follows:

1. In August 2005, we obtained the program database listing projects through May 2005. Of the 75 projects in the database, 30 were near completing or had already received detailed implementation reports. We randomly selected 10 of these, and immediately reviewed associated baseline data to see if it seemed reasonable[5].

2. In March 2006, nearing the program implementation deadline, we reviewed a revised program database and selected additional sites very likely to implement, so that our sample totaled 19 sites (out of 68 active sites).

3. In April 2006, we received the final program database. A significant number of active sites, as well as our sampled 19 sites, were deemed non-participants by the program, so that the total participant population fell to 36 sites. We randomly selected replacements for those of the 19 that had fallen away, so that we ended up with a final sample of 17 sites. Because the population dropped so precipitously, we opted to analyze two fewer sites than before, so that we could devote more resources to each site. Nonetheless, the sample remained quite robust: we selected nearly half of the projects, accounting for 71% and 92% of the claimed PG&E and SCE savings, respectively. Further details of the sample disposition can be found in the Results Section.

[5] This review was meant to establish if additional baseline data collection appeared necessary. From past RCx evaluations, we learned that it is best to avoid collecting additional baseline data unless absolutely necessary, because the chances of a given measure not being implemented, and thus the resources spent gathering data being wasted, are high. Our subsequent experiences bore this out.

2.3 Project-Specific Gross Savings Analysis

2.3.1 Develop project-specific evaluation plan

For each participating site, the program implementer developed an Investigation Phase Report, which included customized baseline information for each recommended measure at the site, as well as a detailed description of each recommended energy efficiency measure, including the investigation findings that led to the measure and recommendations for actions to implement the measure. In addition, the program implementer provided us with ex ante savings estimates, savings calculations, and supporting data for all implemented measures for each sampled project (the number of measures per project ranges from as few as five to nearly two dozen). They also provided contact information for the lead project engineer and the site liaison. Based on this information, we developed a project-specific savings verification plan that encompassed all of the measures claimed to be installed (although sampling may be appropriate in some cases). The development of the plan included (a) a review of the ex ante savings calculations and supporting data for each measure, (b) contact with the site liaison to confirm project/measure completion, and to assess appropriate data collection approaches, and (c) if necessary, contact with the program implementer project engineer to better understand the data and/or analysis. The plan described either how the additional data was integrated into the original spreadsheet or simulation model developed by the program implementer, or how a more appropriate method was applied.

For the simplest, smallest measures, the plan might simply require verifying that a measure was done, in which case we would accept the program estimate of savings. For the larger, more significant measures, we would take appropriate short-term measurements and perform a detailed engineering analysis to assess savings. Depending on the nature of the measures and the magnitude of their expected energy savings, we could have selected only large saver measures, or a sample of measures that accounted for a significant or representative portion of the overall project savings, for the detailed treatment. The most appropriate analysis method was determined on a case-by-case basis, depending on factors such as the information available from the ex ante estimation process, available performance data, ease of further data collection, complexity of determining system performance, the relative savings contribution of an action to the overall program package, and budget constraints. Table 2-1 shows the three levels of analytical rigor that we applied to measures in the sampled projects. It clearly indicates that we applied the highest level of rigor—the “detailed” analysis consistent with IPMVP Option B—to the vast majority of the claimed savings.

Table 2-1: Evaluation Gross Savings Analysis Approaches

Gross savings analysis approach		% of total sampled MMBtu
Verify	Independently verify that measure was implemented, and if so, accept ex ante estimate of savings.	8%
Simple	Make simple adjustments to ex ante savings analysis to reflect actual post conditions determined from observations and one-time measurements.	4%
Detailed	Perform detailed revision to ex ante savings analysis or develop alternative analysis approach using short-term data, observations, and one-time measurements.	88%

Reviewing program baseline data was a key element of developing plans. If it became necessary to supplement their data, we reserved the right to collect additional baseline data from visual inspection of affected systems, one-time measurements, short-term trend logging (EMCS trends or special metering), manufacturers' specifications, and self-reports from building operators and tenants. In some cases, this might require simulating, or recreating, baseline conditions for a short time if feasible.

Once the aggregate M&V plan for all selected measures for a project was complete, we forwarded it to the program implementer for their review, so they could provide comments and supply any relevant additional data they may have had.

2.3.2 Collect data and perform analysis

Once the evaluation plan for a project was firmed up, we arranged with the site contact to obtain planned post measurements and perform supplemental data collection. This included inspecting the building systems and/or supporting documentation to confirm that the tune-up improvements had been made. After evaluation data collection was complete, we summarized the data, and incorporated it in the evaluation savings analysis as specified by the plan. We then developed final evaluation estimates of kW, kWh/year, and therms/year savings for each implemented, sampled measure (or group of measures) and summarized our findings. If appropriate, we discussed any major revision to the site savings estimate with facility staff. For all sampled projects, we provided our analyses to the project implementer so they had an opportunity to provide additional information that could inform our approach and findings.

> For each measure, we assigned a measure life category, each of which corresponds to a standardized estimate of measure lifetime agreed upon from prior evaluation work or from an authoritative source, such as the California Database for Energy Efficient Resources (DEER). We used these measure lives in aggregate to estimate the overall persistence of evaluated program savings. The standard lifetimes were modified upward or downward only if a compelling reason existed (for example, if the site contact mentioned that an air handler where a measure has been implemented was going to be replaced within a year). Only in very clear instances did we deviate from the standard table of measure lives.

2.3.3 Perform follow-up analysis in response to implementer concerns

After we issued the draft program evaluation report in August 2006, the program implementer performed a detailed review of our gross savings calculations and findings. Of the 17 sampled projects, they identified seven where they found sufficient grounds to disagree with the evaluation results, based on their engineering reviews and in some cases, additional data and information from the customer. Their alternative recommended savings would have dramatically increased electrical savings. In fact, the only adjustments they sought were those that increased savings. After we carefully assessed the implementer's critique, we discussed the issues with CPUC staff. The CPUC approved additional EM&V funding for the evaluator to perform additional fieldwork and analysis to resolve discrepancies for critical measures at four projects. After the CPUC reviewed and approved these supplemental findings, we incorporated them into the program-wide EM&V analysis and results. Additional details of the methodology for this supplemental work can be found in Appendix C.

2.4 Project- Specific Net Savings Analysis

We conducted project- and measure-specific data collection and analysis of net energy savings for the sampled projects. Estimates of freeridership, in the form of a net-to-gross ratio (NTGR) for each project or set of measures, relied on self-reported cases collected from participants' responses to the following questions from the participant survey (described further in Section 2.5).

Q4. Before becoming involved in the program, what efforts had you taken on your own towards making the energy saving improvements that were recommended by the program? Please describe what efforts (for example, budgeting money for improvements, getting bids from contractors, ordering equipment, etc.) and be specific about which improvements were involved.

Q5. Thinking about the improvements recommended to you by the program, had you already decided on your own to implement any of these before they were presented to you by the program engineers? (describe which improvements)

Q6. How likely would you have been to perform some or all of these improvements on your own without the engineering analysis provided by the program? Please answer on a scale of 1 to 5 where 1 means not at all likely and 5 means very likely.

Q7. How likely would you have been to perform some or all of these improvements on your own without the financial incentives provided by the program? Please answer on a scale of 1 to 5 where 1 means not at all likely and 5 means very likely.

Q8. If answer to 6 or 7 is greater than or equal to 3: Which of the following describes when you think you might have performed the improvements you just described?

1. This year or next year
2. After next year but within four years
3. More than four years from now

Questions 4 and 5 provide background information for the interviewer to help with probing and judging responses to questions 6 and 7. Freeridership will be determined as follows:

Respondent answers < 3 to Q6 and Q7; freeridership = 0

Respondent answers >= 3 to Q6 or Q7

And answers a to Q8; freeridership (NTGR) = 1

And answers b to Q8; freeridership (NTGR) = 0.5

And answers c to Q8, freeridership (NTGR) = 0

Net savings for the project were equal to the NTGR multiplied by the evaluation estimates of gross savings.

2.5 Process Evaluation

The approach used in this study included the following steps: review program data and records; design interview questionnaires; conduct in-depth interviews with program administrators, consulting firms, participants and non-participants; analyze results; and prepare a final report. Each of these is discussed below.

2.5.1 Initial Data Review and Analysis

The first step was to review existing program data and documents. Documents provided by the BTU program included the following:

- A preliminary list of energy consultants, participants and nonparticipants to be interviewed,
- A selection of promotional brochures, presentations and case studies, and
- An electronic tracking database in Microsoft Access format.

The information collected from this review (as well as follow-up calls asking for additional customer contact information and an updated copy of the tracking database) was used to design the interview guides and to conduct the interviews with participants and nonparticipants.

2.5.2 Design of Interview Questionnaires

The second step was to develop structured interview guides for the study. Interview guides were developed for program administrators and energy consultants, and for participant and nonparticipant customers. Energy consultants were subcontractors to the program implementer and provided services including customer recruitment, building inspection, and engineering analysis.

Topics for the administrator and consultant interview questions included the following:

- Program goals and performance,
- Lessons learned,
- Changes in various program components,
- Suggestions for improving the program, and
- Problems and concerns.

Topics for the participant interview questions included the following:

- How they first heard about the program,
- Perceptions and expectations about the program,
- Awareness of the benefits of retro commissioning,
- Satisfaction with various components of the program,
- Plans for implementing recommendations for improvements,
- How improvements are budgeted, and
- Suggestions for improving the program.

Nonparticipants interviewed for the study were customers who had been contacted to participate in the program but had chosen to not participate. Therefore, these respondents were asked primarily about their reasons for choosing to leave the program or not participate.

Copies of the final questionnaires are provided in Appendix A and Appendix B.

2.5.3 In-Depth Interviews

Interviews were conducted first with program administrators and energy consultants in order to learn more about the BTU program and the issues involved with program participants. Subsequently, participant customers were interviewed. In addition, nonparticipant customers who had been contacted about the program and declined, or whose buildings had received the initial walk-through but lacked potential energy savings, were interviewed.

2.5.4 Interview Sample

The work plan for this study suggested a target sample of eight program administrators and energy consultants, 30 participant customers, and 30 nonparticipant customers. At the time of the evaluation, a list of contact names for eight administrators and consultants (along with an additional nine contacts to use as backup contacts) were provided along with 45 contact names for participant customers and 39 contact names for nonparticipant customers. A three-call protocol was used while conducting the interviews. This protocol allows for an individual to be contacted at least three times (during different days and time of day) for an interview. Contact attempts for several of the "multi-building" participants was performed six or more times. Table 2-2 presents the results for the final sample.

Table 2-2: Completed Samples for Interviews

	Program Administrators and Energy Consultants	Participant Customers	Nonparticipant Customers
Contact information provided	17	45	39
Interviewed	9	18	12
Did not return at least three calls		14	9
Contact no longer with company and no one else knowledgeable			5
Respondent did not remember program enough to complete interview		3	10
Contact information incorrect		7	3
Identified contact was actually a subordinate contact to another on the list		3	

As shown, interviews were completed for nine administrators/consultants, 18 participant customers, and 12 nonparticipant customers.

2.6 Program Savings and Cost-Effectiveness

We extrapolated our findings from the sampled projects to estimate total program savings and cost-effectiveness for each utility (PG&E and SCE) as follows.

1. We derived a savings-weighted realization rate for each utility service area from their respective sampled projects and associated measures. This realization rate compares the program's estimate of gross savings to the final evaluated first-year gross savings—in other words, if both are the same, then the realization rate is one.

2. We multiplied the total program estimate of gross savings for all claimed projects in a given utility service area by the corresponding realization rate. This yielded total evaluated first-year gross savings for each utility.

3. We multiplied total evaluated gross savings for each utility by the corresponding net-to-gross ratio developed in Section 2.4. This yielded total evaluated first-year net savings for each utility.

4. To estimate program savings in future years, we applied the assigned measure life for each evaluated measure to develop a lifetime annual savings stream. We summed these streams by year after implementation to develop a profile of program savings reduction over time, with savings for each year expressed as a percentage of first-year savings. We applied these ratios to the first-year net savings for each utility to estimate net savings in future years.

5. Lastly, we determined program cost-effectiveness by working with the program implementer to make appropriate modifications to the PIP workbook for each utility. These changes included adjusting the total number of projects and the unit savings for these projects.

3. Results

3.1 Reported Accomplishments

The Building Tune-Up program implementation plan set goals of 150 buildings, comprising 36 million square feet of building area, to be treated by the program, split equally between PG&E and SCE service territory. It also established goals of about 37 million kWh/year of net electric savings and 1,080,000 therms/year of net natural gas savings, as well as 10.1 MW of average peak demand reduction. Converting the electric and natural gas savings to a common energy basis, the overall program goal was to save about 236,000 MMBtu/year. These goals were divided equally between the two utilities.

The final database of claimed program savings showed that, overall, 36 projects were completed satisfactorily. While these only account for about a quarter of the project count goal, the projects on average were larger than originally assumed, so that they account for nearly half of the floor area goal. Table 3-1 provides a more detailed breakdown of claimed results compared to program goals. It is worth noting that the program had substantially more successful projects in PG&E territory, compared to SCE territory.

From an energy savings standpoint, program claims of electric savings exceeded the PG&E goal by 21% but fell far short (6%) of the SCE goal. Similarly, claimed average peak demand and gas savings are considerably lower than the goals, both by utility and overall. In total, claimed electric savings and peak demand reduction represent 64% and 11% of their respective goals. Corresponding gas savings represent 31% of the original target.

Table 3-1: Program Goals and Claimed Savings

			Net electric savings		Net gas savings	Total net energy savings
Utility	Number of projects	Total building area (sq. ft.)	kWh/year	Avg. peak kW	therms/year	MMBtu/year
PG&E						
Program Goals*	75	18,000,000	18,720,000	5,034.0	540,000	117,891
Claimed Results	30	14,661,785	22,715,922	1,112.0	273,897	104,919
Claimed % of goal	**40%**	**81%**	**121%**	**22%**	**51%**	**89%**
SCE						
Program Goals*	75	18,000,000	18,720,000	5,034.0	540,000	117,891
Claimed Results	6	1,396,684	1,163,169	-	64,640	10,434
Claimed % of goal	**8%**	**8%**	**6%**	**0%**	**12%**	**9%**
Total						
Program Goals*	150	36,000,000	37,440,000	10,068.0	1,080,000	235,783
Claimed Results	36	16,058,469	23,879,091	1,112.0	338,537	115,353
Claimed % of goal	**24%**	**45%**	**64%**	**11%**	**31%**	**49%**

* From Program implementation plan (PIP) workbooks.

3.2 Sample Disposition

Our final sample selection consisted of 17 projects, whose makeup closely mirrors that of the population overall, as Table 3-2 illustrates. The population of 36 claimed projects consisted of about 60% offices, 20% retail, 10% lodging, and 10% colleges and other types. The sample is fairly representative, consisting of about 50% offices, 20% retail, 20% lodging, and 10% colleges.

Table 3-2: Project Building Types

Building type	Number of claimed projects	% of all projects	Number of sampled projects	% of sampled projects
College	2	6%	2	12%
Hospital	1	3%	0	0%
Lodging	4	11%	3	18%
Office	21	58%	9	53%
Retail	7	19%	3	18%
Miscellaneous	1	3%	0	0%
TOTAL	**36**	**100%**	**17**	**100%**

Table 3-3: Claimed and Sampled Savings

			Net electric savings		**Net gas savings****	**Total net energy savings**
Utility	Number of projects	Total building area (sq. ft.)	kWh/year	Avg. peak kW	therms/year	MMBtu/year
PG&E						
Claimed	30	14,661,785	22,715,922	1,112.0	273,897	104,919
Sampled	14	9,012,839	15,104,437	503.0	228,516	74,403
Sampled % of claimed*	**47%**	**61%**	**66%**	**45%**	**83%**	**71%**
Relative precision @ 90% CI						38%
SCE						
Claimed	6	1,396,684	1,163,169	-	64,640	10,434
Sampled	3	587,000	896,273	-	65,507	9,610
Sampled % of claimed*	**50%**	**42%**	**77%**	**-**	**101%**	**92%**
Relative precision @ 90% CI						130%
Total						
Claimed	36	16,058,469	23,879,091	1,112.0	338,537	115,353
Sampled	17	9,599,839	16,000,710	503.0	294,023	84,013
Sampled % of claimed*	**47%**	**60%**	**67%**	**45%**	**87%**	**73%**
Relative precision @ 90% CI						37%

* The evaluation sample was selected in two rounds. In the first round, we selected 9 projects. In selecting these, we excluded a small number of projects that accounted for less than 2-3% of the total energy savings from projects likely to be completed for each utility. In the second round, we selected 8 more projects, but because of the scarcity of projects, we did not exclude any. This overall approach skewed our sample slightly towards the larger savers, consistent with these percentages.

** Sampled gas savings for SCE projects exceeds claimed savings because of one unsampled project with negative claimed gas savings.

Table 3-3 provides a more detailed breakdown of the fractions of program claims that the sample accounts for. In randomly selecting about half of the claimed projects, we accounted for 60% of the building area, 67% of the electric savings, 45% of the average peak demand reduction, 87% of the gas savings, and 73% of the combined energy savings. These percentages are slightly higher for the six SCE projects. The relative precision at the 90% confidence interval for the combined energy savings is 38% for the PG&E projects, 130% for the SCE projects, and 37% for all projects. These high values for relative precision reflect the small populations from which the two utility samples were drawn.

3.3 Project-Specific Results

3.3.1 Realization Rates

Figure 3-1 shows the kWh, therm, and MMBtu realization rates for the 17 evaluated projects. The kW realization rates are not shown because of the paucity of program claimed estimates of kW reduction. The figure clearly illustrates the wide discrepancies between claimed and evaluated savings on a project-by-project basis. Three projects had little or no evaluated savings, and one project had negative savings. In contrast, actual gas savings for another project were over seven times higher than claimed. Appendix C contains a detailed comparison of claimed and evaluated savings for sampled projects, as well as measure-specific findings for each measure included in the sample.

Note that these realization rates account for both (a) the original EM&V findings and calculations, and (b) the findings of the follow-up fieldwork and analysis undertaken in response to implementer concerns. The latter significantly increased the kWh realization rate for one project, slightly increased it at another project, and dramatically reduced the realization rate for the remaining two projects that received follow-up study. Details of the issues and findings from the supplemental EM&V effort can be found in Appendix D.

We examined the reasons for differences between ex ante and evaluated savings where they existed, and found that in general terms, these differences reflected changes and refinements to the savings calculation methodology for about 40% of the measures. Differences for the other 60% can primarily be explained by the facilities not implementing the measures in the manner originally recommended, i.e., with different set points or schedules, or with reduced or increased measure scope.

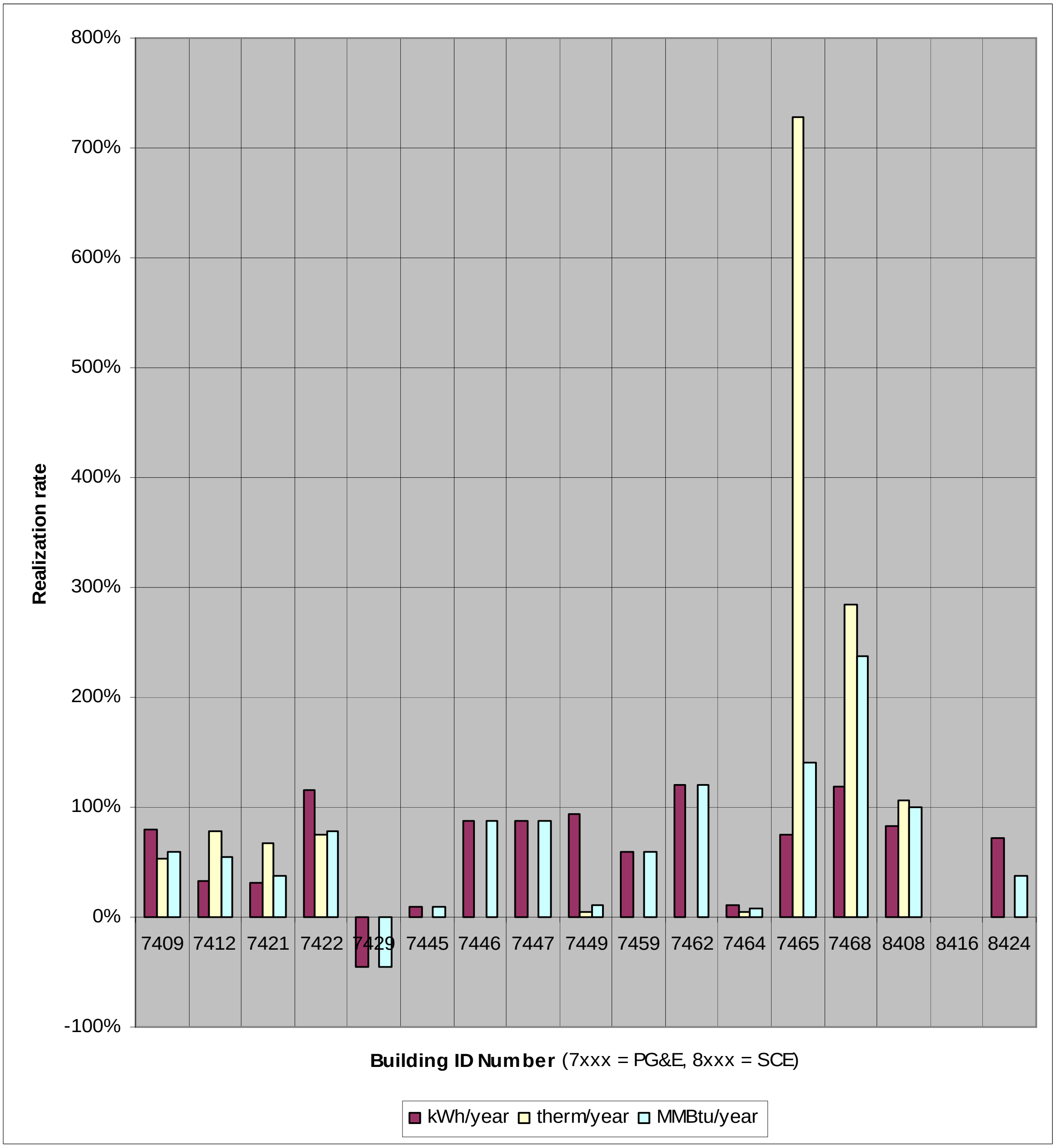
3.3.2 Spillover

The evaluation found clear evidence of spillover—that is, additional activity that occurred as a result of the program beyond what the program claimed—at three of the 17 sampled sites. This fact is not surprising because the abrupt program completion date left many unclaimed projects and measures in the pipeline. In many cases, organizations had already decided to implement certain measures, but were unable to do so soon enough for the program implementer to claim them. We found instances where the facilities also implemented O&M measures recommended by the program. It is also possible that facilities will in the future implement some of the recommended capital measures, although we found no concrete evidence of this. So, we feel certain that some degree of spillover is occurring, although the frequency and magnitude of the savings resulting from it are not known.

3.3.3 Measure lives

To estimate the persistence of the evaluated savings, we applied the deemed tune-up measure lives listed in Table 3-4 to the sampled measures and the total program savings extrapolated from them. In general, we assumed that the first-year savings would not degrade over the lifetime of the measure, but would remain constant. However, we uncovered several instances where facilities had begun replacing or had made near-term plans to replace measure-affected equipment, such as an air handler or a chiller, as part of their normal operations. Such normal replacement truncates the long-term savings streams that could otherwise be expected from implementation of a given measure. Projected savings persistence over a 20-year time horizon is illustrated in Figure 3-2. Additional yearly details of savings persistence can be found in the Tables 3-8 through 3-10. The profiles in the figure show that savings of all types persist nearly in their entirety for the first five years, not surprising since the most common measure in the sample was “Program logic changes to EMCS (add reset control, optimum start/stop, control sequences)”, with a measure life of five years.

Figure 3-1: Realization Rates for Sampled Projects



To calculate a program-wide effective useful life, we combined kWh and therm savings into MMBtu savings, and divided the aggregate annual savings over 20 years by the first-year savings. This yielded the following EULs:

- **PG&E 5.7 years**
- **SCE 12.4 years**

The significant difference between the two utility service areas occurs because of the varying mix of implemented measures between projects in each. By comparison, the PIP cost-effectiveness calculations for this program assumed an effective useful life of eight years.

Table 3-4: Effective Useful Lives for Building Tune-up Measures

Measure life category	Measure Life	# of measures in category	% of measures	Source**
Add or replace control components	10	16	17%	a
Add VFDs to supply fans	15	6	7%	a
Duct insulation material*	20	13	14%	b
HE Centrifugal Chiller Replacement	20	1	1%	b
Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	32	35%	a
Program schedule changes to EMCS. (setpoint, start/stop schedules)	3	13	14%	a
Reduce lighting levels	16	2	2%	a
Repair and recalibrate damper controls	5	5	5%	a
Replace Cooling Tower	15	1	1%	b
Replace smooth belts with Cogged belts	8	2	2%	a
Lighting occupancy sensors	8	1	1%	b

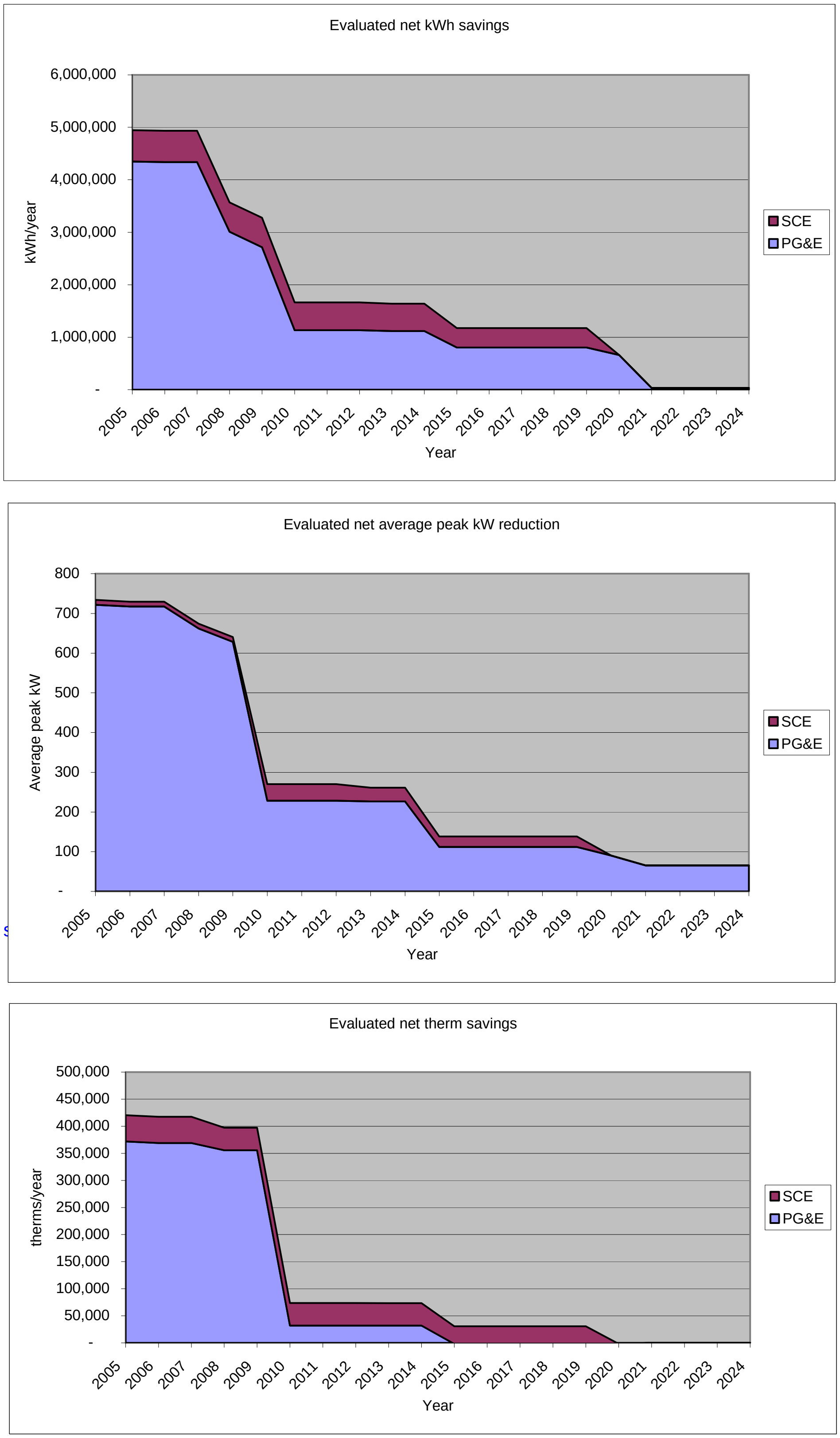
* Best available category from Source B for assorted measures to improve airflow in data rooms by plugging leaks and rearranging floor tiles.

**List of sources:

a) 2004-05 QuEST Building Tune-up Program EM&V plan, Table 6-2: Default lifetimes for expected building tuneup measures (agreed upon by QuEST and SBW).

b) CPUC/CEC 2005 Database for Energy Efficient Resources (DEER) .

Figure 3-2: Evaluated Net Savings over 20 Years



3.4 Program Savings and Cost-Effectiveness

3.4.1 Gross Savings

We summed the evaluated savings for sampled 14 PG&E and three SCE projects and divided these sums by the corresponding savings claimed by the program (note that net and gross savings for the program are the same, since they assumed a net-to-gross ratio of one). These ratios of evaluated to claimed savings constituted the realization rates, which we applied to the non-sampled projects within each utility to estimate total program gross savings. This process can be traced in Table 3-5. PG&E projects overall had realization rates of 32% (kWh), 161% (kW), and 166% (therms), while SCE projects overall had realization rates of 73% (kWh, with kW not applicable) and 100% (therms). Note that across the board, evaluated peak kW reduction was significantly higher than the program estimates, which tended to be conservative (in fact, no kW reduction was claimed for the six SCE projects). Evaluated gas savings were higher than the program claimed, while electric savings was appreciably lower. Applying these realization rates to the balance of claimed savings in non-sampled projects, yielded the final evaluation estimates of first-year gross savings from the program: gross electric energy savings of about 8.3 million kWh annually, average peak demand reduction of 1.8 MW, and natural gas savings of 504,000 therms annually. On a combined energy basis, the program has saved about 79 billion Btu annually.

3.4.2 Net Savings

To estimate the net program impacts based on the evaluated gross savings, we applied the net-to-gross ratios (NTGRs) developed for each energy type and utility. The NTGRs and corresponding net savings can be found in Table 3-6. Further details of how these ratios were established can be found in Section 3.6. Also, Appendix E contains the NTGRs for each evaluated project. The program-level NTGRs ranged from 0.74 to 1.00, indicating that levels of freeridership were fairly low in this program. Overall, they reduced the gross electric savings and demand reduction by 13%, and had negligible effect on therm savings.

The combined net evaluated first-year savings from the BTU program are 7.3 million kWh/year of electric savings, 1.6 MW of average peak demand reduction, and 503,000 therms of natural gas savings. Table 3-7 compares these results to the program estimates of claimed net savings, in the form of net realization rates. Table 3-8 compares these results these net results to the original program goals. Evaluated PG&E savings represent 35% and 84% of the electric and gas goals, respectively. Evaluated SCE savings represent 4% and 9% of the electric and gas goals, respectively. Overall, the program achieved 19% of its electric savings goal, 16% of its demand reduction goal, and 47% of its natural gas savings goals.

Table 3-9 illuminates the key reasons why the program failed to meet its goals. Explanations vary dramatically between utility service areas and fuel savings types. The program was able to exceed its kWh goals for PG&E projects according to their savings claim, but most of these savings fell away because they were not ultimately realized. The situation was reversed for kW and therm savings for PG&E projects: the program was unable to get enough projects implemented to meet these goals, but those that were implemented actually provided more savings than the program had hoped for. For SCE projects, the reason for the savings shortfall was overwhelmingly because of inability of the program to garner enough projects. Across the board, the impact of freeridership was fairly small.

To summarize these comparisons, the program achieved less than a fifth of the electric savings it had hoped to get. Roughly half of this discrepancy occurred because of insufficient projects, while the other half occurred because realized savings are much lower. The primary reason the program only captured about a sixth of the electric demand savings and half the natural gas savings it had sought was insufficient projects, since the realized savings are somewhat better than the program claimed.

Applying the measure lives for each measure and extrapolating to the program, we obtained the expected 20-year savings streams for each utility shown in Tables 3-10 and 3-11, and for the program overall shown in Table 3-12. Note that although the program technically began in 2004, we assumed that substantial savings from implemented measures did not begin until 2005.

Table 3-5: Evaluated Gross Realization Rates

	Program claimed savings				Evaluated gross first-year savings				Gross realization rates			
Utility	kWh/year	kW	therms/ year	MMBtu/ year	kWh/year	kW	therms/ year	MMBtu/ year	kWh/ year	kW	therms/ year	MMBtu/ year
Sample												
PG&E	15,104,437	503.0	228,516	74,403	4,928,183	817.7	372,193	54,039	33%	163%	163%	73%
SCE	896,273	-	65,507	9,610	650,882	13.3	65,767	8,798	73%	-	100%	92%
Total	16,000,710	503.0	294,023	84,013	5,579,065	831.0	437,960	62,837	35%	165%	149%	75%
All projects												
PG&E*	22,715,922	1,112.0	273,897	104,919	7,342,212	1,790.2	454,815	70,540	32%	161%	166%	67%
SCE**	1,163,169	-	64,640	10,434	844,705	17.3	64,896	9,373	73%	-	100%	90%
Total	23,879,091	1,112.0	338,537	115,353	8,326,068	1,837.1	504,265	78,843	35%	165%	149%	68%

* PG&E total savings adjusted for Project 7449, in which campus cogeneration considered to assess ultimate impacts to utilities.

** kW savings for all SCE projects calculated using ratio of kW and kWh savings for sampled SCE projects, since realization rate did not apply.

Table 3-6: Evaluated Net-to-Gross Ratios

	Evaluated gross first-year savings				Evaluated net first-year savings				Net-to-Gross Ratios			
Utility	kWh/year	kW	therms/ year	MMBtu/ year	kWh/year	kW	therms/ year	MMBtu/ year	kWh/ year	kW	therms/ year	MMBtu/ year
Sample												
PG&E	4,928,183	817.7	372,193	54,039	4,350,686	721.9	372,193	52,068	0.88	0.88	1.00	0.96
SCE	650,882	13.3	65,767	8,798	594,298	12.1	48,428	6,871	0.91	0.91	0.74	0.78
Total	5,579,065	831.0	437,960	62,837	4,944,983	734.0	420,621	58,939	0.89	0.88	0.96	0.94
All projects												
PG&E	7,342,212	1,790.2	454,815	70,540	6,481,834	1,580.4	454,815	67,604	0.88	0.88	1.00	0.96
SCE	844,705	17.3	64,896	9,373	771,270	15.8	47,787	7,411	0.91	0.91	0.74	0.79
Total	8,326,068	1,837.1	504,265	78,843	7,253,103	1,596.1	502,602	75,015	0.87	0.87	1.00	0.95

Table 3-7: Evaluated Net Realization Rates

Utility	Program claimed savings kWh/year	kW	therms/ year	MMBtu/ year	Evaluated net first-year savings kWh/year	kW	therms/ year	MMBtu/ year	Net realization rates kWh/ year	kW	therms/ year	MMBtu/ year
All projects												
PG&E	22,715,922	1,112.0	273,897	104,919	6,481,834	1,580.4	454,815	67,604	29%	142%	166%	64%
SCE	1,163,169	-	64,640	10,434	771,270	15.8	47,787	7,411	66%	0%	74%	71%
Total	23,879,091	1,112.0	338,537	115,353	7,253,103	1,596.1	502,602	75,015	30%	144%	148%	65%

Table 3-8: Evaluated Net Savings as Percentage of Program Goals

Utility	Program goals kWh/year	kW	therms/ year	MMBtu/ year	Evaluated net first-year savings kWh/year	kW	therms/ year	MMBtu/ year	Savings as % of goal kWh/ year	kW	therms/ year	MMBtu/ year
PG&E	18,720,000	5,034.0	540,000	117,891	6,481,834	1,580.4	454,815	67,604	35%	31%	84%	57%
SCE	18,720,000	5,034.0	540,000	117,891	771,270	15.8	47,787	7,411	4%	0%	9%	6%
Total	37,440,000	10,068.0	1,080,000	235,783	7,253,103	1,596.1	502,602	75,015	19%	16%	47%	32%

Table 3-9: Reasons for Savings Shortfalls

Utility	Reasons for differences	Effect on savings kWh/year	kW	therms/ year	MMBtu/ year	Shortfall as % of program goal kWh/ year	kW	therms/ year	MMBtu/ year
PG&E	Program unable to meet goal	(3,995,922)	3,922	266,103	12,972	-21%	78%	49%	11%
	Actual savings below program claim	15,373,710	(678)	(180,918)	34,379	82%	-13%	-34%	29%
	Freeridership	860,379	210	-	2,936	5%	4%	0%	2%
	Total difference	12,238,166	3,454	85,185	50,287	**65%**	**69%**	**16%**	**43%**
SCE	Program unable to meet goal	17,556,831	5,034	475,360	107,457	94%	100%	88%	91%
	Actual savings below claim	318,464	(17)	(256)	1,061	2%	0%	0%	1%
	Freeridership (net)	73,435	2	17,109	1,962	0%	0%	3%	2%
	Total difference	17,948,730	5,018	492,213	110,480	**96%**	**100%**	**91%**	**94%**
Total	Program unable to meet goal	13,560,909	8,956	741,463	120,430	36%	89%	69%	51%
	Actual savings below claim	15,553,023	(725)	(165,728)	36,510	42%	-7%	-15%	15%
	Freeridership (net)	1,072,964	241	1,664	3,828	3%	2%	0%	2%
	Total difference	30,186,897	8,472	577,398	160,768	**81%**	**84%**	**53%**	**68%**

Table 3-10: Evaluated SCE Savings over 20 Years

SCE Program Energy Impact Reporting for 2004-2005 Programs

Natural gas savings actually accrue to Sempra/SoCalGas.

Program ID*: 1117-04
Program Name: BUILDING TUNE-UP PROGRAM

Year	Calendar Year	Ex-ante Gross Program-Projected Program MWh Savings (1)	Ex-Post Net Evaluation Confirmed Program MWh Savings (2)	Ex-Ante Gross Program-Projected Peak Program MW Savings (1**)	Ex-Post Evaluation Projected Peak MW Savings (2**)	Ex-Ante Gross Program-Projected Program Therm Savings (1)	Ex-Post Net Evaluation Confirmed Program Therm Savings (2)
1	2004	1,163	-	-	-	64,640	-
2	2005	1,163	771	-	0.016	64,640	47,787
3	2006	1,163	771	-	0.016	64,640	47,787
4	2007	1,163	771	-	0.016	64,640	47,787
5	2008	1,163	728	-	0.016	64,640	41,611
6	2009	1,163	728	-	0.016	64,640	41,611
7	2010	1,163	690	-	0.054	64,640	41,114
8	2011	1,163	690	-	0.054	64,640	41,114
9	2012	-	690	-	0.054		41,114
10	2013	-	679	-	0.045		41,042
11	2014	-	679	-	0.045		41,042
12	2015	-	481	-	0.034		31,860
13	2016	-	481	-	0.034		31,860
14	2017	-	481	-	0.034		31,860
15	2018	-	481	-	0.034		31,860
16	2019	-	481	-	0.034		31,860
17	2020	-	-	-	-		-
18	2021	-	-	-	-		-
19	2022	-	-	-	-		-
20	2023	-	-	-	-		-
TOTAL	**2004-2023**	9,305	9,602			517,120	591,310

* Form completed for the SCE program ID included in the evaluation.
**<u>Definition of Peak MW as used in this evaluation</u>: Average kW reduction during the period Monday-Friday 12 p.m. - 7 p.m., during the months of June through September (consistent with the CPUC Energy Efficiency Policy Manual, Version 2).
1. Gross Program-Projected savings are those savings projected by the program before NTG adjustments.
2. Net Evaluation Confirmed savings are those documented via the evaluation and include the evaluation contractor's NTG adjustments.

Table 3-11: Evaluated PG&E Savings over 20 Years

PG&E Program Energy Impact Reporting for 2004-2005 Programs

Program ID*: 1119-04
Program Name: BUILDING TUNE-UP PROGRAM

Year	Calendar Year	Ex-ante Gross Program-Projected Program MWh Savings (1)	Ex-Post Net Evaluation Confirmed Program MWh Savings (2)	Ex-Ante Gross Program-Projected Peak Program MW Savings (1**)	Ex-Post Evaluation Projected Peak MW Savings (2**)	Ex-Ante Gross Program-Projected Program Therm Savings (1)	Ex-Post Net Evaluation Confirmed Program Therm Savings (2)
1	2004	22,716	-	1.112	-	273,897	-
2	2005	22,716	6,482	1.112	1.580	273,897	454,815
3	2006	22,716	6,462	1.112	1.570	273,897	451,183
4	2007	22,716	6,462	1.112	1.570	273,897	451,183
5	2008	22,716	4,484	1.112	1.449	273,897	434,320
6	2009	22,716	4,046	1.112	1.376	273,897	434,320
7	2010	22,716	1,690	1.112	0.500	273,897	39,127
8	2011	22,716	1,690	1.112	0.500	273,897	39,127
9	2012	-	1,690	-	0.500	-	39,127
10	2013	-	1,664	-	0.496	-	39,127
11	2014	-	1,664	-	0.496	-	39,127
12	2015	-	1,198	-	0.244	-	(2,058)
13	2016	-	1,198	-	0.244	-	(2,058)
14	2017	-	1,198	-	0.244	-	(2,058)
15	2018	-	1,198	-	0.244	-	(2,058)
16	2019	-	1,198	-	0.244	-	(2,058)
17	2020	-	984	-	0.198	-	(2,058)
18	2021	-	48	-	0.144	-	-
19	2022	-	48	-	0.144	-	-
20	2023	-	48	-	0.144	-	-
TOTAL	**2004-2023**	181,727	43,447			2,191,176	2,409,106

*Form completed for the PG&E program ID included in the evaluation.
**Definition of Peak MW as used in this evaluation: Average kW reduction during the period Monday-Friday 12 p.m. - 7 p.m., during the months of June through September (consistent with the CPUC Energy Efficiency Policy Manual, Version 2).
1. Gross Program-Projected savings are those savings projected by the program before NTG adjustments.
2. Net Evaluation Confirmed savings are those documented via the evaluation and include the evaluation contractor's NTG adjustments.

Table 3-12: Evaluated Program Savings over 20 Years

Sum Of Energy Impacts for This 2004-2005 Program

2004-2005 form

Program IDs*:	**1117-04 & 1119-04**							
Program Name:	**BUILDING TUNE-UP PROGRAM**							
Year	**Calendar Year**	**Ex-ante Gross Program-Projected Program MWh Savings (1)**	**Ex-Post Net Evaluation Confirmed Program MWh Savings (2)**	**Ex-Ante Gross Program-Projected Peak Program MW Savings (1**)**	**Ex-Post Evaluation Projected Peak MW Savings (2**)**	**Ex-Ante Gross Program-Projected Program Therm Savings (1)**	**Ex-Post Net Evaluation Confirmed Program Therm Savings (2)**	
1	2004	23,879	-	1.112	-	338,537	-	
2	2005	23,879	7,253	1.112	1.596	338,537	502,602	
3	2006	23,879	7,234	1.112	1.586	338,537	498,970	
4	2007	23,879	7,234	1.112	1.586	338,537	498,970	
5	2008	23,879	5,212	1.112	1.465	338,537	475,930	
6	2009	23,879	4,775	1.112	1.391	338,537	475,930	
7	2010	23,879	2,380	1.112	0.554	338,537	80,241	
8	2011	23,879	2,380	1.112	0.554	338,537	80,241	
9	2012	-	2,380	-	0.554	-	80,241	
10	2013	-	2,342	-	0.541	-	80,168	
11	2014	-	2,342	-	0.541	-	80,168	
12	2015	-	1,678	-	0.279	-	29,802	
13	2016	-	1,678	-	0.279	-	29,802	
14	2017	-	1,678	-	0.279	-	29,802	
15	2018	-	1,678	-	0.279	-	29,802	
16	2019	-	1,678	-	0.279	-	29,802	
17	2020	-	984	-	0.198	-	(2,058)	
18	2021	-	48	-	0.144	-	-	
19	2022	-	48	-	0.144	-	-	
20	2023	-	48	-	0.144	-	-	
TOTAL	**2004-2023**	191,033	53,050			2,708,296	3,000,416	

*This form is for the total energy impacts for the program across all IOU territories in which the program was implemented.
May be multiple ID numbers if implemented in more than one territory.

**Definition of Peak MW as used in this evaluation: Average kW reduction during the period Monday-Friday 12 p.m. - 7 p.m., during the months of June through September (consistent with the CPUC Energy Efficiency Policy Manual, Version 2).

1. Gross Program-Projected savings are those savings projected by the program before NTG adjustments.
2. Net Evaluation Confirmed savings are those documented via the evaluation and include the evaluation contractor's NTG adjustments.

3.4.3 Cost Effectiveness

To re-estimate the cost-effectiveness of the BTU program, we revised the final PIP workbooks provided by the program implementer with the evaluated savings and effective useful life discussed in this report. Specifically, we used the claimed total building areas shown in Table 3-1, the evaluated gross savings and net-to-gross ratios shown in Table 3-6, and the effective useful lives shown in Section 3.3.3. Table 3-13 compares the costs, benefits, and benefit-cost ratios originally proposed by the program with the final evaluated results. The latter indicate that the BTU program was not cost-effective in either the PG&E or SCE service areas. Although the evaluated TRC costs were lower than projected in the PIP workbooks (particularly for the SCE portion of the program), the corresponding TRC benefits were considerably lower, so that the benefit-cost ratios fell well below one.

Table 3-13: Benefit-Cost Ratios

	PG&E		**SCE**		**Combined**	
Total Resource Cost (TRC) test parameter	Program implementation plan (PIP)	Evaluated	Program implementation plan (PIP)	Evaluated	Program implementation plans (PIP)	Evaluated
TRC Costs	$4,962,437	**$4,221,942**	$4,904,534	**$1,393,537**	$9,866,972	**$5,615,479**
TRC Benefits	$9,490,617	**$3,380,452**	$9,490,617	**$593,407**	$18,981,233	**$3,973,860**
TRC Net Benefits	$4,528,179	**($841,490)**	$4,586,082	**($800,130)**	$9,114,262	**($1,641,620)**
TRC Ratio	1.91	**0.80**	1.94	**0.43**	1.92	**0.71**

3.5 Process Interview Results

The results of the interviews are presented by type of respondent. Sections below detail results from interviews with program administrators and consultants, and participants and nonparticipants.

3.5.1 Program Administrators and Energy Consultants

Interviews were conducted with four administrators of the BTU Program and five energy consultants. Findings from those interviews are presented by topic below.

3.5.1.1 Program Goals and Accomplishments

Program administrators reported that the goals of the program were to achieve 18 million kWh energy savings in each of the two targeted utility service areas. In addition, they reported goals of educating building owners on energy efficiency and ensuring persistence of savings.

When asked how the program had performed to date, administrators reported that the targeted number of square feet had been recruited into the program for each service area; however, only 40 to 50 percent of implementation efforts had been completed at the time of the interviews. Several administrators lamented that the program timeframe was not long enough to complete implementation for all of the measures identified through the program. One administrator explained that the program strategy was to recruit a building manager who managed many buildings, rather than to recruit managers of individual buildings. In some cases, the strategy backfired when a customer pulled out the program, causing multiple buildings to be taken out of the program. In addition, problems in the SCE area were reported due to the program not having a local presence in that area.

Administrators reported a number of accomplishments to date in the program. Two administrators reported that the primary accomplishment of the program was to educate building owners and managers about retro commissioning. Two others reported that finding large savings opportunities was the primary accomplishment of the program.

Consultants reported that educating customers on the retro commissioning process was a big accomplishment of the program. One explained that most customers think in terms of hardware because that is what vendors usually try to persuade them to buy.

3.5.1.2 Program Changes

Administrators were asked about changes in various components of the program since its initiation. Their responses are presented below by topic.

Program Staff: All but one administrator reported that changes in staff had taken place over the course of the program. These administrators reported that additional staff had been added to the program, for both management and support, and that responsibilities had been reorganized among the staff. For example, one respondent reported that a new administrative manager was added so that the original manager could focus on engineering issues. Another respondent reported that four or five additional engineers had been hired, and one person had been hired to keep the tracking database updated.

Program Tracking: The program used a Microsoft Access database to track activity. The tracking database was shared by several programs administered by the program implementer. Therefore, when retrieving information from the database for the BTU program, it was important to specify the program in order to filter on those particular records.

One administrator reported that there had only been "minor modifications" made to the tracking database and no significant changes, while the remaining three administrators reported that the database had been improved over the course of the program. Improvements reported included the addition of a full-time staff person working on it, added queries, and more frequent updates.

A copy of the database was provided for the use of this evaluation. A second updated copy was requested several months later. In both copies, it was found that some of the contact information was incorrect or outdated. In addition, records of installed measures were missing for a number of participants. Overall, however, the database was functional.

Program Services: Administrators reported that they have "gotten good at identifying the measures and problem areas," and that they rely heavily on previous reports to do this. Administrators also stated that they found they need to "do hand holding with the customer to get them through." It was reported that the engineering investigative stage has changed in that originally they would notify the customer of their findings and recommendations before starting any work, whereas now they make some changes "along the way" and also teach the customer how to do so.

One administrator reported that the incentive structure had changed. He explained that they found they needed to spend more money on the engineering analysis, which left less money for incentives. In particular, it was reported that originally 7.5 cents per square foot was budgeted for the engineering analysis and the same amount budgeted for rebates. This changed to 11.5 cents per square foot for the engineering analysis and 3.5 cents per square foot for rebates. It was reported that this was a good change because it resulted in a better analysis and "more credible results."

Consultants interviewed reported that report formats for the program had changed multiple times, but the changes had been communicated effectively.

3.5.1.3 Program Implementation and Recommended Changes

Administrators' comments on various aspects of the program are described below.

Marketing and Outreach: Administrators reported they target firms that own or manage multiple buildings to cut down on recruiting costs. For example, they contacted Macy's retail stores and received a list of 28 potential buildings to consider for the program. It was reported that major participant customers have submitted press releases to business journals and trade magazines mentioning the program. Cold calling is still carried out, but not extensively.

One administrator added that they needed to improve the screening process to "weed out the customers who are not serious." Another administrator added that as they gained more experience with why customers delayed projects, it became easier to screen out potential non-committers from the beginning. It was explained that the way customers are screened is to ask them first whether or not they have invested in any energy efficiency improvements. Then, customers are asked to describe their financial situation and budget cycle, their threshold for expenditures, and what approvals will be necessary to proceed with the project.

One administrator suggested that the web site could be improved and more case studies that highlight successful projects could be used as a marketing tool. It was also reported that the program had developed "very effective and professional brochures."

Consultants interviewed for this study reported the program did not provide promotional materials other than a handout, which was "OK but not needed."

Program Tracking: Administrators reported that it is still an issue to get the data entered into the tracking system. One administrator suggested that they need to be clearer with program staff on what data is needed for the database. Another administrator reported that some information was being entered into the system more than once and that that needed to be corrected.

Program Administration and Delivery: One administrator reported that additional account managers were needed to work with customers. He observed that an account manager needs to stay in contact with the customer to help alleviate problems and delays with the project. Administrators commented on four areas of program delivery: the initial walkthrough, the Memorandum of Understanding (MOU), the investigation stage, and customer follow-up.

- *Initial Walkthrough:* Administrators reported this phase currently takes a few hours but should be expanded to a full day. The additional time would allow the program representative to understand the building's systems better so they could put together an improved work scope and budget for the project. Another administrator reported this preliminary investigation should identify specific measures so savings could be estimated earlier. A third administrator reported this preliminary report costs $5,000 to $6,000. In contrast, one consultant interviewed for the study reported that they were paid $2,000 to do the initial report, which took two days. He further suggested that this should be expanded to include at least one extra day and $4,000 in order to do a more thorough job.

- *MOU:* One administrator reported that a phrase in the MOU that is meant to indemnify the utility is not well received by customers. Another administrator reported that the MOU had been reduced from seven pages to two pages and had no "teeth" left in it. It was suggested that the MOU should be more substantial, and that this would increase the program's credibility. A different administrator disagreed and said it was preferable for the MOU to be without a penalty. One consultant interviewed for the study reported that the MOU delays the project because "every company wants to send it to their legal department and modify it." He further suggested that since it was only a good faith estimate it would be better to eliminate it from the program.

- *Investigation Stage:* It was reported that the format for this report had been improved and that it typically runs about 30 pages. One administrator commented that the report is very descriptive but suggested that it also include a work scope for implementation of the measures. It was further suggested by administrators during the interviews that some of the low-cost measures could be implemented during the investigation stage so the savings could be realized sooner. For example, it was suggested that reprogramming controls and minor mechanical fixes, such as broken dampers or greasing dampers, could be done during this stage. In addition, it was reported that the program had to incorporate additional procedures for the final inspection that were requested by PG&E (for example, collecting photographs and receipts to document installation).

- *Customer Follow-Up*: One administrator reported that an account manager was assigned to an account to "recruit and shepherd the participant through the preliminary phase," after which the customer was assigned to an engineering manager for the investigation stage, and then finally the account manager resumed contact for the remainder of the project. It was reported that typical reasons customers did not continue smoothly with implementation included not having the money budgeted for improvements and having to address other issues in their business that are higher priority. One administrator suggested that the program be changed to provide the implementation for the customer through a pool of contractors.

Program Incentives: One administrator reported the incentives should be raised "so they do not have to compete with the Standard Performance Contract (SPC) program." It was further explained that some customers had taken their list of recommendations received from the BTU program to the SPC program, which offers higher incentives. This administrator pointed out that the BTU program could only offer 3.5 cents per kWh, whereas the retrofit incentive through the SPC program was 13 cents per kWh.

A second administrator reported they have flexibility in how much incentive is offered to the customer, and they are able to offer up to 15 cents per square foot. A third administrator reported that the incentives are marketed to “buy the measures down to a one-year payback.” This administrator felt that this was not fair to customers because one customer’s set of measures might have a one-and-a-half year payback and another customer’s set of measures might have a two-year payback so the two customers would receive different incentive amounts.

Customer Response: When asked if customers liked and valued the BTU program, most administrators reported that they did. One administrator reported that 80 percent of the customers contacted liked the program, 10 percent did not like it, and the remaining 10 percent were not sure. All consultants interviewed reported that customers liked and valued the program a lot.

Consultants also reported that customers need a little education to understand retro commissioning. One consultant commented that it made a big difference if there was someone at the customer’s site to champion the project and move it forward. He explained that, where there was not such a person at the customer’s site, other projects tended to take higher priority.

Several consultants reported that budgeting for more expensive measures was an issue with a lot of customers and that this had caused project delays.

3.5.1.4 Lessons Learned

When asked what lessons they had learned during the course of the BTU program, administrators commented on the following areas.

- Administrators reported they needed to screen non-performing customers earlier in the process so they do not spend $20,000 to $40,000 on an engineering analysis for customers who are not committed to continuing.

- One administrator reported he had learned that a local presence in the area “has positive benefits but is not required to run the program.” He felt they had operated successfully in remote areas using property management companies. He added that property managers are not that interested in energy efficiency and therefore it is important to show them the bottom line economic impact.

- Administrators reported they needed to “fit into the customer’s budget cycle better.” They further reported that they had learned what the budget cycles were and how they could structure the program to fit into them. For example, one administrator reported that for privately owned buildings, typically the budget must be in place by September. In contrast, government-owned buildings typically operate on a fiscal or calendar year, and retail buildings typically operate with cash flow and do not need to plan their budget in advance.

Consultants interviewed for this study reported they had learned the following lessons from working with the program:

- One consultant reported he learned how to do the “energy calculations.”

- One consultant reported learning "RCx is a good mechanism for energy savings and there is potential in every building."

- One consultant reported that "the cost-effectiveness of this is better than traditional energy audits and the paybacks are faster. Customers like making what they have work better rather than getting something new."

- One consultant reported that "projects that are most successful are those we implement ourselves, whereas projects where the customer gets his own contractor will take longer."

3.5.1.5 Problems and Concerns

When asked about what concerns they had for the remainder of the program duration, administrators reported they were primarily concerned about "getting the savings." They further explained that, because of the length of time it had taken to identify potential savings and install measures, some customers might not have enough time to implement their recommended measures before the program deadline.

Consultants reported the following concerns:

- The program deadline is approaching.

- More than $2,000 is needed to do the scoping study well.

- More marketing and awareness among property managers is needed.

- A framework is needed to ensure improvements remain in place over time.

3.5.1.6 Recommended Changes

Administrators were asked what they would change about the BTU program if they could. One administrator reported the program needed to screen out non-performing customers earlier in the program. Another reported the program should develop a pool of contractors and implement measures directly for the customer rather than allow them the freedom to do this on their own. In addition, it was suggested that more money be spent on incentives and on customer education (for example, seminars) and that the engineering analysis could be made more efficient and performed for less money.

Consultants recommended spending more time and money on the initial scoping study. In addition, they reported that the program administrators needed to respond sooner to reports submitted to them by the consultants. One consultant also suggested that the program should provide direct implementation. Another consultant recommended eliminating the MOU. Another consultant recommended extending the deadline for implementation so customers could claim the incentive for improvements they will do but may not have time to complete before the program ends.

3.5.2 Participants

As explained previously, 18 participant customers were interviewed about their experiences with the BTU program. Thirteen interviews were conducted in early 2006 and five during the summer of 2006. Their responses are organized by the following topics:

- Awareness of the concept and benefits of retro commissioning,

- Source of information and motivation for participating,
- Opinions of and satisfaction with the program,
- Plans for implementation,
- Budgeting issues,
- Suggestions for improvement, and
- Influence of the program on their project.

3.5.2.1 Awareness

Respondents were asked to describe how aware they were of the benefits of retro commissioning before they were approached by the BTU program. Four respondents reported that they had not heard of retro commissioning before and were introduced to it by the program. Fourteen respondents reported that they were aware of retro commissioning. Those who reported being aware of retro commissioning made the following comments:

- It is hard to find competent people for controls.
- We have read about it and talked about it but the program helped us implement it.
- We are aware but we did not know the avenues to take to implement it.
- The incentive structure made it work.
- This is the first time a program has included an audit to get a baseline.

3.5.2.2 Source of Information and Motivation for Participating

The program participants were asked to explain how they first heard of the BTU program and their motivation for deciding to participate in the program. Most of the respondents were in the process of implementation when they were interviewed. Several had completed implementation, and at least one had not yet started.

One respondent had participated in the program implementer's previous retro commissioning program in Oakland. Two other respondents had also heard about the program from the program implementer, and one of these reported that this occurred at a show in Anaheim in 2004 for the Association of Engineers. Three respondents heard about the program through the Silicon Valley Leadership Group. Two respondents reported hearing about the program through CTG Energetics (one of the program's energy consultants). One respondent heard about the program through Powerlight, who is providing other energy efficiency services to them. Four respondents reported hearing about it through their PG&E representative. Three other respondents reported hearing about it through their industry contacts. One heard about it from corporate headquarters, and the remaining respondent did not remember.

When asked why they participated in the program, nine respondents reported they participated in order to get energy savings. Three respondents reported participating in order to get the free audit. One respondent explained they were trying to reach ENERGY STAR® certification for their building and they thought this would help. Another reported that "it's good to have a second set of eyes looking at things." One respondent reported participating in order to optimize their HVAC system. One respondent stated "they fully funded it; it was a no-brainer" and another similarly responded by saying "no cost – no obligation." The remaining respondent stated that he participated because he was directed to by corporate headquarters.

3.5.2.3 Opinions of and Satisfaction with the Program

Most respondents reported being very happy with the program while two respondents reported being mildly happy with it. The following comments were made:

- The program is absolutely wonderful.
- They identified ways to save energy and everything went smoothly.
- I wouldn't say I was dissatisfied, but it didn't knock my socks off either. We didn't get what we thought we would get. We expected a heavy-duty analysis but they did more of a surface look at things.
- The program met my expectations to a certain degree. There may be areas for improvement.
- We are very happy. They were conservative in their estimates and it ended up being more cost-effective than they thought.
- It exceeded our expectations.
- We got more than we expected. It's a great program.
- They were very responsive and did a good job.
- We liked the very thorough engineering analysis.
- The program engineers worked very well with our engineers.

Positive Aspects. When asked what the liked about the program, four of the respondents mentioned the engineering analysis as a valuable service. Comments from respondents on this subject included the following:

- The analysis was more important to us than the incentive (the cost was small).
- What we liked about BTU was that it addressed operational improvements instead of new equipment and we liked the engineering support. It would have been a contracting issue for us to get an engineer so this was great.
- We liked the high level of technical assistance provided, and we have no budget to hire a consultant to do these kinds of assessments. Both the engineering analysis and incentive were important, but we would not have done anything without the analysis.
- The program brought our engineering staff's attention to the control strategies of the building. It got us more focused on getting energy savings.

Respondents also mentioned other positive aspects of the program. For example, one respondent reported that the recommendations were clear-cut and easy to implement. Another respondent mentioned that he liked the way the program was economically feasible by focusing on measures with a payback of less than one year. Another respondent stated that he liked having another set of eyes look at things and give a second opinion.

Negative Aspects. When asked to describe the major points about the program that they did not like, three of the respondents replied that the primary thing they did not like about the program was the length of time it took to do the analysis. Comments about this subject included the following:

- It took a long time (a year) to get the studies done, and then there wasn't enough time to implement in order to get the incentive. Some of the delay was Quantum's fault and some of it was getting the consultants scheduled.
- The process was slow. We would have liked to get the results sooner.
- It seemed to take a long time to get through with the auditing process; they did not have enough staff to handle requests.

Respondents also gave other negative responses about the program. For example, two respondents reported that they did not like having to sign the MOU. One of these respondents referred to it as a hassle to deal with, and the other respondent lamented that it delayed his project two months. One respondent reported that he was told at the end of his project that he would be getting less incentive than he originally was promised due to a decision made late in the program by PG&E. Several respondents reported that they felt the program did not give them adequate time or attention. In particular, one of these respondents stated that the program representatives "seemed overwhelmed," and he wished they had spent more time with them. A second respondent observed that the administrative duties and engineering responsibilities of the program representatives "diluted their attention." A third respondent reported that the investigative report was more of a surface look at things and contained mostly boilerplate language that would be true for 70 percent of commercial buildings, but did not apply to his unique situation. Another stated that the measures that can be included in the program should be expanded, and finally, a respondent thought that more billing data were being requested than what was actually needed.

3.5.2.4 Individual Aspects of the Program

Respondents were asked to rate several aspects of the program on a scale from 1 to 5, where "1" meant "very dissatisfied" and "5" meant "very satisfied." The results are presented in Table 3-14.

As shown, the mean results are relatively high, and none indicate dissatisfaction, indicating that on average the participants were satisfied with most aspects of the BTU program. The participants reported favorable experiences with the program administrative personnel, scoring them an average of 4.43. Three respondents did not provide a rating for this aspect as they reported they had had no contact with the program administrators. One respondent (who rated this aspect a "3") stated that the program administrators were good about communicating but they were overwhelmed so it took awhile to get results from them. The program engineers received an average rating of 4.77, indicating the respondents were satisfied with this aspect of the program. In fact, 12 of the respondents answering this question rated this aspect a "5."

Table 3-14: Satisfaction with Program

Program Aspect	Mean Response	Number of Responses
Program Administrative Personnel	4.43	15
Program Engineers	4.77	15
Results of Scoping Audit	4.50	8
Memorandum of Understanding (MOU)	3.77	13
Engineering Analysis and Investigative Report	4.50	16
Incentive	3.85	13
Contractor who Installed Improvements	4.92	6
Overall Satisfaction	4.34	16

The MOU received the lowest rating, a 3.77, although this was due primarily to one respondent's rating of a "1" for this aspect. Several respondents stated they understood the MOU was necessary and appreciated the program implementer's willingness to work with them to modify it as necessary, and the most common rating for this aspect was a "4." The program aspect that received the highest rating was the installation contractors, with an average rating of 4.92. Those respondents who answered this question either used their own staff to implement measures or hired a trusted contractor. Respondents rated their overall satisfaction of their retro commissioning project as a 4.34, indicating that, on average, they were satisfied.

3.5.2.5 Plans for Implementation

Respondents were asked about their plans for implementing the program's recommendations.

Several reported that they planned to implement all of the recommended measures or they had already done so. Of those respondents indicating that they would not implement all measures, their reasons for not implementing primarily involved heating or cooling issues. The following comments were noted during the interviews:

- For air conditioning, it was a concern about how the building operated with people. They wanted us to start the chiller later, but the people needed the building to be warmer sooner.

- There was one measure that we did not proceed with because we did not think users would be happy with the results (it was a heating issue).

- It took so long to get the report and then we had to finish by February 28, so for some things, that was not going to happen. Also, they suggested running chillers a particular way and the manufacturer who does our service work did not think we should do that. For the other measures, the payback just wasn't there.

- We run a 24-hour operation and our HVAC needs to run 24 hours. It is difficult to interrupt that service and some of the recommended measures would require a full system shutdown, so we couldn't do that. In addition, some programming measures they suggested did not have much impact and some had poor paybacks.

- It was suggested that the hours for building cleaning be changed. However, the hours currently in use best serve the business practice.

3.5.2.6 Budgeting Issues

Nearly one-half (eight) of the respondents identified payback time as the main criterion for funding projects. Two of these respondents explained that in general they prefer projects with a payback time of less than five years. Another respondent reported they look for a payback time of three years or less and another of two years or less. Two other respondents identified return on investment (ROI) as their main criteria for funding projects.

One respondent reported they had to delay the project one year in order to budget the funds. Over half (10) of the respondents reported that, for this project, the timing of the budget did not matter because the costs were low enough that they used their operating funds or other money they had available for energy conservation projects. Several of them added, however, that, had the project required more money, it would have been a problem since they typically budget for projects like this a year ahead of time. In addition, it was mentioned by two respondents that limited funds are available for energy conservation projects so it helps to get program support. At least two respondents also mentioned that getting preliminary estimates on the cost of the project helped to secure the funds in advance.

3.5.2.7 Suggestions for Improvement

When asked about suggestions for improving the program, three respondents suggested that the engineering analysis report should be delivered in a timely manner. One of these respondents reported that he waited four to five months for the preliminary audit results and eight to nine months for the final report. Another respondent lamented that he had just received his report in January and had only until the end of February to implement measures. Two respondents reported they would like to receive a more in-depth analysis from the program. One of these respondents stated that he would have liked more discussion with the program representatives about their recommendations because he felt some of them were not feasible for his unique situation and the engineers had not done a thorough analysis or discussed his concerns with him.

Other recommendations for improving the program were as follows:

- Send rebate checks sooner.
- Increase marketing efforts; get the word out.
- Extend the length of the program to two to three years.
- Provide spare parts.
- Provide a higher incentive to participants who implement the measures with “in-house” staff.
- The evaluation engineers need to look more ‘professional”.

In addition, respondents were specifically asked what they thought about the program providing a list of approved available contractors to perform implementation of the recommended measures. None of the respondents reported that they would want or use such a list. The most common response was that they wanted control over that aspect of the project and they preferred to use contractors they knew and trusted.

3.5.3 Nonparticipants

As described in Section 2.8, 11 nonparticipants were interviewed. Nonparticipants targeted for this evaluation were those customers who were contacted to participate but declined, or who initially did participate but withdrew or were rejected from the program. The primary reason these individuals were interviewed was to ascertain why they chose to not participate in the program. Their responses were varied and summarized below.

- Three respondents reported they did not have money available at the time they were contacted. One of these respondents indicated they do have it now and would like to proceed if the program continues.

- Three respondents reported that they had done the initial audit but that it revealed only minor potential improvements (and in one case no improvements), and they did not want to proceed. One of these respondents further explained that the program representative was “obnoxious” and kept pushing them to participate in the program “like a used car salesman.”

- One respondent was quite angry because he had heard about the program late and did not have time to participate. He stated that the utilities had dropped the ball by not promoting the program more effectively.

- One respondent explained that he did not want to have to wait around for a rebate; if he needed something done he would just do it on his own. Similarly, another respondent explained he had already completed a similar project with a commercial firm.

- One respondent reported he was not interested in the services the program offered because he was focused on adding cogeneration and building something new rather than fixing what he already had.

- One respondent reported he decided to withdraw from the program because he had initially been told the audit would be free, then the program representatives asked him to pay to have a contractor to collect more information on the EMS systems. He did not want to pay for the data collection because he had been told the analysis would be free.

3.6 Program Influence on Projects

Respondents were asked to discuss the extent to which they would have made the recommended improvements on their own without the influence of the program. In order to appropriately gauge the extent of the influence, respondents were asked a series of questions that included how likely they would have been to perform the improvements on their own without the program, and (for any who indicated positive likelihood) when they might have performed the improvements. The results are discussed below first by participant customer and then by program measure.

3.6.1 Influence by Participant Customer

Eighteen participant customers were interviewed for this study. Interview responses from 12 of these suggest they would not have implemented any of the recommended measures without the influence of the program. One additional respondent indicated he might have implemented measures without the program but not within four years. These 13 respondents are not considered freeriders. For an additional three participant customers, their interview responses indicated there was a positive likelihood that they would have implemented at least some of the measures within four years from the interview time, but would not have during the year they participated in the program. These three respondents are considered to be 50 percent freeriders. The remaining two participant customers indicated they were likely to have implemented one of their measures during the year they participated in the program even if they had not participated. These two respondents are considered to be freeriders.

3.6.2 Influence by Program Measure

Respondents were further asked to break down their responses by measure. However, this proved problematic for several reasons. First, one respondent was still in the investigation stage at the time of the interview and did not know which measures he would be implementing. Second, in most cases the implementation results were not available to the interviewer, as the tracking database had not been updated with this information; therefore the interviewer had to rely on the respondent's memory to ascertain which measures had been implemented. Third, several of the respondents had completed their projects some months (or in one case a year) before the interview and reported they did not remember which measures they had implemented or whether they would have done them without the program. Fourth, some respondents had multiple buildings, including one respondent with 23 different buildings.

For the five respondents with indication of freeridership, measure information is as follows:

- For the first respondent found to have 50% freeridership, measure information was not available in the tracking database, and the respondent reported he did not remember which measures were implemented. He did report, however, that the freeridership applied to 50% of the measures he installed.

- For the second respondent found to have 50% freeridership, measure information was not available in the tracking database, and the respondent reported that the freeridership applied only to the EMS system.

- For the third, he responded that participation in the program resulted in implementation timing two to four years earlier than would have happened otherwise.

- For the first respondent found to have full freeridership, the freeridership applied only to the measure involving correcting the schedule on all tower fans.

- For the second respondent found to have full freeridership, the freeridership applied only to the measure described as "schedule Sprague AHUs (1,2,4) off during nights and holidays."

Details of the freeridership and the corresponding net-to-gross ratios for each evaluated project can be found in the appendix. These ratios, applied to the projects for which the claimed energy savings, yielded the generalized net-to-gross ratios shown in Table 3-15. These ratios range from 0.74 to 1.00, averaging about 0.90, indicating that the level of freeridership in the program is fairly low.

Table 3-15: Evaluated Net-to-Gross Ratios

	NTGR - kWh, kW	NTGR - therms	NTGR - MMBtu
PG&E	0.88	1.00	0.92
SCE	0.91	0.74	0.79
TOTALS	**0.89**	**0.93**	**0.90**

3.7 Key Process Findings

This process evaluation was conducted primarily to assess the effectiveness of the BTU Program. In particular, the assessment looked at administrative effectiveness, program delivery, and customer satisfaction.

This section discusses key findings from the survey results and analysis presented in Section 3.5. These findings are arranged by the following areas:

A. Program administration and delivery
B. Customer response and satisfaction

Overall, this evaluation revealed many positive aspects to implementation of the BTU program. It was evident that program administrators had learned much about the market for retro commissioning services and incorporated those lessons learned into the way they deliver their services. In addition, participants reported high ratings of satisfaction with all areas of the program.

3.7.1 Program Administration and Delivery

Both program administrators and energy consultants reported that one of the primary accomplishments of the program was to educate customers on retro commissioning. However, 78 percent of participant customers interviewed for the study reported that they were already aware of the concept and benefits of retro commissioning before hearing about the program. This finding suggests that, while the program may be educating building owners and managers about retro commissioning, most customers who agree to participate are already educated to a large extent.

Both administrators and consultants suggested that it would be an improvement to the program to offer implementation services through a pool of contractors. This suggestion was offered in an attempt to alleviate customer delays in the implementation process. Participant customers interviewed for the study, however, reported they would not welcome even a list of approved contractors to choose from. Most reported they would use only a contractor they knew and with whom they had experience.

Both administrators and consultants mentioned the MOU as a concern for the program. However, only two participant customers reported dissatisfaction with this part of the program. Most saw it as a minor hassle but one with which they could work. Several participant customers, however, did complain about the length of time it took to do the engineering analysis and receive the report. In addition, some of them reported that the analysis was not in-depth enough and they felt the recommendations did not take into account their specific operations.

Most customers interviewed for this evaluation reported that program representatives were courteous and professional. In particular, several respondents reported that program representatives were very responsive to questions and administered the program well. One respondent, however, reported that the program representative who presented the program to her was obnoxious and pushed her to commit money to the program. Two other respondents stated they thought program representatives seemed overwhelmed or that their attention was "diluted."

3.7.2 Customer Response and Satisfaction

Participant customers reported being at least mildly satisfied with all areas of the program. On a scale of 1 to 5, where "1" meant "very dissatisfied" and "5" meant "very satisfied," participant customers on average rated areas of the program from 3.77 (for the MOU) to 4.77 (for program engineers) and 4.92 (for contractors who installed improvements). Overall satisfaction with their retro commissioning project was rated on average 4.34.

The primary positive aspect of the program reported by participant customers was the free engineering analysis, which most considered very valuable. The primary negative aspect of the program reported by participant customers was the length of time it took to complete the engineering analysis.

For participant customers, the primary reason for not implementing certain measures involved issues with heating or cooling systems. In particular, they felt that implementing these measures would cause discomfort to the building's occupants or would cause unnecessary hardship by shutting down systems that were designed to run continually.

The majority of nonparticipants interviewed who chose not to continue in the program reported two main reasons for not continuing. The first of these reasons involved not having enough money to commit to the project during the timeframe of the program. The second reason was reported by customers who had completed the initial audit but found there were only minor improvements recommended, and they therefore decided not to proceed with the project.

4. Conclusions

Overall, this evaluation found that the 2004-2005 BTU program was not cost-effective. Key reasons for this include difficulties recruiting participants, challenges persuading customers to implement measures by the program incentive deadline, and measures that underperformed and thus did not provide sustained savings. Adding the effects of measures that the program recommended, but that customers implemented after the evaluation deadline, could improve the cost-effectiveness somewhat. These effects fell beyond the scope of this evaluation.

Most participants were satisfied with the program, though there is clearly room for improvement. The evaluation effort revealed a number of refinements that can improve savings estimates and the quality of recommended measures. We feel that further study of this type of program is warranted in the future to provide better confidence in the persistence of program savings, and determine the best means to maintain these savings. These conclusions are discussed in more detail below.

A. The program was not cost-effective.

Weighing the total resource cost (TRC) benefits from the realized net savings against the actual program TRC costs yielded a TRC ratio of 0.71. This indicates that the BTU program was not cost-effective. This was true for both utility service areas, as the evaluated TRC ratios for the PG&E and SCE service areas were 0.80 and 0.43, respectively. As a point of comparison, the evaluated TRC ratio for a prior building tune-up program, Oakland Energy Partners (OEP), was 0.89[6]. The latter evaluation used a similar methodology to the BTU evaluation. We speculate that the higher TRC for OEP may reflect the more relaxed program schedule, which allowed more participants to complete projects.

The BTU program TRC results reflect the ultimate fact that the program was unable to meet its savings goals. The program achieved 19% of the electric savings it had hoped to get. Of this 81% discrepancy, 36% occurred because of insufficient projects, that is, the program was unable to recruit enough, or those recruited did not implement in time. Another 42% of the shortfall occurred because realized savings were much lower than the program claimed. Lack of sufficient projects was the main reason the program only captured 16% of the electric demand savings and 47% of the natural gas savings it had sought, since the realized savings for these quantities were somewhat better than the program claimed.

One factor that may mitigate these results is that our evaluation focused on energy impacts soon after the program was complete. We feel fairly certain that the program will yield additional impacts, in the form of RCx measures the program recommended that participants completed after the evaluation. While these additional impacts may be significant, it is not known if they will suffice to make the program cost-effective.

B. Getting customers to implement measures in a timely manner was problematic, and completed measures frequently underperformed.

The program saw a high attrition rate among initially recruited projects, a minority of which ultimately was successfully completed. Those that were completed often only tackled a small number of the recommended measures. These facts illuminate some of the difficulties inherent in executing a particularly challenging program concept over a relatively short two-year timeframe. Providing more

[6] Obtained from supporting calculations for the *Oakland Energy Partners Large Commercial Tune-Up Program Impact Evaluation*, Itron, Inc. and SBW Consulting, Inc., March 31, 2006.

time to recruit participants and guide them to project completion, as the current 2006-2008 program cycle does, should be helpful in this regard. Future programs should build in ample schedule cushion to accommodate customer decision-making and implementation timelines.

Predicting savings for commissioning measures can be inherently difficult, since the measures are often complex, and the effects subtle. Building operations are generally quite dynamic. "Commissioning the retrocommissioning" is an important step for programs to include, since system changes do not always work as intended. This step did not always happen in the BTU program. In many cases at the evaluated projects, measures were only partially or ineffectively implemented, or were negated by subsequent changes. In some cases, customers attempted to implement measures (such as retrofitting constant volume HVAC systems with variable speed drives and reducing fan speeds), but changed the measures back after getting complaints from building occupants. A number of projects did not investigate the interrelationship between measures and recommended repairs, so when the customer did not complete the repairs, it prevented the measures from yielding recommended savings. These observations point to the care that must be taken balancing energy savings from RCx against proper building function and comfort.

C. <u>The program satisfied most participants, although certain aspects need refinement.</u>

The process evaluation revealed that program administrators learned many useful lessons for streamlining participant recruitment and analysis. Customers for the most part responded well to the program and were satisfied with the results, and several of them reported that the program exceeded their expectations. Some, though, pointed out areas for improvement, such as a slow building analysis process, excessive paperwork, lack of administrative attention, and need to vet the proposed measures better. Clearly, too, the poor participation in SCE territory points to significant marketing and management problems.

The program was found to have a strong influence on customers implementing energy saving measures, with only a few cases of freeridership reported by participants. General recommendations that came forth from the process interviews include:

5. Update tracking database regularly.
6. Streamline investigation process.
7. Discuss HVAC concerns with customers up front.
8. Forego providing approved contractor lists.

D. <u>Future program savings estimates should be improved.</u>

As the wide range of measure realization rates found in this study suggests, accurately estimating savings from common tune-up measures can be very challenging. Savings estimation can be confounded by difficulties collecting reliable data and challenges trying to predict how a facility might actually implement measures. To improve predicted and realized savings estimates, it is critical to capture baseline conditions thoroughly, use best possible measurements and assumptions to estimate ex ante savings, and take post measurements to verify performance and help estimate as-built savings. Some specific steps for doing so include:

<u>Prior to measure implementation</u>

6. Discuss proposed measures in detail with building operators and engineers.
7. Verify the operation of baseline equipment.
8. Adopt a consistent approach to estimating average peak demand reduction.

9. Rely less on assumed values when determining power draw for electrical loads.
10. Perform short-term monitoring for large-saver measures that affect variable loads.

After measure implementation

5. Post-implementation inspections should not just check for measure implementation, but collect sufficient information to adequately re-estimate as-built savings.
6. Verify that actual measure performance meets the original design intent as proposed.
7. Ensure the facility engineering team understands how to properly maintain implemented measures.
8. More work is necessary to verify if the savings last, and if not, determine how to make them last. In this vein, future evaluations may need to incorporate at least two rounds—one right after the program ends, and one at least two years out—to assess savings persistence and spillover effects with more confidence.

5. Appendix

A. Participant Interview Protocol

PG&E / SCE Building Tune-Up Program

Participant Questionnaire

FIRM NAME:______________________ ***CONTACT:*** ________________________

PHONE #: ________________________ ***TITLE:*** ____________________________

DATE:___________________________

Hello, this is ____________. I am with Itron, an independent research firm, and we are conducting an evaluation of the Building Tune-Up Program. I understand that you have participated in that program and I'd like to ask you a few questions about your experience. This should take about 15 minutes and your answers will be kept confidential and will not affect your participation in the program or the incentive you may receive. Would this be a good time?

1. How did you first hear about the Tune-up program?
   a. Who first contacted you about the program?
   b. Were they courteous and professional?

2. How would you describe the current status of the recommendations given to you by the program? *(interviewer should already know this so just confirm)*
   a) We completed ________________ (measures)
   b) We are in the process with ___________ (measures)
   c) We decided to do ____________ (measures) at a later time (when?)
   d) W decided to not do ______________ (measures)

3. What was the single most important reason you decided to participate in the program?
   a. Were there other important reasons?

4. Before becoming involved in the program, what efforts had you taken on your own towards making the energy saving improvements that were recommended by the program? Please describe what efforts (for example, budgeting money for improvements, getting bids from contractors, ordering equipment, etc.) and be specific about which improvements were involved.

5. Thinking about the (measures indicated in Q2), had you already decided on your own to implement any of these before they were presented to you by the program engineers? (describe which ones)

6. *(Ask for individual measure groups based on energy savings)* How likely would you have been to perform this/these improvements on your own without the engineering analysis provided by the program? Please answer on a scale of 1 to 5 where 1 means not at all likely and 5 means very likely.

7. *(Ask for individual measure groups based on energy savings)* How likely would you have been to perform this/these improvements on your own without the financial incentives[7] provided by the program? Please answer on a scale of 1 to 5 where 1 means not at all likely and 5 means very likely.

8. *(If answer to 6 or 7 is greater than or equal to 3; ask for individual measure groups based on energy savings)* Which of the following describes when you think you might have performed this/these improvements?
   a. This year or next year
   b. After next year but within four years
   c. More than four years from now

9. Based on the program's initial description and materials, what services did you expect from the program?

10. How well did the program meet your expectations compared to the program's description?
    a. Please describe what was different than expected?

11. What were the major things about the program that you liked?

12. What were the major things about the program that you did not like?

13. Is there any aspect of the Tune-up program that you think could be improved? (describe)

[7] "Financial incentive" in this context refers to the actual rebates the respondents received.

14. Before you were approached by the Tune-Up program, to what extent were you aware of the benefits of retrocommissioning – would you say you were very aware, somewhat aware or not aware?
    a. (*If very or somewhat aware)* Please describe some of the benefits that were important to you.

15. Using a scale of 1 to 5 where "1" means "very dissatisfied" and "5" means "very satisfied," how would you rate your satisfaction with the following aspects of the program?
    a. Program administrative personnel
    b. Program engineers
    c. Results of scoping audit (walk-through inspection)
    d. MOU
    e. Engineering analysis and report received from the program
    f. Incentives paid to or promised to you
    g. Contractor who implemented your improvements
    h. Your overall satisfaction with the retrocommissioning project

16. What process did you use to choose the contractor who implemented the improvements at your facility? (bidding process or other)
    a. What is your opinion on the program using part of the financial incentive money to provide a contractor to implement recommended improvements instead of asking you to hire your own contractor? Would you say you favor this idea, disapprove of this idea, or are indifferent?
    b. What is your opinion on the program providing you with a short list of approved, available contractors who were ready to implement the recommended improvements and you were required to choose one of the contractors on the list? Would you say you favor this idea, disapprove of this idea, or are indifferent?

17. *(Ask for improvements indicated in Q2 that are planned but not yet started)* What are your plans for implementing the program's recommendations?
    a. When do you expect to begin implementing this/these measures?
    b. Do you have the funds available in your budget this year to implement the recommended improvements?
    c. *(if no)* What is the timing and decision-making process for including these improvements in a future year's budget?

18. (Ask for improvements indicated in Q2 that are refused) What are your reasons for not implementing this/these measures?

19. Please describe how investments in electricity or gas efficiency equipment and controls are handled in your budgeting process.

a. Does one individual decide or is it a group decision? (if one person, position of this decision maker)?
b. Is the decision to go forward based on a rule of thumb like payback time, ROI, or something else? (describe)
c. How much time is needed from the decision to implement improvements until a contractor is hired to complete the work?

20. Did you consider other similar incentive programs before or during participating in the Building Tune-up Program? (describe)

If the following are not available in tracking database, ask.

I also have a few questions about your business.

21. How long have you operated from this location?

22. Do you own or lease this building?

23. Roughly how many people are in the building on an average day?

Thank you very much for your time and feedback.

B. Non-Participant Interview Protocol

PG&E / SCE Building Tune-up Program
Nonparticipant Questionnaire

FIRM NAME:______________________ ***CONTACT: ________________________***
PHONE #: ________________________ ***TITLE: ____________________________***
DATE:___________________________

Hello, this is ___________. I am with Itron, an independent research firm, and we are conducting an evaluation of the Large Commercial Building Tune-Up Program. I understand that you were contacted about the program but decided not to participate. The utilities would like to improve their program and your input will help them do that. I'd like to ask you a few questions about your experience. This should take about 10 minutes and your answers will be kept confidential. Would this be a good time?

How did you first hear about the Tune-up program?

Who first contacted you about the program?

Were they courteous and professional?

Based on the program's initial description and materials, did you think there were any benefits to participating in the program? (describe)

What is the primary reason you decided not to participate in the Tune-up program?

In your opinion, are there other reasons why customers might decline to participate in the program?

What changes would need to be made in the program in order for you to participate?

Before you were approached by the Tune-Up program, to what extent were you aware of the benefits of retrocommissioning – would you say you were very aware, somewhat aware or not aware?

(If very or somewhat aware) Please describe some of the benefits that were important to you.

I'd like to ask your opinion on a possible change in the program. First, if you were to consider participating in the future and the program used part of the financial incentive money to provide a contractor to implement recommended improvements instead of asking you to hire your own contractor, would you say you favor this idea, disapprove of this idea, or are indifferent?

An alternative to that might be that the program provided you with a short list of approved, available contractors who were ready to implement the recommended improvements and you were required to choose one of the contractors on the list. Would you say you favor this idea, disapprove of this idea, or are indifferent?

Please describe how investments in electricity or gas efficiency equipment and controls are handled in your budgeting process.

a. Does one individual decide or is it a group decision? (if one person, position of this decision maker)?

b. Is the decision to go forward based on a rule of thumb like payback time, ROI, or something else? (describe)

c. How much time is needed from the decision to implement improvements until a contractor is hired to complete the work?

Have you installed any energy conservation measures in your building in the past year? (describe)

Are you currently planning on installing any energy efficiency measures in your building? (describe)

Have you participated in other energy conservation programs? (describe)

If the following are not available in tracking database, ask.

I also have a few questions about your business.

How long have you operated from this location?

Do you own or lease this building?

Roughly how many people are in the building on an average day?

Thank you very much for your time and feedback.

C. Evaluated project savings

Table 5-1: Claimed and Evaluated Savings for Sampled Projects

		Program claimed savings			Evaluated gross savings			Realization rates		
Utility	Building ID	Avg peak kW	kWh/year	therms/ year	Avg peak kW	kWh/year	therms/ year	Avg peak kW	kWh/year	therms/ year
PG&E	7409	152.0	163,880	16,070	181.7	129,581	8,421	119.5%	79.1%	52.4%
	7412	-	334,000	11,040	19.0	109,990	8,670	-	32.9%	78.5%
	7421	-	1,098,800	8,800	-	345,715	5,900	-	31.5%	67.0%
	7422	-	83,250	33,980	-	96,711	25,658	-	116.2%	75.5%
	7429	-	3,256,904	-	-	(1,484,283)	-	-	-45.6%	-
	7445	-	4,204,600	-	67.6	410,722	-	-	9.8%	-
	7446	-	1,596,750	-	10.2	1,384,983	-	-	86.7%	-
	7447	32.0	1,160,094	-	24.7	1,002,998	-	77.2%	86.5%	-
	7449	111.0	74,581	29,589	15.4	68,511	544	13.9%	91.9%	1.8%
	7459	208.0	500,373	-	122.0	286,102	-	58.7%	57.2%	-
	7462	-	619,825	-	0.9	744,862	-	-	120.2%	-
	7464	-	340,931	18,348	-	39,917	968	-	11.7%	5.3%
	7465	-	420,033	1,600	31.5	316,221	11,650	-	75.3%	728.1%
	7468	-	1,250,416	109,089	344.7	1,476,153	310,384	-	118.1%	284.5%
SCE	8408	-	685,547	62,736	16.8	570,800	67,072	-	83.3%	106.9%
	8416	-	99,655	2,771	-	-	-	-		
	8424	-	111,071	-	(3.5)	80,082	(1,305)	-	72.1%	-
PG&E subtotal		503.0	15,104,437	228,516	817.7	4,928,183	372,193	162.6%	32.6%	162.9%
SCE subtotal		-	896,273	65,507	13.3	650,882	65,767	-	72.6%	100.4%
Program total		503.0	16,000,710	294,023	831.0	5,579,065	437,960	165.2%	34.9%	149.0%

Table 5-2: Measure-Specific Findings

Utility	building _id	Measure No.	Measure Description	Program actual kW Savings	Program actual kWh Savings	Program actual therms Savings	MMBtu	M&V approach (detailed, verify, etc.)	General findings
PG&E	7409	RCX 1	Main AHU. Replace the exhaust and return air dampers on the two main air handlers. Inspection Comments: Exhaust and return air dampers were replaced on the two main air handlers. The economizer sequence was enabled so when OAT<RAT then OA & RA dampers modulate to maintain SAT setpoint. Or OAT>RAT then OA & RA dampers modulate to maintain min OA fraction.	40	25,700	10,600	1,148	Verify RA & EA dampers operable and economizer setpoints	Savings less than program estimate
PG&E	7409	RCX 3	Replace chilled water valve on AHU 1-2. Inspection Comments: New chilled water valve installed on AHU1, 2. Screen printout shows the CHW valve fully closed, no longer is the valve stuck in the open position.	20	37,000	7,400	866	Verify installation of new valve; MAT, SAT data	Savings less than program estimate
PG&E	7409	RCX 4	Optimize chiller staging sequence. Inspection Comments: Chiller sequence was optimized so that only the lead chiller is enabled unless the load for the lead chiller is 95% then the lag chiller is enabled. Screen shot shows that all lag chillers are off and only main chiller is on when OSA is less than setpoint temp.	72	10,700	-	37	Verify chiller staging strategy	Nochanges
PG&E	7409	RCX 7	Replace 75 watt PAR38 Halogen lamps with 23 watt CFL flood lamps. Inspection Comments: Halogen lamps were replaced with GE warm white 23W electronic compact fluorescent lamps.	20	90,480	(1,930)	116	Spot check to verify implementation; check invoices for quantities and installed lamp description	Savings exceed program estimate
PG&E	7412	RCX 3	Re-enable operation of outside air damper that is open and does not respond to BAS.(Bldg. 1). JB-6/29 - Measure cost to be adjusted later - assumed to be a pro-rated portion of grl. Invoice from Facilities Dynamics (obtained from JS or ML). Inspection Comments: Performed functional testing to confirm repaired/corrected outside air damper operation. Previously OA damper remained open even upon call to close.	-	12,000	1,500	191	Simple	Original analysis overstates savings because of simultaneous heating and cooling.

Utility	building_id	Measure No.	Reasons for differences	Other notes	Eval Avg peak kW Savings	Eval kWh Savings	Eval Therm Savings	Measure life category	Measure life (looked up)	Notes on adjustments to measure life
PG&E	7409	RCX 1	Program estimate assumed Dual Temperature economizer control with hi-limit =74; evaluation assumed economizer control with hi-limit=72, low-limit=45, based on values provided by site personnel.		88	15,702	7,347	Add or replace control components	10	
PG&E	7409	RCX 3	Program estimates assumed supply air temperature depression of 6 degF, which was the extreme. Average value of 2 degF used in evaluation.		(7)	12,479	2,758	Add or replace control components	10	
PG&E	7409	RCX 4			72	10,700	-	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	
PG&E	7409	RCX 7	Approximately 23% more lamps were replaced than estimated in program calculations		28	90,700	(1,684)	Reduce lighting levels	16	
PG&E	7412	RCX 3			1	2,291	170	Add or replace control components	10	

Utility	building _id	Measure No.	Measure Description	Program actual kW Savings	Program actual kWh Savings	Program actual therms Savings	MMBtu	M&V approach (detailed, verify, etc.)	General findings
PG&E	7412	RCX 4	For multizone air handlers employ hot and cold deck reset based on satisfying worst zone. (Bldg. 3). Inspection Comments: CD and HD setpoints were reset to a CD min. of 55 deg F and a max of 65 deg F. HD min of 65 de F and a max of 85 deg F. Functional performance test done by FDE using the strategy of analyzing trend logs which shows passing results. The unit no longer has HD temps of 140 deg F and CD temps of 55 deg F.	-	57,000	9,100	1,105	Detailed	
PG&E	7412	RCX 5	For multizone air handlers, employ a mixed air setpoint reset based on aoutside air temperature. Inspection Comments: The mixed air setpoint was reset to remain several degrees below the cold deck setpoint. The reset also disables the economizer when the OA temp is less than 50 deg F. Mixed air temp setpoint is no longe set to equal the supply air temp for the cold deck.	-	8,000	440	71	Detailed	
PG&E	7412	RCX 8	Adjust HVAC equipment operating times to match occupancy.(Bldg. 3) JB-6/29 - Measure cost adjusted down as programming time considered to be less (@ $100/hr.) To be adjusted later as pro-rated portion of grl. Invoice from Facilities Dynamics (obtained from JS or ML). Inspection Comments: AHUs scheduled: 5:00 AM to 6:00 PM Mon. through Fri. 5:00 AM to 7:00 AM on Sat & Sun. (night purge) See bldg. automation system screen shots	-	257,000	-	877	Detailed	Significantly lower savings.
SCE	8408	L1	Sprague Occupancy Sensors. Install sensors - - approximately 30.. Inspection Comments: Occupancy sensor costs equal or greater than original cost estimate verified.	-	138,300	200	492	Detailed	
SCE	8408	M1	Schedule Sprague AHUs (1,2,4) off during nights and holidays.. Inspection Comments: Only the S___ Library upper floors could be scheduled off. The others require 24/7 conditioning. Re ran Equest model to get revised savings.	-	69,747	16,000	1,838	Detailed	Only AHU 4 was scheduled for setback.

Utility	building_id	Measure No.	Reasons for differences	Other notes	Eval Avg peak kW Savings	Eval kWh Savings	Eval Therm Savings	Measure life category	Measure life (looked up)	Notes on adjustments to measure life
PG&E	7412	RCX 4	Ex ante savings very high (represent over 20% of total building heating use) but was able to verify their reasonableness through alternative approach.		10	32,238	8,060	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	2 of 7 AHUs budgeted and scheduled to be replaced in 2006, so reduce savings for second year and beyond by 2/7 (29%).
PG&E	7412	RCX 5	None.	At least 2 AHUs will be replaced this year.	2	8,000	440	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	2 of 7 AHUs budgeted and scheduled to be replaced in 2006, so reduce savings for second year and beyond by 2/7 (29%).
PG&E	7412	RCX 8	Schedules not set back as much as recommended. Actual affected kW less than estimated, mostly because of lower load factors than 90% assumed, plus fans are on VFDs and don't always run at 100% speed.	At least 2 AHUs will be replaced this year.	6	67,460	-	Program schedule changes to EMCS. (setpoint, start/stop schedules)	3	
SCE	8408	L1	Less affected area than originally estimated. Sensor failure caused more lighting use.	4th floor sensor failure caused the lighting to remain on all hours	8	9,900	100	Lighting occupancy sensors	8	
SCE	8408	M1	Only one of three systems was scheduled for setback.		-	36,100	8,500	Program schedule changes to EMCS. (setpoint, start/stop schedules)	3	

Utility	building _id	Measure No.	Measure Description	Program actual kW Savings	Program actual kWh Savings	Program actual therms Savings	MMBtu	M&V approach (detailed, verify, etc.)	General findings
SCE	8408	M3	Replace AHU 3 way vlavles with 2 way valves. Inspection Comments:	-	104,100	1,500	505	Detailed	
SCE	8408	M4	Heating hot water enable (shut down boilers when setpoint is reached).. Inspection Comments: Boiler setpoints were all changed to get a consistent value per report.	-	(800)	1,936	191	Verify	Accepted the program value
SCE	8408	M12	Heating hot water differential pressure sensor (HW pumps do not vary due to sensor malfunction). Inspection Comments:	-	35,800	(1,700)	(48)	Verify	Accepted the program value
SCE	8408	M13	Chilled water differential pressure sensor (needs recalibration; reads 10% high). Inspection Comments: Sensor required replacement not recalibration	-	5,400	-	18	Verify	Accepted the program value
SCE	8408	M17	Fan variable frequency drives. Inspection Comments: VFD's installed on AHU's per recommenrdations. Costs attached per invoice. Note: significant time spent working with the client to come up with a practiced control strategy for operating the system.	-	333,000	44,800	5,617	Detailed	
PG&E	7421	RCX 1	Repair economizer control on AHU-1, 3, 206 and recalibrate of 2,4, 203-207. Inspection Comments:	-	49,400	-	169	Detailed	AHU-206 was the only unit investigated and is operating properly.

Utility	building_id	Measure No.	Reasons for differences	Other notes	Eval Avg peak kW Savings	Eval kWh Savings	Eval Therm Savings	Measure life category	Measure life (looked up)	Notes on adjustments to measure life
SCE	8408	M3	Ran the model against the other installed measures instead of the original baseline. The eQUEST version difference may have had a significant impact also,.		9	132,000	12,400	Add or replace control components	10	
SCE	8408	M4			-	(800)	1,936	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	
SCE	8408	M12			-	35,800	(1,700)	Add or replace control components	10	
SCE	8408	M13			-	(800)	1,936	Add or replace control components	10	
SCE	8408	M17	Two additional return fans were installed which increased electric savings and slightly decreased gas savings.	EM&V used eQUEST version 44c. The program estimate was based on a slightly older verion, 43a1. Newer version increased electric savings by 200 kWh and decreased gas savings by 700 therms.	-	358,600	43,900	Add VFDs to supply fans	15	
PG&E	7421	RCX 1			-	49,900	-	Repair and recalibrate damper controls	5	

Utility	building _id	Measure No.	Measure Description	Program actual kW Savings	Program actual kWh Savings	Program actual therms Savings	MMBtu	M&V approach (detailed, verify, etc.)	General findings
PG&E	7421	RCX 3	Corridor AHUs;Implement supply air temperature reset for corridor air handlers. Inspection Comments: Building automation system printout showing units with varying setpoints for supply temperature.	-	1,000	5,900	593	Detailed	Screen print provided in Quantum follow-up report show that the system is not responding as proposed in cooling mode.
PG&E	7421	RCX 4	AHU 2 & 206; VFDs for AHUs 2 & 206 were in fault and running at 100%. Repair drives.. Inspection Comments: Building automation screen shot of AHU 206 rumming in automatic at 90% instead of manual at 100%. Repaired. AHU 2 repaired May 2005 by staff.	-	99,800	2,900	631	Detailed	AHU-206 is locked in at 90% as this system does not have a duct sensor for control. AHU-2 was operating at 70% in what looks like a set speed.
PG&E	7421	RCX 6	Turn off ice storage system due to lower direct access electric costs.. Inspection Comments: See Printout. This was an "in-house" measure as pertains to installation costs.	-	130,500	-	445	Detailed	Load profile source is not known.
PG&E	7421	RCX 7	Run one chiller compressor at 60% for longer time period. Reduced chiller cycling and increased efficiency.. Inspection Comments:	-	255,700	-	873	Detailed	Chiller cycling is still present at the same rate as before. There has been no change in length of cycle as proposed.

Utility	building_id	Measure No.	Reasons for differences	Other notes	Eval Avg peak kW Savings	Eval kWh Savings	Eval Therm Savings	Measure life category	Measure life (looked up)	Notes on adjustments to measure life
PG&E	7421	RCX 3		Chiller cycling prevents these units from operating in a stable mode, so the measure results cannot be observed.	-	1,000	5,900	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	
PG&E	7421	RCX 4	Both these systems have VAVboxes which control flow, it is not the fan speed. There are not savings for OSA. There are savings for fan speed reduction to the levels found, using 2.7, not 3.0.		-	61,100	-	Add or replace control components	10	
PG&E	7421	RCX 6	Analysis did not account for added cooling tower fan power. 300tons during peak versus 100tons at night with free cooling.	The chief engineer believes that he is saving energy by cycling the 450ton chiller roughly 13 times a day. Areas are routinely out of setpoint during these cycles and fan speeds are elevated to compensate for high SAT's.	-	115,215	-	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	
PG&E	7421	RCX 7	As long as the bldg load profile does not change then the chilled water system has the same load . With cycles remaining the same there is no savings.	Snapshots are not valid as there is no accounting for either external or internal loads. Limit reset is manual by staff and can not be depended on for long term.	-	-	-	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	

Utility	building _id	Measure No.	Measure Description	Program actual kW Savings	Program actual kWh Savings	Program actual therms Savings	MMBtu	M&V approach (detailed, verify, etc.)	General findings
PG&E	7421	RCX 8	Enable both sets of cooling tower fans to run together. Modulate their fans' speed in unison to maintain condenser water setpoint. Energy savings from operating fan motors at reduced speed.. Inspection Comments: Printout attached showing control sequence logic that enables both the towers together. Fans operate most of the time at minimum speed.	-	65,100	-	222	Detailed	Measure was logical and implemented.
PG&E	7421	RCX 13	Integrate Golden Gate Rooms A-C and Salons 7-9 lighting controls with BAS AHU schedule. Inspection Comments: Change resulted in additional savings	-	497,300	-	1,697	Detailed	Spaces are operating 6AM-midnight/365
PG&E	7422	RCX 3	AHU-1 + AHU-2; Change economizer settings and reduce outside air. Inspection Comments: Unit enthalpy settings changed from curve 'D' where outside air damper won't open until unit is in cooling and OA temp is <55 deg F to 'A' where OA damper opens when unit is in cooling and OA temp is <70 deg F. Provides for additional free cooling.	-	4,330	9,100	925	Detailed	
PG&E	7422	RCX 4	Non-Guest Room Fan Coils; Schedule fan coils operating hours and temperature setpoints. Inspection Comments: Non guest room fan coils scheduled based on occupancy and temperatures controlled during unoccupied periods with a setback.	-	77,500	19,300	2,195	Detailed	

Utility	building_id	Measure No.	Reasons for differences	Other notes	Eval Avg peak kW Savings	Eval kWh Savings	Eval Therm Savings	Measure life category	Measure life (looked up)	Notes on adjustments to measure life
PG&E	7421	RCX 8		as this system does not exceed 900 tons and rarely exceeds 450 tons, one tower should be shut down so the remaining tower can operate in a stable mode at low loads.	-	65,100	-	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	
PG&E	7421	RCX 13	revised hours of operation to use current schedule.	Added at diversity factor to better reflect actaul conference roo mlighting usage.	-	53,400	-	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	
PG&E	7422	RCX 3	Original analysis used the low end bin temps instead of midpoint. EM&V analysis used CZ03 bin temp data. Also adjusted the return air and supply air temps based on observations.		-	4,791	8,650	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	
PG&E	7422	RCX 4	Schedules were different than proposed (some units more and some less hours). The load factors that were assumed were reduced to better represent the coil loads. Electric savings increased due to calculation error in original worksheet.		-	90,500	13,800	Program schedule changes to EMCS. (setpoint, start/stop schedules)	3	

Utility	building _id	Measure No.	Measure Description	Program actual kW Savings	Program actual kWh Savings	Program actual therms Savings	MMBtu	M&V approach (detailed, verify, etc.)	General findings
PG&E	7422	RCX 7	Optimize domestic hot water heaters' control sequence. Minimize boiler cycling.. Inspection Comments: Control panel settings changed to allow boilers to remain on longer and increase delay between second stage. Pump off delay increased to capture remai	-	720	840	86	Verify	
PG&E	7422	RCX 8	Optimize main boilers' control sequence. Reset supply hot water temp by BAS. Inspection Comments: Reset implemented 160-180 deg F. Sequence added to keep hot water return above 140 deg F so condensation does not occur on tubes.	-	700	4,740	476	Detailed	
SCE	8416	1	Replace Variable Speed Drives for Main Air Handlers	-	99,655	2,771	617	Detailed	Zero savings
PG&E	7429	RCX-05	Economizer: Relocate / recalibrate buidling static pressure sensor. Correct control sequence for RA dampers and RA fan. And correct and calibrate the control sequence for the CD economizer. INSTALLED IN ALL TOWERS (A,B,C,D,E,F,H,G). Inspection Comments	-	445,568	-	1,521	Detailed	Bldg B trends show summer airside economizer operations working both pre and post with OSA>RAT; with OSA<RAT the unit went to 30% OSA fixed.
PG&E	7429	RCX-06	Closed heating deck outside dampers permanently. Installed in all towers (A,B,C,D,E,F,H G). Inspection Comments: Logic of "electronic" lockout control strategy is shown in attached document.	-	1,060,768	-	3,620	Verify	Jan 06 (post-install) bldg B trend logs indicate no change from trend logs for Jan 05 (baseline). Measure is not having an effect.

Utility	building_id	Measure No.	Reasons for differences	Other notes	Eval Avg peak kW Savings	Eval kWh Savings	Eval Therm Savings	Measure life category	Measure life (looked up)	Notes on adjustments to measure life
PG&E	7422	RCX 7	None.		-	720	840	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	
PG&E	7422	RCX 8	Reset schedule not set as low as much as recommended. Laods were based on an average supply/return delta temperature instead of varying with outside temperature.		-	700	2,368	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	
SCE	8416	1	Installed equipment not funtioning as intended. All units in manual mode and set at 100% speed.	After VFD installation, it was discovered that the existing BAS can not control the VFD's.	-	-	-	Add VFDs to supply fans	15	
PG&E	7429	RCX-05	Corrected OSA% and CFM based on RCX8. Slight adjustments made to analysis based on findings of supplemental analysis (lower cooling load). Added extrapolation to 8 bldgs.	Used excel model developed for program analysis with changes to OSA% and CFM.	-	31,610	-	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	
PG&E	7429	RCX-06	No change in building operations	Post-installation bldg B trend data shows HDSAT Tracking OSAT. Heating coil appears to be operating at maximum capacity with 28% OSA.	-	-	-	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	

Utility	building _id	Measure No.	Measure Description	Program actual kW Savings	Program actual kWh Savings	Program actual therms Savings	MMBtu	M&V approach (detailed, verify, etc.)	General findings
PG&E	7429	RCX-07	Heating Deck: Reset suppl air temperature based on OAT. INSTALLED IN ALL TOWERS (A,B,C,D,E,F,H,G). Inspection Comments: Attached document illustrates the changes in programming done by IBM. The new reset control strategy is as follows: OAT 35 degrees F -- Hot Deck SPT 105 degrees F. OAT 65 degrees F -- Hot Deck SPT 75 degrees F.	-	827,400	-	2,824	Detailed	Jan 06 (post-install) bldg B trend logs indicate no change from trend logs for Jan 05 (baseline). Measure is not having an effect.
PG&E	7429	RCX-08	Reset Cooling Deck supply air temperature based on OAT. INSTALLED IN ALL TOWERS (A,B,C,D,E,F,H,G). Inspection Comments: See programming changes on attached document. New reset controls strategy is as follows: OAT 55 degrees F - Cold Deck SPT 60 degrees F OAT 70 degrees F - Cold Deck SPT 55 degrees F	-	244,800	-	836	Detailed	CD SAT reset appears to have been modified from recommended setpoints. Above 70 OSAT, SAT setpoint is 50, instead of the proposed 55 and below 55 OSAT, setpoint is 65, not the proposed 60.
PG&E	7429	RCX-09	Twr G.Correct schedule on all tower fans. INSTALLED IN ALL TOWERS (A,B,C,D,E,F,H,G). Inspection Comments: Graph for all towers are attached for reference.	-	678,368	-	2,315	Detailed	Tower fans must run continuously now because of adverse effects of other measures.
PG&E	7445	12b	N__ Datacenter Plug leaks in floor around PDU's and around power cords to IT racks	-	88,700	-	303	Verify	No savings.
PG&E	7445	12c	N__ Datacenter Rearrange floor tiles into cold aisle/hot aisle configuration	-	293,000	-	1,000	Verify	No savings.

Utility	building_id	Measure No.	Reasons for differences	Other notes	Eval Avg peak kW Savings	Eval kWh Savings	Eval Therm Savings	Measure life category	Measure life (looked up)	Notes on adjustments to measure life
PG&E	7429	RCX-07	No change in building operations		-	-	-	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	
PG&E	7429	RCX-08	Setpoint changes are most likely due to critical zone constraints. The lower cooling SAT has increased chiller load. No heating savings because of chiller waste heat recovery (electric boilers are off). Added extrapolation to 8 bldgs.	Used excel model developed for program analysis with changes to CD SAT setpoints. Resulting model was used as the baseline for RCX05 to avoid double counting.	#VALUE!	(83,960)	-	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	
PG&E	7429	RCX-09	Tower fans must run continuously now because of adverse effects of other measures.	Bldg B post trend data show fans do not shut off at night during the work week as they did in the baseline.	-	(1,431,933)	-	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	
PG&E	7445	12b	Measure partially implemented, but because of data center configuration, leakage simply shifted. No savings.		-	-	-	20 years (from 2005 DEER database, measure D03-075 Duct Insulation Material)	20	Customer states all data centers will be consolidated into new one by about 2009, so reduce measure life to 4 years.
PG&E	7445	12c	Measure partially implemented, but because of data center configuration, leakage simply shifted. No savings.		-	-	-	20 years (from 2005 DEER database, measure D03-075 Duct Insulation Material)	20	Customer states all data centers will be consolidated into new one by about 2009, so reduce measure life to 4 years.

Utility	building _id	Measure No.	Measure Description	Program actual kW Savings	Program actual kWh Savings	Program actual therms Savings	MMBtu	M&V approach (detailed, verify, etc.)	General findings
PG&E	7445	3	Close economizer dampers in warm weather and reduce return air leakage	-	79,000	-	270	Simple	Ex ante approach reasonable for measure with relatively small savings.
PG&E	7445	5b	Saturn Datacenter Plug leaks in floor, under PDU's and around power cords under IT racks	-	158,000	-	539	Detailed	Lots of variation in savings between data rooms (34% decrease to 26% increase), indicating that same set of changes affected cooling energy use in different ways.
PG&E	7445	5c	Saturn Datacenter Remove portable cooling units.	-	105,000	-	358	Detailed	Portable cooling units had been removed.
PG&E	7445	5d	Saturn Datacenter rearrange floor tiles into cold aisle//hot aisle configuration	-	524,200	-	1,789	Detailed	(see Measure 5b)
PG&E	7445	6b	Utopia Data Center Plug leaks in floor, around PDU's and around power cords to IT racks	-	242,000	-	826	Detailed	Lots of variation in savings between data rooms (34% decrease to 26% increase), indicating that same set of changes affected cooling energy use in different ways.

Utility	building _id	Measure No.	Measure Description	Program actual kW Savings	Program actual kWh Savings	Program actual therms Savings	MMBtu	M&V approach (detailed, verify, etc.)	General findings
PG&E	7445	3	Close economizer dampers in warm weather and reduce return air leakage	-	79,000	-	270	Simple	Ex ante approach reasonable for measure with relatively small savings.
PG&E	7445	5b	S__ Datacenter Plug leaks in floor, under PDU's and around power cords under IT racks	-	158,000	-	539	Detailed	Lots of variation in savings between data rooms (34% decrease to 26% increase), indicating that same set of changes affected cooling energy use in different ways.
PG&E	7445	5c	S__ Datacenter Remove portable cooling units.	-	105,000	-	358	Detailed	Portable cooling units had been removed.
PG&E	7445	5d	Saturn Datacenter rearrange floor tiles into cold aisle//hot aisle configuration	-	524,200	-	1,789	Detailed	(see Measure 5b)
PG&E	7445	6b	U__ Data Center Plug leaks in floor, around PDU's and around power cords to IT racks	-	242,000	-	826	Detailed	Lots of variation in savings between data rooms (34% decrease to 26% increase), indicating that same set of changes affected cooling energy use in different ways.

Utility	building _id	Measur e No.	Measure Description	Program actual kW Savings	Program actual kWh Savings	Program actual therms Savings	MMBtu	M&V approach (detailed, verify, etc.)	General findings
PG&E	7445	6c	U__ Data Center Rearrange floor tiles into cold aisle / hot aisle configuration	-	799,000	-	2,727	Detailed	(see Measure 6b)
PG&E	7445	7b	C__ S__ Datacenter Plug leaks in floor, around PDU's and around power cords to IT racks	-	179,000	-	611	Detailed	Lots of variation in savings between data rooms (34% decrease to 26% increase), indicating that same set of changes affected cooling energy use in different ways.
PG&E	7445	7c	C__ S__ Datacenter Rearrange floor tiles into cold aisle/hot aisle configuration	-	590,500	-	2,015	Detailed	(see Measure 7b)
PG&E	7445	8b	CA__ Datacenter Plug leaks in floor, around PDU's and around power cords to IT racks	-	58,300	-	199	Detailed	Lots of variation in savings between data rooms (34% decrease to 26% increase), indicating that same set of changes affected cooling energy use in different ways.

Utility	building_id	Measure No.	Reasons for differences	Other notes	Eval Avg peak kW Savings	Eval kWh Savings	Eval Therm Savings	Measure life category	Measure life (looked up)	Notes on adjustments to measure life
PG&E	7445	6c	(see Measure 6b)	Divide original evaluated savings by 5 to account for misapplied units (kW,thermal instead of kW,electric) and for chiller plant efficiency.	(11)	(96,871)	-	20 years (from 2005 DEER database, measure D03-075 Duct Insulation Material)	20	Customer states all data centers will be consolidated into new one by about 2009, so reduce measure life to 4 years.
PG&E	7445	7b	It is possible for some data rooms that the modifications improved airflow, thereby improving cooling and reducing space temperatures, but resulting in higher cooling energy use.	Divide original evaluated savings by 5 to account for misapplied units (kW,thermal instead of kW,electric) and for chiller plant efficiency.	1	10,110	-	20 years (from 2005 DEER database, measure D03-075 Duct Insulation Material)	20	Customer states all data centers will be consolidated into new one by about 2009, so reduce measure life to 4 years.
PG&E	7445	7c	(see Measure 7b)	Divide original evaluated savings by 5 to account for misapplied units (kW,thermal instead of kW,electric) and for chiller plant efficiency.	4	33,396	-	20 years (from 2005 DEER database, measure D03-075 Duct Insulation Material)	20	Customer states all data centers will be consolidated into new one by about 2009, so reduce measure life to 4 years.
PG&E	7445	8b	It is possible for some data rooms that the modifications improved airflow, thereby improving cooling and reducing space temperatures, but resulting in higher cooling energy use.	Divide original evaluated savings by 5 to account for misapplied units (kW,thermal instead of kW,electric) and for chiller plant efficiency.	(2)	(19,151)	-	20 years (from 2005 DEER database, measure D03-075 Duct Insulation Material)	20	Customer states all data centers will be consolidated into new one by about 2009, so reduce measure life to 4 years.

Utility	building_id	Measure No.	Measure Description	Program actual kW Savings	Program actual kWh Savings	Program actual therms Savings	MMBtu	M&V approach (detailed, verify, etc.)	General findings
PG&E	7445	8c	CA__ Datacenter Rearrange floor tiles into cold aisle/hot aisle configuration	-	192,600	-	657	Detailed	(see Measure 8b)
PG&E	7445	9b	T__ L__ Datacenter Plug leaks in floor, around PDU's and around power cords to IT racks	-	208,000	-	710	Detailed	Lots of variation in savings between data rooms (34% decrease to 26% increase), indicating that same set of changes affected cooling energy use in different ways.
PG&E	7445	9c	T__ L__ Datacenter Rearrange floor tiles into cold aisle/hot aisle configuration	-	687,300	-	2,346	Detailed	(see Measure 9b)
PG&E	7446	rcx-01	Economizer. Install relief air diverters on AC 1-6, then remove manual overrides	-	1,359,017	-	4,638	Detailed	Good modeling approach by Quantum. Savings overestimated by about 17%.

Utility	building_id	Measure No.	Reasons for differences	Other notes	Eval Avg peak kW Savings	Eval kWh Savings	Eval Therm Savings	Measure life category	Measure life (looked up)	Notes on adjustments to measure life
PG&E	7445	8c	(see Measure 8b)	Divide original evaluated savings by 5 to account for misapplied units (kW,thermal instead of kW,electric) and for chiller plant efficiency.	(7)	(63,261)	-	20 years (from 2005 DEER database, measure D03-075 Duct Insulation Material)	20	Customer states all data centers will be consolidated into new one by about 2009, so reduce measure life to 4 years.
PG&E	7445	9b	It is possible for some data rooms that the modifications improved airflow, thereby improving cooling and reducing space temperatures, but resulting in higher cooling energy use.	Divide original evaluated savings by 5 to account for misapplied units (kW,thermal instead of kW,electric) and for chiller plant efficiency.	1	8,236	-	20 years (from 2005 DEER database, measure D03-075 Duct Insulation Material)	20	Customer states all data centers will be consolidated into new one by about 2009, so reduce measure life to 4 years.
PG&E	7445	9c	(see Measure 9b)	Divide original evaluated savings by 5 to account for misapplied units (kW,thermal instead of kW,electric) and for chiller plant efficiency.	3	27,204	-	20 years (from 2005 DEER database, measure D03-075 Duct Insulation Material)	20	Customer states all data centers will be consolidated into new one by about 2009, so reduce measure life to 4 years.
PG&E	7446	rcx-01	Did not subtract the 20% min airflow that would be happening regardless of the measure. Slightly higher kW correlation readings vs calculated kW w/ assumed PF by Quantum. Also, SBW regularly measured 468-472V while power calculations used 460V.		-	1,158,887	-	Repair and recalibrate damper controls	5	

Utility	building _id	Measure No.	Measure Description	Program actual kW Savings	Program actual kWh Savings	Program actual therms Savings	MMBtu	M&V approach (detailed, verify, etc.)	General findings
PG&E	7446	rcx-02	VAV Boxes. Command VAV boxes serving labs with CRACs to 133% of design flow when it is cold outside and building is unoccupied.	-	87,528	-	299	Verify	Substantial issues w/ savings documentation. Savings appear to be overestimated by almost 200%.
PG&E	7446	rcx-05	Secondary pumps. Correct pump sequencing.	-	83,626	-	285	Detailed	Savings were underestimated by about 44%.
PG&E	7446	rcx-06	AC unit condenser. Separate condenser fan circuits that are wired in parallel (assumes rcx-01 implemented).	-	66,579	-	227	Detailed	Savings were underestimated by about 15%.
PG&E	7447	RCX 1	HVAC - Chiller, RTU, AHU: Revise EMS Equipment and operating schedule. Inspection Comments: See email from chief. Overides and equipment problem were corrected. Equipment no longer operating 24/7. Change of schedule was not implemented due to difficulty in coordinating with users and unions plus limitation on lighting control system.	-	996,094	-	3,400	Detailed for North Bldg.	Savings did occur but include corrective action on overrides, etc.
PG&E	7447	RCX 4	Replace standard V belts with cogged type belts. Inspection Comments:	-	11,000	-	38	Verify	Project was installed and working for the Owner.

Utility	building_id	Measure No.	Reasons for differences	Other notes	Eval Avg peak kW Savings	Eval kWh Savings	Eval Therm Savings	Measure life category	Measure life (looked up)	Notes on adjustments to measure life
PG&E	7446	rcx-02	Based on info given to reviewer, several rooms had no CRAC and many of the VAV terminal boxes were calculated for airflow volumes exceeding their K factors in the balancing report.	Used same methodolgy and spreadsheet analysis as orignal with updated info.	-	29,365	-	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	
PG&E	7446	rcx-05	Program savings based on 79.4% speed setting on VFD. Sun is running an average of 38%. Evaluation had slightly higher kW correlation readings from our reference curve generated onsite. Pressure differential used in original calcs was off a little bit.	Evaluation projected conservative demand peak savings also.	10	120,216	-	Add VFDs to supply fans	15	VFD actually added to CHWP.
PG&E	7446	rcx-06	Slightly higher kW crelation readings vs calculated kW w/ assumed PF by Quantum. Also, SBW regularly measured 468-472V while power calculations used 460V.	No permanent peak demand savings projected by Quantum or SBW as two compressors will run during the year On Peak anyway.	-	76,515	-	Add or replace control components	10	
PG&E	7447	RCX 1	Owner did not implement any changes in US and West bldgs fans due to tenant & employee resistance. SBW adjusted baseline for North CT fan operation. SBW kW readings slightly different. Equipment op hour recommendations not all incorporated by Macy's.		-	866,175	-	Program schedule changes to EMCS. (setpoint, start/stop schedules)	3	
PG&E	7447	RCX 4	N/A		-	11,000	-	Replace smooth belts with Cogged belts	8	

Utility	building _id	Measure No.	Measure Description	Program actual kW Savings	Program actual kWh Savings	Program actual therms Savings	MMBtu	M&V approach (detailed, verify, etc.)	General findings
PG&E	7447	RCX 5	Raise the chilled water supply temperature set point from 42?F to 50?F.. Inspection Comments: This was implemented by facility personnel with Ignacio R. present.	32	153,000	-	522	Simple	Savings over estimated by about 20%.
PG&E	7449	ECM1	Optimize the minimum economizer setpoint for each air coniditioning unit. Currently, the minimum outside airflow through each unit does not match the original design intent.. Inspection Comments:	7	835	-	3	Verify	Facility only adjusted OSA fractions on 4 of 8 AC units.
PG&E	7449	ECM2	In accordance with current standards, reduce the outside airflow through the minimum fixed damper. Currently, this damper allows excess outside air to flow through the unit.. Inspection Comments:	15	770	-	3	Verify	Measure implemented as recommended.
PG&E	7449	ECM3	Fix the connection between the building static pressure sensor and the EMS. Use the building pressure to control the return fan operation.. Inspection Comments: See attached trend.	12	42,077	-	144	Detailed	Measure appears to have resulted in energy savings.
PG&E	7449	ECM4	Optimize hot water (HW) system by eliminating steam consumption during off hours. The HW system is scheduled to operate from 7 am to midnight, but steam is consumed during all hours.. Inspection Comments:	-	-	21,917	2,192	Detailed	ECM4, in conjunction with ECM6, saved energy while it was effective, but was overridden by system changes at the beginning of 2006, resulting in few hours of shutdown condition.

Utility	building_id	Measure No.	Reasons for differences	Other notes	Eval Avg peak kW Savings	Eval kWh Savings	Eval Therm Savings	Measure life category	Measure life (looked up)	Notes on adjustments to measure life
PG&E	7447	RCX 5	Load was represented in baseline as total of both chillers. Actually one serves as backup chiller to other for West building in this EEM. Additionally, used part load curve supplied as part of RCX 7 to determine demand at part load conditions.		25	125,823	-	Program schedule changes to EMCS. (setpoint, start/stop schedules)	3	
PG&E	7449	ECM1	kW reduction much lower because adjusted to reflect CPUC average peak savings definition.	Because of cogen/TES, electric savings actually translate into gas savings.*	1	968	-	Program schedule changes to EMCS. (setpoint, start/stop schedules)	3	
PG&E	7449	ECM2	kW reduction much lower because adjusted to reflect CPUC average peak savings definition.	Because of cogen/TES, electric savings actually translate into gas savings.*	0	770	-	Add or replace control components	10	
PG&E	7449	ECM3	Savings higher because second return fan able to run at lower speeds that initially estimated. Savings offset slightly by adjusting power to account for motor load factors and VFD efficiencies.		13	66,205	-	Add or replace control components	10	
PG&E	7449	ECM4	Evaluation used actual steam consumption data from post installation period as opposed to projected conditions necessarily used for program estimate.	ECM 4 & 6 interactions make independent analysis impossible. Total savings were divided in proportion to respective program savings. Measure life was only 0.39 years.	-	-	1,033	Program schedule changes to EMCS. (setpoint, start/stop schedules)	0.39	Measure in effect from 8/11/05 through 1/2/06 when unidentified system change defeated the measure. Credit given for effective period.

Utility	building_id	Measure No.	Measure Description	Program actual kW Savings	Program actual kWh Savings	Program actual therms Savings	MMBtu	M&V approach (detailed, verify, etc.)	General findings
PG&E	7449	ECM6	Optimize the supply temperature for the HW system.. Inspection Comments:	77	30,899	7,672	873	Detailed	ECM6, in conjunction with ECM4, saved energy while it was effective, but was apparently overridden by system changes at the beginning of 2006, masking any effect ECM6 may still have.
PG&E	7462	M1	Repair Economizers S3, S11, S12. Inspection Comments: Customer repaired the control circuits for damper linkages for s3, s11, s12 and adjusted damoers to close/open properly. New damper linkage motors were installed in units s1, s7, s10. See photos 799, 800 for new motors. See photos 801, 802 for repaired damper linkages. The cost for all repairs are attached.	-	233,210	-	796	Detailed	Economizers still not working. Facility repaired dampers, but probably did not commission them to ensure they worked properly.
PG&E	7462	M2	Software Adjustment. The damper operation control programming issues for Units S1 and S9 be repaired.. Inspection Comments: Jim Cromer performed all the software changes and a copy of these changes is attached. The outside air temperature was set at 72 deg F for economizer control. The cost for this work is attached.	-	20,484	-	70	Verify	Appears measure was implemented.
PG&E	7462	M3	Return Air Damper Adjustment. Dampers S2, S4, S6, and S8 require adjustment and possibly new parts to operate correctly.. Inspection Comments: Frank Johnson performed all the damper repairs for s2, s4, s6 and s8. See photographs #808, 809, 801, 802 for repaired damper linkages. The cost of these repairs are attached.	-	91,176	-	311	Detailed	Economizers still not working fully. Facility repaired dampers, but probably did not commission them to ensure they worked properly.

Utility	building_id	Measure No.	Reasons for differences	Other notes	Eval Avg peak kW Savings	Eval kWh Savings	Eval Therm Savings	Measure life category	Measure life (looked up)	Notes on adjustments to measure life
PG&E	7449	ECM6	Measure performance (if it is still in effect) masked by unidentified system changes. Evaluation used steam consumption data for post-installation period.	See "Other notes" entry for ECM4. kWh and kW savings values are based on kWh/therm and kW/kWh ratios obtained from program-estimated savings.	4	1,456	361	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	0.39	Measure in effect from 8/11/05 through 1/2/06 when unidentified system change either masked or defeated the measure. Credit given for effective period.
PG&E	7462	M1	No apparent decrease in cooling load.		1	8,212	-	Add or replace control components	10	Because Unit S3 (1 of 3 affected) will be replaced in fall of 2006, we prorated savings by 33% after first year for this measure).
PG&E	7462	M2	N/A		-	20,484	-	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	
PG&E	7462	M3	No apparent decrease in cooling load.		-	-	-	Add or replace control components	10	

Utility	building _id	Measure No.	Measure Description	Program actual kW Savings	Program actual kWh Savings	Program actual therms Savings	MMBtu	M&V approach (detailed, verify, etc.)	General findings
PG&E	7462	M4	Calibrate / replace and relocate outside air temperature sensor & adjust carrier unit economizer lockout temperature.. Inspection Comments: The OA temperature sensor was relocated as seen in photo 804, 807. It was also recalibrated w/ handheld temp guage. The Andover system was 56-8 deg F when the handheld showed 56-6 deg F as shown in photos 805, 806. The control program printout shows that economizer is disabled when OA temp is 72 and enabled when it is 70 or less. The cost of the new temp sensor is $	-	17,947	-	61	Verify	Appears measure was implemented.
PG&E	7462	M5	Adjust unit start time for S4 and S9.. Inspection Comments: The printout of control sequences is attached. All fans and compressors are enabled .5 hour after arrive time and is started only when temp is 74 for compressors and 72 for fans. Weekly schedule for the store is entered for opening and closing times. Jim Cromer performed all changes in the Andover program and provided the printout. Cost for this work is attached	-	77,008	-	263	Simple	
PG&E	7462	M6	Reduce night time lighting. Inspection Comments: Installed relays, rewired lighting circuits and modified EMS for 24 panels.	-	180,000	-	614	Detailed	These savings adjusted using more detailed data, which bear out QuEST's revised claim.
PG&E	7459	M1	Optimize morning fan operation. Inspection Comments: Building Engineer reports full implementation of revised schedule.	-	42,224	-	144	Detailed	Scheduled hours changed but not reduced.
PG&E	7459	M2	Reduce minimum VFD fan speed for first and second floor AHU's. Inspection Comments: Variable speed drives were checked and settings confirmed. Pictures taken	16	174,400	-	595	Detailed	Significant savings.

Utility	building_id	Measure No.	Reasons for differences	Other notes	Eval Avg peak kW Savings	Eval kWh Savings	Eval Therm Savings	Measure life category	Measure life (looked up)	Notes on adjustments to measure life
PG&E	7462	M4	N/A		-	17,947	-	Add or replace control components	10	
PG&E	7462	M5	No significant differences.	As noted in general findings, we suspect that the one-hour assumed hour reduction is optimistic, but could not determine this with enough certainty to override the program value.	-	77,171	-	Program schedule changes to EMCS. (setpoint, start/stop schedules)	3	
PG&E	7462	M6	kW reductions higher than originally predicted.		-	621,048	-	Reduce lighting levels	16	
PG&E	7459	M1		EF config incorrect. 2 SF per 1 EF. EF no longer run.	-	-	-	Program schedule changes to EMCS. (setpoint, start/stop schedules)	3	
PG&E	7459	M2	EFs not run at all. SBW SF logged data showed 9.3 kW vs Quantum 7.5 kW.		32	192,652	-	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	

Utility	building _id	Measur e No.	Measure Description	Program actual kW Savings	Program actual kWh Savings	Program actual therms Savings	MMBtu	M&V approach (detailed, verify, etc.)	General findings
PG&E	7459	M3	Variable Frequency Control of Rooftop Unit Supply and Return Fans. Inspection Comments: Physical verification of VSD's Pictures taken	-	94,300	-	322	Detailed	Slight savings given for RTU-3, none for rest.
PG&E	7459	M4	Replace Rooftop Unit DX Coils with Chilled Water Coils. Inspection Comments: Physical verification of new chilled water coils. Pictures taken.	12	45,500	-	155	Detailed	
PG&E	7459	M5	Variable Frequency Control of Chilled Water / Condenser Water Pumps. Inspection Comments: Physical verification OK. VSD's on wall and one on MCC.	16	23,925	-	82	Detailed	Significant savings with old chiller.
PG&E	7459	M6	Open Hot Deck Dampers to Decrease System Static Pressure Drop. Inspection Comments: Physical verification that hot deck dampers fully open. Pictures taken.	-	6,200	-	21	Verify	Accepted
PG&E	7459	M7	Replace Standard V-Belts with Cogged-Type Belts. Inspection Comments: Physical verification of installed cogged type belts.	2	8,724	-	30	Verify	Accepted
PG&E	7459	R1	Replace Cooling Tower. Inspection Comments: New stainless steel tower was physically verified	-	17,600	-	60	Simple	Savings a little over half predicted.

Utility	building_id	Measure No.	Reasons for differences	Other notes	Eval Avg peak kW Savings	Eval kWh Savings	Eval Therm Savings	Measure life category	Measure life (looked up)	Notes on adjustments to measure life
PG&E	7459	M3	VFD for RTU not enabled. Locked in at ~ 100% for RTU-1. Assumed RTU-2,4 same as RTU-1 since same size.	VFD retrofits for constant volume systems apparently not enabled to maintain flow to furthest branch duct terminations.	1	2,593	-	Add VFDs to supply fans	15	
PG&E	7459	M4		Evaluated with RM2 together. See below.	-	-	-	Add or replace control components	10	
PG&E	7459	M5	Operating hours provided by model were unrealistic.	No longer relevant EEM as chiller has changed. New chiller has different op conditions and efficiencies.	13	30,095	-	Add VFDs to supply fans	15	Actually VFD added to both CHWP and CWP for old chiller that was replaced by RM2 below.
PG&E	7459	M6		Physically verified hot deck dampers open.	-	6,200	-	Repair and recalibrate damper controls	5	
PG&E	7459	M7		Physically observed cogged belts installed and operating.	2	8,724	-	Replace smooth belts with Cogged belts	8	
PG&E	7459	R1	Control and/or equip malfunction on part of chiller and/or CT. Logged load is significantly higer than expected. No apparent max	Assumed problem is system endemic vs seasonal, i.e. savings	-	9,688	-	Replace Cooling Tower	15	Used DOE Measure ID for Efficient HVAC motors - cooling tower fans, D03-088.

Utility	building_id	Measure No.	Measure Description	Program actual kW Savings	Program actual kWh Savings	Program actual therms Savings	MMBtu	M&V approach (detailed, verify, etc.)	General findings
PG&E	7459	R2.2	Install new chiller. Inspection Comments: Physical verification of new chiller	162	87,500	-	299	Detailed	Consumption and demand savings overestimated.
SCE	8424	1	VSDs on SF-1 and SF-2. Inspection Comments: Two, 50hp VSD's (ABB) installed along with new static pressure sensor SF-1 setpoint = 1.7" WC, SF-2 setpoint =1.4" WC	-	61,342	-	209	Detailed	
SCE	8424	2	Economizer system repair (rebuild of the OSA damper, linkages, and actuators) and recalibration. Inspection Comments: Dampers rebuilt, lubed and tested. OSA lockout set at 60 deg F. Return air dampers were 100% closed when system was in outside air cooling mode as they should be. 120 hours at $40 for in-house labor.	-	43,018	-	147	Detailed	
SCE	8424	3	HVAC schedule reduction. Inspection Comments: HVAC start time set 1.5 hours later than before(subject to some seasonal adjustment for v. hot weather) 2 hours at $40/hr in-house labor.	-	6,711	-	23	Detailed	
PG&E	7464	1	Reset supply air temperature based on the lowest SA temperature set point from terminal box. Inspection Comments: Reset was performed at the air handler level	-	173,000	16,582	2,249	Verify, Detailed	Not implemented according to building operator.

Utility	building_id	Measure No.	Reasons for differences	Other notes	Eval Avg peak kW Savings	Eval kWh Savings	Eval Therm Savings	Measure life category	Measure life (looked up)	Notes on adjustments to measure life
PG&E	7459	R2.2	Equip op hrs and chiller baseline demand appear skewed. CT fan operating at higher avg load. Chiller baseline energy too low.	M4 savings were a part of this EEM. Separate documentation appeared to double dip.	74	36,150	-	HE Centrifugal Chiller Replacement	20	DOE Measure ID: D03-117
SCE	8424	1	Modeling errors. Program analysis did not report modelled kW and Therm differences.		29	47,068	(52)	Add VFDs to supply fans	15	
SCE	8424	2	Modeling errors. Program analysis did not report modelled kW and Therm differences.		(33)	33,014	(1,253)	Repair and recalibrate damper controls	5	
SCE	8424	3	No HVAC schedule change based on one month of trend data.		-	-	-	Program schedule changes to EMCS. (setpoint, start/stop schedules)	3	
PG&E	7464	1	No evaluation analysis performed	Global space temperature setpoint is manually adjusted on seasonal basis; variance from this value includes bias of +4/-2 degF plus individual t'stat setting of +4/-4 degF from resulting temperature band, so central control is not precise.	-	-	-	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	

Utility	building_id	Measure No.	Measure Description	Program actual kW Savings	Program actual kWh Savings	Program actual therms Savings	MMBtu	M&V approach (detailed, verify, etc.)	General findings
PG&E	7464	2	Eliminate cooling during morning warmup cycle.. Inspection Comments: Implemented change eliminates cooling any time OA is enough to satisfy cooling needs. Not only duriong warm up cycle.	-	39,917	968	233	Detailed	Measure implementation was attempted and control sequence is in effect, but extraneous conditions require morning cooling.
PG&E	7464	4	Implement optimum stop start strategies for main HVAC systems.. Inspection Comments: HVAC operation schedule was adjusted to reduce operation by about 11 hours a week. See attached screen copy of control screen displaying current HVAC operating schedule.	-	128,014	798	517	Detailed	Not implemented according to building operator.
PG&E	7465	11	Implement optimum stop start strategies for main HVAC systems.	-	68,925	1,600	395	Detailed	Measure not implemented according to site personnel
PG&E	7465	2	Reprogram condenser water pumps sequence of operations	-	256,172	-	874	Detailed	Measure implemented as proposed. Evaluation savings greater than program savings.
PG&E	7465	4	Reprogram chillers to stop low load surge	-	1,136	-	4	Verify	Accepted as submitted
PG&E	7465	5	Reset zone temperature from 72 to 76 deg F	-	61,300	-	209	Detailed	Measure not implemented according to site personnel

Utility	building_id	Measure No.	Reasons for differences	Other notes	Eval Avg peak kW Savings	Eval kWh Savings	Eval Therm Savings	Measure life category	Measure life (looked up)	Notes on adjustments to measure life
PG&E	7464	2	The building is actually in a cool-down mode every morning due to nighttime zone temperatures of 80 to 85 degrees. As a result, this measure is not effective.	Eliminating high nighttime zone temperatures would allow considerable savings.	-	39,917	968	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	
PG&E	7464	4			-	-	-	Program schedule changes to EMCS. (setpoint, start/stop schedules)	3	
PG&E	7465	11	Measure not implemented		-	-	-	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	
PG&E	7465	2	Measured kW on CW pumps for evaluation greater than calculated value used in program calculations.		32	276,252	-	Program schedule changes to EMCS. (setpoint, start/stop schedules)	3	
PG&E	7465	4			-	1,136	-	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	
PG&E	7465	5	No evaluation analysis performed	Global space temperature setpoint is manually adjusted on seasonal basis; variance from this value includes bias of +4/-2 degF plus individual t'stat setting of +4/-4 degF from resulting temperature band, so central control is not precise.	-	-	-	Program schedule changes to EMCS. (setpoint, start/stop schedules)	3	

Utility	building _id	Measure No.	Measure Description	Program actual kW Savings	Program actual kWh Savings	Program actual therms Savings	MMBtu	M&V approach (detailed, verify, etc.)	General findings
PG&E	7465	8	Eliminate cooling during morning warmup	-	32,500	-	111	Detailed	Measure was implemented with apparent slight modifications
PG&E	7468	1	Use all cooling tower cells	-	50,821	-	173	Accept as-is	No changes
PG&E	7468	11	Replace leaking heating valve	-	105,696	25,781	2,939	Detailed	Evaluation savings less than estimated program savings
PG&E	7468	3	Reset condensor water setpoint	-	134,228	-	458	Accept as-is	No Changes
PG&E	7468	4	Replace pressure sensor	-	40,344	-	138	Accept as-is	Nochanges

Utility	building_id	Measure No.	Reasons for differences	Other notes	Eval Avg peak kW Savings	Eval kWh Savings	Eval Therm Savings	Measure life category	Measure life (looked up)	Notes on adjustments to measure life
PG&E	7465	8	Program analysis took fan speed as HZ when it was %. Heating savings was not reported.		-	38,832	11,650	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	
PG&E	7468	1			-	50,821	-	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	
PG&E	7468	11	Evaluation took into account the fact that, when in heating mode, the impact of the leaking valve is reduced	Heating valve simply closed, not replaced	17	40,635	8,327	Add or replace control components	10	
PG&E	7468	3			-	134,228	-	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	
PG&E	7468	4		Moving pressure sensor not required; pump speed control inadvertantly left at 100% following testing - simply needed to restore speed control.	-	40,344	-	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	

Utility	building _id	Measure No.	Measure Description	Program actual kW Savings	Program actual kWh Savings	Program actual therms Savings	MMBtu	M&V approach (detailed, verify, etc.)	General findings
PG&E	7468	5	Adjust HHW reset schedule	-	9,139	13,362	1,367	Detailed	Evaluation savings exceed estimated program savings
PG&E	7468	8	Replace leaking cooling valve	-	56,589	11,655	1,359	Detailed	Evaluation savings very close to program estimates
PG&E	7468	9	Adjust hot air temperature reset schedule	-	265,533	58,291	6,735	Detailed	Evaluation savings exceed estimated program savings
PG&E	7468	10	INCITE	-	588,066	-	2,007	Detailed	Evaluation savings considerably less than program savings

Utility	building_id	Measure No.	Reasons for differences	Other notes	Eval Avg peak kW Savings	Eval kWh Savings	Eval Therm Savings	Measure life category	Measure life (looked up)	Notes on adjustments to measure life
PG&E	7468	5	Estimated savings performed on air side measurements for 4 AHUs and extrapolated to 12; evaluation calcs based on pipe loss and HHW temperature	Used E3 pipe heat loss calculation software with inputs assumed in program analysis for pipe losses.	16	58,950	16,156	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	
PG&E	7468	8			17	55,394	15,101	Add or replace control components	10	
PG&E	7468	9	Boiler efficiency not considered; implemented HA reset values differ from recommendation; program svings based on 1 week in October extrapolated to full year, eval used bin data for occupied periods over a year; small error in estimation equation		272	992,000	270,800	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	
PG&E	7468	10		Core systems generally have a flat static pressure profile once the system stabilizes after startup, due to relatively constant internal loads & little influence from the building skin.	23	103,781	-	Program logic changes to EMCS. (add reset control, optimum start/stop, control sequences)	5	

D. Findings from Supplemental EM&V Effort

This section documents our findings from supplemental data collection and analysis that we, as the evaluator, performed over the past month to augment our August 2006 evaluation of the Building Tune-Up Program. This supplemental effort was undertaken at the CPUC's behest, and included collecting additional field data and performing more analysis to help resolve the more significant uncertainties about the actual energy savings for some of the evaluated projects. The sites and measures subject to the supplemental effort included: all measures at Project 7429, most measures at Projects 7445 and 7464, and one measure at Project 7462. Collectively, these measures accounted for 90% of the difference between the original EM&V kWh savings and the project implementer's suggested revisions.

Fortunately for our efforts, staff at all three visited sites were very helpful, and freely provided facility access and time with key staff. In general, we found that of the measures that we investigated further, only two measures warranted a significant upwards adjustment in verified savings. For the remaining measures, we found strong evidence that the low savings we originally reported were justified. In several cases, the additional information we collected helped resolve important uncertainties in our analyses. Based on this, we feel confident recommending that savings for several measures should in fact be adjusted downward. These include measures at Project 7429, where we found (1) that the electric boilers on which heating savings were based had been taken out of operation, and (2) that the facility needed to run their fans longer to compensate for other poorly functioning measures. We also found that a serious discrepancy in the data collection system at Project 7445, which will dramatically reduce our estimates of realized savings at the site. Our initial rough estimate of the combined impact of all of our enhancements will be to reduce the evaluated electric energy savings from the program by about 2,200,000 kWh/year, reducing the corresponding gross realization rate from 49% to 35%. The realization rate for program gas savings will also drop slightly, from 151% to 149%.

Table 5-4 summarizes our key findings and recommendations for each project and measure examined.

Table 5-3: Summary of Contested Measures Investigated

Project ID #	Affected measures	Original evaluated kWh savings	Program implementer suggested kWh savings	Revised evaluated kWh savings (preliminary)	Scope of supplemental effort	Ultimate findings	Recommended revisions
7429	RCX 5	27,885	445,568	31,610	Analyzed whole-building data for all sites. Inspected mechanical systems, interrogated EMCS, and interviewed facility contact during 2 days of field work.	Cooling load affected by economizer is lower. No heating savings since electric boilers are off.	Adjust evaluated kWh savings to account for lower cooling load; extrapolate to all towers. Eliminate therm savings.
	RCX 6	-	1,063,648	-		Confirmed measure not functioning properly.	Retain evaluated savings of zero.
	RCX 7	-	827,400	-		Confirmed measure not functioning properly.	Retain evaluated savings of zero.
	RCX 8	(11,941)	1,190,952	(83,960)		No heating savings since electric boilers are off.	Extrapolate evaluated kWh savings to all towers. Eliminate therm savings.
	RCX 9	-	508,776	(1,431,933)		Tower fans must run continuously now.	Account for increased fan energy because of RCX6 reducing airflow, apply to all towers.
7445	12b & c	-	381,700	-	Further examined trend data and program calculations. Investigated customer data collection system and data center environment thoroughly and interviewed facility contact during 2 days of field work.	(1) Errors converting customer's estimated cooling loads to actual reduction in chilled water plant electric usage, reducing savings. (2) Spot coolers fed from PDU, so no savings for Measure 5c. (3) Additional factors (increased cooling performance can result in higher usage, elimination of economizer cooling, window heating/cooling effects) may reduce savings further (4) Data centers scheduled to be closed in two years.	(1) Reduce evaluated savings by about 80% to reflect actual electric impacts. Extrapolate to "N" data room. (2) Assign zero savings to spot cooler measure 5C (3) Ignore other effects that reduce savings, since difficult to quantify and magnitude fairly small (4) Reduce measure life from 20 years to 4 years.
	5x-9x	1,768,211	4,910,534	332,618			
7462	M6	31,892	609,008	621,048	Obtained 15-data whole building data from program implementer and reanalyzed.	Data shows significant savings for this measure in line with program implementer's recommended changes to the realized savings amounts.	Based on our analysis, increase evaluated savings to 102% of program implementer's recommended savings estimate of 609,008 kWh/year.
7464	M1	-	173,000	-	Visited site, interviewed customer, and interrogated control system.	Interview with customer facilities staff (including control system programmer) confirmed that measures M1 and M4 were never implemented, although M2 was.	No change to evaluated savings (zero) for M1 and M4. Reinstate ex ante M2 savings. Adjust program savings basis to remove M3 measure savings that were never claimed by program.
	M2	-	39,917	39,917			
	M4	-	128,041	-			
All affected measures		**1,816,047**	10,278,544	**(490,700)**			

Project 7429

Overview

The follow-up site visit occurred on January 22-23, 2007. The evaluator met with the energy manager and systems engineer at the site. The site contact stated that the program measures only saved energy for roughly three months before problems arose. The program had the customer shut down the electric boilers and use the heat reclaim on the chillers. This was not reported in the original program implementer report, although program savings were based on the electric boilers being in operation. The customer reverted to running the fans 24/7 to keep the buildings warm. They have had to re-energize the electric boilers, most likely due to the hot deck (HD) fans being starved for air because of measure RCX06. The customer needed higher heating water temperatures to compensate for reduced airflow, since this measure closed off dampers.

Overall site energy use

The evaluator received from the customer 15-minute interval metering for the site for the complete 2006 calendar year. A comparison between this data and the annual usage identified in the program implementer report for 2004 show roughly a 1-2% increase in energy usage. The energy manager acknowledged that their energy usage has actually increased from 2004 through 2006 (roughly 2%). The energy manager thought equipment was added to the server farm. We reviewed base load demand at night and weekends and saw no increase between 2004 and 2006 that could be attributed to added server equipment. There may have been considerable changes, but the net effect was little to no added load.

Nighttime and weekend usage was compared between the two years and found to be comparable, indicating that there were no additional loads placed in the data center. The customer stated that roughly 200 personnel had been added to the site during that time. Their impact would be minimal on the cooling load as there was no change in outside air quantities, only internal loading which averages 14 occupants per ton of cooling. Therefore, 200 occupants increased the cooling load roughly 14 tons throughout 660,000 square feet of building area.

The observed increase in site energy usage corresponds to the expected negative savings from RCX09 (the latter are discussed further below).

RCX05 Optimize Economizer Operations

Summary of disagreement

The program implementer used measured trend data to determine outside air dampers were fully open at outside air temperatures (OAT) above 75ºF in the winter. Their savings estimate employed a bin analysis spreadsheet model that calculated energy required to temper the air at intervals of 5 ºF of outside air temperature (OAT). Local annual weather data, processed to show the number of occurrences when hourly average OAT falls within each bin, was used to determine the amount of energy consumed in a year. The program implementer used this process for baseline and proposed scenarios to determine savings. We found that the modeled rate of cooling energy consumption exceeded the system capacity and therefore could not reflect actual performance. We therefore adjusted the model inputs to reflect performance that could be achieved to arrive at the indicated savings. Evaluated results need to be multiplied by 8 to reflect implementation in all 8 buildings.

Field notes

The site uses roughly 1,800 tons of mechanical cooling at worst case. This includes 600-plus tons of cooling for data centers and associated CRAC units located in the buildings. It also includes Buildings J and K. Building K is the cafeteria/meeting facility and is almost 58,000 SF with an estimated load of 80 tons. Therefore, roughly 1,100 tons is available for tower cooling, much less than the program assumption of 1,800 tons.

The program interpretation of graphs of economizer operations appears problematic. Cold decks do not operate with 100% outside air above 70ºF, since there is not enough cooling capacity in the coils or the piping distribution system.

The program analysis assumed Tower B was typical of all towers. Screen prints included in the program implementer report clearly show a variety of conditions for each tower. However, since the program extrapolated Tower B savings to all eight towers, and we were unable to find a definitive basis for adjusting the extrapolation, we accepted the program extrapolation. The revised economizer savings for Tower B was thus applied to all eight towers.

The HD fans in all buildings are stopped above OSA temperatures of 73ºF. The heating water system is also shut down. The facility had been using heat recovered from the chillers and not the electric boilers. The program implementer apparently recommended that facility staff turn off the electric boilers. Because of these factors, there are no heating savings for this measure.

Recommended resolution

Adjusted initial evaluated savings to account for two findings: (1) affected cooling load is lower than originally assumed, and (2) lacking better basis, extrapolate savings for one tower to remaining seven towers.

RCX06 Close HD OSA Dampers

Summary of disagreement

The proposed measure was to allow no outside air to the heating coil of the fan system by closing its outside air damper permanently, thus reducing the heating load. Ventilation air was to enter on the cooling side. The evaluator found 28% outside air on heating side using measured air temperature data, including lower temperature for air supplied to building. We also observed closed hot-side air dampers during site visit and the source of outside air was not identified (analysis performed after return from site visit). The program assumption was that the apparent outside air effect was actually due to increased air velocity (increased fan speed) over the heating coil, allowing less time for heat transfer and thus a lower temperature of air supplied to building.

Field notes

During the original EM&V visit, we inspected dampers in three buildings, and confirmed the measure had been implemented. We re-confirmed at the follow-up site visit that the OSA dampers are indeed closed. However, these dampers are very leaky and allow considerable air to pass through them. This was observed in the four fan rooms visited, and is typical, according to facility staff. In addition, several return fans are stalled and flowing little air due to pressure problems associated with all the buildings being interconnected. As a result, the HD must draw air through the also-leaky backdraft dampers that were installed as part of the measure.

The installed backdraft dampers do not meet current code to provide full shutoff capability when the system is down. They allow warm air to bleed out of the building at night due to stack effect. The building restroom exhaust fans running 24/7 exacerbates this. Discussions with facility staff also revealed that the terminal boxes operate using a single shaft for both the hot and cold dampers. These units can go to full shutoff of one duct if the other is being called on for additional heating or cooling. In effect, there is no outside air provided to occupants when a terminal box is in full heating mode, which creates IAQ concerns. These dampers were placed back in their original operating mode after the site visit by facility staff.

Recommended resolution

Follow-up visit confirmed that this measure is not working properly, so retain original evaluated savings estimate of zero.

RCX07 Reset HD Supply Air Setpoint

Summary of disagreement

The program implementer used measured trend data to determine that the hot deck supply air temperature (SAT) was increasing as OAT was increasing when it should, in general, be decreasing (and increasing with falling OAT). Post-implementation data showed the hot deck SAT to be increasing as OAT increases, the opposite of the proposed effect.

Field notes

The reset logic that was implemented had the HD supply air temperature increasing as the outside air temperature increased. The intent was to have the HD supply air temperature increase as the outside air temperature decreased. The way this measure was implemented actually increased the cooling load, because the cold deck had to compensate for added heat load introduced by the HD. In addition, by reducing the heating available, it affected the ability to keep the building warm in the winter. It was beyond the scope of this effort to attempt to quantify these complex effects, so we adopted an estimate of zero savings. Facility staff confirmed that the reset program was not properly programmed; therefore there are no savings for this measure as a result of the program. As a result of the evaluation findings, the facility staff is now planning to correct this issue as soon as possible.

Recommended resolution

The follow-up visit confirmed that this measure was not working properly, so retain original evaluated savings estimate of zero.

RCX08 Reset CD Supply Air Temperature

Summary of disagreement

This measure was to be similar to RCX07 except it was to apply to the cold side of the HVAC system, so SAT was to decrease with rising OAT and vice versa. The program implementer does not dispute that the measure was changed after implementation. The evaluator also identified heating load reduction that accrued from this measure and incorrectly identified it as therm savings. The program implementer contends that reported gas savings should be converted to electric savings and credited to measure.

Field notes

We stand by our analysis of this measure, except for the heat source for the heating savings. We had assumed gas-fired boilers, based on documentation in the original program implementer report. Our latest onsite visit found that space heating is provided by recovered heat. As with RCX05, any natural gas or electric savings associated with heating savings was eliminated since the heat was recovered from the chiller.

Recommended resolution

Retain original evaluated electric savings estimate, but extrapolate to all eight towers. Eliminate heating savings for this measure, since the heat is free from the heat recovery chiller.

RCX09 Correct Schedule on all Tower Fans

Summary of disagreement

This measure was to reduce fan run times by adjusting their schedules to start later and stop earlier. We found fans to be running continuously in the post-implementation period (April 2006) and to be shut off at night in the baseline period, according to trended fan data. The program implementer contends that fans were only run at night during coldest months of year, but not in others, based on conversations with the customer subsequent to evaluation. They also proposed that 75% of the ex ante savings should be granted.

Field notes

All tower fans were operating continuously when the evaluation was conducted. The scheduling was only changed after the program implementer returned to the site and brought the issue to the customer's attention. In their rebuttal to the draft evaluation report, the program implementer stated that the fans only run continuously during the coldest months, and that they had been placed back on their proposed schedule. Had that been the case, they would have been running continuously during the program implementer monitoring period of November-December 2004. The program analysis, though, only states they are running too long, and did not account for them running continuously during the winter. If the fans were to run continuously during the winter months, they could not be reset back to the proposed schedule during this past winter.

The facility energy manager confirmed that the AHU's were operating 24/7 when M&V was conducted. They reverted back to the originally proposed schedule when the program implementer raised this issue after the M&V report was issued. Unfortunately, it appears the customer is unable to keep the buildings warm with the latter schedule.

Tower fans must now run continuously to compensate for the reduced HD airflow, resulting in negative savings. Additionally, outside air is now being heated by the HD during unoccupied hours when the fans would normally be off. Additional outside air is also being introduced through the cold deck, which would subsequently have to be compensated for by the HD at the zone level.

Recommended resolution

It now appears clear that savings for this measure are in fact negative, rather than the zero first evaluated, because the tower fans now run more. Using pre and post fan schedules, estimate the increased fan, heating, and cooling energy for this measure and apply to all towers.

Project 7445

Overview

The follow-up EM&V site visit occurred on January 24-25, 2007. The evaluator met with the customer's project manager. Key findings include:

Improved cooling performance: It appears this project has improved airflows in the customer's data centers, allowing for higher densities and better temperature control. Keeping the labs at lower temperatures using the CRAC units, however, could actually increase energy usage.

Shaky conceptual basis for savings: To estimate savings for the leak sealing measures, the program implementer calculated a percentage of cracks in the floor that could be sealed, and prorated a possible savings based on the equipment kW in the space, limited to 5%. Unfortunately, we could find no published reports supporting this calculation approach, or even the concept that sealing floor tiles in a data center will result in energy savings. A paper published by Lawrence Berkeley National Laboratory, "*Data Centers and Energy Use-Let's look at the Data*"[8], shows how sealing floors and arranging equipment into hot/cold aisles can increase HVAC system utilization, allowing for higher power densities in a server space, and reduced temperature fluctuations. The only reference to energy savings is if there are variable speed drives on the fans, or changes in temperature set points at the chilled water plant. These are the only two areas where HVAC energy efficiency can be affected in this case. Neither of these conditions was present at the customer data centers, as all CRAC units have constant speed fans, and this project did not address the chilled water plants.

Miscalculation of cooling loads: The paper also describes how to calculate the HVAC performance index, which is defined as HVAC power divided by UPS input power. A significant oversight in the program implementer calculations is that they do not take into account overall HVAC system efficiency. After further studying the original program analysis and consulting with the customer, we found that the cooling "kW demand" for the CRAC units was actually heat transfer expressed in kW, not electric demand. The customer data collection system used CRAC CFM and air temperatures, and then calculated heat transfer in kW [where heat transfer in kW = airflow in CFM × 1.08 × (return air – supply air temperatures in ºF) / 3412 Btu/kWh]. This kW refers to thermal energy per unit time, not electrical demand. To correct this, the kW must be converted to tons cooling, by dividing it by a conversion factor 3.5 kW/ton, and then multiplying by the overall HVAC system efficiency. This efficiency, kW/ton, should include not only the chillers, but also pumps, cooling tower fans, and CRAC unit fans. For large central chilled water plants, this number is approximately 0.7 kW/ton. Therefore, any potential savings attributed to these measures and based on the customer data collection system need to be divided by a factor of five (3.5 kW,thermal/ton ÷ 0.7 kW,electric/ton = 5.0 kW,thermal/kW,electric).

Moreover, our fieldwork revealed that the measured values from the customer data collection system were problematic, with PDU (equipment) loads containing CRAC (cooling) loads, with missing PDUs and CRAC units, and other anomalies that add significant potential for error.

Additional envelope effects: The labs have single pane windows, metal frames, and no insulation. As a result, significant heat transfer can occur between the data centers and adjacent offices. Excess heat was then handled by the house HVAC units, which have airside economizers. In the winter, this excess heat may have offset building heating loads somewhat. These effects are quite complex and difficult to model or measure.

Short measure lives: According to the customer project manager, all data centers will be consolidated into a single 60,000SF lab within the next couple of years. So savings from this project will likely persist for three to four years at most, not the 20 years that we had originally assigned.

12b, 12c Seal floor leaks in "N"[9] data center

Summary of disagreement

The customer stated during the onsite EM&V visit that work was not done in this data center. The program implementer later provided documentation indicating some work was indeed done.

Field notes

The "N" lab is really a single space, not two separate rooms as the program implementer report indicates. We confirmed that some of the "N" data center floor leaks were sealed, although sealing only half the floor simply forces more leakage to the remaining half that was not sealed. The "SU" Lab is a large data

[8] Tschudi et al, 2003 ACEEE Summer Study on Energy Efficiency in Industry.
[9] Actual names for the labs have been disguised to protect the confidentiality of the customer.

center located next to the "N" lab and has a large passageway between the two. The "SU" Lab has four large rooftop air handlers serving the space, all equipped with airside economizers. The passageway was opened between the two to allow for supplemental cooling in the "N" lab. This is "free cooling" that was not accounted for. A considerable amount of air was passing into the "N" lab during this site inspection. The free cooling aspect of this "SU" Lab's HVAC system was not accounted for in the program analysis for that space.

Recommended resolution

Work was indeed completed as the program implementer claimed, but because of configuration of data centers, sealing floor leaks in one area simply shifted the leakage to other areas. Retain original evaluation finding of zero savings.

5b,c,d; 6b,c; 7b,c; 8b,c; 9b,9c Seal floor leaks and rearrange floor tiles in five data centers

Summary of disagreement

The program implementer had these four objections: (1) pre kW data periods were incorrect, (2) the evaluator did not adjust for missing load data in two rooms, (3) baseline should be adjusted to reflect improved cooling performance, (4) high savings outlier for "CS" Lab should not have been removed. Objections 1-3 were addressed fully in a previous document and found to be without merit. The fieldwork focused mostly on Objection 4, and determining better what information the customer's data collection system was providing us, and how it related to the savings estimates.

Field notes

"CS" Lab

In the "CS" Lab, the customer only monitors half of the PDUs. This may explain the extremely anomalous results for this room. Given the typical diversity in a data center, it is unlikely that the three unmonitored PDU's were loaded similar to the three that were monitored. Dramatic shifts in loading among the PDUs likely explains the early results (rejected by the evaluator as implausible) for this lab showing an 80% increase in the HVAC efficiency. The unmonitored PDUs had to experience a corresponding reduction in connected load to match the HVAC system load. Therefore, we feel justified in our original EM&V approach of setting aside the partial data for this lab, and instead extrapolating results from other labs to this one.

"SA" Lab

The Spot Coolers listed in Measure 5C were found to be powered from the lab's PDU's and not an external power source. Therefore their demand kW must be deducted from the equipment kW, resulting in no savings for this measure. Another way to look at it is that the spot coolers were data equipment and not cooling units. (Note: during the site visit, the customer project manager stated that there are some CRAC units in other labs that are also powered from PDU's. Due to time constraints, this was not fully investigated.)

Measure 5E, which was not listed as being completed, entailed adding ducting in the ceiling space to assist with returning hot air directly to the CRAC units. In addition, it called for eliminating the house cooling system, which provided roughly 11 tons of cooling. This portion of the measure was implemented but no savings claimed (this may be because implementation occurred after the program deadline of March 15, 2006). This house HVAC unit has an airside economizer, so removing it from the lab cooling system likely has increased HVAC energy usage.

It should also be noted that by improving the airflow, the customer has been able to increase power density by a factor of four in the "SA" Lab, from 40 watts/sq. ft. to 160 watts/sq. ft. The power demand at the site has actually increased as a result of this project.

"CA" Lab

This lab is located at the building perimeter, with large single-pane windows allowing outside air temperatures to greatly affect the space cooling load, reducing it in the winter, and increasing it in the summer. Neither the program nor the EM&V analysis took this into account in their savings analyses, likely owing to the complexities of modeling such effects.

Recommended resolution

1. With the exception of Measure 5C, divide savings by five to properly convert measured cooling data into electrical impacts. Note that this estimate is generous, since it does not account for lost economizer savings, envelope effects, and the uncertainty in the quality of the data collected by the customer. However, these factors' impact on savings should be relatively small, compared to the fact that the overall evaluated savings for this project appears to be less than 350,000 kWh/year (8% realization rate).

2. Eliminate Measure 5C savings, since removing spot coolers in the "SA" Lab simply shifted cooling load.

3. Reduce measure life for all measures to four years.

Project 7462

M-6: Reduce nighttime lighting

Summary of disagreement

More detailed kW data and corrected baseline period suggests lighting savings are much higher.

Field notes

The program implementer provided the evaluator with 15-minute whole building demand data for January 30, 2004 to September 17, 2006. We analyzed these data in a manner similar to the program implementer analysis to confirm their findings. Key assumptions, which we accepted, are that nighttime lighting savings generally occurs between 9 p.m. and 9 a.m. each day, and that the measure changes occurred over 2005, requiring us to eliminate data for that year. Our analysis yielded electric energy of savings of about 621,000 kWh/year, which is 102% of the program implementer's revised recommended savings estimate.

Recommended resolution

Increase evaluated savings to 621,048 kWh/year (no peak demand reduction).

Project 7464

M-1: Reset Supply Air Temperature Based on Zone Requirements

M-2: Eliminate Cooling During Morning Warm-up

M-4: Implement Optimum Start/Stop Strategy

Summary of disagreement

The program implementer contends that these measures were implemented, while the evaluator's initial findings were that they were not.

Field notes

The follow-up site visit occurred on January 26, 2007. The evaluator met with the customer's assistant chief engineer, as well as the DDC system technician who handles any programming changes for the site.

The DDC tech stated that the measure M-1 reset logic proposed by the program was never implemented. The e-mail supplied in Appendix F in the implementer response to the draft EM&V report specifically shows that no action was taken at that time for this measure. There is no action listed under the task as is present for the other tasks.

The DDC tech attempted to program a reset based on the return air temperature, allowing the supply air temperature to vary between 55 and 58ºF, with the return air temperature varying from 74 to 70ºF. Trend logging of these two parameters shows no variation in the supply air temperatures.

Investigation of the fan room yielded the discovery that this measure could not be implemented. There are three fans systems within one plenum, two perimeter fans and one core fan. They have a single chilled water coil bank providing supply air to all three fan systems. The coil control valves operate off a single air temperature sensor. In the morning, the south/east fan will typically require 55ºF air, while in the afternoon, the west/north fan will typically require 55ºF air. There is no period of time where 55ºF supply air will not be required by some zone in the building. Return air is ducted through a single shaft, blending the air from each system.

In a follow-up conversation with the DDC tech regarding measure M-2, he said they did lock out cooling during morning warm-up, but the building is apparently being maintained at an elevated temperature overnight, so bringing the temperature down is delayed until the system goes into normal mode, at which time the economizer cycle is available. The night setback schedule is not active per the programming submitted in the program implementer response. Therefore, this measure was indeed implemented, and is yielding savings, although it operates differently than originally assumed.

The DDC tech also confirmed that measure M-4 was not implemented.

Recommended resolution

Retain original evaluated savings estimate of zero for measures M-1 and M-4. Reinstate the ex ante savings for M-2 (note that because of the relatively small savings for this measure, no more detailed EM&V analysis was warranted).

E. Evaluated net-to-gross ratios

Table 5-4: Net-to-Gross Ratios for Evaluated Projects

Utility	Building ID	NTGR data collected	NTGR - kWh, kW	NTGR - therms	NTGR - MMBtu
PG&E	7404	1	1.00	1.00	1.00
	7408	1	1.00	1.00	1.00
	7409				
	7411	1	1.00	1.00	1.00
	7412	1	1.00	1.00	1.00
	7417				
	7421				
	7422				
	7429	1	0.79	1.00	0.79
	7432	1	1.00	1.00	1.00
	7435				
	7436				
	7437				
	7441				
	7445				
	7446	1	1.00	1.00	1.00
	7447				
	7448				
	7449	1	1.00	1.00	1.00
	7459	1			
	7461				
	7462	1	1.00	1.00	1.00
	7463	1			
	7464	1	1.00	1.00	1.00
	7465	1	1.00	1.00	1.00
	7468	1	1.00	1.00	1.00
	7471				
	7472	1	1.00	1.00	1.00
	7475				
	7481				
SCE	8407	1	1.00	1.00	1.00
	8408	1	0.90	0.74	0.78
	8416				
	8422	1	0.50	0.50	0.50
	8424				
	8443				

Summaries of participant questionnaire responses for selected questions

Question 5: decided to implement some measures before joining program: (No=1 Yes = 2)	Mean = 1.28
Question 6: implementation likely on own without analysis: (scale of 1-5 with 1=not likely and 5=very likely) • Standard error of likelihood of Q5 predicting Q6 (of No predicting a value less than 2 and Yes a value 2 or greater)	Mean = 1.67 Min = 1 Max = 4 0.228
Q7 Implementation likely on own without incentive: (scale of 1-5 with 1=not likely and 5=very likely) • Standard error of likelihood of Q5 predicting Q7 (of No predicting a value less than 2 and Yes a value 2 or greater)	Mean = 1.69 Min = 1 Max = 4 0.299