2003 STATEWIDE NONRESIDENTIAL STANDARD PERFORMANCE CONTRACT (SPC) PROGRAM MEASUREMENT AND EVALUATION STUDY

FINAL REPORT

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APPENDICES

ES. EXECUTIVE SUMMARY

In this report, we present results from a set of evaluation activities focused on California's Nonresidential Standard Performance Contract (SPC) Program for program year 2003 (PY2003). The PY2003 evaluation scope includes process and impact evaluation components. The PY2003 evaluation scope was designed to supplement the PY2002 evaluation effort because the available resources and scope for the PY2003 evaluation were significantly smaller than for PY2002. Due to these scope differences between the evaluation years, sample sizes for the PY2003 evaluation are smaller than those in the PY2002 study. As a result, the primary objective of the PY2003 evaluation effort was to add more sites to the impact evaluation component of the PY2002 evaluation effort. This report focuses on presenting the *combined* impact-related results for PY2002 and PY2003. We also present the combined research findings and recommendations for both program years, which were originally presented and explained in the *PY2002 SPC Impact Evaluation* report.[1]

This PY2003 evaluation effort focused on developing verification, ex post energy savings estimates, and free-ridership estimates for a sample of 25 sites. We also provide a summary of customer and energy-efficiency service provider participant experiences with the PY2003 SPC program. The results of the 25 sites included in the PY2003 SPC evaluation are combined with results from the 40 sites included in the PY2002 SPC evaluation to produce gross savings realization rates[2] and net-of-free-ridership estimates for the two program years combined.

ES.1 COMBINED PY2003 AND PY2002 GROSS IMPACT REALIZATION RATE AND NET-TO-GROSS RATIO

To produce the overall program realization rate, the individual realization rates for each of the sample points in both the PY2003 and PY2002 samples were weighted by the size of the savings associated with the project and the proportion of the total program savings (for PY2003 and PY2002 combined) represented by each sampling cell. The overall weighted program realization rate and the associated confidence interval are show in Exhibit ES-1. The overall weighted realization rate for PY2003 and PY2002 combined is 0.89. The weighted average realization rate is the primary result of interest since it captures the relative contribution of different sized projects and end uses to overall program savings. The 90 percent confidence interval for the 0.89 overall program realization rate is 0.83 to 0.96.[3]

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[1] Quantum, 2005a. *PY2002 SPC Impact Evaluation Report*, prepared for Southern California Electric Company, May 2005. http://calmac.org/publications/Py02_SPC_Final_Impact_Evaluation_and_Appendices.pdf

[2] Realization rates are developed for each site and the program as a whole and are defined as the ratio of program ex ante savings divided by the ex post savings estimated by the evaluation team.

[3] Note that the confidence interval does not capture any of the uncertainty in the ex post savings estimate. The confidence interval only captures the effect of the variation in the ex post to ex ante ratio of the sample with a finite population factor correction that reflects the population of program participants. That is, it is as if the ex post values were known precisely without measurement error. It is important to recognize that the ex post savings themselves are also estimates that can have considerable uncertainty, which is not captured in the reported confidence interval

Exhibit ES-1
Overall Combined PY2003 and PY2002 SPC Program Gross Impact Realization Rate

Sampling Strata	Lighting	HVAC/R	Process/Other
Tier 0	--	--	0.38
Tier 1 & 2 Combined	0.92	0.96	0.88
Tier 3	0.93	0.84	0.99

Total Weighted Gross Impact Realization Rate	0.89
90 Percent Confidence Interval	0.83 to 0.96

To produce an estimate of net-of-free-ridership for the combined program years, the individual realization rates for each of the sites in both the PY2003 and PY2002 samples were also combined and appropriately weighted. The weighted net-of-free-ridership estimate for the combined program years is 0.48. Exhibit E-2 provides the net-of-free-ridership values by tier along with the 90 percent confidence interval.

Exhibit ES-2
Overall Combined PY2003 and PY2002 SPC Program Net-of-Free-Ridership Ratio

Sampling Strata	**Net-of-Free-Ridership Ratio**
Tier 0 and 1	0.43
Tier 2	0.49
Tier 3	0.54

Total Weighted Net-of-Free-Ridership	0.48
90 Percent Confidence Interval	0.42 to 0.55

In recent years, in order to convert the weighted net-of-free-ridership values into a net-to-gross ratio for the program, net-of-free-ridership estimates have been adjusted for self-report bias and spillover.[4] These adjustments add 0.1 for self-report bias and 0.05 for participant spillover.[5] If these adjustments are applied to the combined 2003 and 2002 net-of-free-ridership value of 0.48, the resulting net-to-gross ratio is 0.63.

Detailed recommendations related to gross realization rates, net-to-gross results, and other program features were developed as part of the PY2002 SPC evaluation. Those recommendations apply to both program years. Readers are strongly encouraged to refer to the PY2002 SPC evaluation reports (see footnotes 5 and 6) for this information.

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for the program realization rate. It is likely that the confidence interval would be considerably wider if the uncertainty in the ex post estimates could be statistically quantified.

[4] XENERGY Inc. and Ridge and Associates, 2001b. *Improving the Standard Performance Contracting Program: an Examination of the Historical Evidence and Directions for the Future*, prepared by XENERGY Inc. and Ridge and Associates for Southern California Edison, November, 2001

[5] Note that these adjustments are included in the ex ante net-to-gross ratio of 0.7 adopted by the CPUC and included in the Energy Efficiency Policy Manual.

ES.2 SUMMARY OF PY2003 PARTICIPANT SURVEY FINDINGS

Customer Participant Findings

In general, PY2003 customer participants interviewed reported that they were highly satisfied with the program and gave it very positive overall satisfaction ratings. A large majority (72 percent) of the responding participants reported being very satisfied with the 2003 SPC program. As would be expected, by far the most common strength mentioned was the direct financial value of the incentives (73 percent). Several respondents commented on the ease of paperwork and clear program design, which appears to support the efforts made to streamline the application and M&V processes over the seven-year history of the program. Only five respondents (20 percent) offered opinions on the program's weaknesses. The most common area of complaints concerned the difficulty in satisfying the M&V or the paperwork required by the program (note, however, that measurement is only required of a small fraction of program participants). A few customers also said that the rebate levels were not high enough.

Most customers also reported a very good experience with program and support staff as well as with third-party energy service firms. Nearly two-thirds rated their experience with the program staff as "Excellent." Those respondents that interacted with the SPC program's technical support contractors (36 percent) also rated their experience with the technical contractors as "Excellent" or "Good." The majority (60 percent) of the 2003 respondents found the SPC program tools (website, calculator, manual, etc.) to be very helpful; an increase over the rating given by the 2002 respondents. Customers also found the services of third-party firms to be valuable. Eighty percent of customers who used energy efficiency service providers (EESP) as project sponsors rated their contribution as either very significant or somewhat significant to their decision to implement their SPC projects. Even many respondents who did not use an EESP as a sponsor still made use of third-party contractors for other aspects of their SPC program projects. Roughly half of customers who acted as self-sponsors also received some assistance from a third-party firm to implement their projects.

Nearly half of the customers interviewed reported that utility representatives were their main source of initial information about the SPC program, which is consistent with results from prior years. A majority of the respondents also said that the financial incentives were influential in their decision to implement projects. Sixty percent of 2003 respondents said that the influence of the financial incentives was "Very Significant" in their implementation decision, which was nearly double the percentage of 2002 respondents (31 percent). Five respondents (20 percent) indicated that participation in the 2003 SPC program had also caused their organization to change the way that it made decisions about implementing energy efficiency projects.

EESP Participant Findings

On balance, EESPs participating in the PY2003 SPC program also were satisfied with the program, and felt that the 2003 program represented a much easier to use, more effective approach to capturing energy savings than programs in previous years. EESPs strongly favored the calculated savings approach as being easier to use, involving less uncertainty, and more effectively using program resources, even though most respondents believed that calculated savings tend to understate actual measure performance.

The performance of both utilities and their contractors, though satisfactory overall, was perceived to be uneven by participant EESPs, with several respondents reporting difficulty in working with individual utilities or contractors.

- For utilities, EESP-reported problems centered on slow payment, delays in responding to calls, and delays in the application review process created by one utility's efforts to minimize the amount of work contracted out.

- For technical support contractors, EESP-reported difficulties were focused on lack of reviewer familiarity with or knowledge of the specific measures or technologies being installed.

Most EESPs report that they have made the SPC program an integral part of their marketing efforts and even of their overall business strategy. The ability of EESPs to build the program into their marketing approaches has, however, been hampered by uncertainty regarding the availability of funds, particularly later in the program year. A number of EESPs noted that they do not use SPC incentives in a significant role when selling jobs because they cannot be certain that incentives will be available once the customer decides to implement a project. While some EESPs say that all the jobs for which they receive funding would not have happened in the absence of the program incentives, others stated that many of the projects would still be implemented, albeit at a later time and on a smaller scale.

ES.3 SUMMARY OF APPLICATION AND EX ANTE-RELATED FINDINGS

In developing the ex post savings estimates for both the PY2002 and PY2003 impact evaluations, a significant effort was put into reviewing the SPC application files with respect to project documentation and the technical review conducted by the program administrators and their support contractors. A number of qualitative findings were developed and presented in the *PY2002 SPC Impact Evaluation* report. These findings are repeated here as they were also relevant to the PY2003 program, which was very similar to the PY2002 program. They are discussed further in Section 5 of the *PY2002 SPC Impact Evaluation* report.

- **Wide Range in the Quality of Applications and Supporting Documentation**. There were numerous examples of applications that were well documented. For these sites, we found clear descriptions of the proposed and installed energy saving measures, a comprehensible presentation of the energy savings calculations, and a verifiable description of the completed installation. There were, however, some sites where the rationale for the energy savings was less clear, the supporting documentation inadequate, or the description of the verified installation difficult to follow.

- **Need for Increased Verification and Documentation of Assumptions**. In a number of cases we found assumptions for the program calculations were unverified or undocumented. Some of this may be attributable to the fact that the program was based on calculated instead of measured savings and the fact that the program appropriately sought to decrease application costs and paperwork based on findings from the 1998 and 1999 SPC evaluations; however, increased documentation of input assumptions for savings estimation is needed, particularly, for larger and more complex sites. In addition, some applications did not contain a clear enough description of how the proposed retrofit would reduce energy consumption.

- **Varying Experience and Expertise Levels of the Reviewers.** Review of the program files indicated that there may have been a wide range in the experience level and expertise of the individuals reviewing the SPC applications. Some of the applications had very detailed reports including documented inquiries to the project sponsor requesting more precise information to support the application. However, in some cases the reviewers did not request the kind of information required to develop an appropriate understanding of the proposed project.

- **Difficulty in Assessing Complex Industrial Process Projects.** Related to experience level and expertise of the reviewer is a general observation that assessing the energy savings associated with industrial utility systems such as compressed air and large refrigeration or other industrial process systems is difficult even for experienced reviewers when there is no measurement and verification data upon which to base energy savings calculations. Many of these systems are complex with several interactive components. Load profiles are often difficult to estimate, and in many cases are directly related to production outputs that may be difficult to quantify over long periods of time. Most of the industrial process retrofits share at least some of these characteristics. Measurement and verification requirements were relaxed in the 2002 and 2003 programs, resulting in a higher level of uncertainty for this group of projects.

- **Limited Estimation of kW Peak Demand Savings.** The PY2002 and PY2003 SPC programs did not require and track peak coincident demand savings, although estimates were included in a number of applications. Estimating peak coincident demand kW reduction is generally more complex than estimating annual energy savings. Accurate estimation of demand reduction usually requires that data must be collected and evaluated on an hourly basis. If quantifying demand reduction is important, as we believe it is given the peak demand-related resource importance of energy efficiency programs, more rigorous and systematic estimation of peak demand impacts (both in-program and through the evaluation process) should be considered.

ES.4 SUMMARY OF RECOMMENDATIONS

As a result of the PY2002 findings and realization rate and net-to-gross analyses, a set of recommendations were developed in the *PY2002 SPC Impact Evaluation* report aimed at helping to improve the resource reliability of the program, while trying to remain sensitive to the need to keep the program implementation process from becoming overly complex or difficult (as was the concern in the early years of the program). These recommendations are repeated here and discussed in Chapter 6 of *PY2002 SPC Impact Evaluation* report. Since we have had no involvement with the PY2004 or PY2005 SPC programs, these recommendations do not presume whether any of these recommendations have already been considered or addressed.

- **Consider Targeted Increases in the Level of Technical Documentation**. We recognize the importance of keeping the application process and forms from being overly complex and costly to navigate, a key recommendation from the early program year evaluations. At the same time, it is important that the application documentation not be over-simplified. In particular, large complex projects should require more significant levels of site-specific application data than do other types of projects.

- **Consider a Stronger Application Affidavit Statement Regarding Savings Assumptions**. Included in the current affidavit is a release of liability for injury, violation of law, energy savings shortfall, performance and qualifications of project sponsor, and agreement to permit inspection and measurement of the project. The utilities should consider an additional affidavit statement in the application concerning customer/sponsor-supplied information on operating hours and characteristics of equipment described in the application. This might reduce gaming in the information provided by the project sponsors.

- **Further Standardize the Review Approach and Documentation Requirements for Recurring Complex Projects**. The utilities have made efforts to standardize savings estimates for measures addressed by the SPC calculator and provide guidance for complex measures such as compressed air, large refrigeration projects, and the like. However, it appears that additional effort may be needed to increase the consistency of analyses required of applicants and carried out by program reviewers for these types of projects. This would include a more detailed and rigorous requirement for the supporting documentation and certain types of measurement.

- **Consider Providing or Requiring More Technical Support for Applicants for Complex Projects**. It may be beneficial to offer or require technical consultant assistance to participants to prepare the required documentation for complex projects, particularly for initial submittals that do not meet the level of increased requirements recommended above.

- **Improve Reviewer Documentation**. Require that reviewer calculations, which document the approved savings upon which the incentive is paid, be attached to the installation report. In some cases we found that documentation of energy savings was obvious for the approved application, but not for the final approved incentive which is usually based on the installation report. The basis of the incentive paid to the participant should be well documented and easy to ascertain with the project file.

- **Consider Increasing Conservatism for Calculated Path Savings Estimates; Increasing Measurement for Large Complex Projects; and Increasing the Incentive Premium for Measured Projects**. When the SPC program was shifted from a primarily measurement-based to primarily calculation-based program, the SPC Program managers acknowledged and recognized the limitations of calculations for custom projects but intended that the program err strongly on the conservative side for these projects. The expected result of choosing to err strongly on the conservative side would be realization rates greater than 1.0 for calculated savings projects. Because the estimated ex post realization rate is moderately below 1.0 the program may not be adequately implementing the program managers' intended conservative philosophy for the calculated savings projects. The program should consider making more conservative assumptions for the calculated projects. The program should also consider utilizing measurement more often for the largest and most complex projects (or having this function performed by the evaluation team). If calculated savings are made more conservative, consideration should also be given to increasing the payment difference between the calculated and measured projects.

- **Increase Pre-Installation Measurement for Very Large Projects with Highly Uncertain Baseline Conditions**. Savings cannot be reliably estimated for some types of projects on purely an ex post basis. Pre-installation measurements can significantly improve savings estimates for projects such as complex compressed air and industrial process retrofits. The program includes pre-installation inspection for all projects but only very limited amounts of pre-installation measurement. Consideration should be given to increasing the amount of pre-installation measurement for large, complex measures that cannot otherwise be reliably quantified with only ex post data. Pre-installation measurement can be challenging in practice and burdensome to applicants. Care should be taken in this effort; in some cases, applicant installation schedules and other constraints may outweigh pre-installation measurement in importance. Either the program implementation or the evaluation team could perform these selected pre-installation measurements.

- **Consider Independent Review of the SPC Calculator**. The SPC calculator was used for at least one measure in a significant portion of the applications reviewed. Considering its wide use, it seems prudent to have an independent or peer group evaluation of the SPC calculator; if such a review has not recently been performed.

- **Consider Additional Programmatic Efforts to Reduce Free Ridership**. Suggestions for reducing free ridership in the SPC program were developed in the previously published *PY2002 SPC Process and Market Evaluation* (Quantum, 2004).[6] Approaches to consider include increasing incentive levels for higher payback measures or emerging technologies, incorporating a payback floor, bonus payments for first-time participants, and allowing and encouraging program administrators to exclude projects that are obvious free riders.

ES.5 CONSIDERATIONS FOR FUTURE SPC IMPACT EVALUATIONS

Because PY2002 and PY2003 were the first ex post impact evaluations of the SPC program, we have developed several suggestions related to future impact evaluations:

- **Consider Shifting Ex Post Impact Evaluations from a Program-Year to a Paid-Year Basis or a Combination of Both.** Many PY2002 projects, particularly larger ones, took more than a year longer than the program installation deadline of June 1, 2003 to complete installation. The long lag between participation and installation year makes it extremely difficult to conduct an ex post impact evaluation based on program year. This PY2002 impact evaluation was delayed several times due to the lack of installed projects in our sample.

- **Increase the Scope to Expand Ex Post *Measurement***. In the future, if reliable ex post realization rates are desired for peak demand as well as energy, increased levels of measurement will be needed. We suggest that either a larger percentage of projects should be required to follow the measurement path in the program or the measurement

[6] Quantum, 2004. *PY2002 SPC Process Evaluation and Market Assessment Report*, prepared for Southern California Electric Company, March 2004. See http://www.calmac.org/publications/ 2002_SPC_Final_Report.pdf. See Section 2.1 for discussion of net-to-gross related recommendations.

element of the impact evaluation should be expanded. Future evaluations should also utilize larger sample sizes than that in this study, in particular, to allow estimation of realization rates for the Program by utility.

- **Integrate the Evaluator Early into the Program Process to Enable Pre-Installation Measurement for a Sample of Projects.** If an expanded impact evaluation approach is pursued, it will be important for the evaluation to be integrated into the program implementation process so that pre-installation measurements can be made for large, complex projects and a random sample of other projects.

ES.6 PY2003 PROGRAM ACTIVITY

Exhibit ES-3 summarizes program activity for PY2003, as reflected in September 2004 utility database extracts. At that time, there were 540 unique customers with 725 applications, representing $27 million in incentives statewide. According to the tracking data, a total of 336 GWh and 6.5 million annual therms will be saved if all of the projects are installed. Note that these tracking data do include the effects of net-to-gross or realization rate adjustments or reflect final true up due to projects that do end up being installed.

Exhibit ES-3
Summary of PY2003 Program Activity (as of 9/04)

Activity Level	Statewide	PG&E	SCE	SDG&E
Total unique customers	540	255	243	50
Total number of applications	725	333	325	67
Total unique third-party sponsors	89	37	49	10
Total incentive funds committed ($ million)	26.99	13.15	11.60	2.24
Incentive funds committed to electric measures ($ million)	23.68	10.14	11.60	1.94
Incentive funds committed to gas measures ($ million)	3.31	3.01	0.00	0.30
Total savings from active applications (Btu, trillions)*	4.10	1.97	1.78	0.34
Electric savings from active applications (GWh)	336.11	134.91	173.90	27.29
Gas savings from active applications (therms, millions)	6.54	5.93	0.00	0.60
Average incentives per kWh	$0.070	$0.075	$0.067	$0.071
Average incentives per therm	$0.507	$0.507	-	$0.503

* Conversion rates obtained from *2001 Energy Efficiency Standards for Residential and Non-residential Buildings*, California Energy Commission, June 2001:
1 kWh = 10,239 Btu source energy
1 therm = 100,000 Btu source energy

1. INTRODUCTION

1.1 PY2003 SPC EVALUATION OBJECTIVES AND SCOPE

In this report, we present results from a set of evaluation activities focused on California's Nonresidential Standard Performance Contract (SPC) Program for program year 2003 (PY2003). The PY2003 evaluation scope includes process and impact evaluation components. Note that the PY2003 evaluation scope does not include market assessment, which the PY2002 scope did include.[7] In addition, the scope for the PY2003 evaluation was approximately half that of the PY2002 evaluation. In the impact evaluation component of both the PY2002 and PY2003, site visits and engineering analyses were carried out for a sample of projects.[8] Due to the scope differences between the evaluation years, sample sizes for the PY2003 evaluation are smaller than those in the PY2002 study. As a result, in this report, we present results from both the 2003 site visits as well as results that are combined across both the 2002 and 2003 samples. The primary objective of the PY2003 evaluation effort was to add more sites to the impact evaluation component of the overall *two-year* evaluation effort. Note also that the Executive Summary of this PY2003 evaluation report summarizes the program recommendations presented in the PY2002 evaluation. Readers should refer to the PY2002 evaluation reports for discussion of these findings and recommendations (see footnotes 7 and 8).

This report provides results on verification, ex post energy savings estimates, gross savings realization rates,[9] the net-to-gross ratios (NTGR), and participant experiences with the PY2003 SPC program.

Although the objectives of the evaluation are fairly comprehensive, the resources available to conduct it were limited. In particular, the level of ex post site analysis and measurement conducted for this study were significantly less than what was typical during the 1990s for custom incentive programs that followed the CADMAC impact evaluation protocols. As a result, it is important for readers and users of this report to understand the scope and limitations of the PY2002 and PY2003 impact evaluation efforts.[10]

The remainder of this chapter provides a brief introduction to the 2003 SPC Program, an overview of the SPC program and evaluation activities over time, and a guide to this report.

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[7] Quantum, 2004. *PY2002 SPC Process Evaluation and Market Assessment Report*, prepared for Southern California Electric Company, March 2004. See http://www.calmac.org/publications/ 2002_SPC_Final_Report.pdf. This report includes results of a general market survey of large (>500 kW) non-residential customers and compares these results to a similar survey conducted in 1999.

[8] Quantum, 2005a. *PY2002 SPC Impact Evaluation Report*, prepared for Southern California Electric Company, May 2005. http://calmac.org/publications/Py02_SPC_Final_Impact_Evaluation_and_Appendices.pdf

[9] Realization rates are developed for each site and the program as a whole and are defined as the ratio of program ex ante savings divided by the ex post savings estimated by the evaluation team.

[10] See Section 1.3 of the PY2002 SPC Impact Evaluation (footnote 6) for discussion of these issues.

1.2 SUMMARY OF THE 2003 SPC PROGRAM REQUIREMENTS

As in previous years, the 2003 SPC Program was administered by Pacific Gas & Electric Company (PG&E), Southern California Edison Company (SCE), and San Diego Gas & Electric Company (SDG&E).

Under the 2003 SPC Program, the program administrators offered fixed-price incentives to project sponsors for kWh energy savings achieved by the installation of energy-efficiency measures. The fixed price per kWh, performance measurement protocols, payment terms, and other operating rules of the program were specified in a standard contract. PG&E and SDG&E also offer incentives for energy efficient gas measures, and the incentive rate for these measures increased for the 2003 Program.

To qualify for the SPC, a project must produce a minimum level of energy savings; however, two or more projects may be aggregated within a given utility service territory to meet this requirement. The program is open to almost any equipment replacement or retrofit project for which the savings can be measured and verified with a useful life of greater than 5 years. A sample of eligible measures includes:

- Replacement of standard fluorescent lighting with high-efficiency fluorescent lighting
- Installation of variable-speed drives on electric motors
- Installation of lighting controls to reduce lighting operating hours
- Replacement of standard-efficiency air conditioning with high-efficiency equipment.

Projects that are not eligible include, but are not limited to:

- Any power generation or co-generation project
- Fuel substitution or fuel-switching projects
- New construction projects
- Any repair or maintenance project.

A number of important milestones must be completed as part of the project approval process. Readers unfamiliar with these milestones and other implementation details should review the program procedure manuals or program web sites for more information.[11]

Differences between 2002 and 2003 Programs

Some changes from the 2002 program were implemented in 2003, including:

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[11] Additional programmatic details on the California nonresidential SPC Programs can be found at each utility's web site; PG&E: http://www.pge.com/biz/rebates/spc_contracts/2003_manuals_forms/index.html, SCE: http://www.sce.com/RebatesandSavings/LargeBusiness/SPC/PreviousYearsPublications/, SDG&E: http://www.sdge.com/business/specializedincentives_03.shtml.

- 2003 incentive rates are the same for all customers, except for Gas measures where incentive levels have risen from $0.45/therm saved to $0.60/therm saved.

- The 2003 Program opened in April 2003 and applications were accepted until December 31, 2003 or until all of the utility administrator's SPC incentive funds were committed.

- Air conditioner economizers are no longer eligible for incentives as they are required equipment per California's Title 20/24 standards.

- Comprehensive Lighting pertains only to retrofits where T-12 fluorescent fixtures are replaced by T-8 fixtures. This type of retrofit measure was only eligible when included as a part of a "Comprehensive Retrofit" where at least 20 percent of energy savings come from non-comprehensive lighting replacement measures (e.g., HID lighting replacement, air conditioning retrofits, high efficiency motors or lighting controls).

2003 SPC Incentive Structure

With the exception of gas, retrofit incentives were essentially the same in PY2003. The per-unit incentive levels for the 2003 program are shown in Exhibit 1-1. Incentives for gas measures increased from $0.27/therm in 2000 to $1.00/therm in 2001, then dropped to $0.45/therm in PY2002, and then went to $0.60/therm for PY2003. The financial incentive cannot exceed 50 percent of the project capital cost.

Exhibit 1-1
2003 Program Incentive Levels by Measure Type and Year

Measure Type	Incentive per Unit of Savings
Lighting	$0.05/kWh
HVAC&R	$0.14/kWh
Motors/Other	$0.08/kWh
Gas	$0.60/therm

1.3 HISTORY OF SPC PROGRAM FEATURES AND EVALUATIONS

The statewide nonresidential SPC program has been evaluated every year since its inception in 1998. The focus of the program and emphasis of the evaluation have shifted over time in response to changing policy objectives, program modifications, and funding levels. Exhibit 1-2 provides a summary of the evaluation history of the program.

Exhibit 1-2
Summary of Nonresidential SPC Evaluation Projects: 1998 - 2003

Program Year	Evaluation Components	Evaluation ($000) (Total/Impact)	Regulatory Policy Context	Key Evaluation Findings	Key Program Features/Changes
1998	Market Effects, Process, NTGR	$374/$0	California Board for Energy Efficiency (CBEE) oversight, primary focus on market transformation	Limited market effects, low customer satisfaction, split EESP satisfaction, high costs and frustration associated with M&V and other requirements, moderately high free ridership, program under-subscribed	2-stage application: Basic (BPA) and Detailed (DPA), M&V required for all projects, 3 payments (at install and 1 and 2 years after install)
1999	Market Effects, Process, NTGR	$315/$0	California Board for Energy Efficiency (CBEE) oversight, primary focus on market transformation	Limited market effects, improving customer satisfaction, split EESP satisfaction, continued concern over M&V requirements, moderately high free ridership, program under-subscribed	2-stage application: Basic (BPA) and Detailed (DPA), M&V required for all projects, M&V simplified for lighting and motors, incentives decreased
2000 and 2001	Process, NTGR	$235/$0	Primary oversight by CPUC, focus shifts back quickly to resource acquisition during CA energy crisis	Strong customer and EESP satisfaction, positive response to calculated savings path, moderately high free ridership, program over-subscribed	2000: program separated into "Small" and "Large", peak demand bonuses 2001: 2-stage application changed to 1-stage, M&V optional or at IOU discretion, 1 payment at install if calculated, 2nd payment after 1 year if M&V, large and small components recombined, peak demand bonuses
2002	Impact, Process, Market Assessment, NTGR	$436/$175	Primary oversight by CPUC, continued focus on resource acquisition	Strong customer and EESP satisfaction, moderately high free ridership, program over-subscribed, 0.8 gross realization rate, need for targeted increase in savings measurement	Peak demand bonuses eliminated, lighting incentives < 30% of program, lighting part of comprehensive bundles
2003	Impact, Process, NTGR	$215/$125	Primary oversight by CPUC, continued focus on resource acquisition	See this report's findings	See Section 1.2 of this report

1.4 GUIDE TO THIS REPORT

A guide to each of the elements included in this final report is provided below:

Main Body

- **Executive Summary**: The Executive Summary provides a very short summary of the impact evaluation results.
- **Introduction** (Chapter 1): The Introduction includes a brief program overview, discussion of the overall objectives and scope of the project, evaluation tasks, and this report guide.
- **PY2003 Program Tracking Data Summary** (Chapter 2): This chapter summarizes the PY2003 tracking data by key segmentation variables used in previous SPC evaluations.
- **Sample Plan and Impact Approach** (Chapter 3): This chapter provides a summary of the sample and methods used in the impact evaluation.
- **2003 Gross Impact Results** (Chapter 4): This chapter provides a summary of the site-specific results for PY2003 impact evaluation sample. Full site reports are provided in Appendix A.
- **2003 Customer Interview and Free Ridership Results** (Chapter 5). This section presents results from the 25 customer participant interviews.
- **2003 EESP Interview Results** (Chapter 6). This section presents results from the 25 energy-efficiency service provider participant interviews.
- **Combined 2003 and 2002 Impact and Free-Ridership Results** (Chapter 7). This section presents the combined weighted realization and net-of-free-ridership ratios for the combined program years.
- **Sources** (Chapter 8). This sections lists secondary sources relevant to this evaluation.

Appendices

- **Impact Evaluation Reports** (Appendix A): This appendix includes the individual site level impact evaluation reports. There are 25 reports comprising the PY2003 evaluation.
- **Participant Survey Instruments (**Appendix B and C). These appendices provide the survey instruments used for the participant interviews.

2. SUMMARY OF 2003 SPC PROGRAM TRACKING DATA

This section contains a program activity summary for the 2003 SPC Program. The data presented below includes information on savings, expenditures, and participation characteristics as tracked in the utility program databases.

The information in this section is based on extracts from the program tracking databases maintained by PG&E, SCE and SDG&E that were obtained in August-September 2004. These utility-specific extracts were then aggregated to create a summary of program activity at statewide level. The reader should be aware that these tracking data will likely change as the projects in the 2003 program year are finalized. This is because individual project savings may change somewhat after actual installation (savings may be more or less than planned) and some projects may have dropped out of the program after September 2004.

The section contains the following subsections: Summary of Program Activity; Composition of Applicants; and Statewide Participation Details.

2.1 SUMMARY OF PROGRAM ACTIVITY

Exhibit 2-1 summarizes program activity for PY2003, as reflected in the August-September 2004 database extracts. At that time, there were 540 unique customers with 725 applications, representing $27 million in incentives statewide. According to the tracking data, a total of 336 GWh and 6.5 million annual therms would be saved, which combined represented 4.1 trillion Btu of energy savings. Approximately 12 percent of the incentives were awarded for gas measures. The incentive structure paid on average $0.07/first-year kWh and $0.51/first-year therm saved.

Exhibit 2-1
Summary of PY2003 Program Activity (as of 9/04)

Activity Level	Statewide	PG&E	SCE	SDG&E
Total unique customers	540	255	243	50
Total number of applications	725	333	325	67
Total unique third-party sponsors	89	37	49	10
Total incentive funds committed ($ million)	26.99	13.15	11.60	2.24
Incentive funds committed to electric measures ($ million)	23.68	10.14	11.60	1.94
Incentive funds committed to gas measures ($ million)	3.31	3.01	0.00	0.30
Total savings from active applications (Btu, trillions)*	4.10	1.97	1.78	0.34
Electric savings from active applications (GWh)	336.11	134.91	173.90	27.29
Gas savings from active applications (therms, millions)	6.54	5.93	0.00	0.60
Average incentives per kWh	$0.070	$0.075	$0.067	$0.071
Average incentives per therm	$0.507	$0.507	-	$0.503

* Conversion rates obtained from *2001 Energy Efficiency Standards for Residential and Non-residential Buildings* , California Energy Commission, June 2001:
1 kWh = 10,239 Btu source energy
1 therm = 100,000 Btu source energy

2.2 COMPOSITION OF APPLICANTS: CUSTOMER SELF-SPONSORS VS. EESP-SPONSORED CUSTOMERS

Exhibit 2-2 summarizes program activity and a variety of key indicators for self-sponsored and EESP-sponsored customers.

Exhibit 2-2
PY2003 Program Activity Summary (as of 9/04)

	Self-Sponsored Applications	EESP-Sponsored Applications	Total
Statewide			
Activities			
Number of unique customers	374	181	540
Number of applications	485	240	725
Number of sites	594	287	874
Total incentive funds committed ($ 000's)	$19,247	$7,740	$26,988
Total Btu (trillions)	2.93	1.17	4.10
Total GWh	235	102	336
Total therms (millions)	5.25	1.29	6.54
Comparative Indicators			
Applications per customer	1.30	1.33	1.34
Sites per application	1.22	1.20	1.21
Incentive $ per customer (000's)	$51.46	$42.76	$49.98
Incentive $ per application (000's)	$39.69	$32.25	$37.22
PG&E			
Activities			
Number of unique customers	182	74	255
Number of applications	224	109	333
Number of sites	263	104	365
Total incentive funds committed ($ 000's)	$10,090	$3,059	$13,148
Total Btu (trillions)	1.54	0.43	1.97
Total GWh	105	29	135
Total therms (millions)	4.65	1.29	5.93
Comparative Indicators			
Applications per customer	1.23	1.47	1.31
Sites per application	1.17	0.95	1.10
Incentive $ per customer (000's)	$55.44	$41.33	$51.56
Incentive $ per application (000's)	$45.04	$28.06	$39.48
SCE			
Activities			
Number of unique customers	157	95	243
Number of applications	210	115	325
Number of sites	275	167	438
Total incentive funds committed ($ 000's)	$7,346	$4,250	$11,596
Total Btu (trillions)	1.10	0.68	1.78
Total GWh	107	67	174
Total therms (millions)	0.00	0.00	0.00
Comparative Indicators			
Applications per customer	1.34	1.21	1.34
Sites per application	1.31	1.45	1.35
Incentive $ per customer (000's)	$46.79	$44.73	$47.72
Incentive $ per application (000's)	$34.98	$36.95	$35.68
SDG&E			
Activities			
Number of unique customers	39	13	50
Number of applications	51	16	67
Number of sites	56	16	71
Total incentive funds committed ($ 000's)	$1,812	$432	$2,244
Total Btu (trillions)	0.29	0.05	0.34
Total GWh	22	5	27
Total therms (millions)	0.60	0.00	0.60
Comparative Indicators			
Applications per customer	1.31	1.23	1.34
Sites per application	1.10	1.00	1.06
Incentive $ per customer (000's)	$46.45	$33.23	$44.87
Incentive $ per application (000's)	$35.52	$27.00	$33.49

Self-sponsored customers are those who contract directly with the utility administrators and who are the sponsors of record on their submitted applications. EESP sponsors, as defined in this analysis, are third-party sponsors, such as contractors, engineers, or energy services companies (ESCOs) who contract with the utility administrators on behalf of a host customer facility.

In 2003, EESP-sponsored projects were responsible for 33 percent of the applications, 29 percent of the incentives, and 30 percent of the GWh savings. EESP-sponsored customers signed up slightly more sites per application than self-sponsored customers.

Exhibit 2-3 presents the number of sites per customer for both self-sponsored and EESP-sponsored applications. The overwhelming majority of applications involved only one site. However, 15 percent of the self-sponsored applications and 16 percent of the EESP-sponsored applications covered more than one site.

Exhibit 2-3
Number of Sites per Customer for Accepted Applications (as of 9/04)

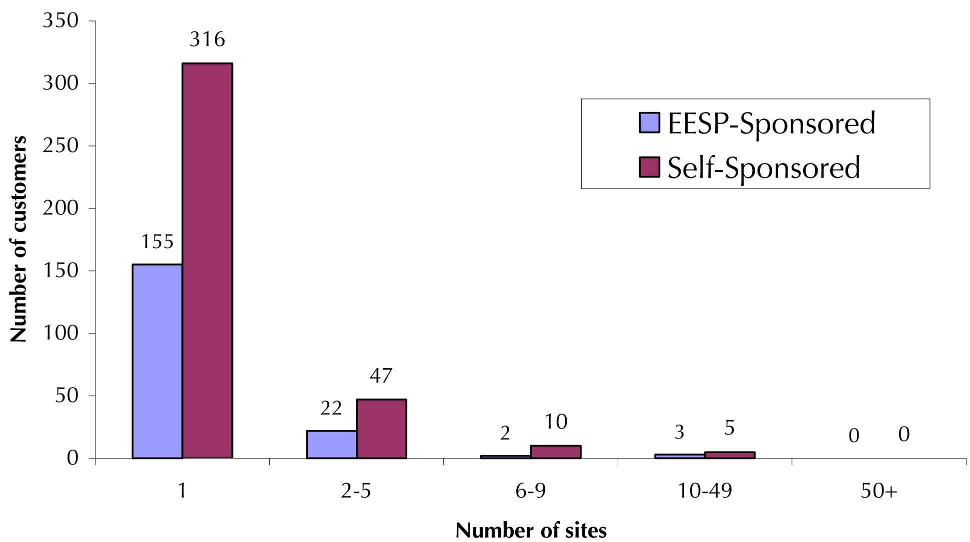


Exhibit 2-4 shows that the percentage of total incentives accounted for by EESP sponsorship varied considerably by utility. The average percentage statewide was 29 percent.

Exhibit 2-4
Percentage of EESP-Sponsored Incentives by Utility (as of 9/04)

Utility	Percent (2003)
PG&E	23%
SCE	37%
SDG&E	19%

2.3 STATEWIDE PARTICIPATION BY END-USER SEGMENTS

Exhibit 2-5 compares customer participants by end-user segment for the 2003 SPC Program. Industrial customers form the largest percentage, with 54 percent of the total. Commercial customers account for the next largest segment, with approximately 38 percent.

Exhibit 2-5
Breakdown of Customer Participants by End-User Segment (as 9/04)

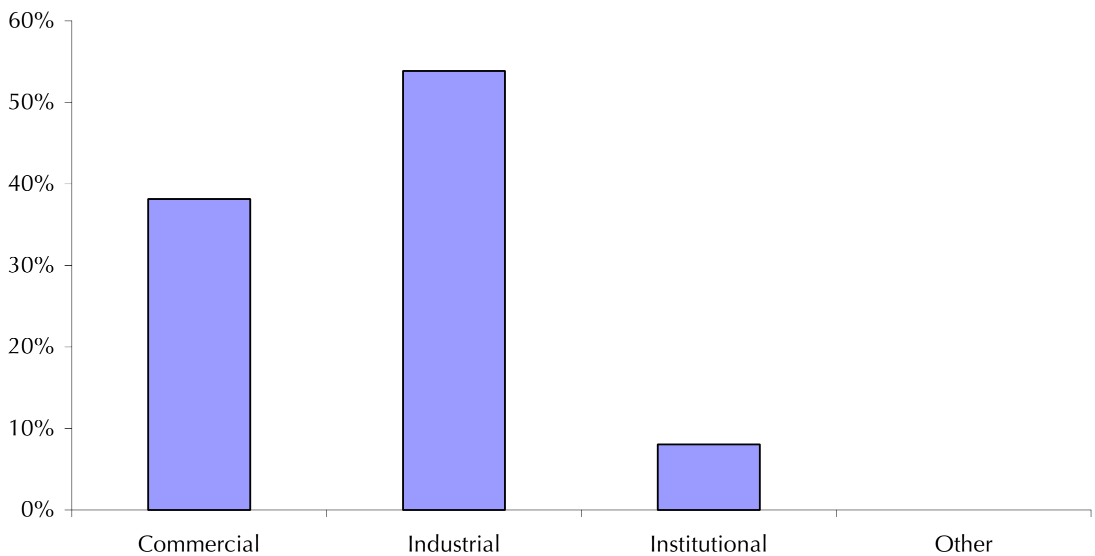


Exhibit 2-6 shows the end-user segments and percent of incentives for active applications for the top 10 end-user participants (including both self-sponsors and EESP-sponsored customers) in 2003. The top 10 end users accounted for 15 percent of total incentives. Eight of the 10 top end users were self-sponsored, while two were EESP-sponsored. Top ten sites represented a much larger share of the SPC program in earlier program years (e.g., 1998, 1999).

Exhibit 2-6
Percent of Program Incentives for Top 10 End Users (as of 9/04)

Rank	Sponsorship	Segment	% of Incentives	Cumulative %
1	SELF	Industrial	2%	2%
2	SELF	Industrial	2%	4%
3	SELF	Commercial	2%	5%
4	SELF	Industrial	2%	7%
5	SELF	Industrial	2%	9%
6	THIRD-PARTY	Commercial	1%	10%
7	SELF	Industrial	1%	11%
8	SELF	Industrial	1%	12%
9	THIRD-PARTY	Industrial	1%	13%
10	SELF	Commercial	1%	15%

Exhibit 2-7 shows the end uses included in active applications in 2003. It shows that Process accounts for the largest number of applications, and for the smallest incentive-per-application figure. Please note that the data supplied by one IOU did not detail the incentives paid by measure. For this IOU, the breakdown of incentives by measure type is our best estimate.

Exhibit 2-7
End Uses Included for Accepted Applications (as of 9/04)

Sponsorship	End-use category	Number of applications	Total incentives ($ 000's)	Average incentives ($ 000's)	% of incentives	Total GWh	% of GWh
Self-sponsored	Lighting	92	$2,670	$29.02	14%	54	23%
	HVAC	79	$4,018	$50.86	21%	34	15%
	Other	62	$2,880	$46.46	15%	28	12%
	Process	165	$4,366	$26.46	23%	64	27%
	Multiple	87	$5,314	$61.08	28%	55	23%
	Total	*485*	*$19,248*	*$39.69*	*100%*	*235*	*100%*
EESP-sponsored	Lighting	63	$1,857	$29.48	24%	38	37%
	HVAC	28	$802	$28.65	10%	8	8%
	Other	21	$742	$35.34	10%	3	3%
	Process	79	$1,944	$24.61	25%	25	24%
	Multiple	49	$2,395	$48.88	31%	29	28%
	Total	*240*	*$7,740*	*$32.25*	*100%*	*102*	*100%*
All	Lighting	155	$4,527	$29.21	17%	92	27%
	HVAC	107	$4,820	$45.05	18%	42	12%
	Other	83	$3,623	$43.65	13%	31	9%
	Process	244	$6,310	$25.86	23%	88	26%
	Multiple	136	$7,709	$56.69	29%	83	25%
	Total	*725*	*$26,989*	*$37.23*	*100%*	*336*	*100%*

In the data for Exhibits 2-8 and 2-9, the multiple-end-use applications were disaggregated into their component end uses. Figure 2-8 shows that in 2003, Process measures received 40 to 50 percent higher incentives than Lighting, HVAC/R and Other.

Exhibit 2-9 presents estimated savings in GWh by end use category. Therm savings are excluded from these figures, because they occur only in a restricted range of end uses. Note, however, that incentives for therm savings totaled approximately $3.3 million, or 12 percent of all incentives awarded.

Exhibit 2-8
End-Use Category Breakdown of Incentives (as of 9/04)

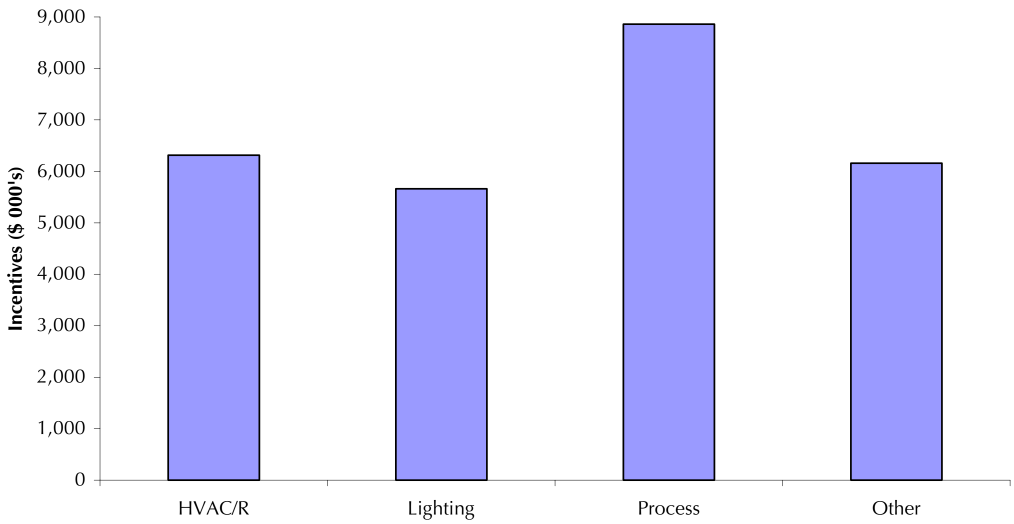


Exhibit 2-9
End-Use Category Breakdown of GWh (as of 9/04)

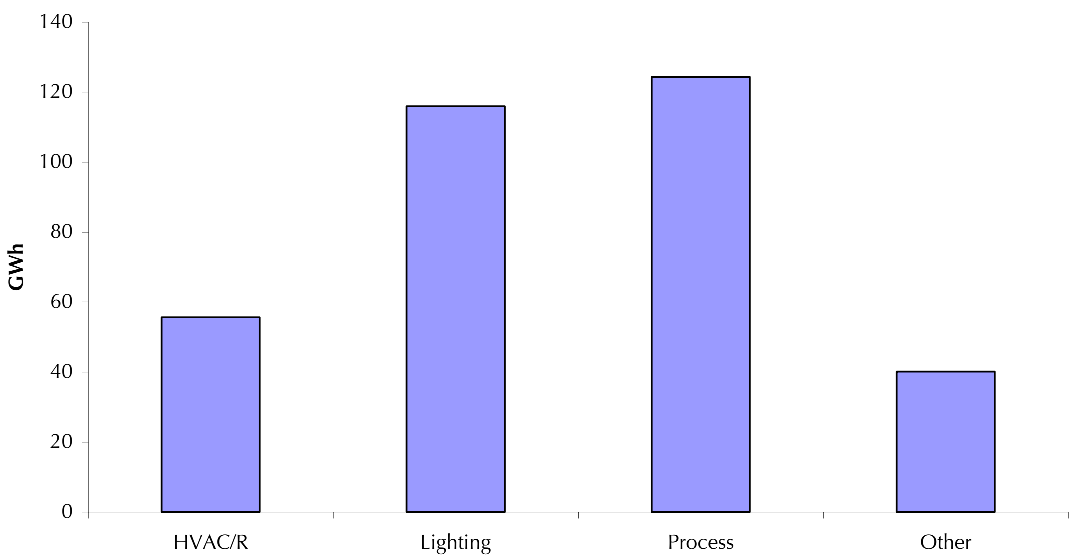
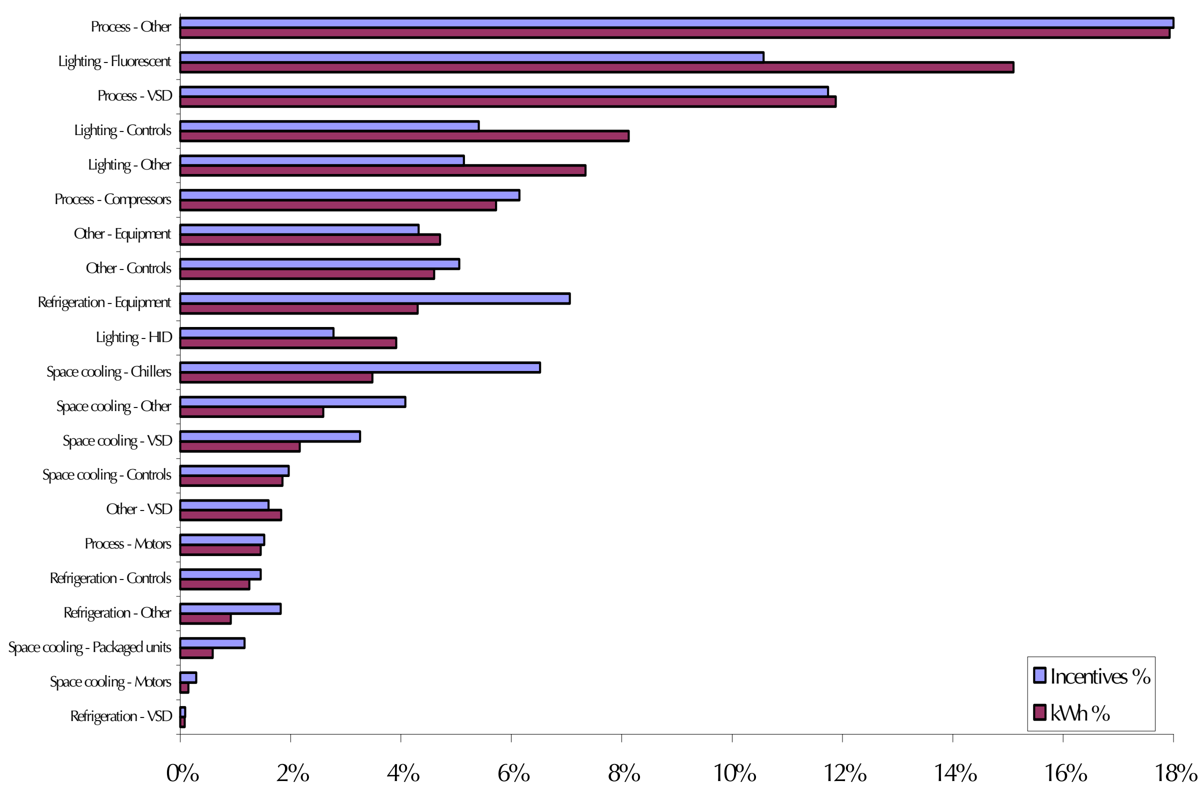


Exhibit 2-10 presents the incentives and kWh savings by end use. The ratios between the two are affected both by the level of incentives per kWh awarded under the program and by the fact that incentives were capped to 50 percent of total project cost. "Process – Other" (including injection molding equipment, energy efficient furnaces, process boilers, process cooling, etc.)

and fluorescent lighting account for the highest percentages of kWh savings. "Process – Other" and "Process – VSD" account for the highest percentages of incentives awarded.

Exhibit 2-10
kWh and Incentives by Project Type (as of 9/04)



* Incentive figures relating to therm savings are excluded.

3. 2003 SAMPLE PLAN AND IMPACT APPROACH

In this chapter, we present the methods used in the impact evaluation. A summary of the sampling plan is provided, followed by an overview of the approach used for the site-specific impact evaluations.

3.1 PY2003 SAMPLING PLAN

In this section, we present the sampling plans for the impact component of the PY2003 SPC evaluation. Due to the scope differences, sample sizes for the PY2003 evaluation are smaller than those in the PY2002 study. As a result, in this report, we present results from both the 2003 site visits and combined results across both the 2002 and 2003 samples. A primary objective of the PY2003 evaluation effort was to augment the 2002 impact evaluation component of the evaluation effort with additional sites. We first present the sampling plan for the PY2003 evaluation and then summarize the combined sample from both the PY2003 and PY2002 evaluation efforts.

The careful selection of the samples is important to the success of the impact evaluation. The approach requires an appropriate segmentation of all participating customers into strata that are analytically compatible. This is important because the findings from the sampled customers are extrapolated to the remaining participant populations based upon application commonality. For both the PY2003 and PY2002 efforts, the segments used to leverage results that we considered consisted of a combination of the following: size of project savings, end-use, savings fuel (electric or gas), IOU, and sponsorship type (customer or third-party).

For the PY2003 impact evaluation, we drew a sample that is proportionally distributed with respect to size of savings, end use, type of sponsorship, and utility. The sample was drawn from customers with active applications as of September 2004. Electricity makes up roughly 90 percent of the savings and incentives for the PY2002 SPC program. Consequently, given budget constraints, it was agreed that the PY2003 and PY2002 impact evaluations would focus on measuring electricity savings. Thus, the primary sampling variable is electricity savings. As with the PY2002 evaluation, we determined that three proportional savings strata would be optimal and would facilitate combining the PY2003 evaluation sites with the PY2002 evaluation sites. The strata each represent one-third of program electricity savings. We refer to these as tiers, with Tier 1 being the tier with the largest projects and Tier 3 the smallest.

A second stratification variable used is end use, as defined by the program. The program pays incentives based on whether projects are classified as Lighting, HVAC/R, or Other.[12] Many projects contain measures from more than one end use. The end use with the largest energy (kWh) savings in an application was assigned as the "primary end use" for the sample design. Stratifying on program end use ensures that the sampled mix of projects is representative of the population mix and allows us to calculate realization rates by end use.

[12] Note that, for payment purposes, "Other" includes industrial process and many controls measures, even controls that apply only to lighting or HVAC/R.

The 2003 program population data for the sampling strata are shown in Exhibits 3-1 and 3-2. These figures are based on data received from the utilities in September 2004.[13] The on-site sample completed for the gross impact estimation had 25 points distributed by size and end use as shown in Exhibits 3-3 and 3-4. A separate telephone survey was implemented to obtain process, satisfaction, and net-to-gross. The distribution of the telephone survey interviews is shown in Exhibit 3-5.

The kWh savings associated with the PY2003 sample represents 8 percent of total program savings in PY2003, whereas the 40 sample points in the PY2002 impact evaluation captured 40 percent of PY2002 program savings. The relatively small percentage of PY2003 program savings captured by the PY2003 sample is due to several factors. First, the PY2003 program is significantly larger than the PY2002 program both in terms of total kWh and total applications. Second, the PY2003 impact sample is significantly smaller than the PY2002 sample. Third, very few of the Tier 1 PY2003 projects were installed in time for inclusion in the PY2003 sample, thus significantly reducing the portion of Tier 1 savings that could be captured. As it turned out, it was necessary to utilize two PY2002 projects in Tier 1 of the PY2003 sample just to meet the sampling quota of 5 sites. For these reasons, the PY2003 sample is not used in this report to estimate a realization rate for the PY2003 program. Rather, as presented in Section 7 of this report, these 25 PY2003 evaluation site results are combined with the 40 PY2002 evaluation site results to produce a weighted realization rate for the combined PY2003 and PY2002 programs.

Exhibit 3-1
PY2003 SPC Electric Population Data by Stratum (as of 9/04)*

kWh strata	Lighting	HVAC/R	Process/Other	Total
Tier 1	37,659,163	17,276,260	56,087,267	111,022,690
Tier 2	46,991,379	17,829,740	48,802,613	113,623,732
Tier 3	31,270,313	20,576,600	59,611,788	111,458,701
Total	115,920,855	55,682,600	164,501,668	**336,105,123**

*The kWh cutpoints are 1,862,567 kWh for Tier 1 and 648,405 kWh for Tier 2.

Exhibit 3-2
PY2003 SPC Electric Population Counts by Stratum (as of 9/04)*

kWh strata	Lighting	HVAC/R	Process/Other	Total
Tier 1	13	6	18	37
Tier 2	45	20	43	108
Tier 3	121	101	316	538
Total	179	127	377	**683**

* Population excludes gas only sites.

[13] Note that the gross ex ante savings for the SPC program will change over time because savings estimates are sometimes adjusted based on the Project Installation Report and project installations can lag several years after the program-funding year. In addition, some projects may have cancelled since September 2004.

Exhibit 3-3
PY2003 SPC Impact Evaluation – On-Site Sampled kWh Savings by Stratum

kWh strata	Lighting	HVAC/R	Process/Other	Total
Tier 1	3,373,451	2,951,387	10,143,515	16,468,353
Tier 2	2,587,137	1,401,134	4,795,714	8,783,985
Tier 3	347,523	277,574	816,077	1,441,174
Total	6,308,111	4,630,095	15,755,306	**26,693,512**

Based on 25 applications sampled

Exhibit 3-4
PY2003 SPC Impact Evaluation – On-Site Sample Counts by Stratum

		Application Counts			
kWh Strata	No. of Applications	Lighting	HVAC/R	O&P	Total
Tier 1	5	1	2	2	5
Tier 2	10	3	2	5	10
Tier 3	10	2	2	6	10
Total		6	6	13	25

Exhibit 3-5
PY2003 SPC Impact Evaluation – Telephone Sample Counts by Stratum

kWh strata	kWh	Sample n
Tier 1	11,842,748	5
Tier 2	10,572,962	11
Tier 3	1,389,358	9
Total	23,805,068	25

3.2 APPROACH TO ESTIMATING EX POST ENERGY SAVINGS

The key steps utilized to develop an overall savings estimate for the program were to:

- independently verify reported measure installation records,
- develop ex post estimates of the energy savings for each project in the sample, and
- apply those findings to the full participant population to obtain a complete estimate of program impacts.

Ex post impact experience with custom nonresidential projects shows that program effects cannot be reliably measured through a multi-customer regression analysis of billing data (an approach typically employed in ex post residential analysis and prescriptive commercial programs). In the past, evaluators have found that this is true due to the fact that custom sites are usually also large customers (typically using in excess of millions of kWh per year), and it is difficult to isolate program effects in the billing regression model because of the many site-specific changes that affect energy consumption (in addition to program changes). For this reason, we adopted the approach used in the previous evaluation protocols and primarily relied on application review, on-site data collection, engineering analyses, and limited (mostly spot) measurements to produce ex post gross impact estimates. However, for some projects that had been completed several months before our evaluation, we did use individual customer pre- and post-retrofit billing records to verify calculated impacts.

This study's approach to the impact analysis consists of a distinct set of steps that are listed below and discussed in the subsections that follow. These steps include:

- developing and implementing the sample design,
- obtaining the sample of SPC application files and associated documentation,
- reviewing the applications and preparing the ex post analysis plans,
- conducting the on-site data collection,
- conducting site-specific verification and developing the ex post impact estimates for each site,
- preparing detailed, site-specific documentation for the ex post sample,
- carrying out a quality control review of the ex post impact estimates and implementing any necessary revisions, and
- extrapolating the final ex post estimates for the sample to the remaining applications.

For the sampled participant sites, the engineering analysis methods used for each evaluation varied from application to application, depending on the measures covered, the availability of additional data, and the application-based calculations submitted. These projects are individually designed and implemented because a diverse mix of end-use technologies and applications is found across the participant population.

A multi-step process was performed, involving verification and engineering-based calculations for each application reviewed. The first step was to obtain and review selected application forms and develop site-specific analysis plans and field data collection plans, targeted to gather missing information or verify application information. This step was followed by an on-site audit to complete the data collection for site characteristics, plant and equipment specifications, measure(s) installed and the operation strategy for applicable equipment. Utilizing the information gathered from the application documentation and site visits, we completed an impact evaluation of the energy and demand savings associated with the target end use for each site in the sample. This evaluation was then documented and submitted for quality control review. The final site-specific evaluation results were then extrapolated to the program population using the ratio estimation method referenced below.

Obtain Sample SPC Application Records

Once the sample was drawn, QC submitted a formal data request to each utility for application records, including verification records and transactions. Once those documents were received, the engineer assigned to each application conducted an initial review. This was used to assess the need for additional documentation that could be obtained from the utility or its third-party program implementation contractor.

Review Applications and Prepare Analysis Plans

For each selected application, we performed an in-depth application review to assess the engineering methods, parameters and assumptions used to generate all adjusted ex-ante impact estimates. Application review served to familiarize the assigned engineer with the gross impact approach applied in the ex ante calculations. This also allowed an assessment of the additional data needs that were required to complete each analysis and the likely sources for obtaining those analytic inputs. Data sources included third-party SPC program implementers, EESPs that participated in a given project, and several on-site sources, including interviews completed at the time of the on-site, visual inspection of the systems and equipment, EMS data downloads and spot measurements. In addition, results of the in-program[14] verification efforts were examined.

Each review included a formal analysis plan that was submitted to the impact project manager. This plan outlined the general ex post impact approach (which may or may not differ from the approach used in each SPC application) and identified calculations necessary to complete the evaluation. The analysis plan specified what data was required to be collected during the site visit.

The ex post methods applied varied in complexity from applications that required an entirely new approach, to those that required an independent calculation using the application-based approach, and finally to those that simply required a careful review and verification of the methods and inputs in the ex-ante calculations.

Conduct On-Site Data Collection

On-site audits were completed for 25 of the customers sampled as part of the PY2003 evaluation. The engineer assigned to each job called to set up an appointment with the customer. During the on-site audit, data identified in the analysis plan was collected, including monitoring records (such as instantaneous spot watt measurements for chillers or other installed equipment, measured condensate temperatures, data from chiller logs, and energy management system (EMS) downloads), equipment nameplate data, system operation sequences and operating schedules, and, of course, a careful description of the baseline condition being modeled.

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[14] We use the term "in-program" to differentiate measurement and other activities conducted by the program administrators and their technical support contractors as opposed to related activities conducted by the evaluation team.

The on-site audit consisted of a combination of interviewing and taking measurements when appropriate and possible. During the interview, the QC team engineer met with a building representative who is knowledgeable about the site's equipment and operation, and asked a series of questions regarding such matters as operating schedules, location of equipment, and equipment operating practices. Following this interview, the engineer made a series of detailed observations and measurements of the building and equipment.

Conduct Site-Specific Verification and Developing the Ex Post Impact Calculations

The application-based estimates of demand and energy impacts were examined and revised as necessary, based on the on-site data, application information, third-party implementer records and billing data when a billing analysis was used.

Calculations were performed at a variety of levels of complexity using methods that include bin models, application of ASHRAE methods and algorithms, and other specialized algorithms and models. In many instances ex post impact estimates were derived by utilizing a different approach from that used in the ex ante calculations. This is especially true for the Process and HVAC end uses. In other cases, the same methodology was employed but with data inputs that were based on findings from our site visits.

During the site visit, the engineer also verified that the proposed measures had been installed as detailed in the SPC application. In many cases this verification was limited to the specific measure or end use being evaluated.

Site-Specific Analysis Documentation

Documentation is provided in Appendix A for each site included in the impact analysis. The documentation for each site includes the following elements:

- Measure Description
- Summary of Program Impact Calculations
- Comments on Program Impact Calculations
- Description of the Impact Evaluation Process
- Impact Evaluation Results
- Supporting Documentation

Quality Control Review

Two levels of quality control review were implemented for this impact evaluation. The first level of quality control occurred within the impact evaluation team. All sites were assigned to a lead senior engineer who conducted the initial impact estimates. A second senior engineer who did not work on the site directly then reviewed each site. This peer-level review focused on the quality and clarity of the documentation and consistency and validity of the estimation methods. The second level of quality control occurred by submitting the draft site reports to the utilities and their SPC technical support contractors for review. This review was important because it sometimes revealed gaps in the project documentation files received by the Quantum team that were important to calculation of the realization rate (e.g., in a few cases, the ex ante values had changed since we had originally received them or more detailed data was received that was not included in the original files).

Estimate Impacts for Participant Population

Based on these 25 customers, engineering-based realization rates were derived at the strata and program end use levels (i.e., for the cells in the sampling matrix). The realization rate is defined as the ratio of ex post-to-ex ante impact. These realization rates are applied back to the remaining participant population by applying the realization rates from the sample to the population within each cell of the sampling matrix. The realization rates within a sampling cell are weighted by the size of the savings for each customer in the sampled cell. The realization rates are weighted across the sampling cells based on the ratio of the total savings for the population of participants in the cell to the entire program savings. As discussed in Section 7, the PY2003 on-site sample and population are combined with the PY2002 sample and population to produce a weighted realization weight for the combined program years.[15]

[15] The overall program realization rate and confidence interval utilize the ratio-estimation methods documented in Chapter 13 – Sampling, page 358, of the TecMKT Works, 2004. *2002 Evaluation Framework Study*, prepared by TecMKT Works for Southern California Edison Company, June. http://www.calmac.org/publications/California_Evaluation_Framework_June_2004.pdf. In addition, the CPUC is currently undertaking a series of workshops to develop new evaluation protocols.

4. 2003 SITE-LEVEL GROSS IMPACT RESULTS

In this chapter we present and discuss the site-specific results of the gross impact analysis for sites analyzed as part of the 2003 SPC evaluation scope. The results are summarized on an unweighted basis by program end use (process/other, lighting, and HVAC). Anonymous site-specific results are included in summary tables. As discussed previously, in Chapter 7 we combine the results from the 25 sites analyzed in the 2003 impact evaluation with the 40 sites analyzed in the 2002 evaluation to produce weighted realization results that leverage the samples from both evaluation years. Detailed site-specific project descriptions, ex ante methods, ex post methods, and ex post results are provided in Appendices A.

A description of the stages of program documentation is provided to facilitate understanding the references to these stages that follow. There are three distinct stages of a project that are documented in each SPC application. These are:

- **Application Submission**: In this first stage, the customer or project sponsor submits the SPC application and supporting savings calculations and documentation to the SPC Program administrator.
- **Application Review**: In this stage, the SPC application is reviewed and savings calculations are adjusted, if necessary, and accepted by the SPC program administrator. An incentive offer is formalized at this stage.
- **Installation Report**: Following the project installation, the SPC administrator's project reviewer performs a site inspection to verify the installation and make adjustments, if necessary, to the energy and demand savings claim. The financial incentive is finalized and paid to the customer based on this assessment. In some cases the SPC program administrator requires measurement (commonly referred to in the Program as "Measurement and Verification" or "M&V") of the savings for the project. In these cases, the financial incentive is based on the results of the measurement.

In this section, we provide summary of ex ante savings for each sampled site, and summary of ex post savings estimates and gross realization rates for each sampled site.

Note that references to project savings and incentive payments for the sampled sites are based on the information the evaluation engineers obtained from the physical program files. In some cases these data may not match the data in the program tracking systems obtained from the utilities due to the fact that program files were obtained after the September 2004 data cut.

In some cases we have set the realization rates to "NA". Realization rates noted as "NA" indicate that the realization rate was not applicable (such as for therms and kW where there are no gas savings), or that the evaluation was inconclusive.

4.1 PROCESS AND CONTROLS END USE

Thirteen projects classified under the process end use were evaluated in the sample. The energy and demand savings approved at the application review stage for this end use were 15,683,276 kWh, 1,208 kW and 1,098 therms. Total financial incentives of $903,468 were offered for these projects.

The revised energy savings approved by the program administrators as part of the Installation Report for the process end use were 15,468,076 kWh, 571 kW and 1,098 therms. Total incentives of $761,220 were paid for these projects.

Energy savings from the program Installation Report, this impact evaluation, and associated realization rates are shown in Exhibit 4-1 for the process end use sample.

The ex post energy savings estimate for the thirteen process end use sites are 11,607,352 kWh, 1,410 kW and zero therms. The realization rates for the kWh energy savings range widely from zero to 1.5. The unweighted average realization rate for the process energy savings is 0.74. The realization rates for the demand kW range from 0.3 to 16.6.[16] The unweighted average realization rate for the process demand savings is 2.9.

Exhibit 4-1
Summary of Ex Ante and Ex Post Savings
Process End Use

Site	Ex Ante Savings			Ex Post Savings			Realization Rate		
	kW	kWh	therms	kW	kWh	therms	kW	kWh	therms
1	-	3,234,000	-	603	3,234,000	-	NA	1.0	-
2	185	6,616,800	-	450	3,566,219	-	2.4	0.5	-
3	132	1,001,973	-	132	798,760	-	1.0	0.8	-
4	79	906,215	-	NA	1,381,021	-	NA	1.5	-
5	10	720,882	-	10	1,020,829	-	1.0	1.4	-
6	107	667,680	-	90	511,391	-	0.8	0.8	-
7	(3)	1,498,965	-	52	526,915	-	16.6	0.4	-
8	-	25,103	1,098	-	-	-	NA	0.0	0.0
9	32	310,325	-	38	344,378	-	1.2	1.1	-
10	20	109,411	-	5	10,306	-	0.3	0.1	-
11	12	48,960	-	19	35,897	-	1.6	0.7	-
12	(1)	96,472	-	13	84,244	-	NA	0.9	-
13	(1)	231,290	-	(2)	93,392	-	1.0	0.4	-
Total	571	15,468,076	1,098	1,410	11,607,352	-			
Average	44	1,189,852	84	118	892,873	-	2.9	0.7	-

1. Realization Rates noted as "NA" indicate that the realization rate was not evaluated or that the evaluation was inconclusive.
2. A dash " - " indicates that no savings was claimed.

16 The core objective of this impact evaluation was to develop realization rates for annual energy savings; realization rates for peak demand were a secondary objective given the study scope. This was because developing defensible realization rates for peak demand usually requires more extensive sub-metering to determine peak coincidence. Several of the peak kW realization rates are shown as “N/A” in the following tables because there were no ex ante values or, absent the use of longer term sub-metering, the ex post analysis was unable to determine peak coincidence. In the PY2002 SPC Impact Evaluation report, we recommended that the scope of future SPC impact evaluations be increased to include increased measurement to support development of peak kW realization rates.

Site-specific findings for the process sample include the following:

- Site 1's kWh realization rate is 1.0. The project is a complex air compressor system modification. The facility was sold to another company after the project was completed. Production has expanded and increased air demand. The ex ante calculations were based on short-term measured data. The application and site visits confirmed that the original calculations were appropriate. It was difficult to re-assess the energy savings for this project because the load profile had changed. Re-estimation of the saving would have required extensive metering. It is likely savings may actually be higher due to increases in production levels. Calculations show 603 kW demand reduction, but the application did not claim any demand reduction.

- Site 2's kWh realization rate is 0.5. The project involved the replacement of inefficient fan impellers with new high efficiency impellers for large industrial fan systems. The site was required to do M&V, however the customer's internal sponsor left the company and the utility hired a consultant to perform the M&V study. We found that the utility's consultant did not account for the significant variability in pre-retrofit fan energy consumption when calculating the impact of the retrofit.

- Site 3's kWh realization rate is 0.8. AIRMaster software was used for the savings calculations for this air compressor system retrofit. Field measured data and AIRMaster input were not included in application. During the site visit, we determined that the hours of operation are less than stated in the ex ante calculations and we adjusted the savings proportionally.

- Site 4's kWh realization rate is 1.6. A mechanical contractor provided the savings calculations for the HVAC fan system VFD retrofits. A few hours of monitoring were used to determine an average fan load, and a single point analysis was performed for the VFD installation. A mathematical error was not identified by the reviewer, and the reported result overstated savings based on the contractor's methodology by more than 100,000 kWh. We recalculated the savings based on an annualized load profile, and determined that the ex ante analysis had greatly underestimated the savings.

- Site 5's kWh realization rate is 1.4. The project involved the installation of VFDs on chiller, pump and air handler motors. During the site visit we found that the customer had adopted a condenser water reset strategy in conjunction with the chiller VFD installation that significantly increased the energy savings associated with the installation. The condenser water reset strategy had not been included in the ex ante calculations.

- Site 6's kWh realization rate is 0.8. Insulation blankets were installed on injection molding equipment heaters. During the site visit, we determined that the hours of operation were overestimated and adjusted the energy savings.

- Site 7's kWh realization rate is 0.4. The SPC calculator was used to estimate the savings. The "Large office building" profile was used for a process cooling load that varies little throughout the year. The reviewer should have corrected this misapplication of the SPC calculator. We created a more realistic load profile for the facility and recalculated the savings.

- Site 8's kWh realization rate is zero. The customer installed an EMS with the primary function of scheduling control of HVAC units, exhaust fans, lighting, and refrigeration compressors. The reviewer did visit the site, however it appears that they may not have verified the controlled points on the EMS system. The controls vendor advised that they do not control exhaust fans or refrigeration compressors with the EMS as shown in the ex ante calculations. It seems that the reviewer did not thoroughly verify the installation. There is a statement in the application that 7 restaurants had already done the same retrofit and perhaps this was the basis for justifying a lower degree of scrutiny for this project. This restaurant now has a drive through window open 24 hours and 2 of the 3 HVAC units operate 24/7. The lighting also operates 24/7, except for the interior menu sign. Energy use has increased because the hours of operation have increased.

- Site 9's kWh realization rate is 1.1. The project involved the replacement of a constant speed air compressor with a variable speed air compressor. The ex post inspection identified that only one air compressor was installed rather than the two specified in the approved application and associated energy savings calculations and concluded that would not affect the energy savings. However, the demand reduction was re-estimated and based on the full load kW of the system before and after the retrofit. During the site visit we determined that the plant load profile had changed and recalculated the savings based on the equipment installed.

- Site 10's kWh realization rate is 0.1. The project involved the installation of a new injection molder. The injection molder that was removed was old and its maintenance was costly in time and money. The customer used a consultant to calculate the rebate available from different new machines. The consultant prepared the rebate application using the SPC calculator and received 30% of the incentive as a fee. The application contained excessive estimates of average production rates and hours of operation. We recalculated the savings based on the operating parameters determined during the site visit.

- Site 11's kWh realization rate is 0.7. The project involved the replacement of a hydraulic system used to operate a conveyor with direct drive electric motors for conveyor operation. The hydraulic system was experiencing maintenance problems, with many parts wearing out. It was expensive to maintain. This was the primary driver behind the retrofit. The reviewer did not accurately describe the system. Two 20 HP motors were replaced, not one 40 HP as implied in the application. Load factors for the motors were not used in the calculations. We found that the hours of operation were overstated in the ex ante calculations, and recalculated the savings using load factors and the hours of operation determined during the site visit.

- Site 12's kWh realization rate is 0.9. VFDs were installed on a cooling tower fan motor and four small air handler fan motors. During the site visit we determined that the hours of operation for the cooling tower fan motor used in the ex ante calculations were overstated and adjusted the savings accordingly.

- Site 13's kWh realization rate is 0.4. VFDs were installed on air handler fan motors. The ex post kWh savings results are less than the ex ante results because the ex ante analysis was performed assuming that the fan systems operate 25 percent more hours than we determined during the evaluation.

4.2 LIGHTING END USE

Six projects classified under the lighting end use were evaluated in the sample. The energy savings approved at the application review stage for this end use was 5,256,283 kWh, 713 kW and 0 therms. Total incentives of $262,814 were offered for these projects. Economic data was not available for two of the projects.

The revised energy savings approved by the program administrators as part of the Installation Report for the lighting end use were 4,271,724 kWh, 713 kW and 0 therms. Total incentives of $213,587 were paid for these projects.

Energy savings from the program Installation Report, this impact evaluation, and associated realization rates are shown in Exhibit 4-2 for the lighting end use sample. The ex post energy savings for the six lighting sites is 4,416,194 kWh, 677 kW, and 0 therms. The realization rates for the kWh energy savings range from 0.3 to 1.2. The unweighted average realization rate for the lighting energy savings is 0.9. The realization rates for the demand kW range from 0.9 to 1.0. The unweighted average realization rate for the lighting demand savings is 1.0.

Site-specific findings of interest for the lighting sample include the following:

- Site 14's kWh realization rate is 1.2. Four hundred watt metal halide fixtures were replaced with 4 lamp T- HO fixtures. During the site visit we determined that 2 lamps were operating on approximately 50 percent of the fixtures. The ex ante calculations were based on all lamps operating when the store is open.

- Site 15's kWh realization is 1.0. Metal halide fixtures were replaced with 4 lamp T-5 HO fixtures with occupancy sensors in the warehouse of this facility. Prior to the retrofit, the ESCO performed extensive occupancy data logging. The data logging gives higher level of confidence in the hours of operation stipulated in the calculations. During the site visit we verified that a high percentage of lights were off.

- Site 16's kWh realization rate is 1.2. Metal halide fixtures were replaced with 4 lamp T-5 HO fixtures with occupancy sensors in this facility. We installed lighting loggers and found occupancy sensor savings are greater than the ex ante calculations for the warehouse areas and adjusted the energy savings.

- Site 17's kWh realization rate is 0.9. Four hundred watt metal halide fixtures were replaced with 4 lamp T-5 HO fixtures in this facility. We found that the customer had overestimated annual hours of operation and adjusted the savings.

- Site 18's kWh realization rate is 0.3. The customer installed lighting occupancy sensors in two office buildings. During the site visit we determined that the customer was vacating the buildings at the end of December 2004. Our belief is that the savings will be zero when the buildings are vacant, and the customer indicated that there was little chance the buildings would be occupied in the next few months. We prorated the savings by 5/12 based on the 5 months of occupancy since the project was completed before the customer vacated the building.

- Site 19's kWh realization rate is 0.8. This application documented a lighting efficiency retrofit. The ex ante calculations overestimated lighting hours of operation. During the site visit we determined that a high proportion of the lights are controlled by a lighting control system. We obtained the lighting control system schedules and recalculated the savings based on the hours of operation determined from the schedules.

Exhibit 4-2
Summary of Ex Ante and Ex Post Savings
Lighting End Use

	Ex Ante Savings			Ex Post Savings			Realization Rate		
Site	kW	kWh	therms	kW	kWh	therms	kW	kWh	therms
14	373	1,399,097	-	338	1,615,587	-	0.9	1.2	NA
15	81	714,451	-	81	714,451	-	1.0	1.0	NA
16	101	872,874	-	101	1,012,554	-	1.0	1.2	NA
17	119	955,136	-	119	876,815	-	1.0	0.9	NA
18	-	119,370	-	-	37,701	-	NA	0.3	NA
19	38	210,796	-	38	159,086	-	1.0	0.8	NA
Total	713	4,271,724	-	677	4,416,194	-			
Average	119	711,954	-	113	736,032	-	1.0	0.9	NA

1. Realization Rates noted as "NA" indicate that the realization rate was not evaluated or that the evaluation was inconclusive.
2. A dash " - " indicates that no savings was claimed.

4.3 HVAC END USE

Six projects classified under the HVAC end use were evaluated in the PY2003 sample. The energy savings approved at the application review stage for the HVAC end use were 4,630,094 kWh, 482 kW and 0 therms. Total incentives of $468,938 were offered for these projects.

The revised energy savings approved by the program administrators as part of the Installation Report for the HVAC end use were 4,630,094 kWh, 637 kW and 0 therms. Total incentives of $468,938 were paid for these projects.

Energy savings from the program Installation Report, this impact evaluation, and associated realization rates are shown in Exhibit 4-3 for the HVAC end use sample. The ex post energy savings for the fourteen electric HVAC end use sites is 4,708,438 kWh, 505 kW, and 0 therms. The realization rates for the kWh energy use range from 0.7 to 1.1. The unweighted average realization rate for the HVAC energy savings is 1.0. The realization rates for the demand kW range from 1.0 to 1.1. The unweighted average realization rate for the HVAC demand savings is 1.0

Site-specific findings of interest for the HVAC sample include the following:

- Site 20's kWh realization rate is 1.1. The customer replaced open multi-deck and "coffin" style refrigerated and frozen food display cases with closed glass door cases in nine supermarkets. We performed a utility bill analysis and found that the savings were slightly higher than claimed in the ex ante calculations.

- Site 21's realization rate is 1.0. This project involves a comprehensive retrofit for Elementary, Middle and High Schools. The primary end use for the impact evaluation is HVAC. Based on the site audits, all the schools visited showed good agreement with the application savings.

- Site 22's kWh realization rate is 0.9. The project involved the installation of an occupancy-based control system in the guest rooms of a vacation time-share facility that resets the room temperature set point based on the status of room occupancy (occupied, unoccupied, or vacant). We obtained 12 months of actual occupancy data from the facility management and readjusted the savings calculations based on the methodology used in the ex ante calculations.

- Site 23's kWh realization rate is 1.0. The customer replaced evaporative condensers on a refrigeration system with new efficient models lowering the refrigeration condensing pressure. The ex ante calculations were performed with a detailed model. A brief period of pre-measurement was performed and the refrigeration load was annualized. Energy usage appears unaffected by weather and loads are fairly constant throughout the year. An ex post billing analysis verified the ex ante savings.

- Site 24's kWh realization rate is 1.1. The project involved the installation of an occupancy based control system similar to Site 22 in the guest rooms of a vacation time-share facility that resets the room temperature set point based on the status of room occupancy (occupied, unoccupied, or vacant). We obtained 12 months of actual occupancy data from the facility management and readjusted the savings calculations based on the methodology used in the ex ante calculations.

- Site 25's kWh realization rate is 0.7. The customer installed VFDs on three 225-ton chillers. During the site visit we determined that the maximum chiller plant load is less than was used in the ex ante calculations and that the minimum chiller plant load is more than was used in the ex ante calculations. The ex post savings are less than the ex ante savings because the ex ante savings were based on a higher peak load and a lower minimum load than the ex post analysis. The ex ante analysis estimates 1,437,073 annual ton hours for the chiller plant. The ex post calculation estimates 1,065,371 ton-hours for the chiller plant, a 35 percent difference.

Exhibit 4-3
Summary of Ex Ante and Ex Post Savings
HVAC End Use

Site	Ex Ante Savings			Ex Post Savings			Realization Rate		
	kW	kWh	therms	kW	kWh	therms	kW	kWh	therms
20	213	1,862,567	-	236	2,065,469	-	1.1	1.1	NA
21	151	1,088,820	-	151	1,088,820	-	1.0	1.0	NA
22	155	632,020	-	NA	575,383	-	NA	0.9	NA
23	118.4	769,114	0	118	769,114	0	1.0	1.0	NA
24	-	55,703	-	-	61,565	-	NA	1.1	NA
25	-	221,870	-	-	148,087	-	NA	0.7	NA
Total	637	4,630,094	-	505	4,708,438	-			
Average	106	771,682	-	101	784,740	-	1.0	1.0	NA

1. Realization Rates noted as "NA" indicate that the realization rate was not evaluated or that the evaluation was inconclusive.
2. A dash " - " indicates that no savings was claimed.

5. 2003 CUSTOMER INTERVIEW AND FREE RIDERSHIP RESULTS

This section summarizes the results from a set of structured interviews conducted with participants in the 2003 SPC Program. The interviews were conducted in March and April of 2005 with representatives from 25 separate customer organizations, accounting for 63 separate SPC program applications. The goal of these interviews was to provide feedback on participant customer experiences as part of the process element of the PY2003 evaluation scope. Note that many of the questions asked in this survey have been included in prior evaluation studies of the SPC program throughout its inception since 1998, thus facilitating consistent benchmarking of results over time.

These interviews are also used to develop an estimate of the net-to-gross ratio for each site and the program overall. As is the case with the 25 gross impact sample points for PY2003, in this report we combine the 25 PY2003 net-to-gross results with the sample of 39 net-to-gross project results completed in the PY2002 SPC impact evaluation. The combined results are presented in Section 6 of this report.

This section contains the following subsections:

- General Characteristics of the 2003 Participant Customer Sample
- Drivers of Program Participation and Project Implementation
- Satisfaction with the Program and Program Processes
- Program Effect on Future Energy Efficiency Actions
- Unweighted Net-to-Gross Results (see Section 7 for weighted results)

5.1 GENERAL CHARACTERISTICS OF THE 2003 PARTICIPANT CUSTOMER SAMPLE

This subsection presents characteristics of the sample of 2003 SPC customer participants with whom in-depth interviews were conducted in March and April of 2005. The customer participant sample for the process interviews was coordinated with the impact evaluation sample and, to the extent feasible, only included customers with completed projects. As a result, 11 of the 25 customers interviewed are also included in the impact evaluation. As presented in Section 3, all customer participants were stratified into three roughly equal-sized strata based on the kWh savings associated with each *unique* customer for *each* utility, resulting in one sample list per utility.

Exhibits 5-1 and 5-2 show the interviews completed by utility and by strata. Consistent with the sample provided, PG&E represented the largest share of the customers interviewed, at 52 percent. This distribution is likely due in part to the number of projects that were already complete at the time the sample was drawn.

Exhibit 5-1
Completed Interviews with 2003 SPC Participants by Utility

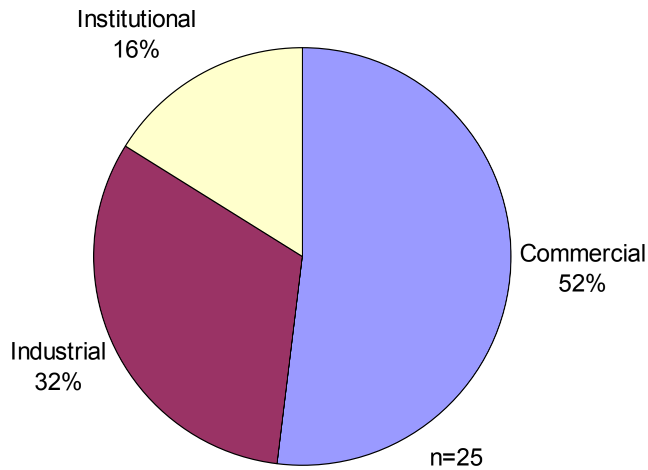
Utility	Percent (2003)
PG&E	48%
SCE	40%
SDG&E	12%
Total Responses	25

Exhibit 5-2
Completed Interviews with 2003 SPC Participants
by Utility and Strata

Savings Strata	PG&E	SCE	SDG&E	Statewide	
Tier 1	2	3	0	5	20%
Tier 2	5	3	3	11	44%
Tier 3	5	4	-	9	36%
Total	*12*	*10*	*3*	*25*	

As shown in Exhibit 5-3, the sample of customers also includes respondents from each of the four major market segments, commercial, industrial, institutional, and agricultural. Over half of the 2003 survey respondents were from the commercial sector, which is a reverse of prior years where industrial customers represented the largest segment within the customer interviews sample. The average square footage for participating sites was roughly 200 thousand.

Exhibit 5-3
Completed Interviews with 2003 SPC Participants by Market Sector



About half of the respondents reported submitting a single application to the 2003 SPC program; another 20 percent had two active applications. The remaining five respondents had from 3 to 22 active applications in the 2003 SPC program.

As shown in Exhibit 5-4, nearly half of those surveyed used Energy Efficiency Service Providers (EESPs) to sponsor their projects. Among those interviewed for the SPC evaluation, this level of EESP sponsorship was up significantly from previous years. The EESP sponsorship share of the sample is also somewhat higher than the 29 percent share in the total program population (see Section 2).

Exhibit 5-4
Completed Interviews 2003 SPC Participants
by Sponsorship Status

Sponsorship Status	Percent (2003)
Self-Sponsor	60%
EESP-Sponsored	40%
Total Responses	25

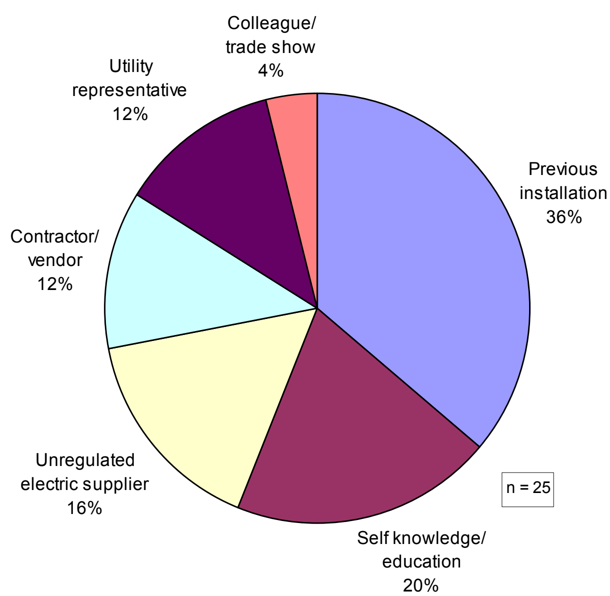
5.2 DRIVERS OF PROGRAM PARTICIPATION AND PROJECT IMPLEMENTATION

In this subsection, we present responses to a series of questions customers were asked about how they made decisions related to SPC projects. Customers were asked a variety of questions about the origin of their SPC project decisions including how they learned about the efficiency measures implemented, their reasons for pursuing the projects, condition of equipment replaced, how and when they learned about the SPC program, and the role and significance of third-party firms in their decision-making processes.

Non-Program Drivers

The most common way the respondents learned about the energy-efficient equipment installed, at 56 percent, was through previous installation or other prior self-knowledge. As shown in Exhibit 5-5, over a third of respondents said that a utility representative, contractor/vendor, or third-party electricity supplier informed them of the energy saving opportunity pursued in the SPC program.

Exhibit 5-5
How 2003 SPC Participants Learned about the Equipment They Installed



As shown in Exhibit 5-6, respondents were asked to describe the reasons that led to their decision to install the measures included in the SPC applications. By far the most common response, cited by 88 percent of those surveyed, was the need to reduce energy costs or energy demand. This is consistent with results from prior years. Getting a rebate was the second most common response, at 24 percent. Only 20 percent cited the need to replace older equipment as a major reason.

Exhibit 5-6
Reasons for SPC Project Installation

Reason to Install	Percent
Reduce energy costs or energy demand	88%
Get rebate	24%
Replace outdated equipment	20%
Improve measure performance	12%
Gain more equipment control	8%
Acquire latest technology	8%
Protect the environment	4%
Total (multiple responses permitted)	25

Exhibit 5-7 shows that 36 percent of the measures installed by the 2003 program respondents consisted of replacing fully functional existing equipment that had problems. Another 36 percent were installing ancillary measures, such as variable speed drives (VSDs). Relatively few customers reported replacing equipment that had actually failed.

Exhibit 5-7
Condition of Equipment Replaced through Program

Reason to Install	Percent
Existing equipment functional but with problems	36%
N/A ancillary equipment installed (VSDs etc.)	36%
Existing equipment fully functional	16%
New equipment installed but no replacement	12%
Existing equipment failed/ non-functional	4%
Other	4%
Don't know/refused	4%
Total (multiple responses permitted)	25

Effect of the Energy Crisis on Energy Efficiency Activities

The survey also asked respondents whether California's 2001 energy crisis affected their decision to install the energy efficiency equipment. Eighteen of the twenty-five respondents (72 percent) said that the energy crisis had impacted their decision. Generally, they reported that rising energy costs and increased fear of blackouts made it possible to get energy efficiency projects approved by management that would not have proceeded otherwise. Two respondents from the government sector said that the crisis led to new policies and larger budgets to encourage the purchase of energy-efficient equipment.

In addition, 60 percent of respondents reported that they had installed, or were in the process of installing other energy efficiency measures as a result of the energy crisis. One quarter reported implementing demand response measures or implementing other demand reduction strategies as well. One respondent said that they switched off their interruptible rate because the interruptions during the day were costing more than the tariff was saving them.

Sources of Program Awareness

Utility representatives were customers' main source of initial information about the SPC program, which is consistent with results from prior years (see Exhibit 5-8). Nearly half of the 2003 respondents cited their representative as their initial source of program information. Several customers (12 percent) cited unregulated electric suppliers as their primary source of program awareness. In 2002, only 3 percent of respondents cited this as a source. Unregulated electric suppliers still provide 36 percent of California's industrial electric load and 15 percent of the state's large commercial load.[17]

Exhibit 5-8
How Customers Learned about Program

Where Heard About Program	Percent
Utility representative	48%
Vendor/Contractor	24%
Unregulated electric supplier	12%
Self-knowledge/ education	8%
Previous participation in SPC	4%
Energy efficiency program (non-utility)	4%
Total Responses	25

The survey also included questions to gauge the affect of utility auditing programs on the SPC Program participation. Seven of the 25 respondents (28 percent) reported that they had received an audit from their utility in the past 3 years. Of the 7 who had received audits, 2 reported receiving the audit in 2004, 2 reported 2003, and 3 could not recall the year. Two respondents said that they had implemented audit recommendations through the SPC program. One customer was implementing electrical submersible pumps in PY2004. The other implemented a lighting retrofit through the SPC but did not recall which year.

[17] California Public Utilities Commission, Direct Access Service Request Summary Report, March 15, 2005. http://www.cpuc.ca.gov/static/industry/electric/electric+markets/direct+access/00thru05.htm

The Influence of Third Party Firms

The percentage of EESP-sponsored applications among customers in the SPC interview sample increased in 2003 compared to recent years. As shown in Exhibit 5-9, 40 percent of 2003 respondents used an EESP to sponsor their SPC application, which is double the 2001 and 2002 figures. In 55 percent of the cases, the customer reported that the EESP initiated contact with them regarding this project. Note, however, that for the population as a whole, the percentage of EESP-sponsored projects increased only slightly between 2002 and 2003 from 23 percent to 29 percent.

We also asked customers who used third-party firms to rate the significance of the overall value of the services provided by the firm for their decision to install the SPC-related measures. The results are presented in Exhibit 5-10. Overall, they found the third-party services to be valuable, with 80 percent of customers who used EESP sponsors rating the contribution as either very significant or somewhat significant. Only 20 percent believed the third-party firm's role was somewhat insignificant. Customers usually reported that the EESP helped with the savings calculations and program paperwork. In some cases the EESP made them aware of the program, conducted audits, or did design work. Note that only EESP-sponsored customers and self-sponsoring customers who reported substantial assistance from an EESP were asked the question regarding the significance of the third-party in their decision-making process.

Even many respondents who did not use an EESP as a sponsor still made use of third-party contractors for their SPC program projects. As discussed above, 53 percent of the self-sponsors also received some assistance from a third-party firm to implement their projects. While all described this third-party assistance as "limited" in nature, nearly half said that a third-party firm had either given them the idea for the project or had convinced them to install the equipment.

Customers were asked to select an option that reflected the role third-party firms played in their decision to install the energy efficiency equipment. Responses to this question are shown in Exhibit 5-11, both overall and by sponsorship type. Almost half reported having developed the project ideas and pursued installation themselves. Among self-sponsors, this figure rises to 53 percent. Another 24 percent said that a third party was responsible for developing the idea, but that they decided on their own to pursue installation. Roughly 28 percent said that a third party was responsible for actually convincing them to pursue implementation of the projects. As would be expected, all answers differ considerably when segmented by sponsorship.

Exhibit 5-9
Self Reported EESP-Sponsorship Among Evaluation Sample 2001-2003

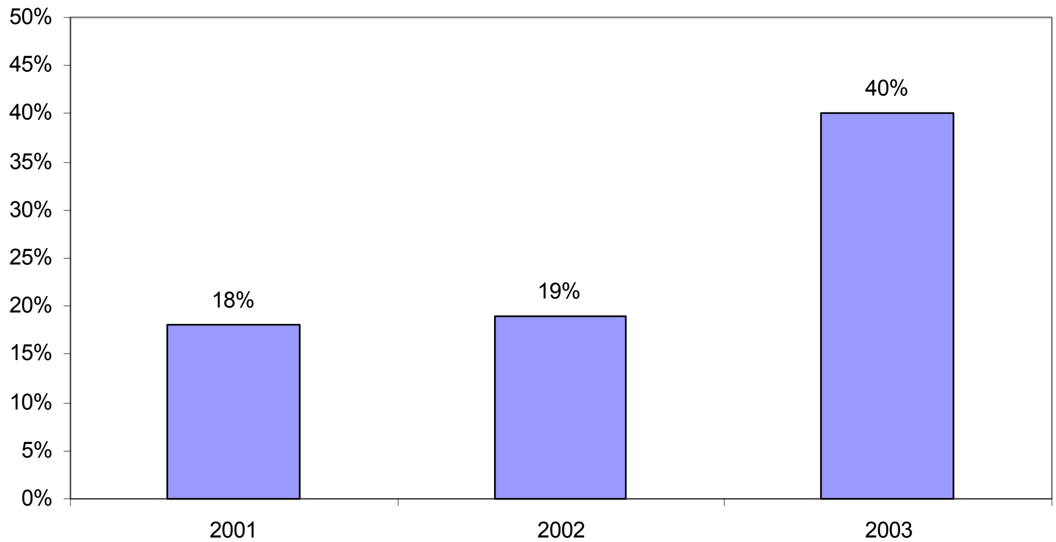


Exhibit 5-10
Significance of Third-Party Firm Services in Decision to Install SPC Projects

Significance of EESP Sponsor	Percent
Very significant	40%
Somewhat significant	40%
Somewhat insignificant	20%
Very insignificant	-
Total Responses	10

Exhibit 5-11
Role of Third-Party Firms in Project Decision-Making

Project Decision-making	EESP Sponsor	Self Sponsor	Percent
Own idea and own decision to install	40%	53%	48%
Third-party gave idea but own decision to install	20%	27%	24%
Third-party gave idea and convinced us to install	40%	-	16%
Own idea but third-party convinced us to install	-	20%	12%
Total Responses	10	15	25

The survey also asked the respondents who had relied heavily on an EESP whether they had worked with them before and whether they would work with them again. Five of these respondents had worked with their EESP or third-party contractor before and four said that they would work with them again. Reasons for not working with them again included unhappiness with contractor installations or with contractor costs, recognition that future work could be done with in-house resources, and company policies that encourage the use of a variety of contractors.

SPC Program Influences on Decision-Making

The survey asked the respondents several questions about their decision-making process for implementing the energy-efficient projects and the influence of the 2003 SPC program on these decisions. As shown in Exhibit 5-12, about half of 2003 respondents had heard about the SPC program before first looking at installing the equipment. This was down slightly from 2002 (64 percent).

Exhibit 5-12
When Participants Heard About the Program

When Heard About SPC?	Percent
Before first looked at installation	52%
After had begun researching	28%
Same Time	8%
After had decided to install	8%
Don't Know/ Refused	4%
Total Responses	25

Customers were asked two key questions centering on the role of SPC incentives in their decision to implement the projects included in their program applications. The first question phrases the influence of the incentives in terms of their significance, while the other question is phrased in terms of what they would have done had the incentives not been available. These questions are part of the series of questions used to calculate the net-to-gross ratios, which are presented in Section 5.5 of this report.

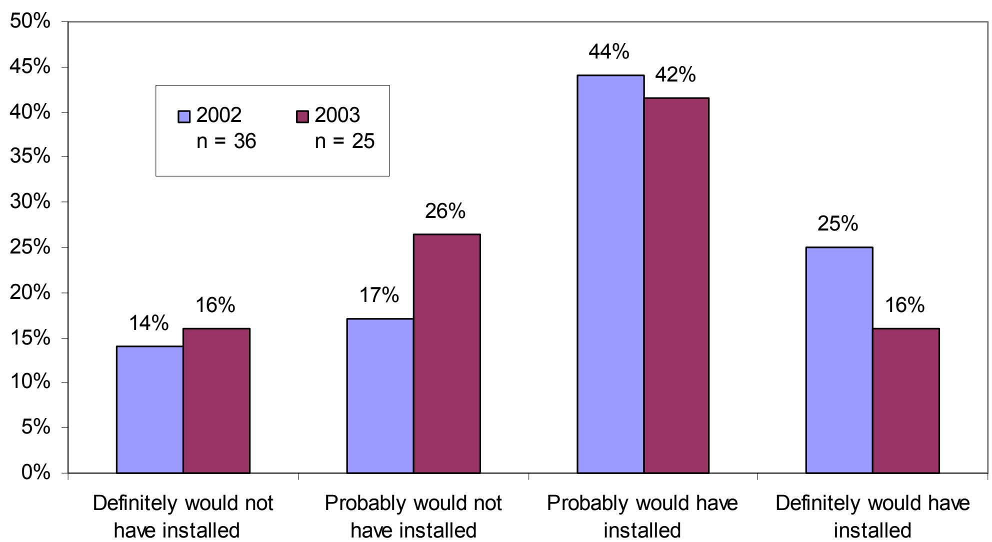
As Exhibit 5-13 shows, a large majority of the respondents said that the financial incentives were influential. The 60 percent of 2003 respondents who said that the influence of the financial incentives was "Very Significant" was nearly double what the 2002 respondents had reported (31 percent). Several 2003 respondents commented that the SPC program financial incentives improved the project paybacks or returns-on-investment enough that projects received managerial approval that would not have proceeded otherwise.

Exhibit 5-13
The Influence of SPC Program Financial Incentives on Decision to Install

Influence of Program Incentives	Percent
Very significant	60%
Somewhat significant	24%
Somewhat insignificant	8%
Very insignificant	8%
Total Responses	25

When asked whether they would have installed the energy-efficient equipment without the SPC program influences (including both financial incentives and any EESP assistance), over half said that they would have either "Probably" or "Definitely" installed the equipment without the program. As illustrated in Exhibit 5-14, this is a higher level of program attribution than was given for the 2002 program, and is more consistent with 1998 through 2001 results.

Exhibit 5-14
Likelihood of Installation without SPC Program
Program Year 2003 versus 2002



All respondents were also asked what type of equipment they would have installed in absence of the program. As presented in Exhibit 5-15, respondents who had said that they either "Probably" or "Definitely Would" have installed the equipment without the program were likely, at 60 percent, to report that they would have installed equipment that was as efficient anyway. They also were very likely to report that they would have installed some type of equipment within 6 months of actual installation. (See Exhibit 5-16)

In contrast, all of the respondents who said that they "Probably" or "Definitely Would Not" have installed the equipment in the absence of the program reported they would not have installed anything in the near future, regardless of efficiency; 40 percent indicated that they might install the same or similar equipment in 2 or more years.

Exhibit 5-15
Likelihood of Same Efficiency without 2003 SPC Program

Likelihood of Same Efficiency Without Program	Likely to install anyway	Unlikely to install anyway	All Respondents
Probably NOT as efficient	7%	10%	8%
Probably as efficient	60%	-	36%
Not applicable for measure (e.g. VSD)	33%	-	20%
Less efficient equipment	7%	-	4%
Would not have installed anything	-	90%	32%
Total Responses	15	10	25

Exhibit 5-16
Timing of Project Without 2003 SPC Program

Timing of Project Without SPC Program	Likely to Install Anyway	Unlikely to Install Anyway	All Respondents
Same time or within 6 months	80%	-	48%
Within two years	7%	-	4%
Two to three years later	7%	10%	8%
Four or more years later	7%	30%	16%
Never	-	40%	16%
Don't know/refused	-	20%	8%
Total Responses	15	10	25

5.3 SATISFACTION WITH THE PROGRAM AND PROGRAM PROCESSES

In this subsection, we present responses to questions concerning the implementation of the 2003 SPC Program. The questions examined satisfaction with the SPC program as a whole, as well as participant satisfaction with specific program attributes. These questions were generally asked on an open-ended basis. They are also broadly similar to the implementation questions asked of EESPs, presented in Section 6.

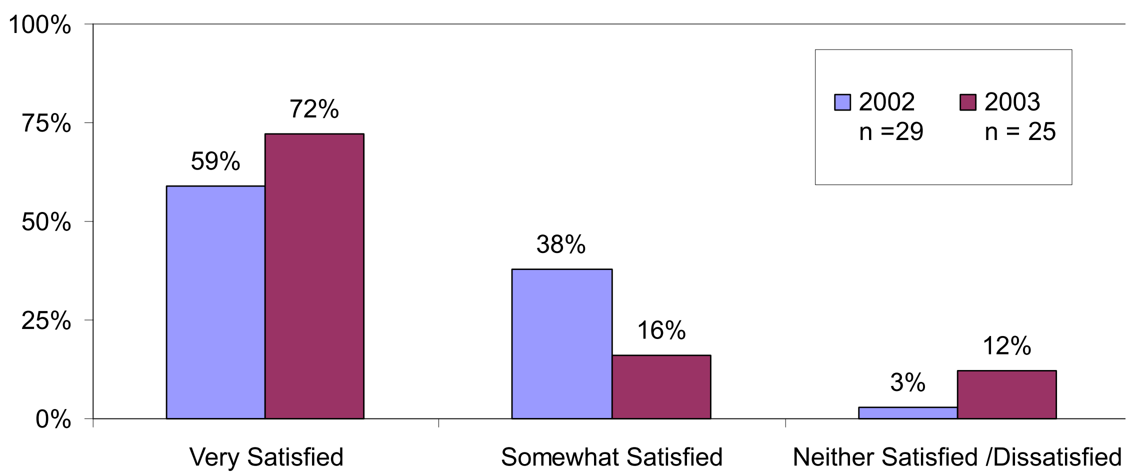
The topics covered include:

- Overall satisfaction with the program
- Program strengths and weaknesses
- Incentive structure and payment processing
- Usefulness of program tools and supporting materials
- Opinions on program management staff.

Overall Program Satisfaction

The survey asked participants to rate their overall satisfaction with the program on a scale of 1 to 5, where 1 meant they were very satisfied with the program or process, and 5 meant they were very dissatisfied. In general, respondents were highly satisfied with the program and gave it very positive overall satisfaction ratings. A large majority (72 percent) of the responding participants reported being very satisfied with the 2003 SPC program, giving the 2003 SPC program a 1 on the 1 to 5 scale (Exhibit 5-17). No respondent reported being dissatisfied with the program.

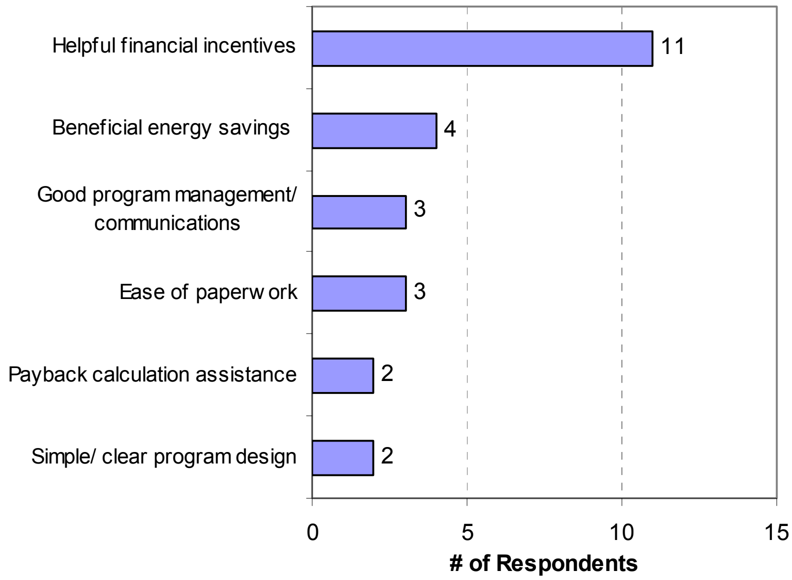
Exhibit 5-17
Overall Program Satisfaction Program Year 2002 versus 2003



Program Strengths and Weaknesses

All the respondents were asked to express what they thought were the strengths and weaknesses of the program. Exhibit 5-18 and Exhibit 5-19 show program attributes that were cited by more than one respondent.

Exhibit 5-18
Positive 2003 SPC Program Attributes Cited by Multiple Respondents
(multiple responses allowed)

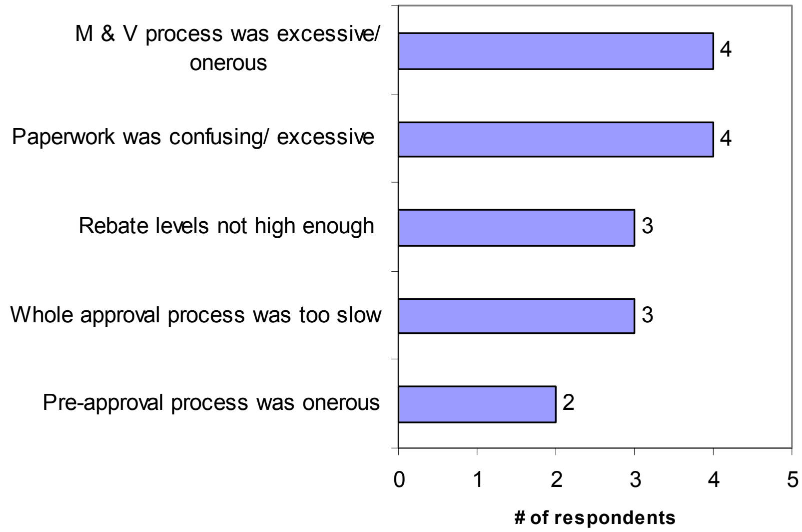


As would be expected, by far the most common strength mentioned was the direct financial value of the incentives (73 percent). The next most cited benefit was the increased energy savings (27 percent). Several respondents commented on the ease of paperwork and clear program design, which testifies to program administrators' efforts to streamline the application and M&V processes over the seven-year history of the program.

Other positive program attributes that were only mentioned by one respondent include the quickness of the program approval process, the quickness of the rebate payment process, and the relative ease of the measurement and verification process.

Only five, or 20 percent, of respondents offered opinions on the program's weaknesses. The most common area of complaints concerned the difficulty in satisfying the M&V and/or the paperwork required by the program (note that measurement is only required of a small fraction of program participants). As would be expected, three of these respondents said that the rebate levels were not high enough.

Exhibit 5-19
Negative 2003 SPC Program Attributes Cited by Multiple Respondents
(multiple responses allowed)



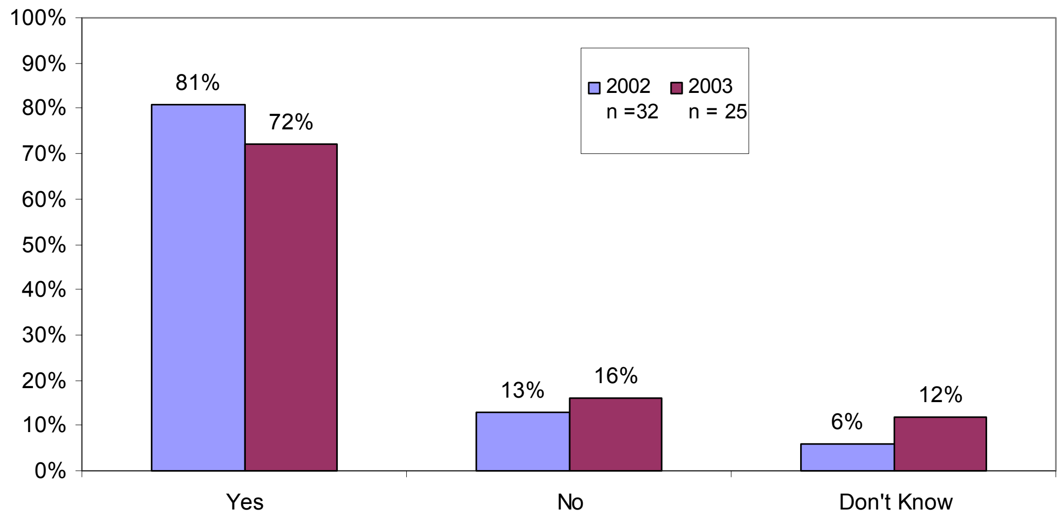
Negative program attributes cited by a single respondent include difficulty locating appropriate contacts for program information, the inability to fill out rebate applications on-line, the inability to use email for official program communications, unclear measure eligibility guidelines, and energy savings calculation methodologies that do not account for changing equipment operating conditions.

Rebate Structure and Payment Processing

The respondents were also asked to comment on the current incentive structure of the program. Most respondents were satisfied with the current structure and did not provide suggestions for improvements. However, a few respondents had recommendations for improvements. Two respondents recommended that incentives be paid for more than 50 percent of project costs. One respondent indicated that more incentive funding should be made available for the SPC program so that customers who start projects later in the program cycle will have access to funding. This may be due to the fact that the funding has been subscribed relatively early in the program year in past years. With the increased funding for programs in PY2004-2005 and planned for PY2006-2008, this is less likely to be a problem in the future.

The survey also queried participants on whether program payment procedures and the timing of payments were reasonable. A large majority of the surveyed 2003 SPC program participants reported that they were reasonable. Exhibit 5-20 presents their responses and compares them to responses from 2002 SPC program participants.

Exhibit 5-20
Reasonableness of Payment Procedures and Timing of Payments
Question P5a: Please describe your experiences with the payment process for your SPC projects. Are payment procedures and timing of payments reasonable?



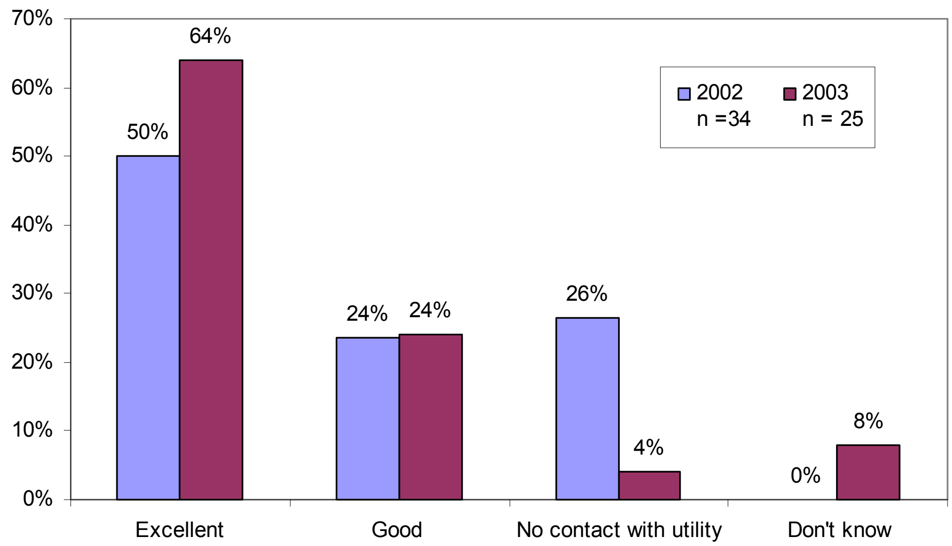
Two of the 2003 respondents who did not think the payment procedures were timely were in the government sector. Both said that the unique way that government contracts are structured makes it especially difficult to wait so long to receive the incentive payments.

Opinions on Administration

Customers were also questioned about their experiences with the utility or the utility's administrative representatives. Most reported a very good experience overall. Exhibit 5-21shows that nearly two-thirds of 2003 respondents rated their experience with the program staff as "Excellent." Several respondents provided additional positive comments either mentioning the name and helpfulness of their SPC contact specifically, or generally saying that the utility was helpful and supportive. None of the 2002 or 2003 respondents reported having a poor experience with the utility staff.

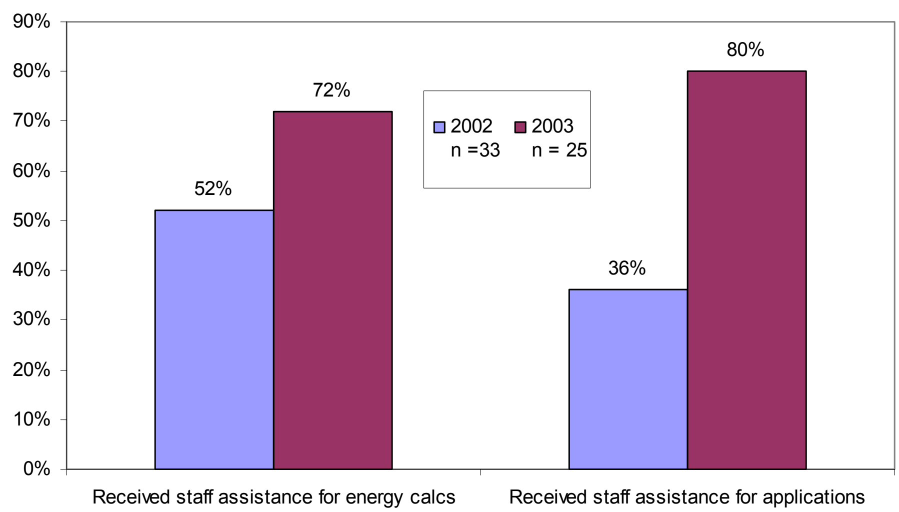
There were three respondents who reported dealing with more than one utility as part of their SPC application. In each case, they reported a consistent experience across utilities.

Exhibit 5-21
Overall Program Experience with Utility Program Staff



The 2003 SPC program participants interviewed were also asked specifically whether they had received assistance from the utility staff for performing energy savings calculations or filling out the SPC program project application forms. A very high percentage of the 2003 respondents sought staff assistance for these tasks. As Exhibit 5-22 shows, program staff resources were utilized much more by 2003 respondents than those interviewed from the 2002 program.

Exhibit 5-22
Use of SPC Program Staff Assistance PY 2002 vs. PY 2003



As would be expected, 2003, EESP-sponsored respondents were less likely to have sought SPC program staff assistance compared to self-sponsored respondents (60 percent versus 93 percent). However, there was virtually no difference between the two participant groups when it came to using the program staff for help with energy savings calculations. Seventy percent of the 2003 EESP-sponsored respondents sought this help compared to 73 percent of the 2003 self-sponsored respondents.

The survey asked respondents whether they had interacted with the SPC program's technical support contractors. Only nine (36 percent) of the 25 respondents said that they had. All nine rated their experience with the technical contractors as "Excellent" or "Good." The few verbal comments about the technical contractors were universally positive.

The survey also asked 2003 respondents whether the SPC utility program staff could provide any additional types of useful assistance. Nine of the respondents did provide suggestions for improving program staff services. These included:

- Perform more audits to help customers identify energy efficient projects (2 respondents),
- Don't require multiple inspections of a single project (1),
- Get involved earlier in the project design phase (1),
- Make it easier to get lists of engineers who can help with SPC calculations (1),
- Do more promotion of the SPC program via utility representatives (1),
- Provide participants with more information about other utility incentive programs (1),
- Use more complex modeling for the calculation of energy savings (1), and
- Communicate more frequently with participants (1).

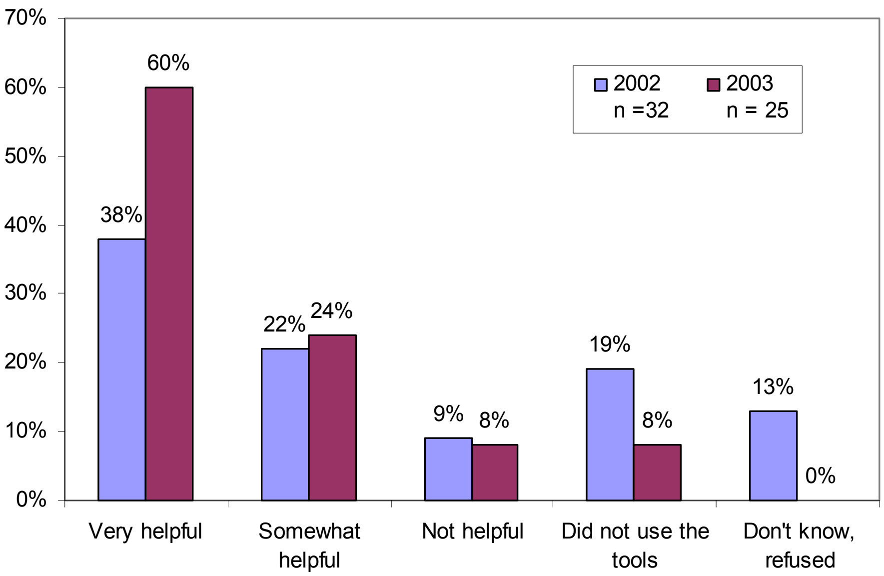
Program Tools

We asked respondents a battery of questions about their use of specific tools offered by the program including the SPC program savings calculator or the program website. The survey asked respondents to rate the helpfulness of the savings calculator and the program website overall. As shown in Exhibit 5-23, 60 percent of the 2003 respondents found the program tools to be very helpful; a large increase over the rating given by the 2002 respondents.

Forty percent of the 2003 SPC program participants interviewed made use of the SPC program website. This was down from the usage level in 2001 (63 percent). However, all verbal comments from 2003 respondents concerning the website were positive.

Only 24 percent of respondents had used the savings calculator, which is similar to the usage level in 2002 (21 percent). The 2003 respondents gave a wide variety of reasons why they did not use the savings calculator including lack of awareness, uncertainty how to use the calculator, reliance on an EESP for savings calculations, the possession of sufficient in-house calculation tools, and the implementation of projects that were too complex for the calculator. However, the few respondents who used the calculator reported it was helpful.

Exhibit 5-23
Rating the Usefulness of the Program Tools (Savings Calculator and Website)



5.4 PROGRAM EFFECT ON FUTURE ENERGY-EFFICIENCY ACTIONS

The study of 2003 SPC program participants looked at participant spillover effects in terms of the program's effect on additional measure installations as well as any changes made to the organizational decision-making practices.

Program Effect on Future Plans for Energy Efficient Measures

Respondents were asked if they planned any additional measures as a result of participating in the program. These would include the implementation of energy efficiency projects by SPC participants that occur within or outside the program (e.g., were not implemented using SPC program resources). Theoretically, the effects of participation in the SPC program – such as increased familiarity and comfort with energy efficient technologies, greater appreciation of energy savings benefits, or new awareness of EESP resources – might cause SPC participants to implement additional energy efficiency projects they would not have implemented otherwise.

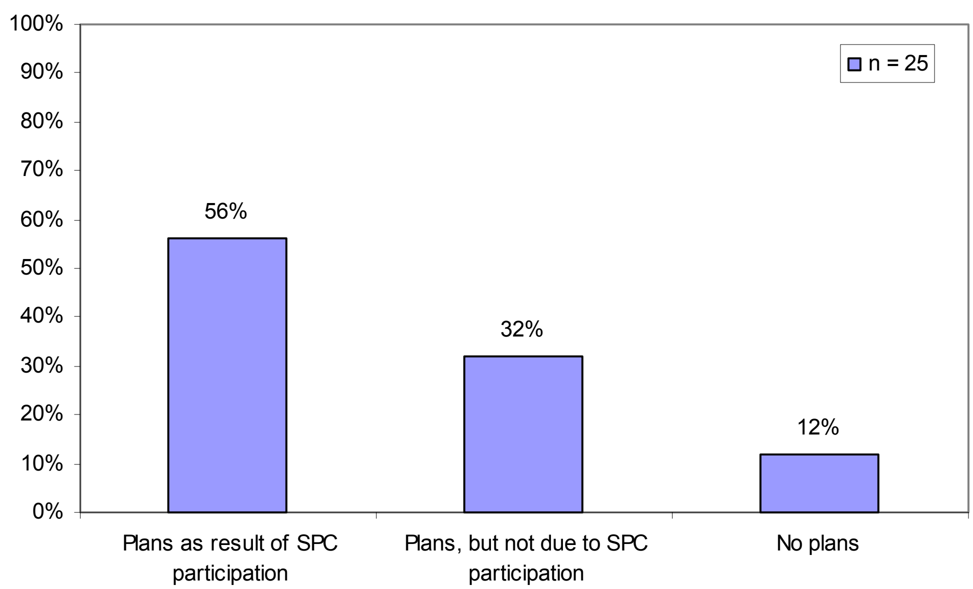
First, the survey asked the respondents whether they had already implemented any other high efficiency measures since participation in the 2003 SPC program that were not part of the 2003 program or any other utility or government energy efficiency program. Nine of the 25 respondents (36 percent) said that they had. These respondents were then asked how significant their experience in the 2003 SPC program was on their decision to install the additional energy efficiency measures. Three of the nine said that the SPC program influence was "Extremely Significant" and four others said that the program influence was "Somewhat Significant." The two others said that the program influence was "Somewhat Insignificant."

These nine respondents were also asked to elaborate on how the SPC program had influenced their decision to pursue these "spillover" projects. The three different SPC program influences mentioned included greater appreciation of the costs savings that could be gained from energy efficiency, greater familiarity with the financial tools needed to demonstrate the benefits of energy efficiency, and greater awareness of the energy efficiency technologies that were available.

The survey then asked these nine respondents why they had not sought SPC program incentives for these energy efficiency projects. Reasons cited included concern that the projects would not qualify for SPC program funding, the belief that the projects were not large enough to justify the elaborate SPC process, concern that the SPC process would take too long, and the knowledge that they already reached the limit on how much SPC program money they could receive.

All 25 survey respondents were also asked whether they planned to implement any additional energy efficiency measures elsewhere in their facility in the future. Fifty-six percent said that they did plan to install additional measures as a result of program participation. Exhibit 5-24 shows the degree to which respondents said that SPC program participation had influenced these plans.

Exhibit 5-24
2003 SPC Participant' Future Plans for Energy Efficiency Projects



The respondents who had plans for implementing additional energy efficiency projects were asked whether they planned to apply for utility energy efficiency program incentives for these projects. All of them said that they probably would, or already had, applied for program incentives.

Program Effect on Organizational Decision-Making Processes

The survey asked respondents whether participation in the 2003 SPC program had caused their organization to change the way that it made decisions about whether to implement energy efficiency projects. Five of the respondents (20 percent) said that it did. These changes in energy-related decision making included:

- Two of the respondents said that they are finding that financial analysis methods that they learned from the SPC program – such as Return on Investment (ROI) and Net Present Value (NPV) – are making it easier to sell energy efficiency projects to upper management;
- Two of the respondents now include utility program incentives in their calculations when considering future energy-related projects;
- One respondent said that his company recently formed a technical committee to review energy efficiency projects; and
- One respondent said that he would like to set up a company policy or rewards system that would encourage investment in energy-efficient equipment. He wondered whether the SPC program staff might have suggested language for such a policy.

5.5 NET OF FREE RIDERSHIP RESULTS FOR 2003 EVALUATION SAMPLE

This section presents the results of estimated free-ridership for the 2003 SPC customer sample. Weighted results for the combined 2002 and 2003 samples are provided in Section 6 of this report. The free ridership data are used to provide an estimate of the percentage of the immediate, gross first-year savings that would have occurred in the absence of the program. The method used to calculate free ridership is based on self-reported information provided in response to the battery of questions included in the telephone interviews that addressed:

- Significance of program incentives on decision to install measures
- Significance of any third-party assistance on decision to install measures
- Likelihood of installing high-efficiency measures in absence of the program
- Estimated time period for installation in absence of the program

In order to develop net-of-free-ridership[18] estimates, customer responses to the battery of questions are converted to numeric values, which we refer to as net-of-free-ridership values (NFRV). Detailed net-of-free-ridership ratios are then calculated for each site included in the analysis. Note that this method has been used extensively as part of previous utility program impact evaluation for programs that require site-specific free ridership and net-to-gross (NTGR)

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[18] Note that we differentiate net-of-free-ridership from net-to-gross. Net-of-free-ridership values account for only free ridership-related effects. Net-to-gross incorporates both free ridership and spillover.

calculations and are consistent with the CADMAC impact evaluation protocols.[19] The results are weighted and adjusted for spillover and self-report bias in order to establish the program NTGR.[20]

Methodology Used to Calculate Net Savings

Initial net-of-free-ridership values were assigned on the basis of customer's responses to three questions: the *significance of program incentives*, the *significance of EESP services*, and the *likelihood of installing anyway* questions.

Exhibit 5-25 presents the values assigned to the significance of program incentives and EESP services in the 2003 results. [21]

Exhibit 5-25
Assignment of Net-of-Free-Ridership Values for Significance of Program

Significance	Assigned Value	Significance of Incentive (n=25)	Significance of EESP Services (n=10)
Extremely Significant	1.0	60%	40%
Very Significant	0.667	24%	40%
Somewhat Significant	0.333	8%	20%
Insignificant	0.0	8%	--

We defined the program significance as being equal to the maximum value of the response to questions about the significance of incentives (survey question number PD6c) and significance of EESP services (PD6a). This value was then averaged with the value assigned to the likelihood of installing anyway question (PD7a), as shown in Exhibit 5-26, to create the initial net-of-free-ridership value, called NFRV1.

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[19] For a discussion of issues related to estimating net-to-gross ratios and free ridership using participant self-reports see *Quality Assurance Guidelines for Statistical, Engineering, and Self-Report Methods for Estimating DSM Impacts*, prepared for the California Demand Side Management Measurement Advisory Committee: The Subcommittee on Modeling Standards for End Use Consumption and Load Impact Models, April 1998. See also CADMAC evaluation protocols at http://www.calmac.org/cadmac-protocols.asp

[20] For more information on the methodology used to adjust for spillover and self-report bias to establish net-to-gross ratios for the SPC program, see XENERGY, 2001. *Improving the Standard Performance Contracting Program: An Examination of the Historical Evidence and Directions for the Future*. Note that although this report recommends a small adjustment for the potential downward bias in the self-report method, it does not recommend that an alternative approach be employed for large nonresidential site evaluations (because alternative methods have more significant limitations for these types of projects).

[21] For the entire battery of questions used in the free-ridership calculations, we allowed multiple responses for those customers who had more than one project under the 2002 NRSPC. In cases where the responses were substantially different by project, the response by project was recorded. As a result, the total number of customer projects used to calculate the preliminary NFRV is 39.

Exhibit 5-26
Assignment of Net-of-Free-Ridership Values for Likelihood of Installing in Absence of Program

Likelihood of Installing Anyway (PD7a)	Assigned Value	Percent (2002) (n=25)
Definitely Would Not Have Installed	1.0	16%
Probably Would Not Have Installed	0.667	26%
Probably Would Have Installed	0.333	42%
Definitely Would Have Installed	0.0	16%
Don't Know	-	-

Once NFRV1 was determined, each project was examined regarding the level of efficiency or number of measures the customer intended to install in the absence of the program, such as those cases where a customer said they would have installed equipment of lower efficiency or installed high-efficiency equipment at fewer sites (PD8 or PD9a, see Exhibit 5-27). The adjustment ranged from 0.0 to +0.2. Adjustments were then added to NFRV1 to create the second ratio, called NFRV2.

Next, the issue of deferred free-ridership was considered. Responses to the timing questions (PD8b or PD9b) were translated, using the conversion table in Exhibit 5-27, into NFRV3.

Exhibit 5-27
Forecasted Installation Conversion

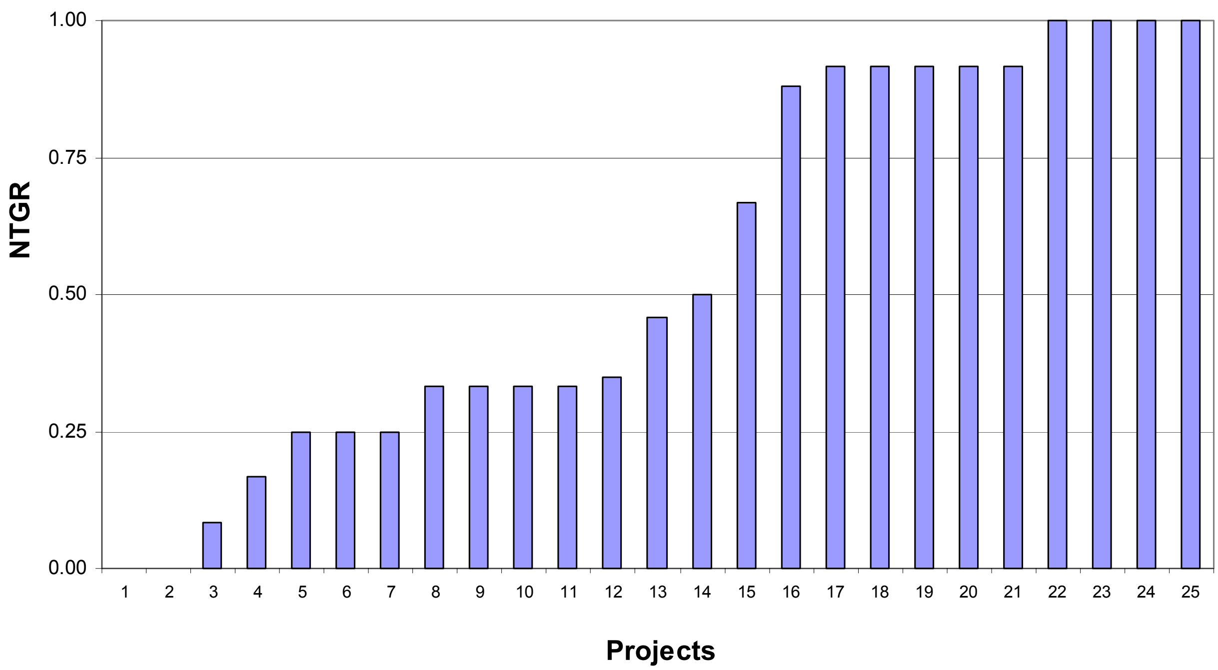
Forecasted Installation of Same Equipment (PD8b or PD9b)	Assigned Value	Percent (2002) (n=25)
At the same time	0.0	48%
Six months to one year	0.063	-
1 to 2 years	0.25	4%
2 to 3 years	0.5	8%
3 to 4 years	0.75	-
4 or more years	1.0	16%
Never	1.0	16%
Don't know	-	8%

Lastly, NFRV2 and NFRV3 were averaged to create the final NFRV. In addition, all cases of inconsistency or response discrepancy as well as all large projects were reviewed to ensure that the final net-of-free-ridership values were as accurate and reliable as possible. Minor adjustments, if necessary, were made based on other responses in the net-to-gross sequence.

Estimate the 2003 Free Ridership

The *unweighted* average net-of-free-ridership value for the 2003 SPC sample is 0.6, representing 25 distinct projects. The range of values calculated across the sampled customers for 2003 is shown in Exhibit 5-28. The free-ridership estimates were then weighted to more accurately reflect the participant population as a whole (ex ante weights were used). The weighting was done to adjust for the effect of the energy savings for different projects and the sampling stratification presented in Section 2; projects with higher kWh savings received heavier weighting, projects with lower kWh savings were weighted less. A ratio estimation approach is used to develop the weighted results. The approach used is consistent with the requirements of the CADMAC evaluation protocols and the ratio estimation methods described the Chapter 13 of *the 2002 Evaluation Framework Study* (TecMKT Works, 2004). For the 2002 SPC, the weighted net-of-free-ridership value is 0.59.

Exhibit 5-28
Range of Net-of-Free-Ridership Values across Sampled 2003 Projects



The 2003 value is compared to the estimated values from previous evaluations (1998 through 2002) in Exhibit 5-29. As shown in the Exhibit, these net-of-free-ridership values have varied somewhat throughout the history of the program but have stayed within a fairly narrow range between 0.40 and 0.65.[22] In Section 7 of this report, because of the relatively small sample for 2003, we combine the 2003 and 2002 samples and populations to produce a weighted net-of-free-ridership results and estimated net-to-gross ratio for the combined program years.

[22] See Quantum 2004 and other previous SPC evaluation reports for discussion of the reasons for free ridership as well as the issues associated with the estimation process.

Exhibit 5-29
Net of Free-Ridership Ratios, 1998-2003

(1 – Free Ridership)	1998	1999	2000	2001	2002	2003
Weighted	0.53*	0.51	0.41	0.65	0.45	0.59
Unweighted	0.49	0.48	0.46	0.55	0.45	0.60

*Weighted by incentives rather than by kWh savings.

6. 2003 ENERGY-EFFICIENCY SERVICE PROVIDER PARTICIPANT INTERVIEWS

This section provides a detailed summary of information collected from in-depth interviews with energy-efficiency service providers (EESPs) regarding the PY2003 Nonresidential Standard Performance Contract (SPC) program. EESPs sponsor SPC projects for customers and play a central role in marketing, developing, and implementing energy-efficiency projects. This section contains the following subsections:

- Types of Firms Interviewed
- Perceived Strengths and Weaknesses of Program
- EESP Satisfaction
- Use of SPC Calculator and Website
- EESP Use of Incentives
- EESP Versus Customer Sponsorship
- Calculated Versus Measured Savings
- Potential Market Effects
- EESP Interview Conclusions

Interviews were conducted with 14 EESPs that participated in the 2003 SPC Program. Almost all had also participated in the SPC program in other years.

6.1 TYPES OF FIRMS INTERVIEWED

The interviewed 2003 participants encompassed a variety of business types. They included 9 EESPs, 2 equipment vendors, 2 traditional ESCOs, and 1 retail energy services company. Participants said they had been providing energy efficiency services for anywhere from 3 to 25 years, with an average of 13 years.

Participating EESPs ranged in size from 2-person operations to large ESCOs and the local sales offices of multinational building automation equipment manufacturers and large energy companies with up to 400 employees nationwide. On average, the participating EESPs interviewed had 57 employees in California, although this average was skewed by three firms with 100 or more employees.

- Six respondents said they do business nationally or internationally, although several emphasized that most of their business was in-state.

- Another six do business statewide, including several who also do business in other western states

- Two companies said they do business only in Southern California.

6.2 PROGRAM STRENGTHS AND WEAKNESSES

The most often cited strength of the SPC program was simply that the availability of funding allows customers to implement projects that otherwise would not meet payback criteria. Several other strengths were mentioned.

- The program is flexible in that it covers a variety of measure and technologies.
- The participation process is straightforward, especially when calculated savings are used.
- Program administrative staff and consultants are generally helpful and responsive, although there were some differences noted among utilities and contractors.

Regarding program strengths, respondents commented that:

- “SPC is the best utility program period, but that does not mean that there can't be improvements. We are very satisfied with the structure and concept of the program, and dissatisfied and frustrated with some of the aspects of the administration. We want to keep building the program.”
- “It’s working very well. There are a couple of things that can be improved, but they are minor issues and basically the program works. It’s the right level of complexity for the types of projects, it has a fair amount of flexibility, every time I submit things not covered by the Calculator, there is an appropriate level of working back and forth with the utility contractor.”
- “Strength is the structure of the program, the fact that it is flexible, we can identify measures that may not fit within a specific category. The fact that it is a standard program means that there is not a preference for one ESCO versus another; it’s open to all vendors suppliers and customers.”
- “The strength is the incentive to influence paybacks basically and maybe you want something more granular than that but that’s bottom line. Money to improve incentives. Improve paybacks.”

The most often cited weakness was the limited and unpredictable availability of funding. EESPs say funding limits hamper consistent marketing of SPC-funded projects and encourage EESPs to offer rebates as “icing on the cake” instead of using the rebates to sell projects that otherwise would not meet payback criteria. Where such projects ultimately receive funding, this would clearly lead to higher levels of free ridership. Other weakness mentioned included:

- Lack of marketing and communication from program administrators to the implementers.
- The absence of a collaborative effort between the Program Administrators and the implementers.
- It takes too long to apply, to receive approval, or to receive rebate money.

- The application process is too complicated.

- The program does not adequately address HVAC.

- Some requirements and calculations were perceived to be arbitrary

- The lack of an appeals process to resolve disputes.

Regarding program weaknesses, respondents commented that:

- "My biggest complaint is that the communications are really poor between the utility, the customer and the SPC sponsor. It needs to be more open and more collaborative. Savings by Design is a more collaborative effort. SPC is not very collaborative."

- "The process was fairly smooth, but I would like to have seen more marketing to the ESCOs about the program, and it would be nice to get updates on changes, money running out, etc. An annual orientation and ongoing contact during projects would be helpful. I have never been approached by a utility to participate in the program. I have never been contacted in 10 years, or invited to a program orientation."

- "Certainly there have been years when it's been really unpredictable when it starts and you hesitate to even bring it up to a customer. If you don't know when it's going to start or you don't know when the money's going to run out. At some point in the year you just stop talking about it or a project where you expected some incentives, the money runs out and people don't know what to do. So that's probably a disadvantage- that it has a sometimes unpredictable start and duration and there's misinformation a lot of times from the reps."

- "Does not adequately address HVAC."

- "We need higher incentives, add incentives for BAS. HVAC and capital equipment replacement is not being given a large enough incentive."

Several respondents said they saw no weaknesses with the program. Similarly, when asked to describe their experiences with the 2003 program rules and requirements, most respondents said they were "reasonable," "clear" or "straightforward." The few negative perceptions related to the complexity of the process and the length of time involved in project review and payment of incentives.

About one-half of respondents thought 2003 incentive levels were reasonable or fair; the other half said they were somewhat low. Many felt that the level of HVAC incentives coupled with using the Title 20 equipment efficiency standards as a baseline, renders HVAC projects economically unattractive to customers.

6.3 EESP SATISFACTION

When asked about their overall satisfaction with the SPC program, 11 of the 13 participating EESPs who offered responses said they were very or somewhat satisfied with the program overall; the remaining two were neither satisfied or dissatisfied. Satisfied respondents attributed their satisfaction with the program to its flexibility, the streamlined application process, and the relative ease of working with calculated savings. The two who were less than satisfied said they had encountered problems with specific projects, as reflected in their comments:

- “We had problems with the only measure in the project, some of which was due to our inexperience. In the future we will let the manufacturer of the unit handle any rebate issues.”

- “The program worked out for (one project), other projects it did not work out too well. Incentive amount was not adequate; it is a little low, and incentive was not enough to make it happen.”

Eleven of the 13 respondents also said their experience with the utilities administering the program had been good or excellent, although several EESPs differentiated their rating between the two or three utilities they worked with. Satisfied EESPs offered the following comments:

- “Always had good support. No complaints.”

- “Received good service from both SCE and SDG&E.”

- “Everything went well.”

- “They did what they were supposed to do, we just weren't experienced enough to see the pitfalls in advance.”

Comments from EESPs who were less satisfied or who offered caveats to their good or excellent rating of utility performance included the following:

- “Our experience was not excellent. We would have liked them to be more proactive, did not understand the process and we were waiting - unclear that post installation inspection was required and they did not contact us. Did not get periodic checkups to see how project was progressing. Lack of support. They should be proactive and follow up.”

- “My experience was all good, except payment issues with SCE and SDG&E. And the failure to allow me to present my case to their engineers in an unbiased manner.”

- “Not as much support as in the past. Program is not being marketed to us.”

- “They have their own different interpretation, some projects they have asked for information that is probably a little over and beyond what is needed. They were unwilling to compromise.”

- I wouldn't say excellent only because there were some timeliness issues. The utility was really, really backed up.… And they told me…that one of the reasons that it took so long for them to process certain things is that they were under direction to try and perform as much of the work in-house and not use as many vendors, so when we did a job it was a lot harder to get responses and process things through the administrators.

Of those who had experience with technical assistance contractors, more than two-thirds rated that experience good or excellent, although several respondents pointed out that the quality of the technical assistance varied from contractor to contractor. Comments included:

- "You know I hate to be this ray of sunshine constantly but it's true they were excellent. Both technical support contractor companies were excellent to deal with. They were very polite, they made an appointment, they were on time. They always called back. They were easy to get a hold of."

- "There is inconsistency from contractor to contractor. Some had untrained or unqualified people reviewing the projects. Lack of experience would be a good way to say it."

- "The support contractors were very helpful, but some of them did not know what they are doing. One sent out a new kid who did not know much about the program himself. And he may not have understood what he was looking at. There was a wide variety in the experience level in the people we interact with."

- "They were handcuffed with the rules, they were willing to consider our rebuttal to their review, they really worked with us and we fell that we were treated fairly - good dialogue."

- "It's frustrating having to reeducate and teach another consulting firm our business. Different attitude with different consultants, some consultants nit pick and challenge a lot of measurements."

- "Sometimes we get into nitpicking, but we are both doing our job and it works out fine."

6.4 USE OF CALCULATOR AND WEBSITE

Participating EESPs were asked both whether they had used the savings calculator and whether they had used the SPC website. About half of 2003 participants said they had used the calculator, and approximately 70 percent had used the website. Two thirds of those who used these tools found them very helpful or somewhat helpful. Comments on the website and calculator included:

- "As websites go, yes, you can always find what you need."

- "It would be helpful if the utilities would post updates on how much money is left in a program year."

- "I would think the calculator would be very helpful for some contractors that don't have real good models themselves. So even though its not real useful to us, its not a bad tool for somebody that doesn't have another alternative."

- "Its what we use because it is what the incentives are based on."

- "We use DOE 2 models, we submit our own calculations, and we check it against the calculator."

6.5 USE OF INCENTIVE FUNDS

About 60 percent of respondents passed the incentive through to the customer completely, while a little more than one-third shared it with the customer. Only one respondent stated that they retained the incentive completely. In almost all cases, EESPs believe that customers simply use the incentive funds to reduce project cost, and that they include the incentive in their payback calculation when deciding whether or not to pursue a project.

6.6 EESP VS. CUSTOMER SPONSORSHIP

More than 40 percent of participating EESPs prefer to sponsor the applications, noting that it gives them greater control over the process and frees the customer from the paperwork. The remaining respondents were evenly split between those who had no preference and those who preferred to let the customer handle the application process as a way to minimize their own paperwork.

Regarding sponsorship, respondents commented that:

- "It's difficult to get customers to fill out any paper work - it is a monumental task. Easier if we do paper work and put it through."
- "It's a lot easier if the customer sponsors the application. Easier for the customers to transact."
- "Some companies have not honored sharing arrangements, we prefer to control the money. Sponsoring includes the responsibility to deliver savings for 5 years- some companies may move and I have to put a hold on payment."
- "Nicer to have control of the money, because we cost share. It is a lot easier to pay out than to be paid for your services."

6.7 CALCULATED VS. MEASURED SAVINGS

Most participating EESPs preferred the calculated savings approach over measured savings, and were enthusiastic about the shift to calculated savings from measured savings in previous program years.

- Benefits cited for the calculated savings approach included ease of application, prompt and complete payment, and reduced costs attributable to EM&V (which one respondent said sometimes amounted to 15 percent of the incentive amount).
- The primary drawback mentioned was that calculated savings values are somewhat conservative and may understate actual energy savings.

Regarding calculated vs. measured savings, respondents commented that:

- "Advantages: it's quick, easy, timely; drawback is that you may give up a few dollars, because calculated is more conservative."

- "Calculated provides certainty for the customer as to what the rebate is going to be. They don't have to wait to find out. Disadvantage is that the standards of calculation are not well defined. Would be good to standardize calculation approach and requirements. Too many unknowns with measured approach, calculated approach lack standardization."

- "The biggest advantage I think is that the detailed calculation gives the owner an accurate expectation of savings…. The second advantage is that it gives us good measure-by-measure targets of what to achieve as we implement the savings, so it's a lot harder to get out in left field and not know where you're at. If we've got a measuring stick to compare with then we try to watch that as we bring sub-systems on line and make sure we're achieving those goals for each of the end-users or measures on a particular project."

- "Advantage is it's simple, disadvantage is its simple. What started out as an ESCO program is now simple enough for customers to do themselves. This takes some of the value of the comprehensiveness and ESCO approach out of the program. Customers look for a limited number of measures instead of a comprehensive project."

- "The calculated approach makes more sense for the customer. Otherwise they pay us to do more work and it reduces their rebate. It keeps the cost of the project down, and the rebate amount is known upfront. More certainty in the incentive."

- "Payout on measured projects is an accounting nightmare. We like to avoid it. It's a liability on the books; an unknown that lingers too long."

6.8 POTENTIAL MARKET EFFECTS

Most respondents said the SPC program had improved their business by enabling them to incorporate the program incentives into their marketing approach. About two-thirds of respondents said the SPC program was very important to their business generally because the availability of incentives encourages projects that otherwise would not be implemented or that would be implemented later. The remainder said the SPC Program was only somewhat important or not very important to their business. Comments included:

- "It influences a large portion of the work we do."

- "It is not the pivotal sales tool, but it is always out there and customers like to hear about it. They feel like they are doing something good, if they get some money out of it they like it. Participation enhances credibility of energy savings claims."

- "We use it 100%; we do more marketing for SPC than anyone. Metals injection molders. We find technologies, we test them, we push the technologies. The utilities do not share information on what they see as good opportunities to push. Utilities do not market or share information about new and exciting areas."

- "We have 11 sales people and none of them are familiar with the program."

On average, EESPs say they include the program in their sales pitch about three-fourths of the time. About half said they incorporate it for all projects, while others decide whether or not to market the program based on the customer's needs, the suitability of the technology they offer, and the availability of funding. One EESP said his firm will only offer the program in certain utility service territories, noting that "nothing will spoil a deal greater than just mentioning a program and having it be such a pain in the neck that the customers says it will spoil the deal with them, so we'd just as soon not mention it, as though it doesn't exist. And it makes it much easier I think."

Few EESP respondents were able to offer examples of innovative or emerging technologies that had been encouraged by the program, with several pointing out that SPC financed primarily standard measures. Two respondents, however, noted that the program had allowed their clients to pursue more advanced projects.

- "We were able to apply a lot of cutting edge energy savings technologies; refrigeration related and process related energy efficiency improvements that without the rebate would still be languishing, such as floating head pressure control and VFDs on evaporator and condenser fans."

- "The program has allowed innovative measures to be included in comprehensive projects. Many of theses companies would not be doing these projects without the incentives."

Many EESPs felt that most attractive projects would eventually be implemented and that SPC incentives help make projects happen sooner or increase the scope of the project being implemented. Some respondents were unable to quantify how many projects would have gone ahead without SPC incentives, but those that were able estimated that on average about 60 percent of the projects would ultimately have gone ahead without SPC incentives. Comments offered by respondents included:

- "The incentives help us get jobs and it reduces the cost for the clients to do the job. The ROI is better, it was increased a little bit, the payback would go from 2 years to 1 year, and instead of 50% of the customers doing the project, 90% would do the project. One year payback projects are quickly adopted, 2 or more year payback projects take a long time to move ahead."

- "(The incentives) definitely help get progress done and I don't think they overdo it because we still have to work real hard to make these projects happen; it's not like they're making the project free or a one year payback. There's still a big decision for these companies doing that but it definitely is having the desired effect of helping projects happen that might not happen without them. "

- "Unfortunately it is very obvious that when the rebates go away, people's capital spending changes, the focus shifts away from energy and it is an unfortunate reality of the market place and I don't expect it to change."

- "Most projects happen that wouldn't otherwise because it tips the economics; something that's a three our four year payback, if you can bring it in to close to two years, that's a project that's going to happen that would never happen otherwise. The other aspect is that it lets you control the timing on projects. A decent project will get done eventually in most companies, but the incentive lets it get done this year instead of three years from now. "

- "I am 100 percent positive that every job that we got a rebate on would not have happened if it wasn't for that program."

- "70-80 percent would not have happened without the SPC program. The rebates enhance the economics."

- "They would probably eventually happen. Probably with a smaller scope, but it probably would have been two or three years out when it fit in the budget, when somebody had extra capital that they wanted to allocate. I think a lot of these projects would eventually happen. It's just the incentive accelerates it to now as apposed to someday when there's extra money laying around."

6.9 EESP INTERVIEW CONCLUSIONS

On balance, EESPs participating in the SPC program were satisfied with the program, and felt that the 2003 program represented a much easier to use, more effective approach to capturing energy savings than programs in previous years. EESPs strongly favored the calculated savings approach as being easier to use, involving less uncertainty, and more effectively using program resources, even though most respondents agreed that calculated savings tend to understate actual measure performance.

The performance of both utilities and their contractors, though satisfactory overall, was perceived to be uneven, with several respondents reporting difficulty in working with individual utilities or contractors.

- For utilities, problems centered on slow payment, delays in responding to calls, and delays in the application review process created by one utility's efforts to minimize the amount of work contracted out.

- For contractors, difficulties were focused on lack of reviewer familiarity with or knowledge of the specific measures or technologies being installed.

Most EESPs have made the SPC program an integral part of their marketing efforts and even of their overall business strategy. The ability of EESPs to build the program into their marketing approaches has, however, been hampered by uncertainty regarding the availability of funds, particularly later in the program year.

While some EESPs say that all the jobs for which they receive funding would not have happened in the absence of incentives, others acknowledge that many of the EE projects would still be implemented, albeit at a later time and on a smaller scale.

7. COMBINED 2003 AND 2002 REALIZATION RATE AND NET-TO-GROSS RESULTS

In this section, we combine and weight the results from the PY2003 and PY2002 impact evaluation efforts. As discussed in Section 3, the intent of the impact evaluation component of the PY2003 evaluation was to build upon the sample developed for the PY2002 impact evaluation to produce a large combined sample across the two program years. Section 3 also presented the combined tracking system data that was used to develop the weights for the combined analysis. Both gross impact realization rates and net-to-gross ratios are estimated using the combined samples for PY2003 and PY2002

7.1 COMBINED PY2003 AND PY2002 GROSS IMPACT REALIZATION RATE

To produce the overall program realization rate, the individual realization rates for each of the sample points in both the PY2003 and PY2002 samples are weighted by the size of the savings associated with the project and the proportion of the total program savings (for PY2003 and PY2002 combined) represented by each sampling cell. The total population savings across the two program years are presented in Section 3.2. The weighting for the overall realization rate was adjusted for two factors. First, because Tier 1 had so few sample points in each end use (even when combined across the program year samples), Tier 1 and Tier 2 are collapsed by end use for the final weighting. Second, because Site 2 from the PY2002 sample is so large compared to the rest of the sites, representing 10 percent of the PY2002 population tracking savings, and is a unique process system, Site 2 is treated as its own tier (Tier 0), as it was in the PY2002 realization rate analysis. Exhibits 7-1 through 7-4 present the collapsed population and sample data used to developed the final weighted results. As noted in the 2002 evaluation report, Site 2 (PY2002) clearly stands out as an extreme outlier in the analysis as shown in Exhibits 7-5 and 7-6, which present the ex ante and ex post savings for the sample with and without Site 2 (PY2002) included.[23] Each chart also includes a unity line, which divides the results into those in which the site-specific realization rates were above one (sites above the line) and below one (sites below the line).

Exhibit 7-1
Tracking System kWh Savings for Combined PY2003 and PY2002 SPC Impact Evaluation Population by Gross Impact Weighting Stratum*

kWh strata	Lighting	HVAC/R	Process/Other	Total
Tier 0			27,179,804	27,179,804
Tier 1 & Tier 2	116,940,217	70,009,716	177,655,302	364,605,235
Tier 3	48,613,969	38,606,325	95,633,014	182,853,308
Total	165,554,186	108,616,041	300,468,120	574,638,347

*The kWh cutpoints are 2,304,383 kWh for Tier 1 and 783,395 kWh for Tier 2.

[23] See the 2002 SPC impact evaluation report (Quantum, 2005) for discussion of this site.

Exhibit 7-2
Tracking System Population for Combined PY2003 and PY2002 SPC Impact Evaluation by Gross Impact Weighting Stratum

kWh strata	Lighting	HVAC/R	Process/Other	Total
Tier 0			1	1
Tier 1 & Tier 2	66	40	88	194
Tier 3	157	166	433	756
Total	223	206	522	**951**

Exhibit 7-3
Tracking System kWh Savings for Combined PY2003 and PY2002 SPC Impact Evaluation Sample by Gross Impact Weighting Stratum

kWh strata	Lighting	HVAC/R	Process/Other	Total
Tier 0			27,179,804	27,179,804
Tier 1 & Tier 2	26,305,148	26,659,630	36,845,550	89,810,328
Tier 3	2,029,233	3,506,658	2,614,565	8,150,456
Total	28,334,381	30,166,288	66,639,919	125,140,588

Exhibit 7-4
Combined PY2003 and PY2002 SPC Impact Evaluation – Sample by Gross Impact Weighting Stratum

kWh strata	Lighting	HVAC/R	Process/Other	Total
Tier 0			1	1
Tier 1 & Tier 2	12	10	16	38
Tier 3	6	8	12	26
Total	18	18	29	65

Exhibit 7-5
Correlation of Ex Post and Ex Ante Savings (kWh) for Combined PY2003 and PY2002 Samples (n = 65) including Tier 0 (Site 2 PY2002)

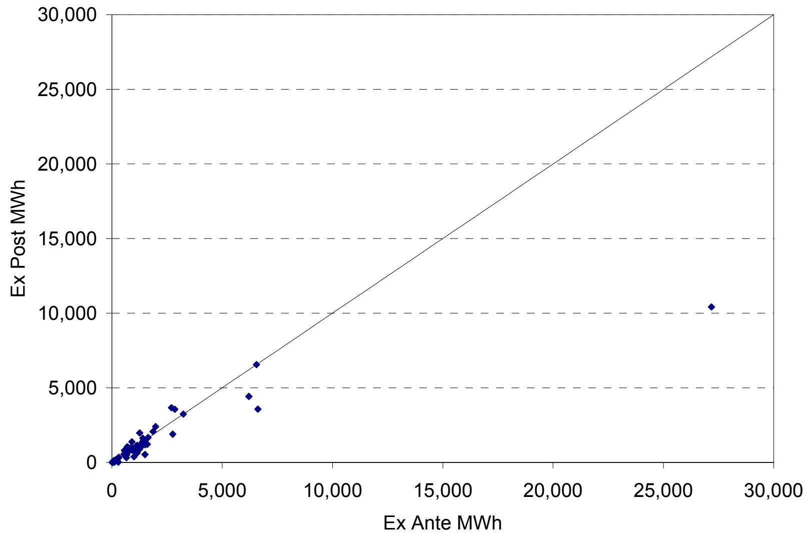
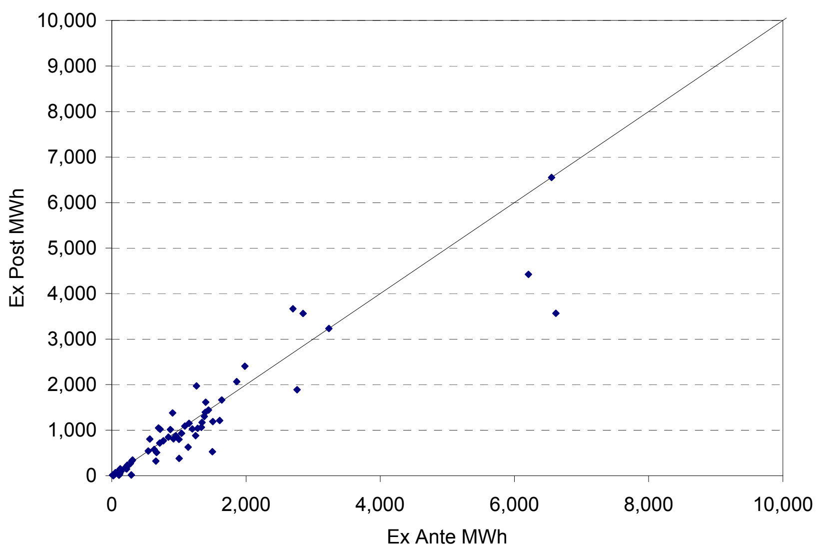


Exhibit 7-6
Correlation of Ex Post and Ex Ante Savings (kWh) for Combined PY2003 and PY2002 Samples (n = 64) excluding Tier 0 (Site 2 PY2002)



The realization rates in the final cells used for the weighting and extrapolation to the program population, as well as the overall weighted program realization rate and the associated confidence interval are show in Exhibit 7-7. Note that any sites for which the analysis was inconclusive are excluded from the calculation of the program realization rate (i.e., they are not defaulted to realization rates of 1.0). The overall weighted realization rate is 0.89. The weighted average realization rate is the primary result of interest since it captures the relative contribution of different sized projects and end uses to overall program savings. The combined PY2003-PY2002 realization rate is higher than the 0.79 realization rate estimated for the PY2002 program. This is attributable to several factors. First, the unweighted site realization rates were slightly higher for the PY2003 program year. Second, the magnitude of the effect of the low realization rate for Site 2 (PY2002) is reduced in the combined 2003 and 2002 analysis. Third, when the 2003 and 2002 populations were combined the boundary definitions for the savings stratum changed, which caused some sites in the samples to move from one tier to another.

The 90 percent confidence interval for the 0.89 overall program realization rate is 0.83 to 0.96. Note that the confidence interval does not capture any of the uncertainty in the ex post savings estimate. The confidence interval only captures the effect of the variation in the ex post to ex ante ratio of the sample with a finite population factor correction that reflects the population of program participants. That is, it is as if the ex post values were known precisely without measurement error. This approach used to develop the confidence interval is consistent with the requirements of the CADMAC evaluation protocols (and the methods described the Evaluation Framework Study) and is constrained by the practical limitations associated with aggregating results from complex, site-specific projects that use a variety of estimation approaches.[24] Nonetheless, as discussed in Chapter 1 and elsewhere in this report, it is important to keep in mind that the ex post savings themselves are also estimates that can have considerable uncertainty, which is not captured in the reported confidence interval for the program realization rate. It is likely that the confidence interval would be considerably wider if the uncertainty in the ex post estimates could be statistically quantified.

Exhibit 7-7
Overall Combined PY2003 and PY2002 SPC Program Gross Impact Realization Rate

Sampling Strata	Lighting	HVAC/R	Process/Other
Tier 0	--	--	0.38
Tier 1 & 2 Combined	0.92	0.96	0.88
Tier 3	0.93	0.84	0.99

Total Weighted Gross Impact Realization Rate	0.89
90 Percent Confidence Interval	0.83 to 0.96

24 As noted in the PY2002 SPC impact evaluation report, if statistical methods such as regression analysis were used on every site, it would be possible to calculate a confidence interval around each of the ex post savings estimates and incorporate this uncertainty into the confidence interval for the overall program realization rate. However, statistical methods are not used on all sites and, as a result, only judgmental estimates of uncertainty are available for some cases. With additional resources, statistical methods (including increased monitoring efforts) could be utilized on more sites in future evaluations; however, the site-specific aspects of the SPC program make it unlikely that a complete quantitative roll-up of site-level uncertainty could be achieved. Nonetheless, this is an important issue that should be investigated further in future SPC evaluations, particularly, when additional resources are available for ex post monitoring activities.

7.2 COMBINED PY2003 AND PY2002 NET-OF-FREE-RIDERSHIP AND NET-TO-GROSS RATIOS

To produce an estimate of net-of-free-ridership for the combined program years, the individual realization rates for each of the sample points in both the PY2003 and PY2002 samples are weighted by the size of the savings associated with the project and the proportion of the total program savings (for PY2003 and PY2002 combined) represented by each sampling stratum. Note that for the net-of-free-ridership analysis, only the size of total SPC savings for each customer was used in the sampling strata, end use was not included. The sampling strata used for the combined net-of-free-ridership analysis are shown in Exhibits 7-8 and 7-9. Applying the same ratio estimation weighting approach referenced previously, the resulting weighted net-of-free-ridership estimate for the combined program years is 0.48. Exhibit 7-10 provides the net-of-free-ridership values by tier along with the 90 percent confidence interval.

Exhibit 7-8
Tracking System kWh Savings and Population Size
for Combined PY2003 and PY2002 SPC Impact Evaluation Population
by Final Net-of-Free-Ridership Weighting Stratum

kWh strata	kWh	Population
Tier 0 and 1	208,695,482	52
Tier 2	183,089,557	143
Tier 3	182,853,308	756
Total	574,638,347	951

Exhibit 7-9
Tracking System kWh Savings and Sample Size
for Combined PY2003 and PY2002 SPC Impact Evaluation Sample
by Final Net-of-Free-Ridership Weighting Stratum*

kWh strata	kWh	Sample Size
Tier 0 and 1	69,704,576	12
Tier 2	32,653,244	23
Tier 3	7,639,438	26
Total	109,997,258	61

*36 PY2002 sites plus 25 PY2003 sites.

Exhibit 7-10
Overall Combined PY2003 and PY2002 SPC Program Net-of-Free-Ridership Ratio

Sampling Strata	Net-of-Free-Ridership Ratio
Tier 0 and 1	0.43
Tier 2	0.49
Tier 3	0.54

Total Weighted Net-of-Free-Ridership	0.48
90 Percent Confidence Interval	0.42 to 0.55

In recent years, in order to convert the weighted net-of-free-ridership values into a net-to-gross ratio for the program, net-of-free-ridership estimates have been adjusted for self-report bias and spillover. A 2001 SPC evaluation study recommended adjustments to correct for these factors based on the following:[25]

- **Self Report Bias.** The study found that there appeared to be a downward bias associated with using the self-report approach and recommended a minimum upward adjustment of 0.10 to account for bias in the self-report technique.

- **Spillover.** Participant spillover is often defined as any additional energy efficiency measures installed as a result of the program influence, but which did not receive program incentives. The 2001 evaluation study found that spillover has not been fully addressed in past evaluations or in the M&E protocols and recommended a minimum upward adjustment of 0.05 in cases where spillover could not be calculated directly. Note that the 0.05 adjustment was estimated based on answers to questions asked of participants in previous SPC evaluations and only accounts for potential *participant* spillover. Non-participant spillover has never been estimated for SPC and could be much more significant.

In 2001, these adjustments were used along with the historic net-to-free-ridership results for the SPC program to recommend a net-to-gross ratio of 0.7 for the CPUC policy manual. The CPUC subsequently adopted this recommendation as the default NTGR for SPC in the Energy Efficiency Policy Manual.

[25] XENERGY Inc. and Ridge and Associates, 2001b. *Improving the Standard Performance Contracting Program: an Examination of the Historical Evidence and Directions for the Future*, prepared by XENERGY Inc. and Ridge and Associates for Southern California Edison, November, 2001

If the minimum adjustments recommended in the 2001 report are applied to the combined 2003 and 2002 net-of-free-ridership value of 0.48, the resulting net-to-gross ratio is:

Weighted Net-of-Free-Ridership Value	0.48
Adjustment to Account for Self-Report Bias	+ 0.10
Adjustment to Account for Spillover	+ 0.05
Estimated 2003 SPC Net-to-Gross Ratio	**= 0.63**

Estimates of free ridership for the SPC program for the combined PY2003 and PY2002 are moderately high, as were free ridership estimates for most of the previous SPC program years and for industrial programs historically.[26] Of course, it is important to remember that both measuring and trying to reduce free ridership are two of the toughest issues in the energy efficiency field. Readers should recognize that we discuss this topic with the understanding that measuring free ridership is extremely difficult and that results can be highly uncertain. In addition, we recognize that it may be somewhat artificial and misleading to try to measure and isolate free ridership within the context of single program years. This is because end users are affected not just by an individual program year in which they participate, but also by the effect of previous years of program interventions. Simply put, today's free rider may be yesterday's program-induced market effect.

Despite these uncertainties and difficulties, when public goods funds are limited, as they always will be, it remains important to try to maximize the net rather than the gross effects of program participation using the best available information to do so.

It is important that the free ridership issue be understood in context, not just for the SPC program, but also for all PGC efficiency programs. To appreciate this, one needs to consider how free ridership has been addressed historically with respect to CPUC-regulated efficiency programs. Prior to 1998, utility administrators faced incentives and disincentives related to free ridership (and program spillover). Specifically, utility shareholder earnings in this period were tied to *net,* not *gross,* savings. In addition, programs were required to have *net,* not just *gross,* ex post impact evaluations. As a result, administrators saw direct financial consequences from ex post measurements of free ridership and spillover. Although this was not a perfect system, it did provide some direct financial motivation for trying to reduce free ridership.

Since 1998, however, net-to-gross ratios have been used for PGC programs on only an ex ante basis. In addition, neither impact evaluations nor ex post net-to-gross estimation have been required. The post-1998 process has certainly been a simpler one, and one that may have been suited to the context of rapidly changing and uncertain regulatory and market environments. Good program management does include targeting customers who would not have taken the recommended energy efficiency actions in the absence of the program. However, the post-1998 approach does not provide program implementers (utility or non-utility) with any direct

[26] For example, an analysis of free ridership levels for California efficiency programs in the 1980s estimated an average free-ridership ratio of 0.5 for industrial incentive programs. See, Rufo, Michael, *An Investigation of Commercial and Industrial Utility Demand-Side Management Program Impacts*, Fourth International Energy Program Evaluation: Conservation and Resource Management Conference, Chicago, IL, August 23-25, 1989.

financial reward for minimizing free ridership during a particular program year. In our judgment, the CPUC should investigate approaches to providing all program implementers with accurate and timely feedback on free ridership levels, and perhaps with more direct financial incentives to minimize free ridership and maximize net program effects (e.g., including spillover).[27]

The foregoing discussion is provided partly to remind readers that difficult issues associated with free ridership and program market effects are not limited to the SPC program. Free ridership and market effects have been important issues associated with the SPC program because these issues were designed into each of the evaluations conducted for this program for the entire history of the program to date (Program Years 1998 through 2003). Free ridership, in particular, was estimated in these evaluations not because it was required from a regulatory perspective, but because the evaluation administrators and consultants believed it provided valuable insight that could be helpful to improving the program.[28] We believe that this proactive approach, although challenging, has proved worthwhile in the long run.[29]

7.3 REFERENCE TO PY2002 EVALUATION REPORT FOR ADDITIONAL FINDINGS AND RECOMMENDATIONS

Detailed recommendations related to gross realization rate and net-to-gross results were developed as part of the PY2002 SPC evaluation (Quantum, 2005).[30] These findings apply equally to the PY2003 SPC program, which was very similar to the PY2002 program. A summary of these recommendations is provided in the Executive Summary of this report. As noted previously, the principal objective of the PY2003 SPC evaluation scope was to supplement the PY2002 SPC evaluation sample with an additional 25 sites to produce estimates of the gross realization and net-of-free-ridership rates for the combined program years. Readers should refer to the *PY2002 SPC Impact Evaluation* report for more detailed qualitative findings and recommendations for improving ex ante estimates and reducing free ridership.

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[27] It is beyond the scope of this evaluation to discuss the variety of possible approaches to this and their associated pros and cons. Some of the issues associated with program evaluation are covered in TecMKT Works, 2004. *2002 Evaluation Framework Study*. In addition, the CPUC is in the process of developing new evaluation protocols.

[28] Note that over this same time period, very few program evaluations, to our knowledge, included formal estimation of free ridership across program years (Savings by Design being one of the exceptions).

[29] For example, the free ridership only net-to-gross ratio of 0.53 from the first evaluation of the SPC in 1998 was adopted by the CPUC as the ex ante net-to-gross ratio for the program, despite caveats in that evaluation that the self-reported method used to estimate free ridership may be biased and that potential spillover benefits were not estimated. An attempt was made to rectify this situation by conducting a multi-year analysis of free ridership that included assessment of the estimation method itself and spillover (see, XENERGY, 2001b). As a result of this expanded effort, the CPUC adopted a revised net-to-gross of 0.70 in the CPUC Energy Efficiency Policy Manual, Version 2, August 2003. Interestingly, most of the other net-to-gross ratios in the current Energy Efficiency Policy Manual have not been updated for five or more years because of the lack of recent studies that address this issue.

[30] http://calmac.org/publications/Py02_SPC_Final_Impact_Evaluation_and_Appendices.pdf

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APPENDIX A
SITE REPORTS

SITE 01 IMPACT EVALUATION
SAMPLE CELL: ORIGINAL TIER: 1 END USE: PROCESS

Measure	Install new air receivers and air compressor controls
Site Description	Plastic bottle manufacturing

Measure Description

This project involved the installation of two 5,000 gallon air receivers at a plastic bottle manufacturer. The new receiver tanks along with the new air compressor automation system and new flow controllers will stabilize pressure and eliminate the need to operate some of the six Bellis high pressure air compressors.

Summary of Ex Ante Impact Calculations

The submitted measure savings used the Engineering Calculations Method. The air compressor baseline energy consumption was calculated based on air compressor operating logs during a 24 hour production period. The data logs sampled compressor percent load and input current of all six active air compressors at 60-minute intervals for the 24 hour period.

For the baseline operation, all six air compressors were operating at various part load conditions (which is very inefficient) loading and unloading based on the varying production requirements. With the increased storage capacity that the new tanks will provide, three of the six air compressors can operate at or close to full load. The energy savings come from operating fewer compressors fully loaded instead of all compressors partly loaded. The calculations showed the same air flow between the baseline air system configuration and the proposed air system configuration which were 4,059 scfm during average production and 4,303 scfm during peak production.

Comments on Ex Ante Calculations

The measure savings calculation methodology is sound and reasonable. The air compressor loading and power consumption were obtained from electronic logs that sampled hourly data for a 24 hour production period.

It was not apparent how the project reviewer approved the installation energy savings at 3,234,000 kWh when the original application showed 2,939,509 kWh and the revised calculation from the applicant had 3,247,883 kWh. The revisions involved correcting errors in the calculation spreadsheet and accounting for savings on the low pressure side due to mist eliminators. The proposed measures eliminate the use of three compressors and the demand savings potential was calculated at 603 kW. The demand savings was omitted from both the project application and the installation report.

Evaluation Process

The evaluation process consisted of a review of the application forms and supporting documentation as well as conducting an on-site survey of the facility.

The on-site survey was conducted on September 16th, 2004. The goal of the inspection was to verify the installation and operation of the modified air compressor system at the facility.

During the site visit, the installation and operation of the two 5,000 gal storage tanks were verified. The high pressure tank (orange tank) had a gauge reading of 600 psig and the low pressure tank (yellow tank) had a gauge reading of 125 psig. The inspector also verified the new mist eliminator filters as being installed and operational. Also the site representative indicated that the new cross over valve system was installed. This cross over valve system is located high above the floor in the compressor room and physical verification of the installation was not possible.

Table 1 (below) lists an inventory of air compressors, model, rated HP, observed run status, observed loading status. The model and motor HP were obtained from the project application, and the operational parameters were observed on the PLC's HMI (human machine interface) screen during the inspection.

Table 1: Air Compressor Operational Status

Unit	Model	Motor Hp	Run Status	Load Status
Compressor #1	Bellis WH28	300	RUN	Load
Compressor #2	Bellis WH28	300	STOP	Unload
Compressor #3	Bellis WH28	300	RUN	Unload
Compressor #4	Bellis WH30	400	STOP	Unload
Compressor #5	Bellis WH50	800	RUN	Load
Compressor #6	Bellis WH50	800	RUN	Load

According to the calculation, the proposed air compressor system modifications eliminated the operation of two Bellis WH28 (300 HP) and one Bellis WH30 (400 HP) air compressors. Table 1 below shows that compressor #2 (WH28 – 300 HP) and #4 (WH30 – 400 HP) are not running and compressor #3 (WH28 – 300 HP) is running unloaded. Therefore the new compressed air storage and control system appear to be meeting expectations and operating much more efficiently than the original system.

Installation Verification

We physically verified the installation of the two 5,000 gallon air receivers and the new air compressor control system. Installation of the flow controllers was verified with the facility representative. A verification summary is shown in Exhibit 1 below.

Scope of Impact Assessment

The on-site survey focused on the operation of the air compressors, the installation and benefits of the two 5,000 gal storage tanks. These were the only measures for this application.

Additional Notes

Based on as review of the program documents, the supporting calculations and observations during the site visit; it would appear that the storage tanks and controls are operating as expected. The facility however was recently purchased and now belongs to a different owner. According to the site representative, the facility has added more production (more molding machines) and more high pressure air compressors since the installation of this project in 2002. Therefore the effects of the added production and air compressors on the overall operation are not easy to assess. Assuming that the plant expanded without the installation of the storage tanks and controls, the consumption would be expected to be higher than what it currently is, and hence have higher savings. If however the baseline for the project were defined as the system following the installation of the controls and storage tanks, the net effect is not apparent.

Given the complexity of the savings calculations and the plant, the budgeted time to conduct the evaluation was inadequate. With an increased budget, a more detailed evaluation of the operating hours and airflows would be possible. Additionally, we would also perform an estimate of the impact of the additional compressors and injection molding machines that have been installed since the retrofit was completed. The primary observation is that most of the savings from this project come from modifying a system that was operating inefficiently.

We estimate an additional 64 hours would be required to perform a more comprehensive impact evaluation.

Economic Information

An economic summary for the air compressor system modifications is shown in Table 2 below. An engineering realization rate calculation is shown in Table 3.

Impact Results

Table 2 Economic Summary Table

Description	Date	Project Cost	Estimated Demand Savings, kW	Estimated Energy Savings, kWh	Estimated Gas Savings, therms	Estimated Annual Cost Savings ($0.13/kWh), $	SPC Incentive, $	Simple Payback w/ incentive, yrs	Simple Payback w/o incentive, yrs
Application Submitted Amount	4/15/2002	$273,400	-	2,939,509	0	$382,136	$235,160	0.10	0.72
Application Approved Amount		$245,905	-	3,234,000	0	$420,420	$122,952	0.29	0.58
Installation Approved Amount (Ex Ante)	8/21/2003	$245,905	-	3,234,000	0	$420,420	$122,952	0.29	0.58
SPC Program Review (Ex Post)	9/30/2004	$245,905	603	3,234,000	0	$420,420	$122,952	0.29	0.58

Table 3 Realization Rate Calculation

	KW	KWh	Therm
SPC Tracking System or Application	0	3,234,000	0
Adjusted Engineering	603	3,234,000	0
Engineering Realization Rate	NA	100%	NA

Exhibit 1- Installation Verification Summary

Measure Description	End Use Category	HVAC Measure Description	Lighting Measure Description	Process Measure Description	Count	Equipment Description	Installation Verified (Explain)	Notes
Compressor Pad Modification	P			Install two 5,000 Gallon Air receivers	2	High and low pressure storage tanks, 5,000 gallons each	Observed both tanks on site.	
Compressor Pad Modification	P			Install Automation System	1	Allen-Bradley control system monitor tank pressures to load available compressors.	Observed compressor loading through the new control system.	
Compressor Pad Modification	P			Install Flow Controllers	1		Could not be physically verified.	

SITE 02 IMPACT EVALUATION
SAMPLE CELL: ORIGINAL TIER: 1 END USE: PROCESS

Measure	***Industrial Fan System Modifications***
Site Description	***Manufacturing***

Measure Description

Replace existing fan impellers with new fan impellers.

Summary of Ex Ante Impact Calculations

The industrial fan systems include a 1,600 HP Pre heater fan, a 3,100 HP Main Precipitator fan and a 1,000 HP Cooler system fan. All motors are DC, variable speed. A consulting firm was engaged by the customer to evaluate potential system improvements and determined that significant energy savings could be achieved by retrofitting the existing fan impellers with new impellers. A small lighting retrofit project was also performed that equates to less than 1% of the ex ante savings and is not evaluated in this report.

The customer's consultant's report includes a very detailed and comprehensive analysis. Fan performance testing was done at the site generally in accordance with AMCA standards and a detailed engineering analysis was used to determine the pre and post retrofit energy consumption for the project.

The electrical usage of the pre retrofit fan systems were calculated based on site fan performance tests, fan curves and engineering calculations. Part of the process (Raw Mill) was not operating during the fan performance tests resulting in a lower gas (air) temperature and lower flow. The consultant normalized the baseline and proposed conditions to account for this. This only affected the Preheater fan analysis. The post retrofit fan energy use was estimated using manufacturer's data for the proposed fan impellers assuming normalized conditions identical to the pre retrofit condition. All systems are assumed to operate at a steady state condition 8,000 hours annually before and after the retrofit.

Table 1 summarizes the pre retrofit performance characteristics from the consultant's report. Table 2 summarizes the ex ante pre and post retrofit energy consumption.

Table 1- Summary of the Customers Consultant's Analysis- Pre retrofit

	Preheater	Main Precipitator	Cooler
Inlet CFM	196,772	260,284	126,582
Temperature Deg F	562	222	181
Total Pressure "WG	19.67	37.69	11.21
Speed RPM	900	990	752
Fan Total Efficiency	60.17	64.77	48.13
Fan Power HP	997.9	2433.8	460.7
Fan Power kW	822.6	1935.1	380.6

Table 2- Summary of the Ex Ante Pre and Post Retrofit Energy Consumption

System	Annual Hours	Pre retrofit			Post retrofit			Savings	
		kW	kWh	Fan Efficiency	kW	kWh	Fan Efficiency	kW	kWh
Preheater	8,000	822.6	6,580,800	60.2%	616.6	4,932,800	80.0%	206.0	1,648,000
Main Precip.	8,000	1,935.1	15,480,800	64.8%	1,432.0	11,456,000	86.8%	503.1	4,024,800
Cooler	8,000	380.6	3,044,800	48.1%	235.3	1,882,400	77.6%	145.3	1,162,400
Total		3,138.3	25,106,400		2,283.9	18,271,200		854.4	6,835,200

The difference between the values in Table 2 and those reported in the application are due to rounding.

The utility required measurement and verification for this project. In accordance with the SPC program rules, 60% of the ex ante incentive payment was made upon completion of the project, and the remainder was reserved pending the results of the measurement and verification.

Unfortunately, the customer's internal project sponsor left the company and there was no follow-up on developing and executing a measurement plan for the project. Additionally the customer encountered problems with the Preheater fan impeller retrofit, and the new impeller was replaced with the old impeller negating the expected energy savings for that portion of the project. When the utility became aware of this situation, a utility sponsored consultant was engaged to complete the measurement and verification and the associated operating report.

The utility's consultant obtained approximately one month of trend log data from the customer for the Main Precipitator and Cooler fan systems. The trend reports average hourly data taken at 1-2 minute intervals during the month of February 2005. Trended data includes motor current, fan RPM, fan damper position, kiln, bypass kiln and roller mill feed rates. A sample of the trend data for February 2005 for the Main Precipitator fan is shown in Exhibit 2 below. DC motor speed is varied by varying the voltage applied to the motor. The customer does not measure or trend this voltage. The utility's consultant calculated the voltage based on DC motor theory which states that DC motor voltage is directly and linearly proportional to the ratio of the observed RPM to the maximum motor RPM multiplied by the maximum voltage. Using this relationship, fan kW was calculated according to the following formulae:

$$kW=(Current_{MEASURED} \times RPM_{MEASURED}/RPM_{MAX} \times Volts_{MAX})/1{,}000\ w/kW$$

The customer advised that since the plant was coming back on line after a maintenance shutdown, several trended periods were not representative of normal operation and these periods were removed from the analysis. The utility's consultant averaged the kW calculated by this method and subtracted the average from the steady state baseline values determined by the customer's consultant, shown in Table 1 above. The result was multiplied by 8,000 annual hours to determine the annual energy savings. The utility's consultant observed that there was a variation in the fan speed and power draw over the measurement period and because of this reduced the peak demand reduction claim to equal the approved baseline kW minus the observed maximum peak kW during the measurement period. Table 3 is a summary of the approved energy savings and demand reduction for the fan impeller retrofit.

Table 3- Summary of the Approved Energy Savings and Demand Reduction

System	Annual Hours	Pre retrofit kW	Pre retrofit kWh	Post retrofit kW max	Post retrofit kW average	Post retrofit kWh	Savings kW	Savings kWh
Main Precip.	8,000	1,935.1	15,480,800	1,771.4	1,251	10,009,600	163.7	5,471,200
Cooler	8,000	380.6	3,044,800	359.7	237	1,899,200	20.9	1,145,600
Total		2,315.7	18,525,600	2,131.1	1,489		184.6	6,616,800

Comments on Ex Ante Calculations

The utility's consultant's calculations are based on the customer's consultant's field measured data and engineering analysis for the pre retrofit and on data measured by the customers SCADA system over approximately one month for the post retrofit energy consumption. The customer's consultant's savings calculations assumed that the fan systems would operate at a steady state fixed point 8,000 hours annually. The trend data from the customer's SCADA system showed variability in the fan system operation and the utility's consultant reduced the demand kW reduction claim on this basis.

The utility's consultant did not however adjust the kWh energy savings claim for the operational variability of the fan system that was observed from the trend data. It appears that it may also be appropriate to adjust the baseline kWh to account for fan system operational variability. The utility's consultant also did not account for the losses in the AC/DC converter in their analysis.

Evaluation Process

The evaluation process consists of a review of the application form and supporting documentation, conducting an on-site survey and then computing impacts using the data collected on-site.

The site survey was conducted on April 1, 2005. Information on the main precipitator and cooler fan systems was gathered through discussions with the facility representatives. We also obtained hourly trend data for the month of March 2005 for the two fan systems from the facility representative. The representative stated that March 2005 was more representative of normal operation than February 2005 since operations had stabilized following a plant shutdown in January 2005.

The facility representative stated that the facility has a permit to operate 7,920 hours annually. This equates to 24 hours per day, 330 days per year. The facility has never quite achieved this many hours of annual production due to planned and unplanned shutdowns, but has come close in recent years, and we have elected to accept this estimate of annual hours of operation for the two fan systems.

We discussed our observation of the February 2005 data that indicate the fan systems do not operate at steady state conditions as assumed in the ex ante analysis and have significant operational variability during periods of normal operation. The facility representatives stated that both fan systems have a high mode and a low mode operation. The operational variability in the main precipitator fan system is associated with the operation of the roller mill. The roller mill frequently requires maintenance during normal operation and while maintenance is being performed airflow through the roller mill is bypassed. The roller mill has a 30 to 34 inch static pressure drop, and when the roller mill is bypassed, fan energy is significantly reduced.

The operational variability in the cooler fan system is primarily affected by the production rates and the product being manufactured and is much less variable. We analyzed the March 2005 data for the fan systems. We calculated the post retrofit fan energy consumption based on DC motor theory in a manner similar to the utility's consultant, except that we also accounted for the losses in the AC/DC power conversion. The customer's consultant estimated the efficiency of the Main Precipitator fan AC/DC converter to be 98%, and the Cooler fan AC/DC converter to be 95% and we accepted these values.

The utility's consultant calculated the voltage based on DC motor theory which states that DC motor voltage is directly and linearly proportional to the ratio of the observed RPM to the maximum motor RPM multiplied by the maximum voltage. This relationship is only accurate when the motor field current and voltage are held constant and the armature voltage is varied to control the speed of the motor. We accepted this assumption inherent in the analysis since we were unable to perform measurement and monitoring for this project.

Fan kW was calculated for each of the hourly data points we received from the customer for March 2005 according to the following formula:

$$kW=(Current_{MEASURED} \times RPM_{MEASURED}/RPM_{MAX} \times Volts_{MAX})/)(1{,}000\ w/kW \times \eta_{CONVERTER})$$

Following our review of the March 2005 data, we characterized the high mode and low mode operation of each fan system based on representative points in the data.

In the "high mode" operation, the Main Precipitator fan power ranged from 1,304 to 1,725 kW averaging 1,533.1 kW for 76.5% of the hours, the Cooler fan ranged from 182-372 kW, averaging 283.9 kW for 95.8% of the hours. In the "low mode" operation, the main precipitator fan power ranged from 18 to 1,286 kW averaging 579.6 kW for 23.5% of the hours, the cooler fan ranged from 4-170 kW, averaging 78.5 kW for 4.2% of the hours. Table 4 provides a summary of the March 2005 data. The March 2005 data for the Main Precipitator fan is shown graphically in Exhibit 3 below.

Table 4-March 2005 Data Summary

	kW Range		kW Average		Percent Hours	
System	High Mode	Low Mode	High Mode	Low Mode	High Mode	Low Mode
Main Precip.	1,304-1,725	18.2-1,286	1,533.1	579.6	76.5%	23.5%
Cooler Fan	182-372	4-170	283.9	78.5	95.8%	4.2%

As stated above, the pre-retrofit fan tests and analysis performed by the customer's consultant only accounted for steady state operation of the systems in the high mode.

We calculated the "high mode" percent reduction in fan kW based on the customer's consultant's pre-retrofit fan tests and the average high mode kW from the March 2005 data. From this analysis we estimated that in the high mode operation, the average main precipitator fan system power was reduced by 402 kW (26.2%) and the average cooler fan system power was reduced by 96.7 kW (34.1%). These calculated values match reasonably well with the customer's consultant's estimated reductions for the Main Precipitator fan and Cooler fan, 26% and 38%, respectively. Table 5 is a summary of the ex post high mode analysis.

Table 5- High Mode Fan kW

	Fan kW	
	Main Precip.	Cooler
Pre -Retrofit	1,935.1	380.6
Post Retrofit (high mode ave)	1,533.1	283.9
kW Reduction	402.0	96.7
Percent Reduction	26.2%	34.1%

We estimated the average pre-retrofit low mode fan kW by assuming that the percent reduction in fan power in the low mode is equal to the percent reduction in the high mode for the respective fan systems. The pre-retrofit fan power in the low mode was estimated using the following formula:

$kW_{PRE-RETROFIT} = kW_{POSTRETROFIT} / (1\text{-Percent reduction}_{HIGHMODE})$

Based on this methodology, we estimated that the pre retrofit low mode average power was 785.6 kW for the Main Precipitator fan and 119.0 kW for the Cooler fan. We estimate that after the retrofit in the "low mode" fan power was reduced by 206 kW for the Main Precipitator fan and 40.5 kW for the Cooler fan. While this approach is not ideal, it attempts to provide a methodology to account for the pre and post retrofit variability in fan system operation. Table 6 is a summary of this analysis.

Table 6- Low Mode Fan kW

	Fan kW	
	Main Precip.	Cooler
Post Retrofit (low mode ave)	579.6	78.5
Percent Reduction (from high mode)	26.2%	34.1%
Pre -Retrofit (low mode calculated)	785.6	119.0
kW Reduction	206.0	40.5

We calculated the annual energy consumption for both fan systems in the high and the low mode before and after the retrofit based on the fan power reduction shown in Tables 5 and 6, and the 7,920 annual hours of operation determined from the site visit assuming the March 2005 data is representative of the average plant operation throughout the operating hours of the year. From this analysis we estimate that the Main Precipitator fan system retrofit has saved 3,169,335 kWh annually and the Cooler fan system retrofit has saved 396,884 kWh annually, for a total of 3,566,219 kWh annually. Table 7 is a summary of the ex post savings analysis.

Table 7- Ex Post Savings Analysis Summary

	Total	High Mode				Low Mode				Total
	Annual	%	Annual	Savings		%	Annual	Savings		Annual
Fan System	Hours	Hours	Hours	kW	Annual kWh	Hours	Hours	kW	Annual kWh	Savings kWh
Main Precip	7,920	76.5%	6,059	402.0	2,435,638	23.5%	1,861	206.0	383,395	2,819,033
Cooler	7,920	95.8%	7,587	96.7	733,698	4.2%	333	40.5	13,489	747,186
Total					3,169,335				396,884	3,566,219

Demand reduction was estimated by subtracting the average "high mode" kW observed in the March 2005 data from the pre-retrofit fan kW for the two fan systems. Total average peak demand reduction is estimated to be 498.7 kW. A summary of the demand reduction is shown in Table 8 below.

Table 8- Summary of Ex Post Average Peak Demand Reduction

	Fan kW		
	Main Precip.	Cooler	Total
Pre-Retrofit	1,935.1	380.6	2,315.7
Post Retrofit (high mode ave)	1,533.1	283.9	1,817.0
kW Reduction	402.0	96.7	498.7

Installation Verification

We verbally verified the installation of the two new fan impellers since the fan systems were in operation at the time of the site visit and the facility was not able to shut down the fan systems to allow us to view the impellers. A verification summary is shown in Exhibit 1 below.

Scope of Impact Assessment

The impact evaluation includes the installation of two fan impellers. A lighting retrofit amounting to less than 1% of the ex ante savings claim was not evaluated.

Additional Notes

The level of analysis employed at this site was not adequate to provide an accurate calculation for energy savings. An additional 60 hours plus the rental of logging equipment would be required to provide a more accurate assessment of the savings for this project. The impact evaluation for this site would have benefited from pre- measurement of the low mode fan operating power for both systems. Additionally it would be more accurate to utilize the same measurement methodology before and after the retrofit.

The ex post demand kW reduction is higher than the utility consultant's value because the average high mode kW value used in the ex post evaluation based on March 2005 data was lower than the peak value used by the utility's consultant from the February 2005 data. The energy savings are less than the utility consultant's estimated values because the utility's consultant did not adjust the pre and post retrofit energy consumption to account for the high mode and low mode operation of the fan systems or the AC/DC converter efficiency. Additionally we found that the annual hours of operation were slightly less than those used in the ex ante analysis.

Economic Information

An economic summary for the installation of the two fan impellers is shown in Table 9 below. An engineering realization rate calculation is shown in Table 10.

Impact Results

Table 9 Economic Summary of the Project

Description	Date	Project Cost	Estimated Demand Savings, kW	Estimated Energy Savings, kWh	Estimated Gas Savings, therms	Estimated Annual Cost Savings ($0.09/kWh), $	SPC Incentive, $	Simple Payback w/ incentive, yrs	Simple Payback w/o incentive, yrs
Application Submitted Amount	12/18/2002	$560,562	854.0	6,832,000	0	$614,880	$285,074	0.45	0.91
Application Approved Amount	2/3/2003	$560,562	854.0	6,832,000	0	$614,880	$285,074	0.45	0.91
Installation Approved Amount (Ex Ante)	11/17/2003	$560,562	854.0	6,832,000	0	$614,880	$285,074	0.45	0.91
Operating Approved Amount	3/9/2005	$411,768	184.6	6,616,800	0	$595,512	$210,677	0.34	0.69
SPC Program Review (Ex Post)	4/15/2005	$411,768	498.7	3,566,219	0	$320,960	$210,677	0.63	1.28

Table 10 Realization Rate Calculation

	KW	KWh	Therm
SPC Tracking System or Application	184.6	6,616,800	0
Adjusted Engineering	498.7	3,566,219	0
Engineering Realization Rate	270%	53.9%	NA

Exhibit 1 Installation Verification Sheet

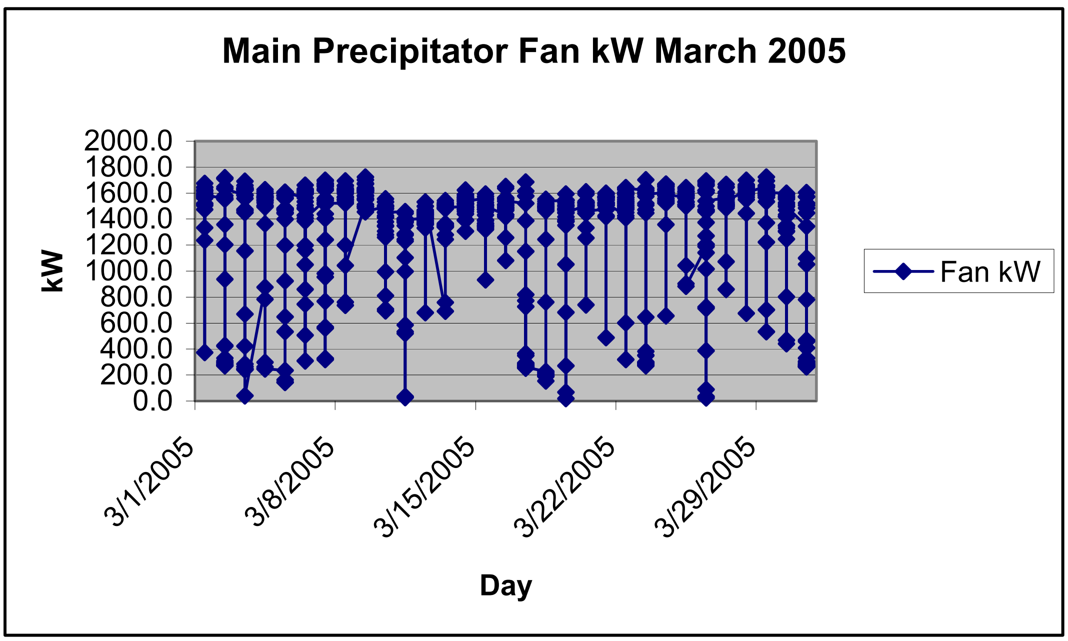
IOU	Customer	Application Number	Measure Description	End-Use Category	HVAC Measure Description	Lighting Measure Description	Process Measure Description	Count	Equipment Description	Installation Verified (Explain)	Notes
PG&E	RMC Pacific Materials Inc.	2K3APGEL02	PROCESS OTHER	P			Replace Industrial Fan Impellers with new Impellers	2	Main Precip Fan: Airsteam type RAF-C630-1127-D3 Cooler Fan: Airsteam type RAF-B100-0830-S3	Verbally Verified with facility representative.	Fan systems could not be shut down during site visit to view impellers.

Exhibit 2 Sample Trend Data February 2005 from Customer's SCADA System

Date/Time	Precip.ID Fan Motor Current	MAIN ID FAN RPM	Precip ID Fan Damper Pos	KILN FEED RATE PV	BYPASS KILN FEED RATE	ROLLER MILL FEED RATE	kW*
21-02-05 03:00 - 21-02-05 04:00	2,062.8	904.0	100.0	151.68	0.00	215.1	1,243.1
21-02-05 04:00 - 21-02-05 05:00	2,008.2	888.5	100.0	153.11	0.00	215.0	1,189.5
21-02-05 05:00 - 21-02-05 06:00	2,117.8	909.7	100.0	161.07	0.00	217.9	1,284.4
21-02-05 06:00 - 21-02-05 07:00	2,163.6	916.1	100.0	164.90	0.00	215.8	1,321.4
21-02-05 07:00 - 21-02-05 08:00	2,344.7	960.9	100.0	176.61	0.00	224.5	1,502.0
21-02-05 08:00 - 21-02-05 09:00	2,319.1	954.3	100.0	171.56	0.00	217.0	1,475.4
21-02-05 09:00 - 21-02-05 10:00	2,342.5	950.0	100.0	181.94	0.00	219.8	1,483.6
21-02-05 10:00 - 21-02-05 11:00	2,353.7	951.4	100.0	182.47	0.00	219.8	1,493.0
21-02-05 11:00 - 21-02-05 12:00	2,347.3	948.4	100.0	187.67	0.00	219.6	1,484.1
21-02-05 12:00 - 21-02-05 13:00	2,396.9	955.8	100.0	192.58	0.00	202.4	1,527.3
21-02-05 13:00 - 21-02-05 14:00	2,394.4	957.2	100.0	192.12	0.00	219.9	1,527.9
21-02-05 14:00 - 21-02-05 15:00	2,394.8	956.4	100.0	191.74	0.00	220.5	1,527.0
21-02-05 15:00 - 21-02-05 16:00	2,473.0	976.7	100.0	191.73	0.00	228.1	1,610.3
21-02-05 16:00 - 21-02-05 17:00	843.9	551.7	100.0	191.63	0.00	15.3	310.4
21-02-05 17:00 - 21-02-05 18:00	910.3	512.5	85.2	104.52	0.00	30.1	311.0
21-02-05 18:00 - 21-02-05 19:00	257.7	284.2	99.6	13.95	0.00	0.1	48.8
21-02-05 19:00 - 21-02-05 20:00	613.8	488.0	100.0	88.55	0.00	0.1	199.7
21-02-05 20:00 - 21-02-05 21:00	1,632.3	788.2	100.0	121.38	0.00	103.7	857.7
21-02-05 21:00 - 21-02-05 22:00	1,963.1	867.2	100.0	155.82	0.00	215.4	1,135.0
21-02-05 22:00 - 21-02-05 23:00	2,059.8	887.9	100.0	169.69	0.00	218.7	1,219.4
21-02-05 23:00 - 22-02-05 00:00	2,185.5	913.1	100.0	183.51	0.00	222.0	1,330.5
22-02-05 00:00 - 22-02-05 01:00	2,194.4	912.9	100.0	190.19	0.00	221.9	1,335.5
22-02-05 01:00 - 22-02-05 02:00	2,164.9	905.0	100.0	190.18	0.00	222.0	1,306.2
22-02-05 02:00 - 22-02-05 03:00	2,248.3	926.0	100.0	193.70	0.00	224.8	1,388.0
22-02-05 03:00 - 22-02-05 04:00	2,359.6	952.3	100.0	196.14	0.00	235.0	1,498.1
22-02-05 04:00 - 22-02-05 05:00	2,340.5	945.9	100.0	198.32	0.00	233.2	1,475.9

Note: Fan kW was calculated by the utility's consultant. Other values are measured by the customer's SCADA system.

Exhibit 3 Main Precipitator Fan kW March 2005



Note: Ex Post Fan kW calculated as described above.

SITE 03 IMPACT EVALUATION
SAMPLE CELL: ORIGINAL TIER: 2 END USE: PROCESS

Measure	***Air Compressor System Modifications***
Site Description	***Manufacturing***

Measure Description

Install compressed air receivers, regulators, and a compressor sequencing controller.

Summary of Ex Ante Impact Calculations

The electrical usage of the existing and proposed compressed air systems were calculated with an industry standard software tool "AIRMaster+", manufacturer specifications, and compressor operating information supplied by the customer. The SPC application implies that the compressed air contractor also performed measurements and monitoring that were used as a basis for the submitted calculations. No measurement data was provided in the application.

The plant manufactures paper packaging products. Four 150 HP rotary screw compressors operate in parallel to serve process equipment.

Information attached to the SPC application contains only the output of the AIRMaster simulation. The simulation was prepared by the compressed air contractor. Input data are not provided. The customer submitted a cover letter with the application that states that the pre retrofit condition "…in which 4 compressors are running constantly fighting each other to satisfy plant demand" will be improved by the retrofit project. The customer letter further states "the proposed solution in which 3 compressors are running with regulation and storage…will effectively remove one compressor from constant operation".

Table 1 is a summary of the AIRMaster output.

Table 1 AIRMaster Analysis Results

	Total kW	kWh
Pre Retrofit	465	3,538,425
Post Retrofit	333	2,536,452
Savings	132	1,001,973

Comments on Ex Ante Calculations

The Ex Ante calculations were prepared using AIRMaster. Measurement data and simulation input data were not provided.

Evaluation Process

The evaluation process consists of a review of the application form and supporting documentation, conducting an on-site survey and then computing impacts using the data collected on-site.

The site survey was conducted on November 16, 2004. Information on the air compressor system sequencing control was collected and verified by reviewing the control display data. Other information related to the system operating conditions was provided by the Plant Engineer. Table 2 summarizes the operational status of each compressor observed during the site visit. Three air compressors were operating and the plant was in full production at the time of the site visit. This observation validates the expectations of the customer that the project would remove one compressor from operation.

Table 2 Summary of Compressor Operational Status

Unit	Manufacturer	HP	On/Off	% Capacity
1	Quincy	150	On	58%
2	Quincy	150	On	75%
3	Gardner	150	Off	0%
4	Quincy	150	On	63%

The facility representative stated that the facility operates 24 hours per day, 5 days per week. The facility is closed 8 holidays annually. The air compressor plant is manually shut down when the facility is unoccupied. Based on this information, the air compressor plant operates 6,065 hours annually.

Annual Hours= 24 hr./day x 5 days/wk x 52.14 weeks/yr. – 8 days x 24 hr/day
Annual Hours= 6,065

The AIRMaster output indicates that the air compressor system operates 7,608 hours annually. . The site representatives stated that the compressed air contractor had performed several weeks of measurement to generate the load profile used in the AIRMaster analysis. Unfortunately the customer could not locate the detailed study, and we have elected to accept the Air Master analysis based on the customer's statement that a detailed analysis formed the basis of the calculations. Since we do not have better information, we accept the energy consumption profile generated by the AIRMaster simulation and prorate the savings calculated by AIRMaster to account for the actual hours of operation of the compressor plant. The energy savings analysis is prorated as follows:

Ex Post $kWh_{\text{pre retrofit}}$ = 6,065 hrs./7,608 hrs. x 3,538,425 kWh
Ex Post $kWh_{\text{pre retrofit}}$ = 2,820,787 kWh

Ex Post $kWh_{\text{post retrofit}}$ = 6,065 hrs./7,608 hrs. x 2,536,452 kWh
Ex Post $kWh_{\text{post retrofit}}$ = 2,022,027

Ex Post kWh Savings = 2,820,787 kWh -2,022,027 kWh
Ex Post kWh Savings= 798,760 kWh

We accept the demand kW savings documented in the Ex Ante calculations. Table 3 is a summary of the Ex Post savings.

Table 3 Summary of the Ex Post Savings

	Total kW	kWh
Pre Retrofit	465	2,820,787
Post Retrofit	333	2,022,027
Savings	132	798,760

Installation Verification

We physically verified the installation of two 1,550 gallon receivers, the pressure regulators and air compressor sequencer. A verification summary is shown in Exhibit 1 below.

Scope of Impact Assessment

The impact evaluation includes the installation of two 1,550 gallon receivers, the pressure regulators and air compressor sequencer. These are the only measures for this SPC application.

Additional Notes

The level of analysis employed at this site was not adequate to provide an accurate calculation for energy savings. An additional 32 hours plus the rental of logging equipment would be required to provide a more accurate assessment of the savings for this project. This site would have benefited from pre-measurement.

Economic Information

An economic summary for the installation of the air compressor system modifications is shown in Table 4 below. An engineering realization rate calculation is shown in Table 5

Impact Results

Table 4 Economic Summary of the Project

Description	Date	Project Cost	Estimated Demand Savings, kW	Estimated Energy Savings, kWh	Estimated Gas Savings, therms	Estimated Annual Cost Savings ($0.13/kWh), $	SPC Incentive, $	Simple Payback w/ incentive, yrs	Simple Payback w/o incentive, yrs
Application Submitted Amount	5/29/2003	$70,000	132.0	1,001,973	0	$130,256	$35,000	0.27	0.54
Application Approved Amount	7/2/2003	$70,000	132.0	1,001,973	0	$130,256	$35,000	0.27	0.54
Installation Approved Amount (Ex Ante)	11/3/2003	$70,000	132.0	1,001,973	0	$130,256	$35,000	0.27	0.54
SPC Program Review (Ex Post)	11/24/2004	$70,000	132.0	798,760	0	$103,839	$35,000	0.34	0.67

Table 5 Realization Rate Calculation

	KW	KWh	Therm
SPC Tracking System or Application	132	1,001,973	0
Adjusted Engineering	132	798,760	0
Engineering Realization Rate	100%	79.7%	NA

Exhibit 1 Installation Verification Sheet

Measure Description	End-Use Category	HVAC Measure Description	Lighting Measure Description	Process Measure Description	Count	Equipment Description	Installation Verified (Explain)	Notes
Air Compressor System	P			Install compressed air receivers, regulators, and a compressor sequencing controller.	NA	Two 1,550 gallon receivers, pressure regulators and air compressor sequencer.	Installation physically verified.	

SITE 04 IMPACT EVALUATION
SAMPLE CELL: ORIGINAL TIER: 2 END USE: PROCESS

Measure	Install VFD's on Air Handler Fan Motors and Cooling Tower Fan Motors
Site Description	High Tech Office

Measure Description

Install four 100 HP VFD's on supply fan motors, three 75 HP VFD's on return fan motors and two 25 HP VFD's on cooling tower fan motors.

Summary of Ex Ante Impact Calculations

The Ex Ante calculations were performed by a mechanical contractor using engineering calculations. Data was obtained from trend logs from an energy management and control system. Fan curves were used for the air handling system, and estimates of operation were used for the cooling tower fan system.

Air Handler Fan Motors

According to data submitted in the application, the system was designed with four 100 HP supply fans, each with a capacity of 72,500 CFM at 5.14 inches of static pressure. Supply fans 1 and 2 serve one common plenum and supply fans 3 and 4 serve another common plenum. There are three 75 HP return fans each with a capacity of 80,000 CFM at 2.36 inches of static pressure that serve all four supply fans with a common return plenum. Trends were logged over a 4-6 hour period on a morning in August. At the time of the trend logging, one 100 HP supply fan motor (SF-3) had failed. Return fan 3 (RF-3) was not operating due to low airflow. The trend logs showed that the air handler fans were operating well below the design air flow. Table 1 summarizes the average flow rate from the trend data for the air handler fans.

Table 1 Summary of Air Handler Trend Data

Fan	CFM
SF-1	8,800
SF-2	10,200
SF-3	-
SF-4	54,900
RF-1	26,200
RF-2	20,500
RF-3	-

The contractor used the trend data and obtained brake horsepower data from the fan curves for the pre-retrofit case. The calculation assumed that supply fan 3 would be repaired and that supply fans three and four would equally split the supply fan air quantity. Also assumed is that the system would run continuously at this average load.

The contractor then calculated the system static pressure requirements based on the average air flow determined from the trend data. Using the calculated static pressure, a new brake horsepower was determined from the fan curves and this was assumed to be the new operating point for the system once the VFD's were installed. Energy use was calculated using the following formulae:

kW = HP x 0.746 kW/HP x 1/motor efficiency
kWh= kW x operating hours

Cooling Tower Fan Motors
The cooling towers are served by one 7.5 HP and one 25 HP fan motor. Using 74 minutes of trend data the contractor performed an evaluation for the installation of VFD's on the cooling tower fan motors. During the 74 minute trend period the 7.5 HP motor operated for 26 minutes, and the 25 HP fan motor operated for 8 minutes. The contractor calculated that the baseline tower fan energy to be 95.6 kWh per day and annualized this result to approximately 35,000 kWh annually.

Through a complicated analysis of cooling tower air flow, the contractor calculated that the average air flow through the cooling tower during the trend period was 40,000 CFM. Using this calculated air flow and the fan laws, the contractor calculated that a VFD driven motor would operate constantly at 1.02 brake horsepower to supply 40,000 CFM to the cooling tower. This equates to approximately 6,680 annual kWh. Table 2 shows a summary of the calculations for the air handler and cooling tower fan motors.

Table 2 Summary of the Ex Ante Savings

System	Pre-retrofit kWh	Post-retrofit kWh	Savings kWh
Supply Fan	1,350,000	1,080,000	270,000
Return Fan	660,000	52,000	608,000
Cooling Tower	34,894	6,679	28,215
Total	2,044,894	1,138,679	906,215

Comments on Ex Ante Calculations

Unfortunately, the contractor made a mathematical error in calculating the pre-retrofit return fan energy. The contractor's calculation indicated that the baseline return fan energy is 660,000 kWh. The correct value based on the contractor's methodology is 562,066 kWh. Also the contractor was liberal in rounding energy consumption estimates. Table 3 is a summary of the corrected calculations with rounding only in the decimal place. The corrected calculations indicate that the savings are 100,338 kWh less than reported in the Ex Ante. If the reviewer had discovered this error, the incentive would have been reduced.

Table 3 Summary of the Corrected Ex Ante Calculations

Fan	Pre retrofit			Post retrofit			Savings
	CFM	HP	kWh	CFM	HP	kWh	kWh
SF-1	8,800	42	274,468	9,500	30	196,049	78,420
SF-2	10,200	45	294,073	9,500	30	196,049	98,024
SF-3	27,500	60	392,098	27,500	53	346,353	45,745
SF-4	27,500	60	392,098	27,500	53	346,353	45,745
SF Total	74,000	207	1,352,737	74,000	166	1,084,803	267,933
RF-1	26,200	44	287,538	23,350	4	26,140	261,398
RF-2	20,500	42	274,468	23,350	4	26,140	248,328
RF-3	-	-	-	-	-	-	-
RF Total	46,700	86	562,007	46,700	8	52,280	509,727
Cooling Tower	40,000	5	34,883	40,000	1	6,666	28,217
Grand Total		298	1,949,626		175	1,143,749	805,877

Evaluation Process

The evaluation process consists of a review of the application form and supporting documentation, conducting an on-site survey and then computing impacts using data collected on-site.

The on-site survey was conducted on November 2, 2004. Information on the retrofit equipment and operating conditions was collected by inspecting the fan motor VFD's and by interviewing the facility representative. The facility representative provided access to mechanical system design drawings and operating hours for the facility.

We confirmed the building design data described above. There are four 100 HP supply fan motors and three 75 HP return fan motors. The cooling towers are served by one 7.5 HP motor and one 25 HP motor. All systems operate continuously to satisfy the conditioning requirements of the building.

The building is approximately 185,000 ft^2, and contains office spaces and some lab areas. The lab areas have raised floors and are served by separate dedicated air conditioning units. We estimate that no more than 150,000 ft^2 are served by the four supply air fan systems with a total capacity of 290,000 cfm. This equates to approximately 2 cfm/ft^2, which is an indication of an air conditioning system that is greatly oversized. A rule of thumb for office space in this geographical area is that maximum airside capacity should be in the range of 1.0 to 1.25 cfm/ft^2. Discussion with facilities representatives indicate that the original plan for the building was to serve the lab areas with the main fan systems, but that this was abandoned in favor of separate dedicated air conditioning units for the lab areas. For some reason the main air handlers were not downsized during he design.

Supply and Return Fans

We elected to perform a temperature bin analysis to generate a load profile for the supply and return fans. The temperature bin analysis used weather data from a nearby airfield. The load profile is generated assuming that the supply air flow varies linearly from a minimum of 74,000 cfm in the 55°F/59°F bin and below, to a maximum of 185,000 cfm in the 90°F/94°F bin and the return air flow varies linearly from a minimum of 74,000 cfm in the 55°F/59°F bin and below, to a maximum of 153,000 cfm in the 90°F/94°F bin. Using the load profile created by this method, and fan unloading curves (part load modifiers) from DOE 2, we used a spreadsheet analysis to estimate the pre and post retrofit energy consumption of the supply and return fan systems.

The part load energy modifier from the DOE 2 program is shown in Exhibit 4. Fan brake HP is from the design documents. The pre-retrofit fans are "BI/AF Inlet Vanes". The post retrofit fans are "Any Var. Fq. Drive". The fan system kW were calculated as follows:

Design kW = BHP x 0.746 kW/HP x 1/motor efficiency x quantity of motors
System kW in each bin = design kW x part load modifier (from DOE 2)
System kWh = system kW x bin hours. More detailed analysis is shown in Exhibits 2 and 3 below.

Cooling Tower Fans
The cooling tower fans represent 3% of the total Ex Ante savings. Therefore we have elected to accept the Ex Ante savings of 28,215 kWh.

Table 4 is a summary of the Ex Post savings analysis.

Table 4 Summary of the Ex Post Savings Analysis

System	Pre-retrofit kWh	Post-retrofit kWh	Savings kWh
Supply Fan	1,328,786	312,980	1,015,806
Return Fan	440,833	103,833	337,000
Cooling Tower	34,894	6,679	28,215
Total	1,804,513	423,493	1,381,021

We did not evaluate the demand kW savings because a more detailed analysis would be required. A more detailed analysis cannot be completed within the budget allowed for this project.

Installation Verification

We physically verified the installation of four 100 HP VFD's on supply fan motors, three 75 HP VFD's on return fan motors and two 25 HP VFD's on cooling tower fan motors. A verification summary is shown in Exhibit 1 below.

Scope of Impact Assessment

The impact evaluation includes the installation of four 100 HP VFD's on supply fan motors, three 75 HP VFD's on return fan motors and two 25 HP VFD's on cooling tower fan motors. These are the only measures for this SPC application.

Additional Notes

The Ex Post kWh savings results are greater than the Ex Ante results because the Ex Ante analysis was performed using a single load point analysis that was not an accurate representation of the average system operating point on an annualized basis. Using a single point analysis based on short term trend logging for VFD applications is not a desirable approach to accurately quantifying energy savings. VFD energy use is sensitive to the required motor speed which in turn is sensitive to the air conditioning load. The air conditioning load is likely to be highly variable throughout the year. A single point analysis based on trend logs taken from a morning in August are not likely to accurately reflect the annualized pre and post retrofit energy consumption.

The amount of time allowed for the evaluation was not adequate A temperature bin analysis is not a very satisfactory method to accurately determine the impact of a fan VFD retrofit. The annual fan airflow profile in this type of facility would be more accurately modeled using a detailed simulation such as DOE 2. We estimate an additional 40 hours would be required to more accurately assess the savings for this project. The impact evaluation for this project would also have benefited from pre measurement.

Economic Information

An economic summary for the installation of the VFD's is shown in Table 5 below. An engineering realization rate calculation is shown in Table 6.

Impact Results

Table 5 Economic Summary of the Project

Description	Date	Project Cost	Estimated Demand Savings, kW	Estimated Energy Savings, kWh	Estimated Gas Savings, therms	Estimated Annual Cost Savings ($0.13/kWh), $	SPC Incentive, $	Simple Payback w/ incentive, yrs	Simple Payback w/o incentive, yrs
Application Submitted Amount	4/25/2003	$140,000	78.7	760,360	0	$98,847	$70,000	0.71	1.42
Application Approved Amount	6/16/2003	$140,000	78.7	906,215	0	$117,808	$70,000	0.59	1.19
Installation Approved Amount (Ex Ante)	8/26/2003	$140,000	78.7	906,215	0	$117,808	$70,000	0.59	1.19
SPC Program Review (Ex Post)	11/19/2004	$140,000	NA	1,381,021	0	$179,533	$70,000	0.39	0.78

Table 6 Realization Rate Calculation

	KW	KWh	Therm
SPC Tracking System or Application	78.7	906,215	0
Adjusted Engineering	NA	1,381,021	0
Engineering Realization Rate	NA	152%	NA

Exhibit 1 Installation Verification Sheet

Measure Description	End-Use Category	HVAC Measure Description	Lighting Measure Description	Process Measure Description	Count	Equipment Description	Installation Verified (Explain)	Notes
PROCESS VARIABLE SPEED DRIVE	P			Install VFD's on four 100 HP and three 75 HP air handler fan motors. Install VFD's on two 25 HP cooling tower fan motors.	9	ABB Variable speed drives.	9 VFD's physically verified.	

Exhibit 2 Ex Post Supply Fan Savings Analysis

Minimum CFM	74,000
Maximum CFM	185,000
Maximum CFM	290,000
Design BHP/fan	95.1
Design kW/fan	75.5
Quantity of Fans	4
Total Design kW	302
Motor efficiency	94%

	Annual	Actual		% Maximum	BI/AF Inlet Vanes	Pre retrofit		VFD	Post retrofit		Savings	
Temperature	Hours	% Max CFM	Total CFM	Design CFM	% Max Power	kW	kWh	% Max Power	kW	kWh	kW	kWh
90/94	6	100.0%	185,000	63.8%	61.0%	184.2	1,105	0.34	102.6	616	81.5	489
85/89	24	91.4%	169,143	58.3%	58.0%	175.1	4,202	0.28	84.5	2,029	90.6	2,174
80/84	84	82.9%	153,286	55.0%	56.0%	169.1	14,201	0.24	72.5	6,086	96.6	8,115
75/79	207	74.3%	137,429	47.4%	53.0%	160.0	33,121	0.18	54.3	11,248	105.7	21,872
70/74	535	65.7%	121,571	41.9%	52.0%	157.0	83,986	0.15	45.3	24,227	111.7	59,760
65/69	1,076	57.1%	105,714	36.5%	50.0%	150.9	162,418	0.13	39.2	42,229	111.7	120,189
60/64	1,754	48.6%	89,857	31.0%	50.0%	150.9	264,759	0.11	33.2	58,247	117.7	206,512
55/59	1,975	40.0%	74,000	25.5%	50.0%	150.9	298,118	0.11	33.2	65,586	117.7	232,532
50/54	1,545	40.0%	74,000	25.5%	50.0%	150.9	233,212	0.11	33.2	51,307	117.7	181,905
45/49	934	40.0%	74,000	25.5%	50.0%	150.9	140,984	0.11	33.2	31,016	117.7	109,967
40/44	451	40.0%	74,000	25.5%	50.0%	150.9	68,077	0.11	33.2	14,977	117.7	53,100
35/39	138	40.0%	74,000	25.5%	50.0%	150.9	20,831	0.11	33.2	4,583	117.7	16,248
30/34	24	40.0%	74,000	25.5%	50.0%	150.9	3,623	0.11	33.2	797	117.7	2,826
25/29	1	40.0%	74,000	25.5%	50.0%	150.9	151	0.11	33.2	33	117.7	118
Total	8,754						1,328,786			312,980		1,015,806

Exhibit 3 Ex Post Return Fan Savings Analysis

Minimum CFM	74,000
Maximum CFM	153,120
Maximum CFM	240,000
Design BHP/fan	63.1
Design kW/fan	50.1
Quantity of Fans	2
Total Design kW	100
Motor efficiency	94%

	Annual	Actual		% Maximum	BI/AF Inlet Vanes	Pre retrofit		VFD	Post retrofit		Savings	
Temperature	Hours	% Max CFM	Total CFM	Design CFM	% Max Power	kW	kWh	% Max Power	kW	kWh	kW	kWh
90/94	6	100.0%	153,120	63.8%	61.0%	61.1	367	0.34	34.1	204	27.0	162
85/89	24	92.6%	141,817	59.1%	58.0%	58.1	1,394	0.28	28.0	673	30.0	721
80/84	84	85.2%	130,514	55.0%	56.0%	56.1	4,711	0.24	24.0	2,019	32.0	2,692
75/79	207	77.9%	119,211	49.7%	53.0%	53.1	10,988	0.18	18.0	3,732	35.1	7,256
70/74	535	70.5%	107,909	45.0%	52.0%	52.1	27,863	0.15	15.0	8,037	37.1	19,826
65/69	1,076	63.1%	96,606	40.3%	50.0%	50.1	53,883	0.13	13.0	14,010	37.1	39,873
60/64	1,754	55.7%	85,303	35.5%	50.0%	50.1	87,835	0.11	11.0	19,324	39.1	68,512
55/59	1,975	48.3%	74,000	30.8%	50.0%	50.1	98,903	0.11	11.0	21,759	39.1	77,144
50/54	1,545	48.3%	74,000	30.8%	50.0%	50.1	77,369	0.11	11.0	17,021	39.1	60,348
45/49	934	48.3%	74,000	30.8%	50.0%	50.1	46,772	0.11	11.0	10,290	39.1	36,482
40/44	451	48.3%	74,000	30.8%	50.0%	50.1	22,585	0.11	11.0	4,969	39.1	17,616
35/39	138	48.3%	74,000	30.8%	50.0%	50.1	6,911	0.11	11.0	1,520	39.1	5,390
30/34	24	48.3%	74,000	30.8%	50.0%	50.1	1,202	0.11	11.0	264	39.1	937
25/29	1	48.3%	74,000	30.8%	50.0%	50.1	50	0.11	11.0	11	39.1	39
Total	8,754						440,833			103,833		337,000

Exhibit 4 DOE 2 Part Load Modifier for Fan Systems

FAN SPEED CONTROLS
Power Relationships

DOE-2.1 CALIFORNIA COMPLIANCE SUPPLEMENT

BI = backward inclined, AF = air foil, FC = forward curved

PART LOAD ENERGY MODIFIER, Y

% FLOW X	BI/AF Outlet Damp or no cntrl 1	BI/AF Inlet Vanes 2	FC Out Damp no cntrl 3	FC Inlet Vanes 4	Vane Ax,Var Pitch 5	Any Var.Fq Drive 6
1.00	1.00	0.98	1.00	0.99	0.99	1.00
0.95	0.98	0.91	0.94	0.88	0.89	0.88
0.90	0.96	0.85	0.87	0.79	0.79	0.77
0.85	0.93	0.79	0.82	0.70	0.70	0.67
0.80	0.91	0.74	0.76	0.62	0.62	0.58
0.75	0.88	0.70	0.70	0.54	0.54	0.49
0.70	0.85	0.65	0.65	0.48	0.47	0.42
0.65	0.82	0.62	0.60	0.42	0.41	0.35
0.60	0.79	0.59	0.56	0.37	0.35	0.29
0.55	0.75	0.56	0.51	0.33	0.31	0.24
0.50	0.71	0.54	0.47	0.29	0.26	0.20
0.45	0.68	0.52	0.43	0.26	0.23	0.16
0.40	0.68	0.51	0.39	0.24	0.20	0.13
0.35	0.68	0.50	0.36	0.23	0.18	0.12
0.30	0.68	0.50	0.33	0.22	0.16	0.11
0.25	0.68	0.50	0.30	0.22	0.15	0.10
0.20 and below	0.68	0.51	0.27	0.23	0.15	0.11

SITE 05 IMPACT EVALUATION
SAMPLE CELL: ORIGINAL TIER: 2 END USE: PROCESS

Measure	***HVAC System Variable Frequency Drives***
Site Description	***Industrial Manufacturing***

Measure Description

Install thirteen variable frequency drives on the chiller and pump motors in a central chilled water plant, and fan motors on two air handling units. This included three 350-ton chillers, two 10-hp air handler fan motors, two 75-hp secondary chilled water pump motors, three 10-hp primary chilled water pump motors and three 25-hp condenser water pump motors.

Summary of Ex Ante Impact Calculations

Savings were calculated using the SPC Estimation Software for the supply fans and the pumps. Adjustments were made in the Ex Ante calculations to correct the actual number of pumps operating, the verified fan and pump motor efficiencies, and to correct for the fact that the chilled water valves on the air handlers were three way valves instead of two way valves at the time of the installation.

The savings for the chiller VFDs was estimated by a customized spreadsheet analysis based on trend log data of chilled water pumping and performance curves from the manufacturer for the chillers with and without the VFDs.

Comments on Ex Ante Calculations

The approved ex ante savings were 720,882 kWh compared to the savings in the original application of 1,013,320 kWh. The corrections to the submitted applications appear to have been appropriate based on the information available at the time of the application and installation..

The calculation supporting the 10.3 kW of demand savings was not available for review at the time of the impact evaluation, but it appears to be reasonable. At the time of the utility system demand peak, all of this equipment would be running close to full capacity, so very little demand savings can be expected.

Evaluation Process

The evaluation process consists of a review of the application form and supporting documentation, conducting an on-site survey and then computing impacts using the on-site data.

The on-site survey was conducted on January 5, 2005. Information on the retrofit equipment and operating conditions was collected through an inspection of the Energy Management System set points and trend logs, inspections of the chillers, pumps and fans involved and through an interview of the customer's engineering staff.

We reviewed and accepted the chiller load profile and savings analysis submitted with the application. The load profile appears reasonable and the chiller performance is based on manufacturer's data.

During the site visit we determined that the customer has lowered the condenser water set point to take advantage of the chiller VFD installation. The condenser supply water was observed to be 49.3°F with an outside air temperature of 55.5°F and a relative humidity of 41.2%. This condenser water temperature is far lower than the usual set point of 85°F for a fixed speed centrifugal chiller. There is an increase in chiller efficiency of approximately 1% for every 2°F reduction in condenser water temperature. Chillers with VFDs can operate with lower condenser water temperatures, saving additional energy. We estimated through spreadsheet analysis and field observations that the chiller energy will be reduced an average of 7.5% based on the new condenser water temperature strategy. This increased the chiller energy savings by 92,971 kWh.

Calculations for the air handler VFDs, the primary chilled water pump VFDs and condenser water pump VFDs, were performed with the SPC calculation software. We reviewed the inputs and accepted the results.

During the site visit we discovered that the chilled water valves on the air handling units had been converted from three way valves to two way valves. Two way valves significantly increase the energy savings associated with the secondary chilled water pump VFDs. We recalculated the secondary chilled water pump VFD savings using the SPC estimation software. The energy savings increased from 198,868 kWh to 405,844 kWh.

Table 1 is a summary of the ex post savings analysis. Table 4 and Table 5 show the savings calculation for the lower condenser water temperature and the inputs to the spreadsheet model.

Table 1 Ex Post Savings Summary

Measure	Savings kWh
Chiller VFDs	494,132
Air Handler VFDs	48,812
Sec. Chilled Water Pump VFDs	405,844
Pri. Chilled Water Pumps VFDs	36,206
Condenser Water Pumps VFDs	35,835
Total	1,020,829

Installation Verification

All of the VFDs are in place and working properly. In addition to the 13 VFDs in the original incentive application, there are also two new VFDs for the cooling tower fans and one original VFD on the third cooling tower. A verification summary is shown in Table 6.

Scope of Impact Assessment

The impact evaluation includes the installation VFD's on supply fan motors, pump motors and chiller motors. These are the only measures for this SPC application.

Additional Notes

Since the completion of the project, the customer replaced two nonworking cooling tower fan motor VFD's and replaced all the three-way control valves on the secondary chilled water loop with two-way valves. Installation of the chiller VFDs has allowed the customer to operate the chillers at a much lower condenser water temperature, saving additional chiller energy.

The customer did not receive incentives for the tower fan VFD's or the two-way valves. The installation of two way chilled water valves on the air handlers significantly increased the savings associated with the secondary chilled water pump VFDs.

The amount of time budgeted for this application was not adequate. The impact evaluation could have been more accurate if there had been monitoring before and after installation. Ideally you would want to monitor power and speeds of all the VFD's, chiller load, and outside dry bulb temperature and wet bulb temperature over the range of ambient temperatures from the warmest summer month to coldest winter month. A full 12 months would be ideal. If the Energy Management System could be set up to record all of this, it would be done automatically. Setting up of the trend logs, plus data reduction at the end would require at least 80 hours considering the large number of points involved. Depending on the success in achieving reliable remote communication with the EMS, checking on the operation of the trend logs over the course of a year could require another 40 hours or more.

Economic Information

An economic summary for the measures for the primary end use is shown in Table 2 below. Table 3 presents the realization rate.

Table 2
Economic Summary Of The Project

Description	Date	Project Cost	Estimated Demand Savings, kW	Estimated Energy Savings, kWh	Estimated Gas Savings, therms	Estimated Annual Cost Savings ($0.13/kWh) ($0.75/therm)	SPC Incentive, $	Simple Payback w/ incentive, yrs.	Simple Payback w/o incentive, yrs.
Application Submitted Amount	6/2/03	$585,638	32.9	1,013,320	0.0	$131,732	$81,066	3.83	4.45
Application Approved Amount	7/2/03	$585,638	10.3	720,882	0.0	$93,715	$57,671	5.63	6.25
Installation Approved Amount (Ex Ante)	11/26/03	$585,638	10.3	720,882	0.0	$93,715	$57,671	5.63	6.25
SPC Impact Evaluation (Ex Post)	1/10/05	$585,638	10.3	1,020,829	0.0	$132,708	$57,671	3.98	4.41

Table 3
Impact Results

	KW	KWh	Therm
SPC Tracking System or Application (Ex Ante)	10.3	720,882	0
Adjusted Engineering (Ex Post)	10.3	1,020,829	0
Engineering Realization Rate	1.0	1.42	N/A

Table 4
Ex Post Calculations Summary

Table 3 Ex Post Calculation Summary

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average temp. (°F)	57	58.3	59.7	62.9	65.7	69.6	73.5	74.8	73.2	68.5	61.8	57.1
High temperature (°F)	68	68.6	69	72.7	73.9	78.1	82.6	84.2	82.8	78.8	73.3	68.8
Low temperature (°F)	46.1	48.1	50.2	53	57.5	61	64.3	65.3	63.5	58.2	50.1	45.4
Precipitation (in)	3	3.1	2.5	0.6	0.2	0.1	0	0.1	0.3	0.4	1.1	1.8

Load based on avg temp	31%	33%	36%	42%	47%	54%	61%	63%	60%	52%	40%	31%
Load based on max temp	51%	52%	53%	59%	62%	69%	77%	80%	78%	71%	61%	52%

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Days with precip.	6	5	5	3	1	0	0	0	1	2	3	5
Wind speed (mph)	5.2	6	6.7	7.4	7.1	7	6.8	6.6	6.2	5.6	5.2	5
Morning humidity (%)	76	78	80	80	81	82	82	82	83	81	79	77
Afternoon humidity (%)	53	54	55	51	55	56	54	53	54	54	53	52
Sunshine (%)	72	71	70	69	60	59	69	71	70	69	75	73
Days clear of clouds	12	10	11	12	10	12	18	19	15	13	13	13
Partly cloudy days	8	7	9	10	13	12	11	10	11	11	8	8
Cloudy days	11	11	11	8	8	6	2	2	4	7	8	10
Snowfall (in)	0	0	0	0	0	0	0	0	0	0	0	0

Average WB temp. (°F) based on aft. RH & DB	58	59	59	61	63	67	70	71	70	67	62	58
Cond. temp. (°F) for 4°F approach	62	63	63	65	67	71	74	75	74	71	66	62
Degrees colder than 85F	23	22	22	20	18	14	11	10	11	14	19	23
Percent increase in eff.	11.5%	11.0%	11.0%	10.0%	9.0%	7.0%	5.5%	5.0%	5.5%	7.0%	9.5%	11.5%
Cond. temp. (°F) for 7°F approach	65	66	66	68	70	74	77	78	77	74	69	65
Degrees colder than 85F	20	19	19	17	15	11	8	7	8	11	16	20
Percent increase in eff.	10.0%	9.5%	9.5%	8.5%	7.5%	5.5%	4.0%	3.5%	4.0%	5.5%	8.0%	10.0%

Average improvement in efficiency 7.5% (This is using average of 11.5% for January and 3.5% for August.)

Est. kWh with constant speed chillers	1,640,780
Orig. Est. kWh with 85F cond. water	1,239,619
Orig. Est. of kWh savings	401,161
Est. kWh with colder cond. Water	1,146,648
New est. of kWh savings for chiller VFD	494,132
All measure savings, kWh	
Chillers	494,132
Air Handlers	48,812
Sec. Chilled Water Pumps	405,844
Pri. Chilled Water Pumps	36,206
Condenser Water Pumps	35,835
Total	1,020,829

Table 5 Inputs to the Ex Post Model

Parameter	Value Reported	Units of Parameter	Notes
Motor sizes	Various	Hp	
Motor efficiencies	Various	%	Nameplates
Motor loading	varies	kW	From trend logs
Time at % speed	Various	Hours	From trend logs
Chiller capacities	350	Tons	
Chiller loading	varies	Tons	From trend logs
Chiller loading	varies	kW	From trend logs
Average temperatures	varies	°F	Local weather records
Running hours	8760	Hours	From trend logs
Installation Date	8/1/2003		

Table 6
Project Verification Sheet

Measure Description	End-Use Category	Process Measure Description	Count	Equipment Description	Installation Verified (Explain)	Notes
Adjustable Speed Drive	P	Install ASD's on chillers, air handlers, pumps.	13	Wall-hung variable frequency drives all in place as proposed.	All of the drives were physically observed.	Savings appear to be greater than predicted due to the additional changeout of the secondary chilled water three-way valves with two-way and additional speed drives on the cooling towers.

SITE 06 IMPACT EVALUATION
SAMPLE CELL: ORIGINAL TIER: 2 END USE: PROCESS

Measure	Install Insulation Blankets on Injection Molding Machines
Site Description	Manufacturing

Measure Description

Install insulation blankets on injection molding machine heaters.

Summary of Ex Ante Impact Calculations

The Ex Ante calculations were performed by the insulation blanket vendor. The vendor assumed an average heater kW before and after the installation and estimated the annual hours of operation. The savings were calculated using the following formulae:

$kW_{saved} = kW_{pre\ retrofit} - kW_{post\ retrofit}$
$kWh_{saved} = kW_{saved}$ x annual hours

The vendor assumed that all 34 machines operate continuously when the facility is open. Facility hours were listed as 24 hours per day, 5 days per week, 52 weeks per year (6,240 hours annually). Table 1 shows a summary of the Ex Ante calculations.

Table 1 Summary of the Ex Ante Calculations

	kW	kWh
Pre retrofit	332	2,071,680
Post retrofit	225	1,404,000
Savings	107	667,680

Detailed Ex Ante calculations are shown below in Table 6. The values in Table 6 are slightly different that the Ex Ante results shown in Table 6 because the vendor rounded the column sums before completing the calculations.

Comments on Ex Ante Calculations

The Ex Ante calculations are based on vendor estimates of average heater input kW before and after the insulation blankets are installed. The vendor also assumed that the injection molders would operate all hours the facility is open, and did not allow for the time required to re-tool or maintain each machine. .

Evaluation Process

The evaluation process consists of a review of the application form and supporting documentation, conducting an on-site survey and then computing impacts using data collected on-site.

The on-site survey was conducted on November 4, 2004. Information on the heater blanket installation and injection molding machine operating parameters was collected by interviewing the facility representative and by inspecting the injection molding machines. The facility representative provided a current production schedule and operating hours for the facility.

The typical manufacturing schedule for the facility is 24 hours per day, five days per week, 52.14 weeks per year minus 9 holidays. The facility representative estimates that each machine operates an average 22.5 hours per day or 5,663 hours annually. Machines require maintenance and re-tooling, and also must be cleaned when the plastic color is changed.

Plastic beads are loaded into the top of the machine. The type of plastic varies based on the product being manufactured, but poly propylene is most commonly used. The heater cylinder has an auger that moves the plastic into the injection molder. A significant amount of heat is created by the friction of the plastic moving through the auger bit the into the machine. The heater cylinder is surrounded by electric resistance heaters, and the electric input is controlled by sensors to maintain the proper cylinder temperature. During the site visit we observed cylinder temperatures shown on monitoring equipment from 400 °F to 450 °F

The site representative informed us that measurements had been made for 2 of the injection molding machines. The machines were tested with and without the heater insulation blanket installed. The test showed that the average heater input kW was reduced by approximately 30% with the insulation blanket installed. The test also confirmed that the estimated input kW provided by the vendor for each machine is reasonably accurate. Table 2 is a summary of the test results for the two injection molding machines.

Table 2 Summary of Test Results

	kW		
Machine #	Uninsulated	Insulated	% savings
24	12.865	8.964	30.3%
26	20.368	14.36	29.5%
Total	33.233	23.324	29.8%

The site inspection revealed that Machine #28 has been retired and that Machine # 16 does not have a heater blanket installed.

Savings were recalculated assuming a 30 % savings for each machine with a heater blanket and with the revised estimated annual hours of operation for the injection molders. A summary of the Ex Post savings analysis is shown in Table 3 below.

Table 3 Summary of Ex Post Savings Analysis

	kW	kWh
Pre retrofit	311.0	1,761,271
Post retrofit	220.7	1,249,879
Savings	90.3	511,391

Detailed Ex Post calculations are shown below in Table 7.

Installation Verification

We physically verified that insulation blankets are installed on 32 injection molding machines. Machine # 16 did not have an insulation blanket installed and Machine # 28 has been retired and removed from the facility. An installation verification sheet is found below in Exhibit 1.

Scope of Impact Assessment

The impact evaluation is for the installation of heater insulation blankets on injection molding machines and is the only measure for this SPC application.

Additional Notes

The ex post savings are less than the ex ante savings because the heater input kW reduction and annual hours of operation are less than what was assumed in the ex ante calculations. Also one machine has been retired and one machine did not have an insulation blanket installed.

The amount of time allowed for the impact evaluation is adequate considering the amount of the incentive. With an additional 16 hours we could have measured the operating hours for a sample of machines and determined their average energy use.

Economic Information

An economic summary for the installation of the heater insulation blankets on the injection molders is shown in Table 4 below. An engineering realization rate calculation is shown in Table 5.

Economic Summary

Table 4 Economic Summary of the Project

Description	Date	Project Cost	Estimated Demand Savings, kW	Estimated Energy Savings, kWh	Estimated Gas Savings, therms	Estimated Annual Cost Savings ($0.13/kWh), $	SPC Incentive, $	Simple Payback w/ incentive, yrs	Simple Payback w/o incentive, yrs
Application Submitted Amount	2/5/2003	$19,450	107	667,680	0	$86,798	$9,725	0.11	0.22
Application Approved Amount	3/28/2003	$19,450	107	667,680	0	$86,798	$9,725	0.11	0.22
Installation Approved Amount (Ex Ante)	8/1/2003	$19,450	107	667,680	0	$86,798	$9,725	0.11	0.22
SPC Program Review (Ex Post)	11/10/2004	$19,450	90	511,391	0	$66,481	$9,725	0.15	0.29

Impact Results

Table 5 Realization Rate Calculation

	KW	KWh	Therm
SPC Tracking System or Application	107	667,680	0
Adjusted Engineering	90	511,391	0
Engineering Realization Rate	84.1%	76.6%	NA

Table 6 Summary of the Ex Ante Calculations

	kW		Annual	Savings		
Machine #	Pre retrofit	Post retrofit	Hours	kW	kWh	% Savings
1	2.00	1.25	6,240	0.75	4,680	37.5%
2	2.00	1.25	6,240	0.75	4,680	37.5%
3	2.50	1.50	6,240	1.00	6,240	40.0%
4	2.00	1.25	6,240	0.75	4,680	37.5%
5	2.00	1.25	6,240	0.75	4,680	37.5%
8	3.00	1.75	6,240	1.25	7,800	41.7%
9	2.00	1.25	6,240	0.75	4,680	37.5%
10	6.00	4.00	6,240	2.00	12,480	33.3%
11	12.00	8.00	6,240	4.00	24,960	33.3%
12	16.00	11.00	6,240	5.00	31,200	31.3%
13	9.00	6.00	6,240	3.00	18,720	33.3%
14	9.00	6.00	6,240	3.00	18,720	33.3%
15	8.50	6.00	6,240	2.50	15,600	29.4%
16	10.00	6.50	6,240	3.50	21,840	35.0%
17	3.00	1.75	6,240	1.25	7,800	41.7%
18	9.00	6.00	6,240	3.00	18,720	33.3%
19	9.00	6.00	6,240	3.00	18,720	33.3%
20	17.00	12.00	6,240	5.00	31,200	29.4%
21	17.00	12.00	6,240	5.00	31,200	29.4%
22	15.00	11.00	6,240	4.00	24,960	26.7%
23	15.00	11.00	6,240	4.00	24,960	26.7%
24	13.00	9.00	6,240	4.00	24,960	30.8%
25	20.00	14.00	6,240	6.00	37,440	30.0%
26	20.00	14.00	6,240	6.00	37,440	30.0%
27	13.00	9.00	6,240	4.00	24,960	30.8%
28	20.00	14.00	6,240	6.00	37,440	30.0%
29	10.00	6.00	6,240	4.00	24,960	40.0%
30	12.00	8.00	6,240	4.00	24,960	33.3%
31	10.00	6.50	6,240	3.50	21,840	35.0%
32	9.00	6.00	6,240	3.00	18,720	33.3%
33	9.00	6.00	6,240	3.00	18,720	33.3%
34	9.00	6.50	6,240	2.50	15,600	27.8%
35	9.00	6.00	6,240	3.00	18,720	33.3%
36	6.00	4.00	6,240	2.00	12,480	33.3%
Total	331.00	225.75		105.25	656,760	31.8%

The values in Table 6 are slightly different than the Ex Ante savings shown in the installation report because the vendor rounded the results before completing the calculations.

Table 7 Summary of the Ex Post Calculations

Machine #	kW Pre retrofit	kW Post retrofit	Annual Hours	Savings kW	Savings kWh	% Savings
1	2.00	1.40	5,663	0.60	3,398	30.0%
2	2.00	1.40	5,663	0.60	3,398	30.0%
3	2.50	1.75	5,663	0.75	4,247	30.0%
4	2.00	1.40	5,663	0.60	3,398	30.0%
5	2.00	1.40	5,663	0.60	3,398	30.0%
8	3.00	2.10	5,663	0.90	5,097	30.0%
9	2.00	1.40	5,663	0.60	3,398	30.0%
10	6.00	4.20	5,663	1.80	10,194	30.0%
11	12.00	8.40	5,663	3.60	20,388	30.0%
12	16.00	11.20	5,663	4.80	27,184	30.0%
13	9.00	6.30	5,663	2.70	15,291	30.0%
14	9.00	6.30	5,663	2.70	15,291	30.0%
15	8.50	5.95	5,663	2.55	14,441	30.0%
16	10.00	10.00	5,663	0.00	-	0.0%
17	3.00	2.10	5,663	0.90	5,097	30.0%
18	9.00	6.30	5,663	2.70	15,291	30.0%
19	9.00	6.30	5,663	2.70	15,291	30.0%
20	17.00	11.90	5,663	5.10	28,883	30.0%
21	17.00	11.90	5,663	5.10	28,883	30.0%
22	15.00	10.50	5,663	4.50	25,485	30.0%
23	15.00	10.50	5,663	4.50	25,485	30.0%
24	13.00	9.10	5,663	3.90	22,087	30.0%
25	20.00	14.00	5,663	6.00	33,980	30.0%
26	20.00	14.00	5,663	6.00	33,980	30.0%
27	13.00	9.10	5,663	3.90	22,087	30.0%
28	0.00	0.00	5,663	0.00	-	0.0%
29	10.00	7.00	5,663	3.00	16,990	30.0%
30	12.00	8.40	5,663	3.60	20,388	30.0%
31	10.00	7.00	5,663	3.00	16,990	30.0%
32	9.00	6.30	5,663	2.70	15,291	30.0%
33	9.00	6.30	5,663	2.70	15,291	30.0%
34	9.00	6.30	5,663	2.70	15,291	30.0%
35	9.00	6.30	5,663	2.70	15,291	30.0%
36	6.00	4.20	5,663	1.80	10,194	30.0%
Total	311.00	220.70		90.30	511,391	29.0%

Exhibit 1 Installation Verification Sheet

Measure Description	End-Use Category	HVAC Measure Description	Lighting Measure Description	Process Measure Description	Count	Equipment Description	Installation Verified (Explain)	Notes
Install Insulation on Injection Molder Heaters	P			Install Insulation Blankets on Injection Molder Heaters	32	Inject ion molder heaters wrapped with insulation blankets.	Physicallly verified that blankets were installed on 32 Injection molders.	Machine # 16 did not have a blanket installed. Machine # 28 has been retired and removed from the facility.

SITE 07 IMPACT EVALUATION
SAMPLE CELL: ORIGINAL TIER: 2 END USE: PROCESS

Measure	Install VFDs on Air Handler Fan Motors
Site Description	Telecommunications Equipment Building

Measure Description

Install VFDs on two 100 HP supply fan motors and two 200 HP supply fan motors.

Summary of Ex Ante Impact Calculations

The Ex Ante calculations were performed using the SPC calculation software. The calculation software requires input including motor nameplate data, field measured motor input power, a description of the building type, location and conditioned area (ft^2). A schedule of operation is also included in the input data.

The SPC calculator input data indicates that there is one 100 HP supply fan motor with an efficiency of 94.1% and one 200 HP supply fan motor with an efficiency of 94.1% operating continuously. The Ex Ante savings are summarized in Table 1.

Table 1 Summary of the Ex Ante Savings

	kW	kWh
Pre Retrofit	220	1,943,807
Post Retrofit	223	444,843
Savings	-3.1	1,498,964

Comments on Ex Ante Calculations

The Ex Ante savings are calculated using the SPC calculation software. The SPC calculator does not require input regarding the fan type (forward curved, backward inclined, air foil, etc.) or pre retrofit volume control method (inlet vanes, discharge damper, rides the fan curve, etc.) These parameters have an impact on the energy savings associated with installing VFD's on fan motors. The building type selected for the analysis is a "Large Office".

Evaluation Process

The evaluation process consists of a review of the application form and supporting documentation, conducting an on-site survey and then computing impacts using data collected on-site.

The survey was conducted on January 5, 2005. Information on the retrofit equipment and operating conditions was collected by inspecting the fan motor VFD's and by interviewing the facility representative.

The retrofit affects two different zones in the building. We determined that each zone is served by two air handling units with full redundant capacity. Only one air handler operates at a time in each zone, and the air handlers are controlled in a lead/lag sequence. Each air handler serving the third floor is equipped with a 100 HP supply fan motor and each air handler serving the fifth floor has a 200 HP supply fan motor. VFD's are installed on the fan motors, there are two 100 HP

VFDs and two 200 HP VFDs. The facility representative stated that all air handlers had inlet vanes installed for fan volume modulation prior to the retrofit. Both systems operate continuously to satisfy internal heat loads from telecommunications equipment.

The areas served by these air handlers have no windows and little occupancy. The facility representative confirmed that the telecommunications equipment heat load is fairly constant and that there is only a small variation in the fan speed observed throughout the year. There are zone dampers that modulate to maintain space temperature set points.

During the site visit we observed that both fan VFDs were operating between 30 and 35 Hz (cycles per second). The facility representative stated that the fan VFDs normally operate between 30 and 35 Hz, and occasionally up to 40 Hz. VFD Hz is directly proportional to the motor RPM. At 60 Hz the fan motor speed would be 100 %. At 30 Hz the fan motor speed would be 50%. Based on this information we created a load profile for the two air handling systems assuming that the air handler fan motor VFDs operate at 30 Hz 33% of the time, 35 Hz 33% of the time, and 40 Hz 33% of the time. Table 2 is a summary of the load profile created for the air handling systems.

Table 2 Air Handler Load Profile

VFD Hz	Percent Speed	Percent Time	Annual Hours
30	50%	33%	2,920
35	58%	33%	2,920
40	67%	33%	2,920

Using the load profile in Table 2, and fan unloading curves (part load modifiers) from DOE 2, we created a spreadsheet analysis to estimate the pre and post retrofit energy consumption of the supply fan systems.

We assumed a load factor of 85% at 100% speed for the motors and verified the motor efficiency to be 95.4% for the 100 HP fan motors and 96.4% for the 200 HP fan motors. The fan full load input power is calculated by the following formula:

kW= HP x load factor x 0.746 kW/HP x 1/motor efficiency

Each fan system has a redundant air handler and only one fan operates at a time for each area. This is equivalent to one fan in each system operating continuously. One 100 HP motor and one 200 HP motor operate simultaneously.

The part load energy modifier from the DOE 2 program is shown in Exhibit 4. The pre-retrofit fans are "BI/AF Inlet Vanes". The post retrofit fans are "Any Var. Fq. Drive". The fan system kW were calculated as follows:

Fan kW at each speed = Full Load kW x part load modifier (from DOE 2)
Fan kWh = fan kW x annual hours

A more detailed analysis is shown in Exhibit 2 and Exhibit 3 below. Table 3 is a summary of the Ex Post savings analysis.

It was assumed that the fans are likely to operate at 40 Hz during the peak period.

kW savings were calculated as the difference between fans operating at 40 Hz and fans operating at 60 Hz with inlet guide vanes.

Table 3 Summary of the Ex Post Savings Analysis

System	Pre-retrofit		Post-retrofit		Savings	
	kW	kWh	kW	kWh	kW	kWh
Supply Fans 3rd floor	41.9	339,649	24.6	163,031	17.3	176,617
Supply Fans 5th floor	83.1	673,649	48.8	323,351	34.3	350,297
Total	124.9	1,013,298	73.4	486,383	51.6	526,915

Installation Verification

We physically verified the installation of VFD's on two 100 HP supply fan motors and two 200 HP supply fan motors. An installation verification summary is shown in Exhibit 1 below.

Scope of Impact Assessment

The impact evaluation includes the installation of VFD's on two 100 HP supply fan motors and two 200 HP supply fan motors. This is the only measure for this SPC application.

Additional Notes

The Ex Post kWh savings results are less than the Ex Ante results because the Ex Ante analysis was performed with the SPC calculator assuming that the fan motors serve a large commercial office building. Presumably, the "Large Office Building" load profile is highly variable, and would show a large savings with a VFD installation. We determined that the fan systems serve a process cooling load that is relatively constant and largely unaffected by ambient temperature conditions. Another significant factor is that the SPC calculator assumes that the pre retrofit fan systems operate at a constant power draw. There does not appear to be an algorithm to unload the pre retrofit fan as the system air flow varies. The fan systems in this project were equipped with fan inlet vanes before the retrofit, and the energy consumption of the fan motors would vary based on the position of the inlet vanes.

The ex post calculations determined that there are demand kW reductions associated with the retrofit that were not claimed in the ex ante savings. The load profile in the SPC calculator likely assumes that the system will operate at 100 % capacity during peak load conditions. The ex post analysis found that fans are likely to operate at 40 Hz during peak hours. The difference between fans operating at 40 Hz and fans operating at 60 Hz with inlet guide vanes was found to be 51 kW.

According to the site representative, the actuators on the fan inlet vanes would periodically stick in one position, eliminating the modulation of the fan airflow. If the inlet vanes were stuck far enough closed, areas would over heat causing operational problems for the telecommunications equipment. The installation of VFD's has eliminated this problem and reduced maintenance costs.

The amount of time allowed for the evaluation was not adequate We estimate that an additional 32 hours plus the rental of logging equipment would be necessary to perform a more accurate assessment of the savings associated with this project. The impact evaluation for this project would also have benefited from pre measurement.

Economic Information

An economic summary for the installation of the VFDs is shown in Table 4 below. An engineering realization rate calculation is shown in Table 5.

Impact Results

Table 4 Economic Summary of the Project

Description	Date	Project Cost	Estimated Demand Savings, kW	Estimated Energy Savings, kWh	Estimated Gas Savings, therms	Estimated Annual Cost Savings ($0.13/kWh), $	SPC Incentive, $	Simple Payback w/ incentive, yrs	Simple Payback w/o incentive, yrs
Application Submitted Amount	3/13/2003	$250,000	(3.1)	1,498,965	0	$194,865	$119,917	0.67	1.28
Application Approved Amount	4/1/2003	$250,000	(3.1)	1,498,964	0	$194,865	$119,917	0.67	1.28
Installation Approved Amount (Ex Ante)	3/5/2004	$250,000	(3.1)	1,498,965	0	$194,865	$119,917	0.67	1.28
SPC Program Review (Ex Post)	1/10/2005	$250,000	51.6	526,915	0	$68,499	$119,917	1.90	3.65

Table 5 Realization Rate Calculation

	KW	KWh	Therm
SPC Tracking System or Application	-3.1	1,498,965	0
Adjusted Engineering	51.6	526,915	0
Engineering Realization Rate	1,664%	35.1%	NA

Exhibit 1 Installation Verification Sheet

Measure Description	End-Use Category	HVAC Measure Description	Lighting Measure Description	Process Measure Description	Count	Equipment Description	Installation Verified (Explain)	Notes
100 HP VSD for HVAC Supply Fans	O			Install VFDs on two 100 HP fan motors.	2	ABB Variable Speed Drives	Physically verified VFD installation.	
200 HP VSD for HVAC Supply Fans	O			Install VFDs on two 200 HP fan motors.	2	ABB Variable Speed Drives	Physically verified VFD installation.	

Exhibit 2 Ex Post Supply Fan Savings Analysis 100 HP Fan Motors

Fan HP	100
Fan Load Factor	85%
Full Load BHP/fan	85.0
Motor Efficiency	95.4%
Full Load kW/fan	66.5
Quantity of Fans	1
Total Full Load kW	66

Annual	% Maximum	BI/AF Inlet Vanes	Pre retrofit		VFD	Post retrofit		Savings	
Hours	Design CFM	% Max Power	kW	kWh	% Max Power	kW	kWh	kW	kWh
2,920	67.0%	63.0%	42	122,274	37%	25	71,811	17	50,462
2,920	58.0%	58.0%	39	112,569	27%	18	52,403	21	60,166
2,920	50.0%	54.0%	36	104,806	20%	13	38,817	23	65,989
8,760				339,649			163,031		176,617

Fan quantity is set to one, since only one fan operates at a time.

Exhibit 3 Ex Post Supply Fan Savings Analysis 200 HP Fan Motors

Fan HP	200
Fan Load Factor	85%
Full Load BHP/fan	170.0
Motor Efficiency	96.2%
Full Load kW/fan	131.8
Quantity of Fans	1
Total Full Load kW	132

Annual	% Maximum	BI/AF Inlet Vanes	Pre retrofit		VFD	Post retrofit		Savings	
Hours	Design CFM	% Max Power	kW	kWh	% Max Power	kW	kWh	kW	kWh
2,920	67.0%	63.0%	83	242,514	37%	49	142,429	34	100,085
2,920	58.0%	58.0%	76	223,266	27%	36	103,934	41	119,332
2,920	50.0%	54.0%	71	207,869	20%	26	76,988	45	130,880
8,760				673,649			323,351		350,297

Fan quantity is set to one, since only one fan operates at a time.

Exhibit 4 DOE 2 Part Load Modifier for Fan Systems

FAN SPEED CONTROLS
Power Relationships

DOE-2.1 CALIFORNIA COMPLIANCE SUPPLEMENT

BI = backward inclined, AF = air foil, FC = forward curved

PART LOAD ENERGY MODIFIER, Y

% FLOW X	BI/AF Outlet Damp or no cntrl 1	BI/AF Inlet Vanes 2	FC Out Damp no cntrl 3	FC Inlet Vanes 4	Vane Ax,Var Pitch 5	Any Var.Fq Drive 6
1.00	1.00	0.98	1.00	0.99	0.99	1.00
0.95	0.98	0.91	0.94	0.88	0.89	0.88
0.90	0.96	0.85	0.87	0.79	0.79	0.77
0.85	0.93	0.79	0.82	0.70	0.70	0.67
0.80	0.91	0.74	0.76	0.62	0.62	0.58
0.75	0.88	0.70	0.70	0.54	0.54	0.49
0.70	0.85	0.65	0.65	0.48	0.47	0.42
0.65	0.82	0.62	0.60	0.42	0.41	0.35
0.60	0.79	0.59	0.56	0.37	0.35	0.29
0.55	0.75	0.56	0.51	0.33	0.31	0.24
0.50	0.71	0.54	0.47	0.29	0.26	0.20
0.45	0.68	0.52	0.43	0.26	0.23	0.16
0.40	0.68	0.51	0.39	0.24	0.20	0.13
0.35	0.68	0.50	0.36	0.23	0.18	0.12
0.30	0.68	0.50	0.33	0.22	0.16	0.11
0.25	0.68	0.50	0.30	0.22	0.15	0.10
0.20 and below	0.68	0.51	0.27	0.23	0.15	0.11

SITE 08 IMPACT EVALUATION
SAMPLE CELL: ORIGINAL TIER: 3 END USE: HVAC/R

Measure	Install Energy Management System
Site Description	Restaurant

Measure Description

Install energy management system to schedule equipment on and off.

Summary of Ex Ante Impact Calculations

The Ex Ante calculations were performed by a combination of engineering calculations and savings estimates based on the results of similar installations. Engineering calculations were based on following formulae:

HVAC Fan Energy Pre and Post Retrofit:
kW=Full Load Amps x Volts x square root 3/1,000 w/kW
kWh= kW x operating hours
Full load amps and volts are from the equipment nameplate.

Exhaust Fan Energy Pre and Post Retrofit
kW= HP x 0.746 kW/HP x 0.80 load factor
kWh= kW x operating hours

Refrigeration Compressor Energy Pre and Post Retrofit
kW = Full Load Amps x 125% x Volts
kWh= kW x operating hours

HVAC Natural Gas Savings:
Therms saved = Annual therms x 12%

A summary of the Ex Ante Savings for HVAC fans is shown in Table 1, a summary for the exhaust fans in Table 2, a summary for the refrigeration compressors is shown in Table 3 and a summary for the HVAC natural gas savings is shown in Table 4. Table 5 is a summary of all HVAC and refrigeration measures.

Table 1 Summary of Ex Ante HVAC Fan Energy Savings

		Supply Fan		Load		Pre retrofit		Post retrofit		Savings
Unit	Quantity	Full Load Amps	Volts	Factor	kW	Hours	kWh	Hours	kWh	kWh
Kitchen	1	7.5	208	1.0	2.70	8,736	23,605	6,864	18,547	5,058
Lobby #1	1	7.5	208	1.0	2.70	8,736	23,605	6,136	16,579	7,025
Lobby #2	1	7.5	208	1.0	2.70	8,736	23,605	6,136	16,579	7,025
Total							70,814		51,705	19,109

Table 2 Summary of Ex Ante Exhaust Fan Energy Savings

			Load		Pre retrofit		Post retrofit		Savings
Equipment	Quantity	HP	Factor	kW	Hours	kWh	Hours	kWh	kWh
Exhaust	3	0.75	0.8	1.34	6,864	9,217	6,499	8,727	490
Restroom	1			0.40	7,036	2,814	6,136	2,454	360
TOTAL									850

Table 3 Summary of Ex Ante Refrigeration Compressor Energy Savings

						Pre retrofit		Post retrofit		Savings
Equipment	Quantity	Amps	Volts	Factor	kW	Hours	kWh	Hours	kWh	kWh
Mac 6 Freezer	1	16.7	208	125%	4.342	6,864	29,803	6,136	26,643	3,161
Mac 6 Cooler	1	10.6	208	125%	2.756	6,864	18,917	6,136	16,911	2,006
Total							48,721		43,553	5,167

Table 4 Summary of Ex Ante HVAC Natural Gas Energy Savings

Annual Therms	Estimated Savings %	Savings (Therms)
9,150	12%	1,098

Table 5 Summary of All Ex Ante HVAC and Refrigeration Savings

Measure	kWh	Therms
HVAC Supply Fans	19,109	-
Exhaust Fans	850	-
Compressors	5,167	-
HVAC Natural Gas	-	1,098
Total	25,126	1,098

The slight difference in savings calculated above (25,126 kWh versus 25,103 kWh shown in the installation report) is due to rounding.

Comments on Ex Ante Calculations

The Ex Ante calculations are inconsistent in their approach to fan energy savings. Calculations for the HVAC supply fans do not incorporate a load factor. The calculation for the exhaust fans does use a load factor of 0.80. The calculations for refrigeration compressors use a 125% factor that is not explained and the calculations imply that the compressors run continuously which is unlikely.

Natural gas savings are based on an assumed 12 percent savings estimated from other similar projects. Unfortunately the gas savings do not appear to account for hot water heating or cooking equipment gas usage which is a significant portion of gas consumption throughout the year

Post retrofit hours of operation presumably come from the energy management system schedules.

Evaluation Process

The evaluation process consists of a review of the application form and supporting documentation, conducting an on-site survey and then computing impacts using data collected on-site.

The on-site survey was conducted on October 29, 2004. Information on the EMS system and equipment controlled after the retrofit was collected on site and by interviewing the facility representatives. The facility representative provided current hours for the restaurant. We also contacted the contractor who installed the EMS and now remotely monitors the operation of the facility.

We were informed by the facility representative that the restaurant is open from 5 AM to midnight, Sunday-Thursday, 5 AM – 1AM Friday and Saturday, and is only closed on Christmas. This equates to 7,019 hours annually. The restaurant hours were the same before the retrofit.

The facility representative stated that prior to the retrofit the restaurant manager was responsible to turn lights, exhaust fans and other equipment on and off

In February 2004, the drive through window began operating 24 hours per day, 7 days per week., and is also closed on Christmas. This equates to 8,736 hours annually.

We contacted the EMS contractor to review the equipment controlled by the EMS and the daily schedules of operation. The EMS contractor informed us that the exhaust fans and refrigeration compressors are not controlled by the EMS. The Kitchen AC unit and Lobby AC unit #1 operate 24 hours seven days per week. Lobby AC unit #2 operates the same hours the restaurant is open, 7,019 hours annually.

During the site visit we verified the nameplate data for the AC units, exhaust fans and refrigeration compressors. The only discrepancy is the full load amps for lobby AC unit #2. We found that unit to have a nameplate rating of 10.6 FLA instead of the 7.5 FLA used in the Ex Ante Calculations. We adjusted the pre-retrofit hours of operation to match the new schedule of operation for the store. Based on the information gathered and an assumed 80% load factor on the HVAC supply fans, we performed the Ex Post calculations.

Table 1 Summary of Ex Post HVAC Fan Energy Savings

		Supply Fan		Load		Pre retrofit		Post retrofit		Savings
Unit	Quantity	Full Load Amps	Volts	Factor	kW	Hours	kWh	Hours	kWh	kWh
Kitchen	1	7.5	208	0.8	2.16	8,736	18,884	8,736	18,884	-
Lobby #1	1	7.5	208	0.8	2.16	8,736	18,884	8,736	18,884	-
Lobby #2	1	10.6	208	0.8	3.06	7,019	21,443	7,019	21,443	-
Total							59,211		59,211	-

1. Load factor for fans assumed to be 80%.

Table 2 Summary of Ex Post Exhaust Fan Energy Savings

			Load		Pre retrofit		Post retrofit		Savings
Equipment	Quantity	HP	Factor	kW	Hours	kWh	Hours	kWh	kWh
Exhaust	1	0.75	0.8	0.45	8,736	3,910	8,736	3,910	-
Exhaust	2	0.33	0.8	0.39	8,736	3,441	8,736	3,441	-
Restroom	1	0.14	0.8	0.09	8,736	745	8,736	745	-
TOTAL						8,096		8,096	-

1. Load factor for fans assumed to be 80%.

Table 3 Summary of Ex Post Refrigeration Compressor Energy Savings

						Pre retrofit		Post retrofit		Savings
Equipment	Quantity	Amps	Volts	Factor	kW	Hours	kWh	Hours	kWh	kWh
Mac 6 Freezer	1	16.7	208	125%	4.342	2,826	12,270	2,826	12,270	-
Mac 6 Cooler	1	10.6	208	125%	2.756	2,826	7,788	2,826	7,788	-
Total							20,059		20,059	-

1. Refrigeration compressors are not controlled by the EMS, pre and post retrofit hours assumed equal.
2. Assumed refrigeration compressors operate 30% of annuual hours (2,628 hours annually.)

Table 4 Summary of Ex Post HVAC Natural Gas Energy Savings

Annual Therms	Estimated Savings %	Savings (Therms)
9,150	0%	-

Table 5 Summary of All Ex Post HVAC and Refrigeration Savings

Measure	kWh	Therms
HVAC Supply Fans	-	-
Exhaust Fans	-	-
Compressors	-	-
HVAC Natural Gas	-	-
Total	-	-

Installation Verification

We physically verified the full load amps and horsepower of the equipment listed in the SPC application. Discussion with the EMS contractor revealed that the exhaust fans and refrigeration compressors are not controlled by the EMS although an incentive was paid based on this equipment being controlled by the EMS. An installation verification summary is shown in Exhibit 1 below.

Scope of Impact Assessment

The impact evaluation includes analysis of the installation of an energy management system for the HVAC, exhaust fan and refrigeration systems. Energy management system control for the lighting system was not evaluated.

Additional Notes

Since the restaurant is now open 24 hours per day 364 days per year, the savings associated with scheduling equipment is zero. The savings associated with the refrigeration compressors are zero because the compressors are not controlled by the EMS.

Natural gas energy savings associated with scheduling the HVAC units were calculated as an assumed 12 percent of annual therms, and did not account for cooking use or water heating use, which are significant. There is no engineering basis for the stated assumption. The natural gas savings are zero because two of the three AC units operate 8,736 hours annually, and it appears likely that the claim was greatly overstated because it did not account for water heating and cooking natural gas consumption. The gas savings associated with the third AC unit is negligible, since the area it serves is adjacent to another area, which will continue to indirectly condition this space even though the unit is off.

The customer installed the EMS with the sole function of scheduling control of HVAC units, exhaust fans, lighting, and refrigeration compressors.
The reviewer did visit the site, however it appears that they never verified the controlled points on the EMS system. The controls vendor advised that they do not control exhaust fans of refrigeration compressors with the EMS as shown in the Ex Ante calculations. The reviewer did an insufficient job verifying the installation and stated that since 7 other restaurants had done the same retrofit it was assumed to be operating as specified in the application.

The customer advised that this retrofit had been performed on 20 restaurants that they operate, and that they have not realized the savings expected from the project. It appears that the deficiencies in reviewing this application may have been repeated at other sites operated by this customer.

This restaurant now has a drive through window open 24 hours and 2 of the 3 HVAC units operate most of the year. The lighting also operates most of the year, except for the interior menu sign. Energy use has increased because the hours of operation have increased.

Time allowed for the assessment of this site was adequate and no additional work is necessary.

Economic Information

An economic summary for the installation of the energy management system is shown in Table 6 below. An engineering realization rate calculation is shown in Table 7.

Impact Results

Table 6 Economic Summary of the Project (Excluding Lighting Controls)

Description	Date	Project Cost	Estimated Demand Savings, kW	Estimated Energy Savings, kWh	Estimated Gas Savings, therms	Estimated Annual Cost Savings ($0.13/kWh, 0.75 $/therm),	SPC Incentive, $	Simple Payback w/ incentive, yrs	Simple Payback w/o incentive, yrs
Application Submitted Amount	11/5/2003	$12,250	-	24,744	1,098	$4,040	$2,638.32	2.38	3.03
Application Approved Amount	12/15/2003	$12,250	-	25,103	1,098	$4,087	$2,667.04	2.34	3.00
Installation Approved Amount	2/24/2004	$12,250	-	25,103	1,098	$4,087	$2,667.04	2.34	3.00
SPC Program Review	11/7/2004	$12,250	-	0	0	$0	$2,667.04	NA	NA

Impact Results

Table 7 Realization Rate Calculation

	KW	KWh	Therm
SPC Tracking System or Application	0	25,103	1,098
Adjusted Engineering	0	0	0
Engineering Realization Rate	NA	0%.	N/A

Exhibit 1 Installation Verification Summary Sheet

Measure Description	End-Use Category	HVAC Measure Description	Lighting Measure Description	Process Measure Description	Count	Equipment Description	Installation Verified (Explain)	Notes
HVAC CONTROLS	H	Install EMS for scheduling control.			1	ESMS Centurion System	Physically verified panels installed in facility.	Exhaust fans not controlled by EMS. Facility now open 24/7, two AC units operate continuously.
LIGHTING CONTROLS	L		Install EMS for scheduling control.		1	ESMS Centurion System	Physically verified panels installed in facility.	Most lighting now on 24/7.
NON-PROCESS BOILER OTHER	O			Install EMS for scheduling control.	1	ESMS Centurion System	Physically verified panels installed in facility.	Gas savings were likely overestimated and now facility operates 24/7, so gas savings associated with scheduling are likely zero.
PROCESS OTHER	P			Install EMS for scheduling control.	1	ESMS Centurion System	Physically verified panels installed in facility.	Refrigeration compressors not controlled by EMS.

SITE 09 IMPACT EVALUATION
SAMPLE CELL: ORIGINAL TIER: 3 END USE: PROCESS

Measure Replaced constant speed air compressor with new VSD driven air compressor

Site Description Plastic packaging manufacturer

Measure Description A single 150-horsepower screw air compressor was replaced with a new 100-horsepower VSD air compressor. The original designed called for an additional 67-horsepower VSD compressor to be installed, but it was not. The air load of the plant has somewhat decreased since the installation of the new compressor due to lower production.

Summary of Ex Ante Impact Calculations The ex ante impacts were calculated using monitoring data of the existing 150-hp air compressor to estimate the air demand (cfm) profile of the facility and calculating the energy consumption required for a baseline compressor and the proposed compressors. The baseline compressor was not the existing compressor, rather a similar compressor with the performance characteristics as defined by the Air Challenge program. It was stated that this is a requirement of the SPC program.

The baseline compressor was a 150-hp screw compressor with a load/unload control. This type of compressor requires 68% of the full load horsepower when unloaded. Therefore, the part load efficiency is not very good. The proposed system was originally designed to include a 100-hp and a 67-hp compressor, both with VSD control. The VSD controls would provide much better part load efficiency.

In addition, having two compressors would allow one compressor to be off during low load periods. Table 1 provides the specifications of the baseline and proposed compressors. Tables 2 and 3 show the energy consumption calculations for the baseline and proposed compressors required to satisfy the air demand profile developed from the monitoring data. Table 4 shows the savings.

Table 1
Baseline Compressor Specifications

#	Model	HP	BHP	motor efficiency	Max kW	Max kW check	Unloaded % power
Baseline	6150	150	150	0.925	125.8	120.9	68%
Proposed #1	L45SR	67	67	0.9	50	55.5	
Proposed #2	L75SR	100	100	0.9	75	82.9	
#	Model	Max scfm	scfm/bhp	bhp/100cfm	Calculated kW/100scfm	AirMaster kW/100scfm	Allowed Eff
Baseline	6150	670	4.5	22.4	18.8	17.9	17.9
Proposed #1	L45SR	280	4.2	23.9	17.9		17.9
Proposed #2	L75SR	431	4.3	23.2	17.4		17.4

Table 2
Ex Ante Baseline Energy Consumption

Operating Point acfm	% Capacity	% Power at no load	% Full Load Power	Package Power	Calculated kW	Annual Hours	Annual kWh
50.00	7%	68%	70%	17.90	84.42	71	5,994
92.00	14%	68%	72%	17.90	86.82	26	2,257
184.00	27%	68%	77%	17.90	92.09	12	1,105
255.00	38%	68%	80%	17.90	96.16	477	45,868
314.00	47%	68%	83%	17.90	99.54	2,940	292,643
373.00	56%	68%	86%	17.90	102.92	2,877	296,095
439.00	66%	68%	89%	17.90	106.70	1,666	177,759
507.00	76%	68%	92%	17.90	110.59	625	69,121
569.00	85%	68%	95%	17.90	114.14	44	5,022
653.00	97%	68%	99%	17.90	118.96	21	2,498
				Peak	118.96	8,759	898,362

Table 3
Ex Ante Proposed Energy Consumption

System acfm	Compressor	Compressor acfm	% Capacity	% Full Load Power	Package Power	Calculated kW	Annual Hours	Annual kWh
50.00	L45SR	50.00	18%	19%	17.86	9.38	71	666
	L75SR	0.00	0%	0%	17.40	0.00	71	0
92.00	L45SR	92.00	33%	35%	17.86	17.25	26	449
	L75SR	0.00	0%	0%	17.40	0.00	26	0
184.00	L45SR	184.00	66%	69%	17.86	34.50	12	414
	L75SR	0.00	0%	0%	17.40	0.00	12	0
255.00	L45SR	255.00	91%	96%	17.86	47.81	477	22,807
	L75SR	0.00	0%	0%	17.40	0.00	477	0
314.00	L45SR	0.00	0%	0%	17.86	0.00	2,940	0
	L75SR	314.00	73%	76%	17.40	57.37	2,940	168,675
373.00	L45SR	0.00	0%	0%	17.86	0.00	2,877	0
	L75SR	373.00	87%	91%	17.40	68.15	2,877	196,075
439.00	L45SR	8.00	3%	3%	17.86	1.50	1,666	2,499
	L75SR	431.00	100%	105%	17.40	78.75	1,666	131,198
507.00	L45SR	76.00	27%	29%	17.86	14.25	625	8,906
	L75SR	431.00	100%	105%	17.40	78.75	625	49,219
569.00	L45SR	138.00	49%	52%	17.86	25.88	44	1,139
	L75SR	431.00	100%	105%	17.40	78.75	44	3,465
653.00	L45SR	222.00	79%	83%	17.86	41.63	21	874
	L75SR	431.00	100%	105%	17.40	78.75	21	1,654
Total					Peak	120.38		588,037

Table 4
Ex Ante Energy and Demand Savings

	Existing	Proposed	Energy Savings
Peak kW	118.96	120.38	-1.42
kWh	898,362	588,037	310,325

Comments on Ex Ante Calculations

The ex ante calculations are a standard method for determining the energy consumption of air compressors given an air demand profile. Using this method in conjunction with a measured air demand profile provides a solid estimate of the impacts of the project.

Using the baseline efficiency as specified by the Air Challenge program, as is required in the SPC program, does not impact the results significantly.

The ex ante post inspection identified that only one air compressor was installed rather than the two specified in the approved application and associated energy savings calculations. However, the was no adjustment made to the energy savings estimates or incentive level (and no justification was provided).

Evaluation Process

The evaluation process included verification of the equipment installed and the existing air demand profile of the facility. During the on-site visit we found that only one air compressor was installed. Only the 100-hp compressor was installed. The 67-hp compressor was never installed. One compressor does not provide the capacity to handle the air demand of the facility as it was measured. Therefore, the air demand of the facility must have gone down. The new air demand profile was obtained from the recording meter on the new compressor. The compressor logs the number of hours that it operates in each of five load bins and records the total cfm output during the measurement period. We confirmed that the meters have not been reset since installation of the new compressor. The current (post) air demand profile is shown in Table 5.

Tables 6 and 7 show the energy consumption of the baseline compressor and the new compressor based on this profile. Table 8 provides the resulting savings values.

Table 5
Current Air Demand Profile

Average % Flow	Average Existing Flow (scfm)	Annual Hours of Operation
10	43	58
30.5	131	332
50.5	218	3,563
70.5	304	3,790
90.5	390	1,017
Total		8,760

Table 6
Evaluation Baseline Energy Consumption

Operating Point acfm	% Capacity	% Power at no load	% Full Load Power	kW/100 scfm	Calculated kW	Annual Hours	Annual kWh
43	6%	68%	70%	17.90	84.02	58	4,873
131	20%	68%	74%	17.90	89.08	332	29,575
218	32%	68%	78%	17.90	94.02	3,563	334,992
304	45%	68%	83%	17.90	98.96	3,790	375,048
390	58%	68%	87%	17.90	103.89	1,017	105,661
Total				Peak	103.89	8,760	850,149

Table 7
Evaluation New Energy Consumption

Operating Point acfm	% Capacity	% Power at no load	% Full Load Power	kW/100 scfm	Calculated kW	Annual Hours	Annual kWh
43	10%	0%	11%	20.32	9.20	58	533
131	31%	0%	32%	20.32	28.05	332	9,314
218	51%	0%	53%	20.32	46.45	3,563	165,501
304	71%	0%	74%	20.32	64.85	3,790	245,766
390	91%	0%	95%	20.32	83.24	1,017	84,657
Total				Peak		8,760	505,771

Table 8
Evaluation Energy and Demand Savings

	Existing	Proposed	Energy Savings
Peak kW	125.8	87.6	38.2
kWh	850,149	505,771	344,378

Installation Verification Verification of a new 100 hp VSD air compressor was performed on Jan. 7, 2005. The air compressor model was the same as provided in the application. However, there was not an additional 67 hp air compressor installed as originally proposed. This was due to a reduction in the air demand, however the energy savings are still realized. Table 11 is a project verification summary sheet.

Scope of Impact Assessment The impact evaluation includes the replacement of a 150 hp air compressor with a new 100 hp air compressor with a VFD. This is the only measure for this SPC application..

Additional Notes The M&V for this project was sufficient due to the fact that the new air compressors recorded the critical data needed to estimate the energy savings. Most compressed air projects require at least short term monitoring to determine a load profile which is critical to any compressed air analysis.

Economic Information An economic summary for the measures in the primary end use is shown in Table 9 below. An engineering realization rate calculation is shown in Table 10.

Table 9
Economic Summary Of The Project

File Financial Values	Date	Project Cost	Estimated Customer kW Savings	Estimated Customer Annual kWh Savings	Estimated Gas Savings, therms	Estimated Annual Cost Savings ($0.13/kWh) ($0.75/therms)	SPC Incentive, $	Simple Payback w/ Incentive, yrs.	Simple Payback w/o Incentive, yrs.
Application Submitted	06/12/2003	$83,364	0.0	323,478	0.0	$42,052	$25,878	1.4	2.0
Application Approved	08/01/2003	$83,364	0.0	310,325	0.0	$40,342	$24,826	1.5	2.1
Installation Approved (Ex Ante)	12/18/2003	$83,364	0.0	310,325	0.0	$40,342	$24,826	1.5	2.1
SPC Impact Evaluation (Ex Post)	01/07/2005	$83,364	38.2	344,378	0.0	$44,769	$24,826	1.3	1.9

Table 10
Impact Results

	KW	KWh	Therm
SPC Tracking System or Application (Ex Ante)	0.0	310,325	0
Adjusted Engineering (Ex Post)	38.2	344,378	0
Engineering Realization Rate	N/A	1.11	N/A

Table 11
Project Verification Sheet

Measure Description	End-Use Category	Process Measure Description	Count	Equipment Description	Installation Verified (Explain)	Notes
Air Compressor - VSD	P	Install new air compressor with VSD.	2	One 100-hp and one 67-hp VSD air compressors were proposed	Only the 100-hp compressor was installed. However, the savings are being realized.	The SCE post inspection performed by AESC also noted that only one air compressor was installed. However, no changes were made to the impact and incentive levels.

SITE 10 IMPACT EVALUATION
SAMPLE CELL: ORIGINAL TIER: 3 END USE: PROCESS

Measure	Install New Injection Molding Machine
Site Description	Manufacturing

Measure Description

A new all electric injection molding machine replaced a standard hydraulic injection molding machine.

Summary of Ex Ante Impact Calculations

The Ex Ante calculations were performed using the SPC calculation software for the pre and post retrofit. The ex ante calculations assumed an average production rate of 60 lb/hr. and that the injection molder would operate 6,120 hours annually. The installation reviewer also performed short term power measurement on the new injection molder. Table 1 summarizes the results of the Ex Ante calculations.

Table 1 Summary of the Ex Ante Savings Calculation

	kW	kWh
Pre retrofit	25.3	139,386
Post retrofit	5.4	29,976
Savings	19.9	109,410

Comments on Ex Ante Calculations

The primary inputs to the SPC calculation software for this measure are the quantity of machines, the type of machine, machine capacity (tons), annual operating hours, and average production rate (lb/hr). Short term monitoring performed by the installation reviewer determined that the average power demand for the new injection molder was 5.4 kW.

Evaluation Process

The evaluation process consists of a review of the application form and supporting documentation, conducting an on-site survey and then computing impacts using data collected on-site.

The on-site survey was conducted on October 29, 2004. Information on the new injection molding machine and operating parameters was collected by interviewing the facility representative and by inspecting the injection molding machine. The facility representative provided a current production schedule and operating hours for the facility.

The typical manufacturing schedule for the facility is 16.5 hours per day, five days per week, 52 weeks per year minus 8 holidays or 4,158 hours annually. The facility representative estimates that the new injection molder operates approximately 65% of the time (2,702 hours annually).

The facility representative estimated that the average production rate for the new injection molder varies between 15 – 35 pounds per hr., averaging 22 pounds per hour. The injection molding machine was operating during the site visit. We viewed the digital control panel and determined that the injection molder was making a product every 18.3 seconds. The facility representative stated that the item being manufactured weighs approximately 80 pounds per 1,000 items. Using this information we calculated the production rate to be 15.7 pounds per hour.

1 item/18.3 sec x 3,600 sec/hr. x 80 lb./1,000 items= 15.7 lb/ hr.

Utilizing the SPC calculation software we recalculated the pre and post retrofit energy savings using the data collected during the site visit(2,702 operating hours, 16 lb./hr. production rate). The energy and demand savings are summarized in Table 2 below and the SPC measure report is included as Exhibit 1 Below.

Table 2 Summary of Ex Post Savings Analysis

	kW	kWh
Pre retrofit	6.7	16,411
Post retrofit	1.5	6,105
Savings	5.2	10,306

Installation Verification

We physically verified that a Mitsubishi model 180 MSJ-10 plastic injection molder is installed and operating at the facility. An installation verification sheet is found below in Exhibit 2. The facility representative confirmed that the Van Dorn 150 injection molder has been removed from the site.

Scope of Impact Assessment

The impact evaluation is for the installation of one new injection molding machine and is the only measure for this NSPC application.

Additional Notes

The ex post savings are less than the ex ante because the production rate and annual hours of operation are significantly lower than what was assumed in the ex ante calculations.

The amount of time allowed for the impact evaluation was adequate.

Economic Information

An economic summary for the installation of the new injection molder is shown in Table 3 below. An engineering realization rate calculation is shown in Table 4.

Economic Summary

Table 3 Economic Summary of the Project

Description	Date	Project Cost	Estimated Demand Savings, kW	Estimated Energy Savings, kWh	Estimated Gas Savings, therms	Estimated Annual Cost Savings ($0.13/kWh), $	SPC Incentive, $	Simple Payback w/ incentive, yrs	Simple Payback w/o incentive, yrs
Application Submitted Amount	7/21/2003	$100,000	26.5	143,020	0	$18,593	$11,441	4.76	5.38
Application Approved Amount	9/25/2003	$100,000	19.9	109,411	0	$14,223	$8,753	6.42	7.03
Installation Approved Amount	11/21/2003	$100,000	19.9	109,411	0	$14,223	$8,753	6.42	7.03
SPC Program Review	11/1/2004	$100,000	5.2	10,306	0	$1,340	$8,753	68.11	74.64

Impact Results

Table 4 Realization Rate Calculation

	KW	KWh	Therm
SPC Tracking System or Application	19.9	109,411	0
Adjusted Engineering	5.2	10,306	0
Engineering Realization Rate	26%	9.4%	NA

Exhibit 1 NSPC Calculator Measure Summary

Standard Performance Contract

Energy Savings Sheet

Standard Performance Contract Program 2003
SPC Program

MEASURE #1 SUMMARY INFORMATION

Estimation Software - Injection Molder

Site Name	Anderson Mould
Meter ID #	Meter
Description	Install All Electric Injection Molder

Existing Equipment Specification

Manufacturer	Van Dorn	**Model Number**	150
Serial Number		**Quantity of Machines**	1
Type of Machine	Standard Hydraulic Machine	**Machine Capacity (tons)**	150
Average Production Rate (lb/hr)	16	**Annual Operating Hours (hr)**	2,702

Proposed Equipment Specification

Manufacturer	Mitsubishi	**Model Number**	180 MSJ-10
Serial Number		**Quantity of Machines**	1
Type of Machine	All Electric Machine	**Machine Capacity (tons)**	180
Average Production Rate (lb/hr)	16	**Annual Operating Hours (hr)**	2,702

Measure Energy Savings Estimate

	kW	**kWh**
Baseline Usage	6.7	16,411
Proposed Usage	1.5	6,105
Annual Savings	5.3	10,305
Estimated Incentive		$824.41

Exhibit 2 Installation Verification Sheet

Measure Description	End-Use Category	HVAC Measure Description	Lighting Measure Description	Process Measure Description	Count	Equipment Description	Installation Verified (Explain)	Notes
PROCESS CHANGE/ADD EQUIPMENT	P			Replace standard hydraulic injection molder with new all electric injection molder.	1	Mitsubishi 180 Ton all electric injection molder.	Physically verified that the new injection molder is installed and operating at the facility.	

SITE 11 IMPACT EVALUATION
SAMPLE CELL: ORIGINAL TIER: 3 END USE: PROCESS

Measure	Replace One 40 Horsepower Motor with Two 7.5 Horsepower Motors
Site Description	Food Processing

Measure Description

Replace 40 HP motor with two 7.5 HP motors.

Summary of Ex Ante Impact Calculations

The Ex Ante calculations were performed by engineering calculations using the following formulae:
kW = HP x 0.746 kW/HP x 1/motor efficiency
kWh= kW x operating hours

Hours of operation before and after the retrofit are assumed to be 2,040 annually The 40 HP motor is listed as 81.5% efficient. The new 7.5 HP motors are shown as 88.5% efficient. Table 1 summarizes the Ex Ante Savings calculation.

Table 1 Summary of the Ex Ante Savings

	Motor HP	Quantity	Efficiency	Annual Hours	kW	kwh
Pre-Retrofit	40	1	81.5%	2,040	36.6	74,692
Post retrofit	7.5	2	88.5%	2,040	12.6	25,794
Savings					24.0	48,898

1. Small difference beween Tracking system saving kWh and the calculation above is due to rounding error
2. Tracking system shows 12.0 kW demand savings, appears to be an error by the reviewer.

Comments on Ex Ante Calculations

The Ex Ante calculations imply that the load factor for the motors is 1.0 before and after the retrofit. There is no explanation in the application concerning what has allowed a 40 HP motor to be replaced by two 7.5 HP motors.

The installation reviewer also appears to have made an error transferring the calculated demand kW savings to the application. The Ex Ante calculation shows a 24 kW demand savings as shown in Table 1, but the value listed in the installation report review is 12 kW.

Evaluation Process

The evaluation process consists of a review of the application form and supporting documentation, conducting an on-site survey and then computing impacts using data collected on-site.

The on-site survey was conducted on October 29, 2004. Information on the retrofit equipment and operating conditions was collected by inspecting the dump hydraulic equipment and by interviewing the facility representative. The facility representative provided a current production schedule and operating hours for the facility.

During the site visit we determined that the retrofit involved the installation of two 7.5 HP motors that directly drive two separate conveyor systems. The 7.5 HP motors replaced two 20 HP motors that operated in parallel. The 20 HP motors were connected to hydraulic pumps which pressurized the hydraulic system and drove hydraulic motors. The hydraulic motors powered the conveyor system. The hydraulic system was old and inefficient. Inefficiency was caused by leaks in the hydraulic system and the age of the hydraulic motors that powered the conveyors.

The schedule for the facility is 24 hours per day, seven days per week for the length of the crop season. The site representative stated that at 78 days this year, the crop season was a slightly longer than average. This equates to 1,872 hours of operation.

Discussions with the site representative indicate that the load factor on the motors pre and post retrofit is less than 1.0. We have assumed that the load factor is 0.80 for the Ex Post savings analysis.

The Ex Post calculations were performed by engineering calculations using the following formulae:
kW = HP x 0.746 kW/HP x Load Factor x 1/motor efficiency
kWh= kW x operating hours
The Ex post savings are summarized in Table 2 below.

Table 2 Summary of Ex Post Savings Analysis

	Motor HP	Quantity	Efficiency	Annual Hours	Load Factor	kW	kwh
Pre-Retrofit	20	2	81.5%	1,872	0.8	29.3	54,832
Post retrofit	7.5	2	88.5%	1,872	0.8	10.1	18,936
Savings						19.2	35,897

Installation Verification

We were unable to access the nameplate of the 7.5 HP motors because of their location in the conveyor system. The site representative verified that two 7.5 HP motors with an efficiency of 88.5% are installed and operating at the facility. An installation verification sheet is found below in Exhibit 1.

Scope of Impact Assessment

The impact evaluation covers the installation of two new 7.5 HP motors and is the only measure for this NSPC application.

Additional Notes

The Ex Post kWh savings results are less than the Ex Ante results because the hours of operation and load factor are less than assumed in the Ex Ante calculations. The Ex Post kW demand savings are larger that the Ex Ante savings because of an error made by the SPC reviewer.

The amount of time allowed for the evaluation was adequate, and no additional work is necessary.

Economic Information

An economic summary for the installation of the two new 7.5 HP motors is shown in Table 3 below. An engineering realization rate calculation is shown in Table 4.

Table 3 Economic Summary of the Project

Description	Date	Project Cost	Estimated Demand Savings, kW	Estimated Energy Savings, kWh	Estimated Gas Savings, therms	Estimated Annual Cost Savings ($0.13/kWh), $	SPC Incentive, $	Simple Payback w/ incentive, yrs	Simple Payback w/o incentive, yrs
Application Submitted Amount	2/5/2003	$28,550	8	49,460	0	$6,430	$3,957	3.82	4.44
Application Approved Amount	5/19/2003	$28,550	12	48,960	0	$6,365	$3,917	3.87	4.49
Installation Approved Amount	2/4/2004	$28,550	12	48,960	0	$6,365	$3,917	3.87	4.49
SPC Program Review	11/1/2004	$28,550	19	35,897	0	$4,667	$3,917	5.28	6.12

Impact Results

Table 4 Realization Rate Calculation

	KW	KWh	Therm
SPC Tracking System or Application	12.0	48,960	0
Adjusted Engineering	19.2	35,897	0
Engineering Realization Rate	160%	73.3%	N/A

Exhibit 1 Installation Verification Sheet

Measure Description	End-Use Category	HVAC Measure Description	Lighting Measure Description	Process Measure Description	Count	Equipment Description	Installation Verified (Explain)	Notes
PROCESS CHANGE/ADD EQUIPMENT	P			Replace hydraulic system that powered conveyor system with two 20 HP motors with two 7.5 HP direct drive motors.	2	7.5 HP motors	Physically verified two motors directly powering conveyor system.	Could not access motors to verify HP. Site representative verifed that the motors are 7.5 HP each.

SITE 12 IMPACT EVALUATION
SAMPLE CELL: ORIGINAL TIER: 3 END USE: PROCESS

Measure	***VFDs for Cooling Tower and Air Handler Fan Motors***
Site Description	***Hotel***

Measure Description

Install a variable frequency drive on the 30 hp motor of a cooling tower that serves 375 heat pumps and five refrigeration compressors, and install variable frequency drives (VFDs) on the supply fans of four package air conditioning units. The motor sizes of the supply fans for the package units are one 7.5-hp and four 5-hp.

Summary of Ex Ante Impact Calculations

Savings for the cooling tower VFD were calculated using the SPC Estimation Software – Variable Speed Drive for Process. Operating hours were set to 12 hours per day. Savings for the supply fans for the package air conditioning units VFDs were calculated using the SPC Estimation Software – Variable Speed Drive for HVAC Supply fans. Operating hours were set to 8 hours per day.

Comments on Ex Ante Calculations

The SPC Estimation Software is a standard estimating tool used statewide. With the proper inputs, the SPC Estimation Software produces reasonable estimates of energy savings. The inputs for Ex Ante SPC Estimation Software calculations of savings for the VFDs included detailed information on the motors for the supply fans and the cooling tower. These included number, size, voltage, full load amps, model number, etc. It also included an estimated profile of the percent of hours that the motors will spend at various speeds in 5% increments from 20% to 100%.

Some changes were made in the application review to properly adjust for the fact that there are three 7.5-hp fans and one 5-hp fan, rather than four 7.5-hp as described in the original application's estimate of savings. Also, the estimate of savings for the cooling tower VFD was adjusted to using 4,380 hours instead of the 8,760 hours used in the original estimate of savings. This would have been a reasonable estimate to use for most cases. However, as discussed below, even 4,380 hours appears to have been a high estimate for this application.

Evaluation Process

The evaluation process consists of a review of the application form and supporting documentation, conducting an on-site survey and then computing impacts using the on-site data.

The on-site survey was conducted on January 3, 2005. Information on the retrofit equipment and operating conditions was collected through an inspection of the cooling tower, the tower fan speed drive, and refrigeration equipment, inspection of the four supply fan VFD's, and through an interview with the facility representative.

The facility representative stated that in summer prior to the retrofit, the tower tended to run at 50 to 60% speed. This means that the load on the tower was only 50% to 60% of maximum capacity of the tower even during the warmest months of the year. This indicates that before the VFD was installed, the tower fan would operate about 60% of the time at full speed in the summer months. This is not consistent with the ex ante estimate of operating hours, but is consistent with the sizing of the tower and the occupancy of the hotel. The tower is sized at about 400 tons of cooling capacity. The total load of all of the heat pumps and refrigeration compressors is only 293 tons, or less than 75% of the tower capacity. The food service refrigeration load is 1.6% of the total load. The hotel is about a mile from a major theme park. Most guests are out of their rooms from morning until late evening, so the load on the guest room heat pumps would be minimal at the time of the electric utility summer system peak demand. The 60 %operating time for the cooling tower fan stated by the facility representative seems reasonable considering the oversizing of the tower for the load, and the fact that on a peak summer day, there would be few people in the hotel.

These discussions provided input data for development of a relationship between tower loading and outdoor dry bulb temperature before and after the retrofit. With the VFD, the tower fan runs continuously and the speed is adjusted automatically to maintain leaving water temperature set point. A simplified model was created using monthly average weather data for the hotel location. The model estimates the energy use of the constant speed and variable speed motors as a function of ambient temperature. The model is shown below in Table 3.

The simplified model compared the average temperature for each month to an assumed design peak condition of 95°F dry bulb, and an estimated balance point temperature of 45°F dry bulb. This method is an adaptation from the American Society of Heating, Refrigeration and Air-conditioning Engineers procedure known as the Modified Bin Method. So for example, the average temperature for the month of August is 74.5°F dry bulb. The percentage of time that the cooling tower would run to satisfy the air conditioning load would be:

$$(74.5°F - 45°F)/(95°F - 45°F) = 59.0\%.$$

In addition to the air conditioning load, the food service kitchen refrigeration units are water cooled from the cooling tower loop. The capacity of these refrigeration loads is 1.6% of the cooling tower capacity. This is a fairly constant load year-round. So the load on the tower including the air conditioning and the kitchen refrigeration is:

$$59.0\% + 1.6\% = 60.6\% \text{ for the month of August}$$

Prior to the installation of the VFD, the tower fan would have run an average of 60.6% of the time. And with the VFD, the fan would run constantly at an average speed of 60.6%. This is consistent with the description by the Chief Engineer. This calculation was done for each month to create a table of the number of hours in the year that the fan would run at different increments of speed. This profile of time vs. speed was entered into the 2004 SPC Estimation Software for Variable Speed Drive for Process Equipment. All of the other appropriate entries for the details on the motor were entered the same as in the previous runs of the Estimation Software used by the customer for the original application and by the reviewer in the application review. Because of fewer number of hours overall (2,208) was used in this estimate, the Ex Post savings are less than the Ex Ante savings.

Installation Verification

The VFD's for the supply fans are installed and working properly according to the facility representative. The supply fans were off at the time of the site visit, because the programmable thermostats had shut them off. There were no events going on in the rooms that they serve. The VFD for the cooling tower was in place and had been working properly until it broke down the week before the verification visit. Repair of the unit was scheduled for the following week. A photograph of the VFD for the cooling tower is shown below:

Scope of Impact Assessment

In addition to the primary process measure of the cooling tower fan VFD and VFDs added to the supply air fans of four package rooftop air conditioners, there were other incentive measures at this site including adding time clock controls for some indoor and outdoor lighting. These were also installed and found to be operating correctly. The type and number of lighting fixtures served were verified. In addition to the VFDs and lighting control, the customer at the same time had installed programmable thermostats for the four ballroom spaces. These package units had previously run 24 hours a day, seven days a week. At the time of the site visit, the programmable thermostats scheduled off all four of the ballroom package units. They did not receive incentives for these programmable thermostats, but appear to be achieving substantial energy savings from them. The facility representative stated that last summer's electric bills were reduced from $66,000 in 2003 to $44,000 in 2004. This would mean as much as 2,000,000 in annual kWh savings, far more than expected by the VFD's and lighting controls alone. The total approved estimate of savings for the VFD's and lighting timers was 122,382.

The Ex Post savings are less than the Ex Ante savings because operating hours of the cooling tower were determined to be less than those used in the Ex Ante calculations.

Additional Notes

The impact evaluation would be more accurate if there had been monitoring before and after installation. Ideally it would be desirable to monitor power, dry bulb temperature, and wetbulb temperature over the range of temperatures from hottest summer month to coldest winter month. This effort could require up to an additional 40 hours.

Economic Information

An economic summary for the measures in the primary end use is shown in Table 1 below.

Table 1
Economic Summary Of The Project (Primary End Use Only)

Description	Date	Project Cost	Estimated Demand Savings, kW	Estimated Energy Savings, kWh	Estimated Gas Savings, therms	Estimated Annual Cost Savings ($0.13/kWh) ($0.75/therm)	SPC Incentive, $	Simple Payback w/ incentive, yrs.	Simple Payback w/o incentive, yrs.
Application Submitted Amount	06/02/03	$35,000	0.0	132,652	0.0	$17,245	$10,612	1.41	2.03
Application Approved Amount	06/23/03	$35,000	-1.3	96,472	0.0	$12,541	$7,718	2.18	2.79
Installation Approved Amount (Ex Ante)	09/05/03	$35,000	-1.3	96,472	0.0	$12,541	$7,718	2.18	2.79
SPC Impact Evaluation (Ex Post)	01/10/05	$35,000	12.7	84,244	0.0	$10,952	$7,718	2.49	3.20

Table 2
Impact Results (Primary End Use Only)

	KW	KWh	Therm
SPC Tracking System or Application (Ex Ante)	-1.3	96,472	0
Adjusted Engineering (Ex Post)	12.7	84,244	0
Engineering Realization Rate	N/A	0.87	N/A

Table 3
Ex Post Calculations Summary

Hours vs. est. load

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg. Temp	57.5	58.6	59.8	62.7	65.7	69.4	73.2	74.5	73.2	68.7	62.3	57.7
Days	31	28	31	30	31	30	31	31	30	31	30	31
Hours	744	672	744	720	744	720	744	744	720	744	720	744
Avg. % of load	25%	27%	30%	35%	41%	49%	56%	59.0%	56%	47%	35%	25%
Including Refr.	27%	29%	31%	37%	43%	50%	58%	61%	58%	49%	36%	27%
CT CV fan hr.	197.9	193.5	232.1	266.4	319.9	362.9	431.5	450.9	417.6	364.6	260.6	200.9

Avg. % of l	hours	% of yr.	
25	1,488	17%	
30	1,416	16%	
35	1,440	16%	
40		0%	
45	744	8%	
50	1,464	17%	
55		0%	
60	2,208	25%	
	8,760	100%	-

Total Cooling Tower constant speed fan hours:	3,699
Total Cooling Tower fan kWh use at 20.5 kW:	75,826
Total fan kWh with VFD by SPC 2004 Estimation Software:	31,043
Savings, kWh	44,783
Total fan kW savings with VFD by SPC 2004 Estimation Software:	14

Table 4

Inputs to Model

Parameter	Value Reported	Units of Parameter	Notes
Total Heat Pump Capacity	288.25	Tons	From Chief Engineer
Total Food Service Refrigeration	4.82	Tons	Equipment catalog
Total Connected Cooling Capacity	293.07	Tons	
Cooling Tower Capacity	400	Tons	Equipment catalog
Pre-Retrofit Control	On/off constant speed		
Post-Retrofit Control	VFD		
Supply fan motor ratings	5 and 7.5	Hp	
Motor efficiency	84	%	
Power factor`	90	%	
Operating hours	8	Hours per day	
Installation Date	8/18/2003		

Table 5
Project Verification Sheet

Measure Description	End-Use Category	Lighting Measure Description	Process Measure Description	Count	Equipment Description	Installation Verified (Explain)	Notes
Timing Device	L	Install timers for the hallwhays, ouside and sme common area lighting.		2	Intermatic brand 24-hour motor-driven timers	An additional third timer was also installed, but with no incentive.	Inside lights are being operated at fewer hours than the original predicted estimate for post-installation lighting use.
Variable Speed Drives	P		Install ASD's on air handler and cooling tower fan motors.	5	One 30-hp on the cooling tower, and three 5-hp and one 7.5-hp on package units	The 30-hp VFD had failed the week before the inspection, but was to be repaired.	The cooling load of the refrigeration equipment appears to be much smaller than the original estimates.

SITE 13 IMPACT EVALUATION
SAMPLE CELL: ORIGINAL TIER: 3 END USE: PROCESS

Measure	Install VFD's on Air Handler Fan Motors
Site Description	Commercial Office

Measure Description

Install VFD's on two 60 HP supply fan motors.

Summary of Ex Ante Impact Calculations

The Ex Ante calculations were performed by a mechanical contractor using the SPC calculation software. The calculation software requires input including motor nameplate data, field measured motor input power, a description of the building type, location and conditioned area (ft^2). A schedule of operation is also included in the input data.

The input data indicates that there are two 60 HP motors with an efficiency of 86.5 % operating 14 hours per day Monday-Friday and 6 hours per day on Saturday or 3,963 hours annually. The Ex Ante savings are summarized in Table 1.

Table 1 Summary of the Ex Ante Savings

	kW	kWh
Pre Retrofit	82.6	327,506
Post Retrofit	83.9	96,216
Savings	-1.3	231,290

Comments on Ex Ante Calculations

The Ex Ante savings are calculated using the SPC calculation software. The SPC calculator does not require input regarding the fan type (forward curved, backward incline, air foil, etc.) or pre retrofit volume control method (inlet vanes, discharge damper, rides the fan curve, etc.) These parameters have an impact on the energy savings associated with installing VFD's on fan motors.

Evaluation Process

The evaluation process consists of a review of the application form and supporting documentation, conducting an on-site survey and then computing impacts using data collected on-site.

The survey was conducted on December 1, 2004. Information on the retrofit equipment and operating conditions was collected by inspecting the fan motor VFD's and by interviewing the facility representative. The facility representative provided operating hours for the facility.

We confirmed that there are two air handling units with 60 HP supply fan motors. VFD's are installed on the fan motors. Both systems are controlled by an energy management system with an optimum start routine. The facility representative stated that the air handlers will start as early as 3:30 AM on a cold morning or as late as 6:30 AM on a mild morning, and estimates the average start time to be 5:30 AM. The building is normally conditioned Monday – Friday and the energy management system schedules the air handling units off at 6 PM Monday – Friday, and off Saturdays, Sundays and Holidays. The estimated annual hours of operation are as follows.

5 days/week x 12.5 hr/day x 52.14 weeks/year –8 holidays x 12.5 hr/day = 3,158 hours annually

Supply Fans

We elected to perform a temperature bin analysis to generate a load profile for the supply fans. The temperature bin analysis used weather data from a nearby airfield. The load profile is generated assuming that the air flow varies linearly from a minimum of 35% capacity in the 55°F/59°F bin and below, to a maximum of 100% capacity in the 100°F/104°F bin and above. Using the load profile created by this method, and fan unloading curves (part load modifiers) from DOE 2, we used a spreadsheet analysis to estimate the pre and post retrofit energy consumption of the supply fan systems.

We assumed a load factor of 85% and verified the motor efficiency to be 86.5% for the two fan motors. The total fan full load input power is calculated to be approximately 88 kW by the following formula:
kW= HP x load factor x 0.746 kW/HP x 1/motor efficiency x quantity of motors
kW= 60 HP x 0.85 x 0.746 x 1/0.865 x 2

The part load energy modifier from the DOE 2 program is shown in Exhibit 3. . The pre-retrofit fans are "BI/AF Inlet Vanes". The post retrofit fans are "Any Var. Fq. Drive". The fan system kW were calculated as follows:

Total fan kW in each bin = Total Full Load kW x part load modifier (from DOE 2)
Total fan kWh = total fan kW x bin hours. A more detailed analysis is shown in Exhibit 2 below.

Table 2 is a summary of the Ex Post savings analysis.

Table 2 Summary of the Ex Post Savings Analysis

	kW	kWh
Pre Retrofit	86.2	151,756
Post Retrofit	88	58,364
Savings	-1.8	93,392

Installation Verification

We physically verified the installation of two 60 HP VFD's on supply fan motors. An installation verification summary is shown in Exhibit 1 below.

Scope of Impact Assessment

The impact evaluation includes the installation of VFD's on two 60 HP supply fan motors. This is the only measure for this SPC application.

Additional Notes

The Ex Post kWh savings results are less than the Ex Ante results because the Ex Ante analysis was performed assuming that the fan systems operate 25% more hours than we determined during the evaluation. Another significant factor is that the SPC calculator assumes that the pre retrofit fan systems operate at a constant power draw. There does not appear to be an algorithm to unload the pre retrofit fan as the system air flow varies. The fan systems in this project were equipped with a fan inlet modulation device before the retrofit, and the energy consumption of the fan motors would vary based on the position of the modulating device.

According to the site representative, the actuators on the fan inlet cones would periodically get out of alignment and stick in one position, eliminating the modulation of the inlet cone. If the cone was stuck far enough open, the fan motor would overload tripping the breakers upon startup. The installation of VFD's has eliminated this problem and reduced maintenance costs.

The amount of time allowed for the evaluation was not adequate A temperature bin analysis is not a very satisfactory method to accurately determine the impact of a chiller VFD retrofit. The chiller load profile in this type of facility would be more accurately modeled using a detailed simulation such as DOE 2. We estimate an additional 40 hours would be required to more accurately assess the savings for this project. The impact evaluation for this project would have benefited from pre measurement.

Economic Information

An economic summary for the installation of the VFD's is shown in Table 3 below. An engineering realization rate calculation is shown in Table 4.

Impact Results

Table 3 Economic Summary of the Project

Description	Date	Project Cost	Estimated Demand Savings, kW	Estimated Energy Savings, kWh	Estimated Gas Savings, therms	Estimated Annual Cost Savings ($0.13/kWh), $	SPC Incentive, $	Simple Payback w/ incentive, yrs	Simple Payback w/o incentive, yrs
Application Submitted Amount	3/1/2003	$26,000	(1.4)	231,290	0	$30,068	$13,000	0.43	0.86
Application Approved Amount	4/14/2003	$26,000	(1.4)	231,290	0	$30,068	$13,000	0.43	0.86
Installation Approved Amount (Ex Ante)	6/24/2003	$26,000	(1.4)	231,290	0	$30,068	$13,000	0.43	0.86
SPC Program Review (Ex Post)	12/3/2004	$26,000	(1.8)	93,392	0	$12,141	$13,000	1.07	2.14

Table 4 Realization Rate Calculation

	KW	KWh	Therm
SPC Tracking System or Application	-1.4	231,290	0
Adjusted Engineering	-1.8	93,392	0
Engineering Realization Rate	100%	40.4%	NA

We have set the kW realization rate to 100% since the savings claim is small and the difference in the calculated values is also small.

Exhibit 1 Installation Verification Sheet

Measure Description	End-Use Category	HVAC Measure Description	Lighting Measure Description	Process Measure Description	Count	Equipment Description	Installation Verified (Explain)	Notes
HVAC ADJUSTABLE SPEED DRIVE	H	Install adjustable speed drives on supply fan motors.			2	Danfoss adjustable speed drives.	Physically verified the installation of adjustable speed drives on two 60 HP supply fan motors.	

Exhibit 2 Ex Post Supply Fan Savings Analysis

Minimum CFM	33,600
Maximum CFM	96,000
Fan HP	60
Fan Load Factor	85%
Full Load BHP/fan	51.0
Motor Efficiency	86.5%
Full Load kW/fan	44.0
Quantity of Fans	2
Total Full Load kW	88

Temperature	Annual Hours	Total CFM	% Maximum Design CFM	BI/AF Inlet Vanes % Max Power	Pre retrofit		VFD % Max Power	Post retrofit		Savings	
					kW	kWh		kW	kWh	kW	kWh
105/109	3.5	96,000	100.0%	98.0%	86	298	1.00	88	305	(2)	(6)
100/104	9.9	96,000	100.0%	98.0%	86	851	1.00	88	868	(2)	(17)
95/99	36.7	89,067	92.8%	88.0%	77	2,841	0.83	73	2,679	4	161
90/94	72.1	82,133	85.6%	80.0%	70	5,073	0.68	60	4,312	11	761
85/89	110.6	75,200	78.3%	72.0%	63	7,003	0.55	48	5,349	15	1,653
80/84	158.2	68,267	71.1%	66.0%	58	9,188	0.43	38	5,986	20	3,202
75/79	211.5	61,333	63.9%	61.0%	54	11,350	0.33	29	6,140	25	5,210
70/74	253.7	54,400	56.7%	56.0%	49	12,496	0.25	22	5,579	27	6,917
65/69	303.3	47,467	49.4%	54.0%	48	14,408	0.20	18	5,336	30	9,071
60/64	406.9	40,533	42.2%	51.0%	45	18,255	0.14	12	5,011	33	13,244
55/59	511.9	33,600	35.0%	50.0%	44	22,516	0.12	11	5,404	33	17,112
50/54	441.7	33,600	35.0%	50.0%	44	19,427	0.12	11	4,662	33	14,765
45/49	300.0	33,600	35.0%	50.0%	44	13,194	0.12	11	3,166	33	10,027
40/44	203.5	33,600	35.0%	50.0%	44	8,951	0.12	11	2,148	33	6,803
35/39	93.5	33,600	35.0%	50.0%	44	4,111	0.12	11	987	33	3,124
30/34	33.3	33,600	35.0%	50.0%	44	1,464	0.12	11	351	33	1,112
25/29	6.9	33,600	35.0%	50.0%	44	305	0.12	11	73	33	231
20/24	0.6	33,600	35.0%	50.0%	44	27	0.12	11	6	33	20
Total	3,158					151,756			58,364		93,392

Exhibit 3 DOE 2 Part Load Modifier for Fan Systems

FAN SPEED CONTROLS
Power Relationships

DOE-2.1 CALIFORNIA COMPLIANCE SUPPLEMENT

BI = backward inclined, AF = air foil, FC = forward curved

PART LOAD ENERGY MODIFIER, Y

% FLOW X	BI/AF Outlet Damp or no cntrl 1	BI/AF Inlet Vanes 2	FC Out Damp no cntrl 3	FC Inlet Vanes 4	Vane Ax,Var Pitch 5	Any Var.Fq Drive 6
1.00	1.00	0.98	1.00	0.99	0.99	1.00
0.95	0.98	0.91	0.94	0.88	0.89	0.88
0.90	0.96	0.85	0.87	0.79	0.79	0.77
0.85	0.93	0.79	0.82	0.70	0.70	0.67
0.80	0.91	0.74	0.76	0.62	0.62	0.58
0.75	0.88	0.70	0.70	0.54	0.54	0.49
0.70	0.85	0.65	0.65	0.48	0.47	0.42
0.65	0.82	0.62	0.60	0.42	0.41	0.35
0.60	0.79	0.59	0.56	0.37	0.35	0.29
0.55	0.75	0.56	0.51	0.33	0.31	0.24
0.50	0.71	0.54	0.47	0.29	0.26	0.20
0.45	0.68	0.52	0.43	0.26	0.23	0.16
0.40	0.68	0.51	0.39	0.24	0.20	0.13
0.35	0.68	0.50	0.36	0.23	0.18	0.12
0.30	0.68	0.50	0.33	0.22	0.16	0.11
0.25	0.68	0.50	0.30	0.22	0.15	0.10
0.20 and below	0.68	0.51	0.27	0.23	0.15	0.11

SITE 14 IMPACT EVALUATION
SAMPLE CELL: ORIGINAL TIER: 1 END USE: LIGHTING

Measure	***Lighting efficiency***
Site Description	***Retail Stores***

Measure Description

Replace 400 watt metal halide fixtures with high output, 4 lamp T-5 fixtures.

Summary of Ex Ante Impact Calculations

Simple pre- and post-retrofit algorithm using fixture connected loads and hours of operation.

Comments on Ex Ante Calculations

The application includes the lighting retrofit for 6 retail stores plus 57 fixtures from another store that had reached the maximum incentive allowed under the Express Efficiency program. The additional 57 fixtures were added to this application. One store is evaluated in this report.

The ex-ante savings were estimated by creating a detailed pre and post retrofit lighting fixture inventory and calculating the change in lighting power based on fixture watts published in the SPC Lighting Wattage Tables. Lighting energy use was calculated using estimated hours of operation before and after the retrofit.

A detailed summary of the estimated pre and post retrofit operating hours for each type of area was provided by the energy services company that developed and managed the project. According to documentation in the application, the store is normally open 82 hours per week, 52 weeks per year. Employees occupy the store before and after the store is open. A lighting control system schedules the operation of the lighting system.

Before the retrofit, there were fifty seven 400 watt metal halide fixtures operating 112.5 hours per week (employee + store open mode), 52 weeks per year and one hundred forty 400 watt metal halide fixtures operating 82 hours per week (store open mode), 52 weeks per year.

The retrofit fixtures each have four T-5 high output lamps. The fixtures are wired such that the two inner lamps operate together and the two outer lamps operate together. Each fixture can have two lamps, 4 lamps or no lamps operating. The pairs of lamps on each fixture are grouped together in different circuits that are individually controlled by the lighting control system. According to the ex ante calculations there are 197 four lamp fixtures. Ninety four pairs of lamps operate 112.5 hours per week (employee + store open mode), 103 pairs of lamps operate 82 hours per week (store open mode) and 197 pairs of lamps operate 82 hours per week (store open mode). All fixtures are assumed to operate 52 weeks per year.

Pre and post retrofit calculations of lighting loads and energy use were performed using the following formula.

kW = Fixture Watts/1,000 w/kW x Fixture quantity
kWh = kW x Operating hours

Operating hours are calculated as follows:
Employee + Open= 112.5 hrs/week x 52 weeks/year
Employee + Open= 5,850 hours/year

Store Open = 82 hours/week x 52 weeks/year
Store Open = 4,264 hours/year

Table 1 is a summary of the pre retrofit lighting calculations, Table 2 is a summary of the post retrofit lighting calculations and Table 3 is a summary of the energy savings and demand reduction.

Table 1 Pre Retrofit Lighting Calculations Store 766

					Annual	
Mode	Fixture	Quantity	w/fixture	Peak kW	Hours	kWh
Employee + Store Open	MH 400 W	57	458	26.1	5,850	152,720
Store Open	MH 400 W	140	458	64.1	4,264	273,408
Total		197		90		426,128

Table 2 Post Retrofit Lighting Calculations Store 766

					Annual	
Mode	Fixture	Quantity	w/fixture	Peak kW	Hours	kWh
Employee + Store Open	2 Lamp T-5 HO Outer	94	117	11.0	5,850	64,338
Store Open	2 Lamp T-5 HO Inner	103	117	12.1	4,264	51,385
Store Open	2 Lamp T-5 HO Outer	197	117	23.0	4,264	98,281
				46		214,005

Table 3 Summary of the Ex Ante Calculations Store 766

	Total kW	kWh
Pre Retrofit	90	426,128
Post Retrofit	46	214,005
Savings	44	212,123

Evaluation Process

The evaluation process consists of a review of the application form and supporting documentation, conducting an on-site survey and interview with a store manager, and re-estimation of the lighting retrofit savings. One store is evaluated in this report.

Evaluation for the lighting retrofit included a verification of the fixture counts, lamp type and number of lamps. Pre and post retrofit operating hours for the lighting system were reviewed in detail with the store manager.

The store manager stated that the store is open 81 hours per week, and closes for two holidays. Lights are turned on by the lighting control system 2.5 hours before the store opens and off 1.5 hours after the store closes, 7 days per week. The store manager confirmed that only a portion of the lights are on during the employee occupied mode. In the absence of better information, we accept the ex ante quantity of fifty seven 400 watt metal halide fixtures on before the retrofit and 94 fixtures with two T-5 lamps on after the retrofit, during the employee occupied mode.

During the site visit conducted on December 16, 2004 when the store was open, we confirmed that there are 197 fixtures with four T-5 lamps. We observed 97 fixtures with 4 lamps on, 92 fixtures with 2 lamps on, and 8 fixtures with no lamps on. We used this observation as the basis of the ex post savings estimate for the "Store Open" mode.

The facility observes 2 holidays annually. Annual hours of operation for lighting before the retrofit are calculated as follows:

Annual weeks open=52.14 weeks/yr - 2 days/7days/week
Annual weeks open = 51.85

Employee mode annual hours= 51.85 weeks x 7 days/week x 4 hours/day
Employee mode annual hours= 1,452

Store open mode annual hours= 51.85 weeks x 81 hours/week
Store open mode annual hours= 4,200

Employee + store open hours= 1,452 + 4,200
Employee + store open hours= 5,652

Pre and post retrofit calculations of lighting loads and energy use were performed using the following formula.

kW = Fixture Watts/1,000 w/kW x Fixture quantity
kWh = kW x Operating hours

Based on the data collected during the site visit we recalculated the energy savings for the lighting retrofit. Table 4 is a summary of the pre retrofit lighting calculations, Table 5 is a summary of the post retrofit lighting calculations and Table 6 is a summary of the energy savings and demand reduction for the project.

Table 4 Pre Retrofit Energy Analysis Store 766

					Annual	
Mode	Fixture	Quantity	w/fixture	Peak kW	Hours	kWh
Employee + Open	MH 400 W	57	458	26.1	5,652	147,542
Store Open	MH 400 W	132	458	60.5	4,200	253,906
Total		189		87		401,448

Table 5 Post Retrofit Energy Analysis Store 766

					Annual	
Mode	Fixture	Quantity	w/fixture	Peak kW	Hours	kWh
Employee	2 Lamp T-5 HO Outer	94	117	0.0	1,452	15,967
Store Open	2 Lamp T-5 HO Inner	92	117	10.8	4,200	45,207
Store Open	4 Lamp T-5 HO	97	234	22.7	4,200	95,328
				33		156,502

Table 6 Summary of the Ex Post Lighting Savings Store 766

	Total kW	kWh
Pre Retrofit	87	401,448
Post Retrofit	33	156,502
Savings	53	244,946

Installation Verification

We confirmed the installation of 197 four lamp T-5 fixtures in Store 766. A verification summary is shown in Exhibit 1 below.

Scope of Impact Assessment

The impact evaluation includes the installation of lighting efficiency measures. The application is for 6 retail stores plus 57 fixtures from another store that reached the maximum incentive under the Express Efficiency program and were included in this application. One site was evaluated. This is the only measure for this SPC application.

Additional Notes

The ex post kWh savings are greater than the ex ante kWh savings because we found that almost half of the fixtures were operating with only 2 lamps on during the store open hours. The ex ante calculations assumed that 4 lamps would operate on each fixture during the store open hours. The four lamp configuration with pairs of lamps controlled separately has given the store management greater flexibility to adjust the lighting levels than was possible with the 400 watt metal halide fixtures. The ex post annual hours of operation are slightly less than the ex ante annual hours of operation.

The ex post demand reduction kW are less than the ex ante. The application reviewer appears to have made an error by not accounting for the fact that the original project application had 8 sites and the installation report documents 6 installed sites plus the 57 fixtures from another store as described above. This error is more than 90 kW (373.2 kW vs. 280.6 kW). Although we found that the demand reduction was greater for the store evaluated, neglecting to subtract the stores not installed in this application has reduced the realization rate for this application to approximately 90%.

The amount of time allowed for this project was not adequate. A more precise evaluation would include multiple sites, lighting logger installation and a verification of the number of fixtures operating in each mode (two lamps, four lamps or no lamps on). We estimate an additional 40 hours would be required to complete this work.

The application is for 6 retail stores. Since only one store was evaluated, we have extrapolated the results over the entire application by calculating the realization rate and applying it to the entire project. Table 7 is a summary of the realization rate calculation for the store 766, Table 8 is a summary of the corrected ex ante savings accounting for the stores included in the application, and Table 9 is a summary of the energy savings and demand reduction prorated for the entire project.

Table 7 Realization Rate for Store 766

	kW	kWh
Ex Ante Savings	44	212,123
Ex Post Savings	53	244,946
Realization Rate	120.3%	115.5%

Table 8 Corrected Ex Ante kWh and kW for All Stores

Store Number	Fixtures	kWh			kW
		Pre Retrofit	Post Retrofit	Savings	
662	199	437,297	217,484	219,813	44.6
664	202	446,061	218,436	227,625	45.2
667	181	392,702	197,112	195,590	40.5
669	231	506,328	248,856	257,472	51.7
670	186	404,645	200,987	203,658	41.7
766	197	426,127	214,004	212,123	44.1
Subtotal	1,196			1,316,281	
671	57			82,817	12.8
Total Ex Ante	1,253			1,399,098	280.6

Table 9 Ex Post Energy Savings and Demand Reduction for the Project

	kW	kWh
Ex Ante Savings	280.6	1,399,098
Realization Rate	120.3%	115.5%
Ex Post Savings	337.6	1,615,587

Economic Information

An economic summary for the installation of the lighting efficiency and controls measures is shown in Table 10 below. An engineering realization rate calculation is shown in Table 11.

Impact Results

Table 10 Economic Summary of the Project

Description	Date	Project Cost	Estimated Demand Savings, kW	Estimated Energy Savings, kWh	Estimated Gas Savings, therms	Estimated Annual Cost Savings ($0.13/kWh), $	SPC Incentive, $	Simple Payback w/ incentive, yrs	Simple Payback w/o incentive, yrs
Application Submitted Amount	4/9/2003	$529,540	354.0	2,300,779	0	$299,101	$115,039	1.39	1.77
Application Approved Amount	4/30/2003	$529,540	373.2	2,383,656	0	$309,875	$119,182	1.32	1.71
Installation Approved Amount (Ex Ante)	10/9/2003	$529,540	373.2	1,399,098	0	$181,883	$69,955	2.53	2.91
SPC Program Review (Ex Post)	12/23/2004	$529,540	337.6	1,615,587	0	$210,026	$69,955	2.19	2.52

Table 11 Realization Rate Calculation

	KW	KWh	Therm
SPC Tracking System or Application	373.2	1,399,098	0
Adjusted Engineering	337.6	1,615,587	0
Engineering Realization Rate	90.5%	115.5%	NA

Exhibit 1 Installation Verification Sheet

Measure Description	End-Use Category	HVAC Measure Description	Lighting Measure Description	Process Measure Description	Count	Equipment Description	Installation Verified (Explain)	Notes
LIGHTING - OTHER	L		Replace 400 watt metal halide fixtures with 4 lamp T-5 HO fixtures		1,253	4 lamp T-5 HO fixtures	Verified fixture quantity and lamp type at one store. There are 6 stores in this application.	

SITE 15 IMPACT EVALUATION
SAMPLE CELL: ORIGINAL TIER: 2 END USE: LIGHTING

Measure	***Lighting efficiency and controls***
Site Description	***Warehouse***

Measure Description

Replace Hi-Bay high pressure sodium fixtures with T-5 fixtures. Install occupancy sensor controls. Replace magnetic ballasts with electronic ballasts in office areas.

Summary of Ex Ante Impact Calculations

Simple pre- and post-retrofit algorithm using fixture connected loads and hours of operation. Occupancy data logging was performed for more than 1 month to estimate savings potential in the warehouse area.

Comments on Ex Ante Calculations

The ex-ante savings were determined by performing a detailed pre and post retrofit lighting fixture inventory and calculating the change in lighting power based on fixture watts published in the SPC Lighting Wattage Tables. Lighting energy use was calculated using estimated hours of operation, and reduction of the base hours for the occupancy sensor installation.

A detailed summary of the estimated pre and post retrofit operating hours for each type of area was provided by the energy services company that developed and managed the project. In the warehouse areas,. estimated annual hours of lighting operation were 7,020 for the pre retrofit, and ranged from 1,755 to 6,143 for the post retrofit in areas where occupancy sensors are installed. In the office areas, estimated annual hours of lighting operation range from 2,190 to 7,020 before the retrofit, and from 365 to 2,299 after the retrofit in areas where occupancy sensors are installed.

Data logging performed by the project sponsor showed that based on the occupancy data logging, warehouse lighting hours of operation could be reduced by 41%- 87% in areas where occupancy sensors are installed. The un-weighted potential average reduction in lighting hours is 58.8%.

The application documents approximately two hundred eighty five 400 watt high pressure sodium fixtures interior lighting fixtures converted to two hundred eighty six four lamp T-5 high output fixtures. There are also some ballast replacements and incandescent to compact fluorescent conversions in the office areas.

Some four lamp T-5 fixtures are equipped with occupancy sensors that reduce the fixture to two lamp operation when no occupancy is sensed. Occupancy sensors were installed for all fixtures in the warehouse except fixtures in the aisles.

Pre and post retrofit calculations of lighting loads and energy use were performed using the following formula.

kW = Fixture Watts/1,000 w/kW x Fixture quantity
kWh = kW x Operating hours

Table 1 is a summary of the ex ante lighting savings.

Table 1 Summary of the Ex Ante Lighting Savings

	Total kW	kWh
Lighting Efficiency	65	651,285
Lighting Controls	16	63,166
Total	81	714,451

Evaluation Process

The evaluation process consists of a review of the application form and supporting documentation, conducting an on-site survey and interview with facilities personnel, and re-estimation of the lighting retrofit savings.

Evaluation for the lighting retrofit included a spot check of the fixture counts, lamp type and number of lamps and a verification of occupancy sensor installation for selected areas. Pre and post retrofit operating hours for lighting were reviewed in detail with the facility manager.

The facility representative stated that the facility operates 24 hours per day, six days per week. Lights before and after the retrofit are manually switched off during unoccupied hours. The facility observes 8 holidays annually. Annual hours of operation for lighting before the retrofit are estimated to be:

Annual hours=52.14 weeks/yr x 6 day/week x 24 hr/ day – 8 days x 24 hr./day
Annual hours= 7,316.

The facility representative confirmed the fixture counts for the pre and post retrofit. During the site visit we observed many areas with lights off, but are unable to confirm the percent of lighting hours reduced by the installation of occupancy sensors. Therefore we have accepted the occupancy sensor data logging performed by the project sponsor as being a reasonable representation of the occupancy sensor savings for this project.

Given the uncertainty of the reduction in lighting hours of operation, and our slightly higher estimate of pre retrofit hours of operation, we have elected to accept the Ex Ante kW and kWh savings estimate. Table 2 summarizes the Ex Post savings estimate.

Table 2 Summary of the Ex Post Lighting Savings

	Total kW	kWh
Lighting Efficiency	65	651,285
Lighting Controls	16	63,166
Total	81	714,451

Installation Verification

We confirmed the installation of T-5 fixtures, occupancy sensors and ballast replacements with the facility representative. A verification summary is shown in Exhibit 1 below.

Scope of Impact Assessment The impact evaluation includes the installation of lighting efficiency and lighting controls measures. These are the only measures for this SPC application.

Additional Notes The project sponsor performed occupancy data logging and used the results as a basis for the savings calculations. This level of measurement gives a higher confidence in the savings estimate for this project compared to projects without a measured basis.

The amount of time allowed for this project was adequate and no further work is necessary.

Economic Information An economic summary for the installation of the lighting efficiency and controls measures is shown in Table 3 below. An engineering realization rate calculation is shown in Table 4.

Impact Results

Table 3 Economic Summary of the Project

Description	Date	Project Cost	Estimated Demand Savings, kW	Estimated Energy Savings, kWh	Estimated Gas Savings, therms	Estimated Annual Cost Savings ($0.13/kWh), $	SPC Incentive, $	Simple Payback w/ incentive, yrs	Simple Payback w/o incentive, yrs
Application Submitted Amount	2/3/2003	$187,124	81.1	715,537	0	$93,020	$35,777	1.63	2.01
Application Approved Amount	3/10/2003	$187,124	80.8	714,451	0	$92,879	$35,723	1.63	2.01
Installation Approved Amount (Ex Ante)	5/8/2003	$187,124	80.8	714,451	0	$92,879	$35,723	1.63	2.01
SPC Program Review (Ex Post)	11/22/2004	$187,124	80.8	714,451	0	$92,879	$35,723	1.63	2.01

Table 4 Realization Rate Calculation

	KW	KWh	Therm
SPC Tracking System or Application	80.8	714,451	0
Adjusted Engineering	80.8	714,451	0
Engineering Realization Rate	100%	100%	NA

Exhibit 1 Installation Verification Sheet

Measure Description	End-Use Category	HVAC Measure Description	Lighting Measure Description	Process Measure Description	Count	Equipment Description	Installation Verified (Explain)	Notes
Indoor System Modification - Fluorescent	L		Replace 400 W HPS fixtures with 4 lamp T-% fixtures. Replace magnetic ballasts with electronic in office areas		285- 400 W HPS replaced with 286 T-5 fixtures.	HPS fixtures replaced with T-5, high output.	Fixture replacement physically verified. Site representative confirmed fixture counts.	Ballast replacement not physically verified. Site representative confirmed replacement of ballasts.
Occupancy Sensors	L		Occupancy sensors installed on HI-Bay lights in most areas.			Occupancy sensors installed on individual HI-Bay fixtures.	Occupancy sensors physically verified. Site representative confirmed fixture counts.	

SITE 16 IMPACT EVALUATION
SAMPLE CELL: ORIGINAL TIER: 2 END USE: LIGHTING

Measure	***Comprehensive Lighting Upgrade***
Site Description	***Factory***

Measure Description

This comprehensive lighting upgrade included replacing T-12 fluorescent lamps and magnetic ballasts with T-8 lamps and electronic ballasts, high pressure sodium fixtures were replaced with T-5 HO fixtures with integral occupancy sensors and pulse start metal halide fixtures. Exit signs were converted to LED, and the installation of occupancy sensors for some fluorescent fixtures was completed. In the warehouse and production areas each new T-5 HO fixture has a dedicated occupancy sensor and each fixture operates independently.

Summary of Ex Ante Impact Calculations

Savings were calculated using a custom spreadsheet with estimates of operating hours and fixture power use before and after the retrofit.

Comments on Ex Ante Calculations

An adjustment was made during the application review to lower the reduction in operating hours associated with the installation of the occupancy sensors in the warehouse and production areas. A maximum savings of 45%, or post-installation runtime of 55%, was used in the adjustment. This adjustment is in compliance with 2003 SPC guidelines. Some fixture wattages were also adjusted. These adjustments are reasonable.

The base case calculations showed a maximum annual operating time for the lighting in the warehouse of 6,864 hours a year. The customer's technical services manager was interviewed during the on-site visit for the evaluation. According to him, the lights tended to be on 24 hours a day, seven days a week prior to the installation of the occupancy sensors in the warehouse. Therefore, the ex ante savings would appear to be conservative.

Evaluation Process

The evaluation process consists of a review of the application file and supporting documentation, conducting an on-site survey, installing lighting loggers in representative locations, and then computing impacts using the on-site and logger data.

The on-site survey was conducted on January 4, 2005. Information on the retrofit equipment and operating schedules was collected through a sample inspection of the warehouse and production areas that received new fixtures and occupancy sensors, and interview with the technical services manager. The warehouse and production area was chosen over the office areas for the impact evaluation because that area contributed to a much greater proportion of the total project impacts.

The data from the lighting logger analysis was used to adjust the ex ante calculations. This produced a new estimate of savings. The revised calculation is shown below in Table 3. Lighting loggers were installed for selected areas of the warehouse for 7 days. Analysis of the logger data indicated that the operating hours for a large number of fixtures is considerably less than estimated in the ex ante calculations. Loggers were placed in two "stock" areas and we found that the lights were on an average of 10.5% of the time for these areas. In low traffic areas we found lights on less than 1% of the time. The logger installed in the high traffic area failed so we accepted the ex ante post retrofit hours of operation.

The adjusted impacts are 1,012,554 kWh and 101.3 kW.

Installation Verification

The types and numbers of new fixtures were verified on a qualitative basis. There was not enough time budgeted to do a detailed fixture count. The verification confirmed that the previous high pressure sodium and F96T12HO fixtures were now replaced with T5 HO and pulse start metal halide fixtures. Also on a qualitative basis, a cursory view of the ceiling from the ends of the space confirmed that overall, a high proportion of the lights were off during the inspection

Scope of Impact Assessment

Ten categories of fixtures were evaluated out of a total of 41 categories. This included 426 installed fixtures out of a total of 1,012 installed fixtures. The ten categories evaluated account for 729,925 kWh of the approved 872,874 kWh of savings. The new estimate of savings based on the actual hours that the lights in the warehouse were on is 1,012,554 kWh. Since the lights are expected to be on for normal occupation, the estimate of demand reduction is unchanged at 101.3 kW.

Additional Notes

Considering the detail provided in the ex ante file, this level of evaluation effort was reasonable to determine accurate impacts. The evaluation could have been more accurate if there had been monitoring over a longer period of time. There may be seasonal differences in the operation the lights, since there may be seasonal differences in the sale of the products stored here and resulting warehouse activity. Actual power readings of the lighting circuits would also be more accurate than light logger readings and estimated kW reduction, but much more expensive to perform. This effort could require up to an additional 80 hours.

Economic Information

An economic summary for the measures in the primary end use is shown in Table 1 below. Table 2 shows the realization rate for the project.

Table 1
Economic Summary Of The Project

Description	Date	Project Cost	Estimated Demand Savings, kW	Estimated Energy Savings, kWh	Estimated Gas Savings, therms	Estimated Annual Cost Savings ($0.13/kWh) ($0.75/therm)	SPC Incentive, $	Simple Payback w/ incentive, yrs.	Simple Payback w/o incentive, yrs.
Application Submitted Amount	04/02/03	$284,019	98.2	893,432	0.0	$116,146	$44,671.60	2.06	2.45
Application Approved Amount	05/30/03	$284,019	101.3	872,874	0.0	$113,474	$43,643.71	2.12	2.50
Installation Approved Amount (Ex Ante)	10/29/03	$284,019	101.3	872,874	0.0	$113,474	$43,643.71	2.12	2.50
SPC Impact Evaluation (Ex Post)	01/17/05	$284,019	101.3	1,012,554	0.0	$131,632	$43,643.71	1.83	2.16

Table 2
Impact Results

	KW	KWh	Therm
SPC Tracking System or Application (Ex Ante)	101.3	872,874	0
Adjusted Engineering (Ex Post)	101.3	1,012,554	0
Engineering Realization Rate	1.00	1.16	N/A

Table 3
Ex Post Calculations Summary

Warehouse

Existing Qty	SPC ECM	Existing Fixture	Install Qty	SPC ECM	Usage Group	New Fixture or Conversion	Existing Lighting System Watts Each	Existing Lighting System Total kW	Existing Lighting System Annual Hours	Existing Lighting System Total kWh	New Lighting System Watts Each	New Lighting System Total kW	New Lighting System Annual Hours	New Lighting System Total kWh
26	HPS400/1	HPS400 Hi-Bay	108	F42ILL/T4-R (G2)	CM	2LF32T8 - 8' Strip Tandem	465	12.09	6,864	82,986	51	5.51	6,864	37,807
9	HPS400/1	HPS400 Hi-Bay	12	F44PHL/2	CP-DP	PTHBS-SQ2-4-2X4-4L54	465	4.19	6,864	28,726	234	2.81	5,059	14,207
75	HPS400/1	HPS400 Hi-Bay	84	F44PHL/2	CP-HT	PTHBS-SQ2-4-2X4-4L54	465	34.88	6,864	239,382	234	19.66	5,491	107,935
2	F82EHS	2L F96T12-HO	2	F44PHL/2	CP-DP	PTHBS-SQ2-4-2X4-4L54	227	0.45	6,864	3,116	234	0.47	5,059	2,368
24	HPS400/1	HPS400 Hi-Bay	24	F44PHL/2	CF-LT	PTHAS-SQ4-2-1X8-4L54	465	11.16	6,864	76,602	234	5.62	67	378
127	HPS400/1	HPS400 Hi-Bay	174	F44PHL/2	CF-SA	PTHAS-SQ4-2-1X8-4L54	465	59.06	6,864	405,354	234	40.72	332	13,499
7	F82EHS	2L F96T12-HO	7	F44PHL/2	CF-SA	PTHAS-SQ4-2-1X8-4L54	227	1.59	6,864	10,907	234	1.64	332	543
8	HPS400/1	HPS400 Hi-Bay	8	F42PHL	CF-LT	PTHBS-SQ2-2-1X4-2L54-DPL	465	3.72	6,864	25,534	117	0.94	67	63
7	HPS400/1	HPS400 Hi-Bay	7	MH320PS/1	CM	MH320 Pulse Start Hi-Bay	465	3.26	6,864	22,342	365	2.56	6,864	17,538
85	F82EHS	2L F96T12-HO	-	Removed	-	Remove and Cap Power	227	19.30	6,864	132,441	-	-	-	-
27	F42EE	2L F40T12	-	Removed	-	Remove and Cap Power	72	1.94	6,864	13,344	-	-	-	-
4	F82EE	2L F96T12-SL	-	Removed	-	Remove and Cap Power	123	0.49	6,864	3,377	-	-	-	-
401		Total Fixtures	426					152.11		1,044,110		79.90		194,337

Office							Existing Lighting System				New Lighting System			
Existing Qty	SPC ECM	Existing Fixture	Install Qty	SPC ECM	Usage Group	New Fixture or Conversion	Watts Each	Total kW	Annual Hours	Total kWh	Watts Each	Total kW	Annual Hours	Total kWh
1	F82ES	2L96T12-SL	1	F44ILL-R (G2)	O	4L32T8-LP Conversion	128	0.13	3,432	439	102	0.10	3,432	350
40	F82ES	2L96T12-SL	40	F44ILL-R (G2)	W	4L32T8-LP Conversion	128	5.12	6,864	35,144	102	4.08	6,864	28,005
62	F82EHS	2L96T12-HO	62	F44ILL-R (G2)	W	4L32T8-HP Conversion	227	14.07	6,864	96,604	102	6.32	6,864	43,408
78	F82ES	2L96T12-SL	78	F44ILL-R (G2)	W	4L32T8-LP Conversion	128	9.98	6,864	68,530	102	7.96	6,864	54,610
6	F82EHS	2L96T12-HO	6	F44ILL-R (G2)	W	4L32T8-LP Conversion	227	1.36	6,864	9,349	102	0.61	6,864	4,201
9	I20/2	Inc or Fluor Exit Sign	9	ELED	E	New LED Exit Sign	40	0.36	8,760	3,154	4	0.04	8,760	315
4	I20/2	Inc Exit w/Bugeye	4	ELED	E	New LED Exit Sign w/Bugeye	40	0.16	8,760	1,402	4	0.02	8,760	140
6	N/A	None	6	F42ILL-R (G2)	W	New STS-2-1x4-2L32-LP Strip	-	-	6,864	-	52	0.31	6,864	2,142
3	I75/1	75A19 Incandescent	3	F41ILL (G2)	O	New WBTW-1-1x4-1L32- Wrap	75	0.23	3,432	772	31	0.09	3,432	319
14	F42EE	2L40T12 1x4 Wrap	14	F42ILL-R (G2)	H	New SWR-2-1x4-2L32-STD Wrap	72	1.01	6,864	6,919	52	0.73	6,864	4,997
1	F42EE	2L40T12 1x8 Wrap	1	F82ILL-R	H	New SWR-2-1x8-4L32-STD Wrap	72	0.07	6,864	494	98	0.10	6,864	673
1	F41EE	1L40T12	1	F41ILL (G2)	H	1L32T8-LP LBO	43	0.04	6,864	295	31	0.03	6,864	213
11	F41EE	1L40T12	11	F41ILL (G2)	W	1L32T8-LP LBO	43	0.47	6,864	3,247	31	0.34	6,864	2,341
1	F42EE	2L40T12	1	F42ILL-R (G2)	H	2L32T8-LP LBO	72	0.07	6,864	494	52	0.05	6,864	357
31	F42EE	2L40T12	31	F42ILL-R (G2)	O	2L32T8-LP LBO	72	2.23	3,432	7,660	52	1.61	3,432	5,532
2	F42EE	2L40T12	2	F42ILL-R (G2)	O-CF	2L32T8-LP LBO	72	0.14	3,432	494	52	0.10	2,299	239
4	F42EE	2L40T12	4	F42ILL-R (G2)	U	2L32T8-LP LBO	72	0.29	2,190	631	52	0.21	2,190	456
39	F42EE	2L40T12	39	F42ILL-R (G2)	W	2L32T8-LP LBO	72	2.81	6,864	19,274	52	2.03	6,864	13,920
27	F44EE	4L40T12	27	F44ILL-R (G2)	O	4L32T8-LP LBO	144	3.89	3,432	13,344	102	2.75	3,432	9,452
3	F44EE	4L40T12	3	F44ILL-R (G2)	U	4L32T8-LP LBO	144	0.43	2,190	946	102	0.31	2,190	670
41	F44EE	4L40T12	41	F44ILL-R (G2)	W	4L32T8-LP LBO	144	5.90	6,864	40,525	102	4.18	6,864	28,705
2	I150/1	150A23	2	Removed	W	Remove & Cap Power	150	0.30	6,864	2,059	-	-	6,864	-
13	F44EE	4L40T12	13	F42ILL-V (G2)	H	2L32T8-HP White Reflector Kit	144	1.87	6,864	12,849	79	1.03	6,864	7,049
126	F44EE	4L40T12	126	F42ILL-V (G2)	O	2L32T8-HP White Reflector Kit	144	18.14	3,432	62,270	79	9.95	3,432	34,162
14	F44EE	4L40T12	14	F42ILL-V (G2)	O-CF	2L32T8-HP White Reflector Kit	144	2.02	3,432	6,919	79	1.11	2,299	2,543
1	F44EE	4L40T12	1	F42ILL-V (G2)	U	2L32T8-HP White Reflector Kit	144	0.14	2,190	315	79	0.08	2,190	173
1	F44EE	4L40T12	1	F42ILL-V (G2)	U-CF	2L32T8-HP White Reflector Kit	144	0.14	2,190	315	79	0.08	986	78
30	F44EE	4L40T12	30	F42ILL-V (G2)	W	2L32T8-HP White Reflector Kit	144	4.32	6,864	29,652	79	2.37	6,864	16,268
15	N/A	W&R Only	15	N/A	W	W&R Only	-	-	6,864	-	-	-	6,864	-
586		Total Fixtures	586					75.72		424,097		46.59		261,318

Table 4
Summary of Impact Evaluation

Lightings	Demand Savings (kW)	Controls Savings (kWh)	Efficiency Savings (kWh)	Total kWh Savings
HID	72.21	354,104	495,670	849,774
Fluorescents	28.66	1,466	157,214	158,680
LED	0.47	0	4,100	4,100
Total	101.34	355,569	656,984	1,012,554
% of Total Savings		35.12%	64.88%	

Table 5
Inputs to Model

Parameter	Value Reported	Units of Parameter	Notes
Office fixture original power use	75.72	kW	Application documents
Office fixture new power use	46.59	kW	Application documents
Office fixture operating hours before	Various	Hours	Application documents
Office fixture operating hours after	Various	Hours	Application documents
Warehouse fixture original power use	152.11	kW	Application documents
Warehouse fixture new power use	79.9	kW	Application documents
Warehouse fixture operating hours before	6,864	Hours	Application documents
Warehouse fixture operating hours after	Various	Hours	Lighting loggers
Installation Date	10/02/2003		

Table 6
Project Verification Sheet

Measure Description	End-Use Category	Lighting Measure Description	Count	Equipment Description	Installation Verified (Explain)	Notes
Occupancy Sensors	L	Install occupancy sensors for fixtures in offices, new fixtures for warehouse with integral sensors	328	T5HO fixtures have individual occupancy sensors on each fixture	Lighting loggers were installed in the warehouse to determine actual hours of use with the new sensors	It was easily observed in the inspection that most of the lighting in the warehouse was off until someone walked into the space.
Indoor System Replacement - Fluorescent	L	Replace T-12 with T-8 in offices, replace HID with T5HO and pulse start metal halide in warehouse, LED exits	1012	T-8 conversions include reduced light output electronic ballasts, LED exits replaced incandescent and fluorescent	On-site inspection included visual confirmation of the installation of the new T5HO fixtures	Customer staff is very happy with the improvement in light level and the superior color rendition of the T5HO fixtures compared to the previous high pressure sodium.

SITE 17 IMPACT EVALUATION
SAMPLE CELL: ORIGINAL TIER: 2 END USE: LIGHTING

Measure	***Lighting efficiency***
Site Description	***Industrial Manufacturing***

Measure Description

Replace 400 watt metal halide fixtures with high output, 4 lamp T-5 fixtures.

Summary of Ex Ante Impact Calculations

Simple pre- and post-retrofit algorithm using fixture connected loads and hours of operation.

Comments on Ex Ante Calculations

The application includes the lighting retrofit for two industrial buildings. The ex-ante savings were estimated by creating a pre and post retrofit lighting fixture inventory and calculating the change in lighting power based on fixture watts published in the SPC Lighting Wattage Tables. Lighting energy use was calculated using estimated hours of operation before and after the retrofit. The customer utilized the SPC calculator for the project. The original application was updated by the project reviewer to reflect an increase in the number of metal halide fixtures being retrofit for the project, and the deletion of some T-12 fixture retrofits from the project.

A summary of the estimated pre and post retrofit operating hours for each building was provided by the customer. According to documentation in the application, lights in both buildings operate 8,000 hours annually before and after the retrofit.

Before the retrofit, there were two hundred seventy eight 400 watt metal halide fixtures operating in Building 13 and two hundred fifty five 400 watt metal halide fixtures operating in Building 14. Each metal halide fixture was replaced with a fixture that has four T-5 high output lamps.

Pre and post retrofit calculations of lighting loads and energy use were performed using the following formula.

kW = Fixture Watts/1,000 w/kW x Fixture quantity
kWh = kW x Operating hours

Table 1 is a summary of the pre retrofit lighting calculations, Table 2 is a summary of the post retrofit lighting calculations and Table 3 is a summary of the energy savings and demand reduction.

Table 1 Pre Retrofit Lighting Calculations

					Annual	
Area	Fixture	Quantity	w/fixture	Peak kW	Hours	kWh
Building 13	MH 400 W	278	458	127.3	8,000	1,018,592
Building 14	MH 400 W	255	458	116.8	8,000	934,320
Total		533		244.1		1,952,912

Table 2 Post Retrofit Lighting Calculations

Area	Fixture	Quantity	w/fixture	Peak kW	Annual Hours	Annual kWh
Building 13	4 Lamp T-5 HO	278	234	65.1	8,000	520,416
Building 14	4 Lamp T-5 HO	255	234	59.7	8,000	477,360
Total		533		124.7		997,776

Table 3 Summary of the Ex Ante Calculations

	Total kW	kWh
Pre Retrofit	244.1	1,952,912
Post Retrofit	124.7	997,776
Savings	119.4	955,136

Evaluation Process

The evaluation process consists of a review of the application form and supporting documentation, conducting an on-site survey and interview with a facility representative, and re-estimation of the lighting retrofit savings.

Evaluation for the lighting retrofit included a verification of the fixture counts, lamp type and number of lamps. Pre and post retrofit operating hours for the lighting system were reviewed in detail with the facility representative.

Buildings 13 and 14 are large open high bay manufacturing areas. The facility representative stated that Buildings 13 and 14 are occupied 24 hours per day Monday- Friday, and 12 hours per day on Saturday and Sunday. The facility observes 8 holidays annually. All lights are manually switched on and off, and security personnel are responsible for turning lights off when the buildings are unoccupied. Based on this information we calculated the annual hours of operation as follows:
Hours per week= 5 days x 24 hours/day + 2 days x 12 hours/day
Hours per week= 144

Weeks per year= 52.14 weeks/year- 8 holidays/7 days/week
Weeks per year= 51

Annual Hours= 144 hours/week x 51 weeks/year
Annual Hours= 7,344

During the site visit the facility representative confirmed that 278 fixtures are installed in Building 13 and 255 fixtures are installed in Building 14. We verified that each fixture has four T-5 high output lamps.

Pre and post retrofit calculations of lighting loads and energy use were performed using the following formula.

kW = Fixture Watts/1,000 w/kW x Fixture quantity
kWh = kW x Operating hours

Based on the data collected during the site visit we recalculated the energy savings for the lighting retrofit. Table 4 is a summary of the pre retrofit lighting calculations, Table 5 is a summary of the post retrofit lighting calculations and Table 6 is a summary of the energy savings and demand reduction for the project.

Table 4 Pre Retrofit Energy Analysis

Area	Fixture	Quantity	w/fixture	Peak kW	Annual Hours	Annual kWh
Building 13	MH 400 W	278	458	127.3	7,344	935,067
Building 14	MH 400 W	255	458	116.8	7,344	857,706
Total		533		244.1		1,792,773

Table 5 Post Retrofit Energy Analysis

Area	Fixture	Quantity	w/fixture	Peak kW	Annual Hours	Annual kWh
Building 13	4 Lamp T-5 HO	278	234	65.1	7,344	477,742
Building 14	4 Lamp T-5 HO	255	234	59.7	7,344	438,216
Total		533		124.7		915,958

Table 6 Summary of the Ex Post Lighting Savings

	Total kW	kWh
Pre Retrofit	244	1,792,773
Post Retrofit	125	915,958
Savings	119	876,815

Installation Verification

We confirmed the installation of 278 four lamp high output T-5 fixtures in Building 13 and 255 four lamp high output T-5 fixtures in Building 13. A verification summary is shown in Exhibit 1 below.

Scope of Impact Assessment

The impact evaluation includes the installation of lighting efficiency measures. This is the only measure for this SPC application.

Additional Notes

The ex post savings are less than the ex ante savings because we determined that the ex post annual hours of operation are less than the ex ante annual hours of operation.

The amount of time allowed for this project was adequate and no further analysis is necessary.

Economic Information

An economic summary for the installation of the lighting efficiency and controls measures is shown in Table 7 below. An engineering realization rate calculation is shown in Table 8.

Impact Results

Table 7 Economic Summary of the Project

Description	Date	Project Cost	Estimated Demand Savings, kW	Estimated Energy Savings, kWh	Estimated Gas Savings, therms	Estimated Annual Cost Savings ($0.13/kWh), $	SPC Incentive, $	Simple Payback w/ incentive, yrs	Simple Payback w/o incentive, yrs
Application Submitted Amount	8/28/2003	$218,433	116.9	935,168	0	$121,572	$46,758	1.41	1.80
Application Approved Amount	10/24/2003	$218,433	119.4	955,136	0	$124,168	$47,757	1.37	1.76
Installation Approved Amount (Ex Ante)	3/25/2004	$218,433	119.4	955,136	0	$124,168	$47,757	1.37	1.76
SPC Program Review (Ex Post)	1/7/2005	$218,433	119.4	876,815	0	$113,986	$47,757	1.50	1.92

Table 8 Realization Rate Calculation

	KW	KWh	Therm
SPC Tracking System or Application	119.4	955,136	0
Adjusted Engineering	119.4	876,815	0
Engineering Realization Rate	100%	91.8%	NA

Exhibit 1 Installation Verification Sheet

Measure Description	End-Use Category	HVAC Measure Description	Lighting Measure Description	Process Measure Description	Count	Equipment Description	Installation Verified (Explain)	Notes
HID/T-5 Retrofit	L		Replace 400 watt metal halide fixtures with 4 lamp T-5 HO fixtures		Building 13: 278 fixtures. Building 14: 255 fixtures	4 lamp T-5 HO fixtures	Verified fixture quantity and lamp type .	

SITE 18 IMPACT EVALUATION
SAMPLE CELL: ORIGINAL TIER: 3 END USE: LIGHTING

Measure	***Lighting controls***
Site Description	***Commercial Office***

Measure Description

Install occupancy sensor controls.

Summary of Ex Ante Impact Calculations

Simple pre- and post-retrofit algorithm using fixture connected loads and hours of operation.

Comments on Ex Ante Calculations

The ex-ante savings were determined by creating a lighting fixture inventory and calculating the change in lighting energy based on assumed hours of operation before and after the occupancy sensor retrofit.

A detailed summary of the estimated pre and post retrofit operating hours for each type of area was not provided. The savings calculations are based on the assumption that all lights are on 4,000 hours annually before the retrofit and 3,000 hours annually after the retrofit, a 25% reduction in annual operating hours. There is no differentiation of hours of operation and savings based on the type of space. For instance, a conference room is likely to have different hours of operation than a private office.

The project reviewer noted discrepancies in the supporting information submitted with the application. The occupancy sensor controls vendor had submitted calculations that were used as the basis of the savings claim for the project. The original savings claim indicated that lighting energy use would be reduced by 44% with the installation of occupancy sensors. The reviewer felt this claim was excessive and reduced the savings to 25% of the calculated annual energy consumption. The reviewer contacted the installation contractor and the contractor provided a matrix showing different fixture types, watts per fixture and quantity of fixtures.

Two buildings were retrofit with occupancy sensors. The reviewer's hand written notes and calculations indicate that based on the matrix provided by the contractor, the connected lighting load for Building 1 is 58.252 kW, and 61.118 kW for Building 2.

Pre and post retrofit calculations of lighting loads and energy use were generated using the following formula.

kW = Fixture Watts/1,000 w/kW x Fixture quantity
kWh = kW x Operating hours

Table 1 is a summary of the ex ante lighting savings.

Table 1 Summary of the Ex Ante Lighting Savings

	Total	Pre retrofit		Post retrofit		Savings
	kW	Hours	kWh	Hours	kWh	kWh
B1 Lighting Controls	58.252	4,000	233,008	3,000	174,756	58,252
B2 Lighting Controls	61.118	4,000	244,472	3,000	183,354	61,118
Total	119.370		477,480		358,110	119,370

Evaluation Process

The evaluation process consists of a review of the application form and supporting documentation, conducting an on-site survey and interview with facilities personnel, and re-estimation of the lighting retrofit savings.

Evaluation for the occupancy sensor retrofit included a verification of the occupancy sensor installation for selected areas. Pre and post retrofit operating hours for lighting were reviewed in detail with the facility representative.

The facility representative stated that the facility is occupied from 7 AM to 11PM (16 hours per day), five days per week. Lights before and after the retrofit are swept off by an energy management system at 11 PM and every 2 hours after that until 6 AM. Prior to the retrofit, lights were manually switched on and off by the occupants until the energy management system sweeps them off. The facility observes 8 holidays annually. The maximum annual hours of operation for lighting before the retrofit are estimated to be:

Annual hours=52.14 weeks/yr x 5 days/week x 16 hr./day – 8 days x 16 hr./day
Annual hours= 4,043.

Assuming that all lights operate 16 hours daily seems questionable considering that each building is approximately 150,000 ft^2 and contains open offices, private offices, conference rooms, restrooms, labs, kitchen break areas, hallways, etc. During the site visit we observed that many lights were manually switched off, bypassing the occupancy controls. This is partly because the company has reduced the number of employees by approximately 50%. Based on our observations, about 25% of fixtures were off in the building. We therefore have elected to reduce the average pre-retrofit hours of operation by 25% to 3,032 hours annually.

Annual hours= 4,043x (1-0.25)
Annual hours=3,032

Using the lighting inventory matrix provided by the installation contractor with the fixture quantities and watts per fixture, we calculated the connected load to be approximately 103 kW for Building 1 and 104 kW for Building 2. These calculated values are much higher than those used by the reviewer (58 kW and 61 kW, respectively). Table 2 is a summary of the connected kW for each Building based on the matrix submitted by the contractor.

Table 2 Summary of Connected kW by Building

Building 1

Fixture	Watts	Quantity	kW
A	116	16	1.9
B	62	24	1.5
C	93	174	16.2
D	85	326	27.7
E	108	393	42.4
F	30	375	11.3
G	54	39	2.1
Total		1,347	103.04

Building 2

Fixture	Watts	Quantity	kW
A	116	21	2.4
B	62	31	1.9
C	93	150	14.0
D	85	356	30.3
E	108	419	45.3
F	30	260	7.8
G	54	43	2.3
Total		1,280	103.94

We contacted the contractor and were informed that the person who was responsible for the project has left the company. The person who assisted us tried in vain to resolve the discrepancy between the connected lighting load shown in the lighting inventory matrix and the connected load used by the application reviewer. We have therefore concluded that the application reviewer may have made a mathematical error in calculating the connected lighting load for each building. However since we are unable to resolve the discrepancy between the reviewer's connected lighting load and the load we calculated using the contractor's matrix, we have decided to accept the lower connected loads used by the reviewer.

Using the connected lighting load determined by the application reviewer, the reduced hours of operation before the retrofit and accepting the estimated 25% reduction in operating hours due to the installation of the occupancy sensors, we recalculated the energy savings. A summary of the energy savings is shown in Table 3. The estimated hours of lighting operation after the retrofit are calculated as follows:

Annual hours $_{\text{post retrofit}}$ = 3,032x (1-0.25)

Annual hours $_{\text{post retrofit}}$ =2,274

Table 3 Summary of 12 Month Energy Savings

	Total	Pre retrofit		Post retrofit		Savings
	kW	Hours	kWh	Hours	kWh	kWh
B1 Lighting Controls	58.252	3,032	176,620	2,274	132,465	44,155
B2 Lighting Controls	61.118	3,032	185,310	2,274	138,982	46,327
Total	119.370		361,930		271,447	90,482

The facility representative informed us that the company will vacate the two buildings at the end of December 2004. The company is consolidating its operations into a single building nearby. The company still has a lease on the two buildings and is responsible for their maintenance during the term of the lease. The representative indicated that the company is attempting to sub lease the buildings but has not had any success so far, and expects that it will take several months to find an sub lessor, if one can be found.

The project was installed by the end of July 2004, and by the end of December 2004 the occupancy sensors will have operated for 5 months. After the current tenant vacates the buildings we expect the energy savings from the occupancy sensor installation to approach zero. When the building is reoccupied, some energy savings will likely be realized again. We have elected to prorate the expected annual energy savings shown in Table 3 by the percent of the occupied months for the first year following the installation. We have low confidence that the buildings will be sublet in the foreseeable future, so we assume that the occupancy sensors will save energy for 5 out of 12 months.

The Ex Post savings are calculated as follows

90,482 kWh x 5 months/12 months= 37,701 kWh.

Table 4 summarizes the Ex Post Savings

Table 4 Summary of the Ex Post Savings Analysis

	Savings kWh
Lighting Controls	37,701

Installation Verification

We confirmed the installation of occupancy sensors by spot checking two floors in each building and verified that the sensors had been installed in other areas with the facility representative. A verification summary is shown in Exhibit 1 below.

Scope of Impact Assessment

The impact evaluation includes the installation of lighting controls. This is the only measure for this SPC application.

Additional Notes

The Ex Post savings are less than the Ex Ante savings because we estimate that the pre retrofit hours of operation are less than what was used in the Ex Ante analysis. Additionally we discovered that the customer will vacate the facility by the end of December 2004, eliminating the savings from the occupancy sensors for the foreseeable future.

It is unfortunate that we found discrepancies in the application regarding the connected lighting load, and a lack of differentiation of lighting hours of operation based on the type of area.

The amount of time allowed for this analysis was not adequate. An additional 32 hours would be required to devise and execute an measurement analysis to more accurately determine the energy savings associated with the occupancy sensors for these two large buildings. This site would have benefited from pre measurement.

Economic Information

An economic summary for the installation of the lighting efficiency and controls measures is shown in Table 5 below. An engineering realization rate calculation is shown in Table 6.

Impact Results

Table 5 Economic Summary of the Project

Description	Date	Project Cost	Estimated Demand Savings, kW	Estimated Energy Savings, kWh	Estimated Gas Savings, therms	Estimated Annual Cost Savings ($0.13/kWh), $	SPC Incentive, $	Simple Payback w/ incentive, yrs	Simple Payback w/o incentive, yrs
Application Submitted Amount	2/6/2003	$112,532	-	296,975	0	$38,607	$14,849	2.53	2.91
Application Approved Amount	3/5/2003	$112,532	-	119,370	0	$15,518	$5,969	6.87	7.25
Installation Approved Amount (Ex Ante)	8/12/2003	$112,532	-	119,370	0	$15,518	$5,969	6.87	7.25
SPC Program Review (Ex Post)	12/10/2004	$112,532	-	37,701	0	$4,901	$5,969	21.74	22.96

Table 6 Realization Rate Calculation

	KW	KWh	Therm
SPC Tracking System or Application	0	119,370	0
Adjusted Engineering	0	37,701	0
Engineering Realization Rate	NA	31.6%	NA

If we had not determined that the buildings will be vacated by the end of December 2004, the kWh realization rate would have been 75.8%.

Exhibit 1 Installation Verification Sheet

Measure Description	End-Use Category	HVAC Measure Description	Lighting Measure Description	Process Measure Description	Count	Equipment Description	Installation Verified (Explain)	Notes
LIGHTING CONTROLS	L		Install occupancy sensors.		NA	Watt Stopper occupancy sensors.	Physically verified the installation of sensors on two floors of two 150,000 ft2 buildings.	Customer vacating the buildings at the end of December 2004. Seems unlikely the buildings will be occupied in the near future.

SITE 19 IMPACT EVALUATION
SAMPLE CELL: ORIGINAL TIER: 3 END USE: LIGHTING

Measure	***Lighting controls and lighting efficiency***
Site Description	***Commercial Office***

Measure Description

De-lamp selected fixtures, group re-lamp with "Eco" 30 watt T-8 lamps, install occupancy sensor controls in selected areas.

Summary of Ex Ante Impact Calculations

Simple pre- and post-retrofit algorithm using fixture connected loads and hours of operation.

Comments on Ex Ante Calculations

The ex-ante savings were determined by creating a detailed pre and post retrofit lighting fixture inventory and calculating the change in lighting power based on fixture watts. Lighting energy use was calculated using estimated hours of operation, and reduction of the base hours for areas where the occupancy sensors were installed.

A detailed summary of the estimated pre and post retrofit operating hours for each type of area was not provided by the lighting contractor. The savings calculations are based on the assumption that all lights are on 5,000 hours annually before the retrofit and 5,000 hours annually after the retrofit, for all areas except those that have occupancy sensors installed. Post retrofit hours are assumed to be 3,500 in areas with occupancy sensors, a 30% reduction in annual operating hours. There is no differentiation of hours of operation and savings based on the type of area.

Pre and post retrofit calculations of lighting loads and energy use were generated using the following formula.

kW = Fixture Watts/1,000 w/kW x Fixture quantity
kWh = kW x Operating hours

Table 1 is shows the detailed ex ante lighting savings analysis and Table 2 is a summary of the savings analysis.

Note that the occupancy sensors are installed on fixture type A only.

Table 1 Ex Ante Savings Analysis

Pre retrofit

Fixture	Watts	Quantity	kW	Hours	kWh
A	90	254	22.9	5,000	114,300
B	90	516	46.4	5,000	232,200
C	90	36	3.2	5,000	16,200
D	59	45	2.7	5,000	13,275
E	59	16	0.9	5,000	4,720
F	112	21	2.4	5,000	11,760
G	59	114	6.7	5,000	33,630
H	59	5	0.3	5,000	1,475
I	109	34	3.7	5,000	18,530
Total		1,041	89.22		446,090

Post Retrofit

Fixture	Watts	Quantity	kW	Hours	kWh
A	51	254	13.0	3,500	45,339
B	51	516	26.3	5,000	131,580
C	77	36	2.8	5,000	13,860
D	27	45	1.2	5,000	6,075
E	51	16	0.8	5,000	4,080
F	51	21	1.1	5,000	5,355
G	31	114	3.5	5,000	17,670
H	59	5	0.3	5,000	1,475
I	58	34	2.0	5,000	9,860
Total		1,041	50.95		235,294

Table 2 Summary of the Ex Ante Savings Analysis

	Total kW	Annual kWh
Pre Retrofit	89.22	446,090
Post Retrofit	50.95	235,294
Savings	38.27	210,796

Evaluation Process

The evaluation process consists of a review of the application form and supporting documentation, conducting an on-site survey and interview with facilities personnel, and re-estimation of the lighting retrofit savings.

Evaluation of the lighting retrofit included a spot check of the fixture lamp type, number of lamps and a verification of the occupancy sensor installation for selected areas. Pre and post retrofit operating hours for the lighting system were reviewed in detail with the facility manager.

The facility representative stated that the facility is occupied approximately 16 hours per day, five days per week. Lights before and after the retrofit are controlled by a central lighting control system for all areas except those with occupancy sensors. The facility observes 8 holidays annually and lights are scheduled off on holidays by the lighting control system. During the site visit we obtained a copy of the lighting schedule for the circuits controlled by the central lighting control system. From the schedule we calculated the un-weighted annual average lighting hours to be 3,626. Table 3 shows the relay controlled, the daily and annual hours of operation . We were unable to determine the watts controlled by each relay, so we simply calculated the arithmetic average to estimate the average annual hours of operation for the lighting not controlled by occupancy sensors.

Table 3 Summary of Lighting Control System Schedules

Relay	hr/day	day/wk	wk/yr	Annual Hours
1	15.0	5	50.54	3,791
2	19.0	5	50.54	4,801
3	14.0	5	50.54	3,538
4	19.0	5	50.54	4,801
5	14.0	5	50.54	3,538
6	19.0	5	50.54	4,801
7	18.0	5	50.54	4,549
8	18.0	5	50.54	4,549
9	15.0	5	50.54	3,791
10	16.0	5	50.54	4,043
11	15.0	5	50.54	3,791
12	14.5	5	50.54	3,664
13	15.0	5	50.54	3,791
14	13.0	5	50.54	3,285
15	18.0	5	50.54	4,549
16	18.0	5	50.54	4,549
17	18.0	5	50.54	4,549
19	18.0	5	50.54	4,549
21	18.0	5	50.54	4,549
23	18.0	5	50.54	4,549
2-6	12.0	5	50.54	3,032
2-8	12.0	5	50.54	3,032
2-2	12.0	5	50.54	3,032
2-4	12.0	5	50.54	3,032
2-29	11.5	5	50.54	2,906
2-31	11.5	5	50.54	2,906
2-25	11.5	5	50.54	2,906
2-27	11.5	5	50.54	2,906
2-21	12.0	5	50.54	3,032
2-23	12.0	5	50.54	3,032
2-17	13.5	5	50.54	3,411
2-19	13.5	5	50.54	3,411
2-13	13.5	5	50.54	3,411
2-15	13.5	5	50.54	3,411
2-10	13.5	5	50.54	3,411
2-12	13.5	5	50.54	3,411
2-7	13.0	5	50.54	3,285
2-5	13.0	5	50.54	3,285
2-9	13.0	5	50.54	3,285
2-11	13.0	5	50.54	3,285
2-1	13.0	5	50.54	3,285
2-3	13.0	5	50.54	3,285
2-32	13.5	5	50.54	3,411
2-30	13.5	5	50.54	3,411
2-26	13.5	5	50.54	3,411
2-22	13.5	5	50.54	3,411
2-20	13.5	5	50.54	3,411
2-14	13.5	5	50.54	3,411
2-16	13.5	5	50.54	3,411
2-18	13.5	5	50.54	3,411
Average				3,626

8 holidays= 1.6 weeks off, 52.14-1.6=50.54 weeks

The facility representative estimated that 70% of the areas controlled by occupancy sensors are private offices. The remaining 30% are break rooms, copy rooms, restrooms and server rooms. We estimated that prior to the occupancy sensor retrofit, lights were on 9 hours per day, 5 days per week, 48.54 weeks per year in the private offices, and 24 hours per day 7 days per week 50.54 weeks per year in other areas. We weighted these two area types by the estimated percent of total area controlled by occupancy sensors to determine the pre retrofit hours of operation for the lighting fixtures now controlled by occupancy sensors. Using this method, we calculated the annual operation to be 4,076 hours for these areas. Table 4 is a summary of the estimated annual hours of operation before the retrofit for the areas now controlled by occupancy sensors.

Table 4 Pre Retrofit Hours of Operation Areas Now Controlled by Occupancy Sensors

Area	hr/day	day/wk	wk/yr	Annual Hours	Weight by Area	Weighted Hours
Private Office	9	5	48.54	2,184	70%	1,529
Other Areas	24	7	50.54	8,491	30%	2,547
Total						4,076

2 weeks vacation + 8 holidays= 3.6 weeks off 52.14-3.6=48.54 weeks
8 holidays= 1.6 weeks off, 52.14-1.6=50.54 weeks

The application does not contain a space by space lighting inventory that shows the pre and post retrofit lighting fixture count and the number of lamps for each fixture. Only gross totals of each fixture type are provided. We have accepted the gross fixture inventories which are the basis of the ex ante calculations, and recalculated the energy savings based on the hours of operation shown in Tables 3 and 4 above. For areas with occupancy sensors (fixture type A), we accepted the estimated 30% reduction in operating hours. Our calculations assume that Fixture type A operates an average of 4,076 hours annually before the retrofit and 2,853 hours annually after the retrofit. Fixture types B-I are assumed to operate 3,626 hours annually before and after the retrofit.

Pre and post retrofit calculations of lighting loads and energy use were generated using the following formula.

kW = Fixture Watts/1,000 w/kW x Fixture quantity
kWh = kW x Operating hours

Table 5 shows the detailed ex ante lighting savings analysis and Table 6 is a summary of the savings analysis.

Table 5 Ex Post Savings Analysis

Pre Retrofit

Fixture	Watts	Quantity	kW	Hours	kWh
A	90	254	22.9	4,076	93,183
B	90	516	46.4	3,626	168,403
C	90	36	3.2	3,626	11,749
D	59	45	2.7	3,626	9,628
E	59	16	0.9	3,626	3,423
F	112	21	2.4	3,626	8,529
G	59	114	6.7	3,626	24,390
H	59	5	0.3	3,626	1,070
I	109	34	3.7	3,626	13,439
Total		1,041	89.22		333,813

Post Retrofit

Fixture	Watts	Quantity	kW	Hours	kWh
A	51	254	13.0	2,853	36,962
B	51	516	26.3	3,626	95,428
C	77	36	2.8	3,626	10,052
D	27	45	1.2	3,626	4,406
E	51	16	0.8	3,626	2,959
F	51	21	1.1	3,626	3,884
G	31	114	3.5	3,626	12,815
H	59	5	0.3	3,626	1,070
I	58	34	2.0	3,626	7,151
Total		1,041	50.95		174,727

Table 6 Summary of the Ex Post Savings Analysis

	Total kW	Annual kWh
Pre Retrofit	89.22	333,813
Post Retrofit	50.95	174,727
Savings	38.27	159,086

Installation Verification

We confirmed the installation of occupancy sensors by spot checking both floors in the building, we verified that fixtures had been group re-lamped with 30 watt "eco" lamps and verified that many of the fixtures had been de-lamped. An installation verification summary is shown in Exhibit 1 below.

Scope of Impact Assessment

The impact evaluation includes the installation of lighting controls and lighting efficiency measures. These are the only measures for this SPC application.

Additional Notes

The Ex Post savings are less than the Ex Ante savings because we estimate that the pre and post retrofit hours of operation are less than what was used in the Ex Ante analysis.

The amount of time allowed for this analysis was adequate, and no additional time is necessary for this project.

Economic Information

An economic summary for the installation of the lighting efficiency and controls measures is shown in Table 7 below. An engineering realization rate calculation is shown in Table 8.

Impact Results

Table 7 Economic Summary of the Project

Description	Date	Project Cost	Estimated Demand Savings, kW	Estimated Energy Savings, kWh	Estimated Gas Savings, therms	Estimated Annual Cost Savings ($0.13/kWh) $	SPC Incentive, $	Simple Payback w/ incentive, yrs	Simple Payback w/o incentive, yrs
Application Submitted Amount	10/16/2003	$32,354	33	184,247	0	$23,952	$9,212	0.97	1.35
Application Approved Amount	12/5/2003	$32,354	38	210,796	0	$27,403	$10,540	0.80	1.18
Installation Approved Amount (Ex Ante)	2/9/2004	$32,354	38	210,796	0	$27,403	$10,540	0.80	1.18
SPC Program Review (Ex Post)	12/27/2004	$32,354	38	159,086	0	$20,681	$10,540	1.05	1.56

Table 8 Realization Rate Calculation

	KW	KWh	Therm
SPC Tracking System or Application	38	210,796	0
Adjusted Engineering	38	159,086	0
Engineering Realization Rate	100%	75.5%	NA

Exhibit 1 Installation Verification Sheet

Measure Description	End-Use Category	HVAC Measure Description	Lighting Measure Description	Process Measure Description	Count	Equipment Description	Installation Verified (Explain)	Notes
LIGHTING - OTHER	L		Delamp selected fixtures. Group relamp with "eco" 30 watt T-8s. Install occupancy sensors.		Did not count equipment.	"Eco" 30 watt lamps. Occupancy sensors.	Physically verified delamped fixtures, "Eco" lamps and occupancy sensors in selected areas.	

SITE 20 IMPACT EVALUATION
SAMPLE CELL: ORIGINAL   TIER: 1   END USE: HVAC & REFRIGERATION

Measure

Replaced open multi-deck and "coffin" style refrigerated and frozen food display cases with closed glass door cases.

Site Description

Supermarkets

Measure Description

Open multi-deck and coffin style refrigerated display cases were replaced by closed glass door cases in nine grocery stores. Glass door cases have about half the energy loss of open cases and therefore significantly reduce the refrigeration load required to keep product refrigerated or frozen. The refrigeration compressors were not modified.

Summary of Ex Ante Impact Calculations

The ex ante impacts were calculated using the manufacturers' specifications for btu/hr. losses of each case type. The losses for the open style cases are measured in btu/hr. per linear foot and the losses for the new cases are measured in btu/hr. per door. The reduction in btu/hr. losses was converted to energy savings using the rated performance of the refrigeration compressors. The ex ante impact calculations are shown in Table 4 below. The calculations are in two groups: 4 identical stores and another 5 identical stores.

Comments on Ex Ante Calculations

The ex ante impacts were estimated in a simplified manner. It is pointed out in the application that the interactive affect of the store HVAC load and the affect of a reduced load on the condenser fans was ignored. Also, the increase in energy use due to anti-sweat heaters installed on the new doors was not accounted for.

The impact on HVAC energy consumption could be substantial. Without the cold air escaping from the display cases to the store, the HVAC load increases. This effect would be very difficult to estimate due to the many factors that are involved. The mixing of the cool air to the entire store would be dependant on the physical layout of the store, the mixing of the air in the space, and the actual amount of air conditioning that would be utilized before and after the change.

For example, prior to the retrofit, areas of the store may have been "overcooled" by the refrigeration. When this excess cooling was eliminated by the installation of new glass door cases, the stores can maintained a warmer, more comfortable, temperature in those areas that were previously too cold. HVAC cooling is supplemented by the cooling escaping from the display cases.

Given the highly interactive nature of this project, a very detailed simulation model or long-term monitoring would be required to estimate the effects of these modifications on the HVAC, condenser fans, and anti-sweat heater energy consumption. The ex ante approach is a simplified method of evaluation for this project that chose to ignore some of the interactive aspects of the impact of the installation.

Evaluation Process The approach to verifying the claimed energy savings was to perform billing analysis for each of the nine stores. Information obtained during the initial interview with the corporate refrigeration supervisor directed the evaluation effort towards using billing analysis. According to the participant, the stores have not had other significant changes to the energy consumption other than the display case replacements and a lighting retrofit. Internal analysis done by the participant estimated that they are saving approximately 18% from the refrigeration project. This is more than the ex ante claimed savings.

The evaluation process included verification and operation of the equipment installed as well as investigation of the current operating parameters and changes to the facility energy use. On-site visits were carried out at three of the nine stores. The three stores represented the different regions where the nine stores were located. At each site, interviews were conducted with the manager as well as others who had worked at the location for many years. The interviews focused on identifying changes to the store since 2000 that would significantly affect the energy consumption. In addition, a complete survey of the retrofit lighting was obtained to determine the impact of that project. The results of the data collection are:

- 2 Packaged rooftop HVAC units were added to Store 118 near the entrance,
- 1 Packaged rooftop HVAC unit was added to Store 98 near the entrance,
- Refrigerated island type produce displays were added at one store. The impact is very minimal given that the produce is maintained at a relatively high temperature (55-65 °F),
- After 2000 a lighting retrofit was performed on all stores that included delamping half the lamps and retrofitting T12s to T8s on the sales floor. Impacts of the lighting retrofit were 7%, 10%, and 11% of the surveyed store's total energy consumption.

Energy consumption for 1999/2000 and 2003/2004 was provided by the facility representative for 8 of the 9 stores. The ex post billing analysis involved adjusting the baseline data to remove the impacts of changes other than the display case replacement. The following process was used in the analysis:

- We assumed that the lighting retrofit was the only project completed since the 1999/2000 base year utility bills that required adjustment in order to isolate the display case impacts.
- The lighting impact was calculated for the 3 stores in the evaluation on-site sample. The average savings as a percent of the total facility consumption (9%) was applied to the 5 stores not visited.
- The added HVAC load and anti-sweat heater load is accounted for in the billing analysis and is part of the display case measure.
- The added load of the produce island is too minimal to effect the results and was therefore ignored.
- Billing data was available for 8 of the 9 stores. The evaluation/ex ante realization rate for 8 stores was extrapolated to 9 stores.
- After adjusting for the lighting impacts the annual savings was calculated for each store as the 1999/2000 kWh per year minus the 2003/2004 kWh per year.

The evaluation analysis is shown in Table 5 below.

Installation Verification

On-site verification of the installed and operational measures was performed at three of the nine sites. The sites were spread out across the region. The number of glass freezer doors specified in the application was confirmed to be accurate at each of the three sites. Table 3 is a verification summary sheet.

Scope of Impact Assessment

The billing analysis method of evaluation provides less precise estimation of the impacts than modeling or monitoring. However, both of these approaches would have been very costly at nine sites or even a sample of the sites. The ex ante engineering estimate was reviewed and determined to be acceptable with a reasonable basis. Given that the billing analysis and the engineering estimates are relatively similar, we are fairly confident that the impacts of this project are being realized.

The evaluation was performed for the installation of new refrigerated and frozen food cases at nine supermarkets. This was the only measure for this SPC application.

Additional Notes

A more robust analysis of the energy impacts of this project could have been completed with significant effort. Such effort would include long term monitoring or a very detailed simulation model of a sample of the stores. Both of these methods would likely improve the accuracy of the estimated impacts. An additional 80 hours would be required for this effort.

Economic Information

An economic summary for the measures in the primary end use is shown in Table 1 below.

Table 1
Economic Summary Of The Project

File Financial Values	Date	Project Cost	Estimated Customer kW Savings	Estimated Customer Annual kWh Savings	Estimated Gas Savings, therms	Estimated Annual Cost Savings ($0.13/kWh) ($0.75/therms)	SPC Incentive, $	Simple Payback w/ Incentive, yrs.	Simple Payback w/o Incentive, yrs.
Application Submitted	04/01/2003	$4,000,000	233.0	2,039,250	0.0	$265,103	$285,495	15.1	14.0
Application Approved	07/31/2003	$3,600,000	212.8	1,862,567	0.0	$242,134	$260,759	14.9	13.8
Installation Approved (Ex Ante)	10/07/2003	$3,600,000	212.8	1,862,567	0.0	$242,134	$260,759	14.9	13.8
SPC Impact Evaluation (Ex Post)	01/07/2005	$3,600,000	235.8	2,065,469	0.0	$268,511	$260,759	13.4	12.4

Table 2
Impact Results

	KW	KWh	Therm
SPC Tracking System or Application (Ex Ante)	212.8	1,862,567	0
Adjusted Engineering (Ex Post)	235.8	2,065,469	0
Engineering Realization Rate	1.11	1.11	N/A

Table 3
Project Verification Sheet

Measure Description	End-Use Category	HVAC Measure Description	Count	Equipment Description	Installation Verified (Explain)	Notes
Refrigeration	H	Coffin /Mulitdeck Freezers replaced with glass door freezers.	0			This store was removed from the application bc/ it was completed prior to applying for the SPC incentive.
Refrigeration	H	Coffin /Mulitdeck Freezers replaced with glass door freezers.	76	Hussmann RIFF Glass door Freezers	All equipment was installed as indicated in the project file at sampled locations.	Verified the quantity of new freezer glass doors at sample of stores.
Refrigeration	H	Coffin /Mulitdeck Freezers replaced with glass door freezers.	76	Hussmann RIFF Glass door Freezers	All equipment was installed as indicated in the project file at sampled locations.	Verified the quantity of new freezer glass doors at sample of stores.
Refrigeration	H	Coffin /Mulitdeck Freezers replaced with glass door freezers.	76	Hussmann RIFF Glass door Freezers	All equipment was installed as indicated in the project file at sampled locations.	Verified the quantity of new freezer glass doors at sample of stores.
Refrigeration	H	Coffin /Mulitdeck Freezers replaced with glass door freezers.	76	Hussmann RIFF Glass door Freezers	All equipment was installed as indicated in the project file at sampled locations.	Verified the quantity of new freezer glass doors at sample of stores.
Refrigeration	H	Coffin /Mulitdeck Freezers replaced with glass door freezers.	94	Hussmann RIFF Glass door Freezers	All equipment was installed as indicated in the project file at sampled locations.	Verified the quantity of new freezer glass doors at sample of stores.
Refrigeration	H	Coffin /Mulitdeck Freezers replaced with glass door freezers.	94	Hussmann RIFF Glass door Freezers	All equipment was installed as indicated in the project file at sampled locations.	Verified the quantity of new freezer glass doors at sample of stores.
Refrigeration	H	Coffin /Mulitdeck Freezers replaced with glass door freezers.	94	Hussmann RIFF Glass door Freezers	All equipment was installed as indicated in the project file at sampled locations.	Verified the quantity of new freezer glass doors at sample of stores.
Refrigeration	H	Coffin /Mulitdeck Freezers replaced with glass door freezers.	94	Hussmann RIFF Glass door Freezers	All equipment was installed as indicated in the project file at sampled locations.	Verified the quantity of new freezer glass doors at sample of stores.
Refrigeration	H	Coffin /Mulitdeck Freezers replaced with glass door freezers.	94	Hussmann RIFF Glass door Freezers	All equipment was installed as indicated in the project file at sampled locations.	Verified the quantity of new freezer glass doors at sample of stores.

Table 4
Ex Ante Impact Calculations

Pre	***Stores***	***73, 74, 79, 83***								
System	Case Style	Make/Model	Case Length	SST F	Btu/h-ft.	Btu/h	Compressor	Watt-h/Btu	kW	kWh/yr.
7	Coffin Freezer	Tyler LF_LFS Frozen	44	-30	410	18,040	9RS-0765	0.219	3.9	34,548
8	Coffin Freezer	Tyler LF_LFS Frozen	44	-30	410	18,040	9RS-0765	0.219	3.9	34,548
9	Open Multideck	Tyler L6F- Frozen	24	-20	1742	41,808	9RS-0765	0.198	8.3	72,515
10	Open Multideck	Tyler L6F- Frozen	24	-20	1742	41,808	9RS-0765	0.198	8.3	72,515
11	Open Multideck	Tyler L6F- Frozen	24	-20	1742	41,808	9RS-0765	0.198	8.3	72,515
12	Open Multideck	Tyler L6F- Frozen	24	-20	1742	41,808	9RS-0765	0.198	8.3	72,515
						203,312			41.0	359,156
Post										
System	Case Style	Make/Model	# of Doors	SST F	Btu/h-door	Btu/h	Compressor	Watt-h/Btu	kW	kWh/yr.
7	Glass Door Freez	Hussmann RIFF	19	-23	1350	25,650	9RS-0765	0.203	5.2	45,619
8	Glass Door Freez	Hussmann RIFF	21	-23	1350	28,350	9RS-0765	0.203	5.8	50,421
9	Glass Door Freez	Hussmann RIFF	19	-23	1350	25,650	9RS-0765	0.203	5.2	45,619
10	Glass Door Freez	Hussmann RIFF	17	-23	1350	22,950	9RS-0765	0.203	4.7	40,817
						102,600			20.8	182,475
Savings per Store						100,712			20.2	176,681

Pre	***Stores***	***84, 95, 97, 98, 118***								
System	Case Style	Make/Model	Case Length	SST F	Btu/h-ft.	Btu/h	Compressor	Watt-h/Btu	kW	kWh/yr.
7	Coffin Freezer	Tyler LF_LFS Frozen	54	-30	410	22,140	9RS-0765	0.219	4.8	42,400
8	Coffin Freezer	Tyler LF_LFS Frozen	62	-30	410	25,420	9RS-0765	0.219	5.6	48,681
9	Open Multideck	Tyler L6F- Frozen	36	-20	1742	62,712	4RL-1550	0.204	12.8	111,838
10	Open Multideck	Tyler L6F- Frozen	36	-20	1742	62,712	4RL-1550	0.204	12.8	111,838
11	Open Multideck	Tyler L6F- Frozen	24	-20	1742	41,808	9RS-0765	0.198	8.3	72,515
12	Open Multideck	Tyler L6F- Frozen	24	-20	1742	41,808	9RS-0765	0.198	8.3	72,515
						256,600			52.5	459,787
Post										
System	Case Style	Make/Model	# of Doors	SST F	Btu/h-door	Btu/h	Compressor	Watt-h/Btu	kW	kWh/yr.
7	Glass Door Freez	Hussmann RIFF	24	-23	1350	32,400	4RL-1550	0.208	6.7	59,088
8	Glass Door Freez	Hussmann RIFF	24	-23	1350	32,400	4RL-1550	0.208	6.7	59,088
9	Glass Door Freez	Hussmann RIFF	23	-23	1350	31,050	9RS-0765	0.203	6.3	55,222
10	Glass Door Freez	Hussmann RIFF	23	-23	1350	31,050	9RS-0765	0.203	6.3	55,222
						126,900			26.1	228,621
Savings per Store						129,700			26.4	231,167

Total Savings		# Stores	kW	kWh/yr.
	Store Type A	4	80.7	706,725
	Store Type B	5	131.9	1,155,833
	Total	9	212.6	1,862,558

Table 5
Evaluation Billing Analysis

Store #	1999/2000 Energy kWh/yr	Lighting Retrofit Energy kWh/yr	Baseline Energy kWh/yr	2003/2004 Energy kWh/yr	Bill History Savings kWh/yr	Ex Ante Savings kWh/yr	Avg. Demand kW	Ex Ante Savings kW
73	1,492,796	135,795	1,357,001	1,030,108	326,893	176,683	37.3	20.2
74	1,545,545	140,593	1,404,952	1,208,105	196,847	176,683	22.5	20.2
83	1,741,910	158,456	1,583,454	1,270,653	312,801	176,683	35.7	20.2
94	1,783,904	162,276	1,621,628	1,454,971	166,657	231,167	19.0	26.4
95	1,652,370	108,587	1,543,783	1,331,101	212,682	231,167	24.3	26.4
97	1,631,165	148,382	1,482,783	1,276,539	206,244	231,167	23.5	26.4
98	1,721,251	183,278	1,537,973	1,414,040	123,933	231,167	14.1	26.4
118	1,931,367	194,499	1,736,868	1,413,385	323,483	231,167	36.9	26.4
79	no data	no data	no data	no data	no data	176,683	no data	20.2
					1,869,539	1,685,884	213	193
	Average Lighting Adjustment			Realization for 8 stores		111%		111%
		9.1%						
						kWh/yr.		kW
				Total Ex Ante		1,862,567		213
				Total Eval		2,065,469		236

After 2000 they did a lighting retrofit that reduced the energy use 9%. Delamped half the lamps and installed T8s.
The lighting impact was calculated for the 3 stores in the evaluation on-site sample. The average savings as a percent of the total facility consumption was applied to the 5 stores not visited.

Billing data not available for store 79. The evaluation/ex ante realization rate for 8 stores was extrapolated to 9 stores.

Additional produce coolers were added to some stores.

Additional HVAC was added to Store 98 and 118.

SITE 21 IMPACT EVALUATION
SAMPLE CELL: ORIGINAL   TIER: 1   END USE: HVAC

Measure	Install high efficiency HVAC units, HVAC controls, high efficiency lighting, and lighting controls at 12 schools
Site Description	Elementary, Middle and High Schools

Measure Description

Each school received a complete lighting retrofit with two schools receiving additional lighting controls. Each school also received high efficiency packaged units with economizers and new HVAC controls. One high school installed a high efficiency motor for heat vents in the gymnasium.

Summary of Ex Ante Impact Calculations

The measure savings were all calculated using the SPC software. The inputs for the lighting measures were fixture wattage and hours of operation. For schools with packaged units, the inputs were unit efficiency, size and the hours of operation. The premium efficiency motor measure was calculated by estimating a 15-hp motor that operates 3,000 hours per year. The savings come from replacing a baseline motor that was 91% efficient with a motor that is 92.4% efficient. Controls savings were calculated from the proposed system efficiency and the difference between the baseline and proposed hours of operation.

Comments on Ex Ante Calculations

The SPC software provides an estimate of the savings for each of the measures. The input power and hours of operation for each measure appear reasonable and consistent with observations from the site survey.

Evaluation Process

The evaluation process consisted of a review of the application forms and supporting documentation as well as conducting an on-site survey of a middle school and two high schools. These sites contributed approximately 40% of the total energy savings for the application.

The on-site survey was conducted on January 29, 2004. The survey focused on the lighting and controls measures. A sample of rooms were inspected to determine if the lighting was consistent with the application. The rooms inspected also received occupancy sensors for the lights and HVAC sensors installed on all exterior doors. The door sensors disable the HVAC units for the rooms whenever the doors are open for a period of time.

The typical schedule for the high school is 8 AM to 5 PM Monday through Friday. The school is not in session during the summer, but has summer school that occupies roughly half the school and lasts approximately 8 weeks. The school is off for 2 weeks at Christmas, 2 weeks in spring and 2 and 1/2 months in the summer.

Based on the site audits, all the schools visited showed good agreement with the application savings. The only discrepancy noted was that the gymnasium at the high school was actually retrofit with high output T-5 lamps instead of the submitted 320-watt pulse start metal halides. The 6-lamp T-5 high output fixtures installed have an input wattage of approximately 351 watts, which is less than the 368 watts submitted for the metal halides. Therefore, the savings estimate is slightly conservative, since the number of fixtures was the same.

Installation Verification

We physically verified the installation of three measures at three sites. An installation verification summary is shown in Exhibit 1 below.

Scope of Impact Assessment

The total project, involving twelve sites with one to four measures per site was reviewed for reasonableness. The on-site survey focused on three schools and three measures. The primary end use for this applicatiion is HVAC.

Additional Notes

The review of this project involved onsite verification of the measures installed. The only discrepancy noted between the application and the site survey resulted in a very slight (less than 1%) increase in energy savings. Since this means the estimated savings are conservative, no adjustment to the savings was made.

An attempt to estimate savings for the high school through billing analysis was also performed, but the results of this analysis were inconclusive.

Economic Information

An economic summary for the HVAC measures in the project is shown in Table 1 below. An engineering realization rate calculation for the HVAC measures is shown in Table 2.

Impact Results

Table 1 Economic Summary of the Project HVAC Measures Only

Description	Date	Project Cost	Estimated Demand Savings, kW	Estimated Energy Savings, kWh	Estimated Gas Savings, therms	Estimated Annual Cost Savings ($0.13/kWh), $	SPC Incentive, $	Simple Payback w/ incentive, yrs	Simple Payback w/o incentive, yrs
Application Submitted Amount	6/19/2002	$1,069,296	151.0	1,088,820	0	$141,547	$90,902	6.91	7.55
Application Approved Amount		$1,069,296	151.0	1,088,820	0	$141,547	$90,902	6.91	7.55
Installation Approved Amount (Ex Ante)	9/10/2003	$1,069,296	151.0	1,088,820	0	$141,547	$90,902	6.91	7.55
SPC Program Review (Ex Post)	8/31/2004	$1,069,296	151.0	1,088,820	0	$141,547	$90,902	6.91	7.55

Table 2 Realization Rate Calculation HVAC Measures Only

	KW	KWh	Therm
SPC Tracking System or Application	151	1,088,820	0
Adjusted Engineering	151	1,088,820	0
Engineering Realization Rate	100%	100%	N/A

Exhibit 1 Installation Verification Sheet

Measure Description	Target End-Use	HVAC Measure Description	Lighting Measure Description	Process Measure Description	Count	Equipment Description	Installation Verified (Explain)	Notes
New Economizers	L	Install new economizers.			12 schools	Economizers and controls.	Verified the installation in 3 of 12 schools.	
Classroom AC replacement	L	Replace rooftop packaged AC units.			12 schools	High efficiency rooftop packed units.	Verified the installation in 3 of 12 schools.	
Lighting Replacement	L		Lighting efficiency upgrades.		12 schools	T-5, T-8 and HID Lighting retrofits.	Verified the installation in 3 of 12 schools.	
Install EMS	L			Energy amangement system installation.	12 schools	Install EMS on AC units.	Verified the installation in 3 of 12 schools.	

SITE 22 IMPACT EVALUATION
SAMPLE CELL: ORIGINAL TIER: 2 END USE: HVAC

Measure	***Install Energy Management System***
Site Description	***Vacation Time Share Units***

Measure Description

Install an energy management system that sets back the thermostat controlling the space temperature when the apartment unit is unoccupied or vacant.

Summary of Ex Ante Impact Calculations

An energy management system was installed to control the air conditioning unit and some of the lighting in each apartment. Upon entering an apartment unit, a guest inserts a room key into the master wall control switch. This triggers a radio frequency transmitter that sets the energy management system to the "occupied mode". In the occupied mode, the guest has full control over the space temperature set point. If the patio sliding glass door is opened, a door sensor sends a signal and the apartment air conditioning unit in turned off. When the guest removes the room key and leaves the apartment, the energy management system takes control of the air conditioning unit thermostat and adjusts the space temperature to 80 °F if the unit is left in the cooling mode, and to 60 °F if the unit is left in the heating mode.

The Ex ante calculations were performed using an eQuest simulation. The simulation was performed for a typical 950 ft^2 unit for three different scenarios that are briefly described below:

Scenario 1: Baseline
This scenario calculates the energy consumption of the apartments for a full year assuming that the air conditioning units are enabled continuously whether the unit is occupied, unoccupied or vacant. The documentation states that the space temperature set point would be 72 °F.

Scenario 2: Occupied - Energy Management System Installed
This scenario calculates the energy consumption of the apartments assuming that the units are occupied for a full year and that the air conditioning units are enabled continuously. Occupancy is assumed to be from 7 PM to 7 AM. The documentation states that the space temperature set point would be 72 °F when occupied. When the unit is unoccupied, the assumption is that the air conditioning unit has been left in the auto mode, and the energy management system takes control of the unit thermostat and adjusts the space temperature to 80 °F if the unit is left in the cooling mode, and 60 °F if the unit is left in the heating mode.

Scenario 3: Vacant - Energy Management System Installed
This scenario calculates the energy consumption of the apartments assuming that the units are vacant for a full year. When the apartments are vacant, the air conditioning units have been left in the auto mode, and the energy management system takes control of the unit thermostat and adjusts the space temperature to 80 °F if the unit is left in the cooling mode, and 60 °F if the unit is left in the heating mode.

The project sponsor then subtracted the energy consumption of Scenario 2 from Scenario 1 to estimate how much energy would be saved by the energy management system if the property was occupied for a full year, and then multiplied the result by the assumed occupancy rate for the property to determine the savings when occupied.

Similarly, Scenario 3 was subtracted from Scenario 1 to estimate how much energy would be saved by the energy management system if the property was vacant for a full year and then multiplied the result by the assumed vacancy rate for the property to determine the savings when vacant.

The results were added together and the sum is the expected savings for the measure. The occupancy rate is assumed to be 60%, and the vacancy rate is 40%.

KWh_{saved} = Occupancy % x(Scenario 1- Scenario 2) + Vacancy % x (Scenario 1- Scenario 3)

The application reviewer accepted the calculation methodology but did make some changes to the assumptions used in the eQuest simulations. The project application documents that the kW/ton for the reciprocating chillers was changed from 0.84 kW/ton to 0.9375 kW/ton, the occupied temperature setpoint was changed from 70 °F to 72 °F, plug loads were added at a value of 0.31w/ft^2, lighting loads were added at a value of 0.35w/$ft^2$and some other values were adjusted. The project sponsor estimated that before accounting for occupancy, 40% of the energy savings would occur in scenario 2 and 60% would occur in scenario 3. Table 1 is a summary of the Ex Ante Savings that include the changes to the eQuest simulation made by the application reviewer.

Table 1 Summary of the Ex Ante Savings

	kW	kWh
Energy Management System	155	632,020

Comments on Ex Ante Calculations

The inputs for the eQuest simulation were not provided. Some of the inputs are discussed in the application review and installation review, and it appears that the reviewers did a thorough job of assessing the accuracy of the physical parameters used in the eQuest model.

The energy savings are based upon assumptions of guest and management behavior before and after the retrofit. The savings are based on the premise that the guests and management leave the air conditioning units on continuously, when the space is occupied, unoccupied or vacant. There is no consideration for seasonality in this assumption- that perhaps in Spring or Fall the occupant or management may decide to turn the air conditioning off some or all of the time, or the possibility that facility housekeeping may set back the thermostats when the units are vacant.

The original installation report was completed in June 2003. In December 2003 a revised installation report was issued. The original installation report did not claim any demand kW savings. The revised installation report approved demand savings of 154.5 kW. It is unknown what prompted a review of this project nearly 6 months after the original approval.

The eQuest model assumes that when rented, each unit is continuously unoccupied 7 AM to 7 PM (12 hours). The unoccupied period coincides with the peak electrical demand period. Since this is a time share it seems that some guests, especially the elderly or those with children, may not be away for such a long continuous period. Considering that there are 260 apartments, it is unlikely that all units will be unoccupied or vacant continuously for 12 hours daily.

The premise of the HVAC energy savings claim is that an apartment will use less energy when the thermostat is reset from 72 °F to 80 °F. Assuming a guest vacates their apartment at 7 AM, the space temperature would rise to 80 °F before the air conditioning unit comes on. After that point the unit would remain on as long as the thermostat is above 80 °F. When a guest returned to the apartment and set the thermostat to 72 °F, the air conditioning unit would run to bring the space temperature down to 72 °F.

Also it is possible to defeat the energy management system. Guests are offered more than one room key, and could conceivably leave one key in the energy management system controller when they leave the space, thereby keeping the system in the occupied mode.

The issues raised above render the demand savings claim questionable. However the budget allowed for this project does not afford enough time to further explore the premise of the savings claim as it impacts peak demand savings.

Evaluation Process

The evaluation process consists of a review of the application form and supporting documentation, conducting an on-site survey and then computing impacts using the data collected on site.

The site survey was conducted on November 19, 2004. Information on the energy management system was collected by interviewing the facility representative and verifying the operation of the system. We also obtained 12 months of occupancy data from the facility representative.

Data obtained from the site visit indicates that the occupancy rate is different than what was used in the Ex Ante savings analysis. The Ex Ante savings analysis and the sponsor submitted savings analysis assume that the occupancy rate is 60% and the vacancy rate is 40%. Data from the site visit indicates that for the past 12 months, the occupancy rate was approximately 78.5%. Table 2 is a summary of the monthly occupancy data and the weighted average occupancy for the past 12 months.

Table 2 Occupancy Data

Month	% Occupied	Days	Weight
Oct '04	85.0%	31	26.4
Sept '04	80.0%	30	24.0
Aug '04	96.0%	31	29.8
July '04	94.0%	31	29.1
June '04	89.0%	30	26.7
May '04	79.0%	31	24.5
Apr '04	85.0%	30	25.5
Mar '04	81.0%	31	25.1
Feb '04	66.0%	28	18.5
Jan '04	52.0%	31	16.1
Dec '03	55.0%	31	17.1
Nov '03	80.0%	30	24.0
Total		365	286.7
Average			78.5%

Table 3 summarizes the results of the eQuest analysis submitted by the project sponsor.

Table 3 Results of Sponsor Submitted e Quest Analysis

Scenario		eQuest* kWh	Occupancy %	Vacancy %	Savings kWh
2	Occupied Savings	576,960	60%		346,176
3	Vacant Savings	857,960		40%	343,184
	Total	1,434,920			689,360

* Total annual savings calculated from the eQuest simulation.

The reviewer made some changes to the input of the eQuest analysis as described above and recalculated the Ex Ante energy savings to be 632,020 kWh annually. Unfortunately, we did not receive the reviewer's revised breakdown of the energy consumption associated with each scenario. To estimate the savings associated with each scenario, we have assumed that the savings for each scenario are proportional to the ratio of the Ex Ante savings and the sponsor submitted savings. The Ex Ante savings associated with each scenario were calculated as follows:

Ex Ante Savings

$kWh_{scenario2}$=

Sponsor $kWh_{scenario2}$ x Ex Ante Total kWh Savings /Sponsor Total kWh Savings

$kWh_{scenario2}$= 576,960x 632,020 /689,360

$kWh_{scenario2}$= 528,969 kWh

$kWh_{scenario3}$=

Sponsor $kWh_{scenario3}$ x Ex Ante Total kWh Savings /Sponsor Total kWh Savings

$kWh_{scenario3}$= 857,960x 632,020 /689,360

$kWh_{scenario3}$= 786,596 kWh

Table 4 is a summary of the Ex Ante Savings calculated by the proportional method above.

Table 4 Summary of the Ex Ante Saving Analysis

Scenario		eQuest* kWh	Occupancy %	Vacancy %	Savings kWh
2	Occupied Savings	528,969	60%		317,382
3	Vacant Savings	786,596		40%	314,638
	Total	1,315,565			632,020

* Total annual savings calculated from the eQuest simulation extrapolated from Sponsor submitted data.

We calculated the Ex Post savings based on the occupancy rates obtained from the facility representative and the annual Ex Ante energy savings determined for each scenario shown in Table 4 above using the following formula:

KWh_{saved} = Occupancy % x Scenario 2 Annual Savings + Vacancy % x Scenario 3 Annual Savings

Table 5 is a summary of the Ex Post savings analysis without adjustment for the quantity of units controlled by the energy management system.

Table 5 Ex Post Savings Without Room Quantity Adjustment

Scenario		eQuest* kWh	Occupancy %	Vacancy %	Savings kWh
2	Occupied Savings	528,969	78.5%		415,494
3	Vacant Savings	786,596		21.5%	168,741
	Total	1,315,565			584,236

* Total annual savings calculated from the eQuest simulation extrapolated from Sponsor submitted data.

The Ex Ante calculations are based on the installation of the energy management system in 264 units. During the site visit the facility representative stated that the energy management system is installed in 260 units. We have proportionally reduced the energy savings calculated in Table 5 by multiplying the result by 98.5% which is the ratio of 260 units/264 units. Table 6 is a summary of the Ex Post Savings adjusted for the correct quantity of units controlled by the energy management system.

Table 6 Ex Post Savings Summary, Corrected for Unit Quantity

	kW	kWh
Energy Management System	NA	575,383

Based on the discussion in the "Comments on the Ex Ante Calculations" above, we have elected to set the kW to "NA."

Installation Verification

We confirmed the installation of the energy management system in 260 apartment units with the facility representative. We verified the operation of the system in one unit. A verification summary is shown in Exhibit 1 below.

Scope of Impact Assessment

The impact evaluation includes the installation the energy management system for the air conditioning units. The energy management system also controls a limited amount of lighting. Control of the lighting was not evaluated.

Additional Notes

The Ex Post savings are less than the Ex Ante savings because the occupancy rate is higher than what was used to calculate the Ex Ante savings. The eQuest simulation indicates that savings are greater during vacant periods than occupied periods, so decreasing the portion of vacant time, decreases the savings estimate. Additionally we identified a slight discrepancy in the number of apartments that have the energy management system installed. The Ex Ante calculations are based on the installation of the energy management system in 264 units. During the site visit the facility representative stated that the energy management system is installed in 260 units. We proportionally reduced the energy savings calculated in Table 5 by multiplying the result by 98.5% which is the ratio of 260 units/264 units.

The amount of time allowed for this site was not adequate to accurately determine the savings associated with this project. There are far too many assumptions about the occupied hours and the behavior of the occupants and management which form the basis of the savings calculations. Long term monitoring would be required to more accurately verify the savings associated with this project. We estimate an additional 40 hours plus the rental of logging equipment would be required to complete this task.

Economic Information

An economic summary for the installation of the energy management system controlling the air conditioning units is shown in Table 7 below. An engineering realization rate calculation is shown in Table 8.

Impact Results

Table 7 Economic Summary of the Project

Description	Date	Project Cost	Estimated Demand Savings, kW	Estimated Energy Savings, kWh	Estimated Gas Savings, therms	Estimated Annual Cost Savings ($0.13/kWh), $	SPC Incentive, $	Simple Payback w/ incentive, yrs	Simple Payback w/o incentive, yrs
Application Submitted Amount	2/24/2003	$88,440	-	689,360	0	$89,617	$44,220	0.49	0.99
Application Approved Amount	4/3/2003	$88,440	-	632,020	0	$82,163	$44,220	0.54	1.08
Installation Approved Amount (Ex Ante)	12/9/2003	$88,440	154.5	632,020	0	$82,163	$44,220	0.54	1.08
SPC Program Review (Ex Post)	12/8/2004	$88,440	NA	575,383	0	$74,800	$44,220	0.59	1.18

Table 8 Realization Rate Calculation

	KW	KWh	Therm
SPC Tracking System or Application	154.5	632,020	0
Adjusted Engineering	NA	575,383	0
Engineering Realization Rate	NA	91.0%	NA

Based on the discussion in the “Comments on the Ex Ante Calculations” above, we have elected to set the kW realization rate to “NA.”

Exhibit 1 Installation Verification Sheet

End-Use Category	HVAC Measure Description	Lighting Measure Description	Process Measure Description	Count	Equipment Description	Installation Verified (Explain)	Notes
L		Install energy management system that turns off selected lights when the unit is unoccupied or vacant.		260	Room key activated radio frequency transmitter that controls the energy management system "occupied" and "unoccupied" modes.	Installation verified in one room. Facility representative verified that 260 units have EMS installed.	
H	Install energy management system that sets back the thermostat controlling the space temperature when the unit is unoccupied or vacant.			260	Room key activated radio frequency transmitter that controls the energy management system "occupied" and "unoccupied" modes.	Installation verified in one room. Facility representative verified that 260 units have EMS installed.	

SITE 23- IMPACT EVALUATION
SAMPLE CELL: ORIGINAL TIER: 2 END USE: HVAC & REFRIGERATION

Measure

Replaced evaporative condensers with more efficient and oversized evaporative condensers. The evaporative condensers serve the facility's refrigeration plant.

Site Description

Food Processing and Refrigerated Storage Facility

Measure Description

New oversized evaporative condensers replaced the existing evaporative condensers. The new condensers provide more heat rejection thus allowing the ammonia refrigeration plant to operate more efficiently. The compressor plant now operates with a discharge temperature in the low 70's °F where it was in the low 90's °F before the project. The compressor plant consists of three ammonia compressors. The low temperature (-40°F suction temp.) accumulator is served by a 250-horsepower compressor. The medium temperature (25°F suction temp.) accumulator is served by a 250-horsepower and a 200-horsepower compressor.

Summary of Ex Ante Impact Calculations

A very robust impact calculation was provided by the customer. The spreadsheet model was calibrated with the results of short term monitoring of the refrigeration load in October 1999. The model estimated the energy consumption of the refrigeration plant, including compressors and condensers, and predicted the energy consumption of the plant with the new condensers. The model is an annual hourly calculation that utilizes the performance tables of the compressors to determine the capacity and brake horsepower of each compressor at the specified suction and discharge temperatures. A sample of the ex ante model is provided in Tables 5, 6, 7, and 8 below. A summary of the existing and proposed energy usage and savings generated by the model are shown below in Table 1.

Table 1
Ex Ante Results

	Condenser Energy	Compressor Energy	Total Energy	Max kW
Existing	221,425	1,994,788	2,216,213	326.7
Proposed	239,940	2,745,387	2,985,327	445.1
Savings	**18,514**	**750,599**	**769,114**	**118.4**

Comments on Ex Ante Calculations

The ex ante calculation was performed with a very detailed model. We reviewed the model and conclude that it was a good prediction of the project impacts. A shortcoming of the model is that it is based on a load profile that was developed from short term monitoring that may not represent the annual loads of the facility. The monitoring data did not show any correlation to ambient weather conditions. Therefore the weekday and weekend average monitored load was applied to each week of the annual model.

If the refrigeration load were actually consistent week to week throughout the year the model would be an accurate estimate of the impacts. However, it appears that the facility load is extremely variable month to month and is dependant upon customer orders that affect the amount of product produced and refrigerated.

Given that the model provides a solid calculation methodology, it can be assumed that the impact estimate is only a good as the accuracy of the annual load profile. With the lack of a more accurate manner in which to extrapolate the short term measure load profile, the linear method used was a reasonable approach.

Evaluation Process

The evaluation process included verification of the equipment installed as well as investigation of the current operating parameters and changes to the facility energy use.

The refrigeration energy use accounts for greater than 80 percent of the total facility consumption. Therefore, it was expected that the reduction in energy consumption should be identifiable in the billing history prior to and following the installation of the new condensers. Given this approach, billing history was obtained from 1999 through 2004. Fifteen-minute interval data was downloaded from the customers Silicon Energy (SCE) Energy Manager on-line account for the period of March 2003 through December 2004. Prior to March 2003 the facility was under a prior ownership and the data was not immediately available. Monthly data was obtained from the utility going back to 1999.

Weather sensitivity should be identifiable in the billing history if it were a major factor. From review of the facility billing history it appears that the facility is not highly sensitive to changes in the weather.

On-site the evaluation efforts concentrated on quantifying changes to the facility and/or production that had significantly effected energy consumption. This was done primarily by interview with the plant facilities manager and visual inspection. In general the plant operations have remained the same since the installation of the new condensers. Some additional refrigeration evaporator coils have been added to the low temperature side, but they were added as "pre-coolers" to product that was originally frozen. The new coil cools hot food on a conveyor belt prior to going into a freezer. The coil was installed to remove as much steam prior to the freezer to reduce frost build-up. Overall, the net effect on the refrigeration plant is not likely more than an increase of 5-7%. It is estimated that the added load to the refrigeration plant has been no more than five percent. Production obviously has a large impact on the energy consumption of the facility and refrigeration plant. Production records were not available for the evaluation. However, the plant facilities manager indicated that production from 2000 to present has not changed significantly on an annual basis.

An analysis of the billing data before and after the new condensers were installed was performed to identify the reduction in energy use. Billing records show a decrease in energy use of nearly 670,000 kWh per year without adjustments made for any increase in load following the installation. When a 5% increase in post installation energy use is deducted from the post installation data (to account for the new refrigeration coils) the results of the billing analysis are nearly 840,000 kWh per year. Therefore, the conclusion of the evaluation is that the ex ante estimates were reasonably accurate and do not require adjustment from the evaluation effort. The billing data and analysis is shown in Tables 10 and 11 below.

Installation Verification The new condensers were verified to be installed and operational. The condensers are Baltimore Aircoil model number CXV 337. The other equipment specified in the file, and used for the ex ante calculations, was also verified.

Scope of Impact Assessment The new condensers were the only measure implemented by this customer. The evaluation assessed the entire project.

Additional Notes The effort applied to developing the ex ante estimates was very robust and the evaluation budget and timeline did not allow for post monitoring of the refrigeration system directly to measure the savings. Monitoring the system and accounting for all the variables that apply to refrigeration would have required a substantial evaluation effort. To do this we estimate that an additional requirement of 40 hours would have been needed.

Economic Information An economic summary for the measures in the primary end use is shown in Table 1 below.

Table 2
Economic Summary Of The Project

File Financial Values	Date	Project Cost	Estimated Customer kW Savings	Estimated Customer Annual kWh Savings	Estimated Gas Savings, therms	Estimated Annual Cost Savings ($0.13/kWh) ($0.75/therms)	SPC Incentive, $	Simple Payback w/ Incentive, yrs.	Simple Payback w/o Incentive, yrs.
Application Submitted	02/20/2003	$148,000	126.0	808,485	0.0	$105,103	$64,678	1.4	0.8
Application Approved	05/05/2003	$148,000	118.4	769,114	0.0	$99,985	$74,000	1.5	0.7
Installation Approved (Ex Ante)	04/15/2003	$148,000	118.4	769,114	0.0	$99,985	$74,000	1.5	0.7
SPC Impact Evaluation (Ex Post)	01/07/2005	$148,000	118.4	769,114	0.0	$99,985	$74,000	1.5	0.7

Table 3
Impact Results

	KW	KWh	Therm
SPC Tracking System or Application (Ex Ante)	118.4	769,114	0
Adjusted Engineering (Ex Post)	118.4	769,114	0
Engineering Realization Rate	1.00	1.00	NA

Table 4
Project Verification Sheet

Measure Description	End-Use Category	HVAC Measure Description	Count	Equipment Description	Installation Verified (Explain)	Notes
Install new evaporative condensers.	H	Install new evaporative condensers with higher capacity on an ammonia refrigeration system	2	New oversized evaporative condensers were installed. BAC model CXV 337	Visually verified the new condensers and checked the make and model number.	

Table 5
Ex Ante Model (Sample) – Existing Energy Use

Date & Time	Dry Bulb	Wet Bulb	$Load_{-40}$ Load in terms of tons refrig. (TR) of low temp system	$Load_{25}$ Load in terms of tons refrig. (TR) of med. temp system	Comp3 Load % of compressor full load capacity	Sat. Int. Temp	Comp3 HP % of BHP at given TR load from specs.	Hi Stage Cap Combined comp. 1&2 Max Cap.	Comp1 Max Cap Adj. Total TR Capacity of Comp.	Comp1 Load Uses control strategy to determine loads on Comp 1&2	Comp1HP % of BHP at given TR load from specs.	Comp2 Max Cap Adj. Total TR Capacity of Comp.	Comp2 Load Uses control strategy to determine loads on Comp 1&2	Comp2 HP % of BHP at given TR load from specs.
07/01/1999 1:00	62.49	56.92	52.3	299.6	28.9%	25	153.5	440.7	252.0	59.5%	148.0	188.7	79.4%	141.5
07/01/1999 2:00	62.58	56.82	50.3	295.5	27.8%	25	153.5	440.7	252.0	58.6%	148.0	188.7	78.3%	141.5
07/01/1999 3:00	62.59	56.73	53.6	291.3	29.6%	25	153.5	440.7	252.0	57.8%	148.0	188.7	77.2%	137.8
07/01/1999 4:00	62.31	56.48	52.1	291.7	28.8%	25	153.5	440.0	251.5	58.0%	145.4	188.4	77.4%	135.3
07/01/1999 5:00	62.21	56.21	50.7	294.9	28.0%	25	153.5	440.0	251.5	58.6%	145.4	188.4	78.3%	138.9
07/01/1999 6:00	62.30	56.16	53.4	281.3	29.5%	25	153.5	439.2	251.1	56.0%	139.1	188.1	74.8%	129.4
07/01/1999 7:00	62.57	56.55	49.4	294.9	27.3%	25	151.1	440.7	252.0	58.5%	148.0	188.7	78.1%	141.5
07/01/1999 8:00	64.05	57.50	54.8	305.0	30.3%	25	155.9	441.4	252.4	60.4%	154.5	189.0	80.7%	147.8
07/01/1999 9:00	66.08	58.89	49.4	297.7	27.3%	25	151.1	441.4	252.4	59.0%	150.6	189.0	78.8%	144.0
07/01/1999 10:00	69.07	60.48	57.0	306.2	31.5%	25	155.9	442.8	253.2	60.5%	159.9	189.6	80.7%	153.1
07/01/1999 11:00	70.00	61.13	52.5	299.5	29.0%	25	153.5	442.8	253.2	59.1%	155.8	189.6	79.0%	149.2
07/01/1999 12:00	71.90	62.05	58.1	301.9	32.1%	25	155.9	443.5	253.6	59.5%	158.4	189.9	79.5%	151.8
07/01/1999 13:00	71.50	61.73	58.0	317.3	32.1%	25	155.9	444.2	254.0	50.2%	148.9	190.2	99.8%	190.4
07/01/1999 14:00	71.30	61.68	54.4	316.5	30.1%	25	155.9	444.2	254.0	62.3%	165.3	190.2	83.2%	162.8
07/01/1999 15:00	70.90	61.43	57.3	318.7	31.7%	25	155.9	444.2	254.0	50.7%	148.9	190.2	99.8%	190.4
07/01/1999 16:00	70.50	61.27	48.8	303.4	27.0%	25	151.1	442.8	253.2	59.9%	155.8	189.6	80.0%	153.1
07/01/1999 17:00	69.24	60.78	53.6	312.1	29.6%	25	153.5	443.5	253.6	61.5%	162.6	189.9	82.2%	155.8
07/01/1999 18:00	67.73	59.81	51.8	312.9	28.6%	25	153.5	442.8	253.2	61.8%	159.9	189.6	82.5%	157.2
07/01/1999 19:00	65.03	58.14	52.9	328.5	29.3%	25	153.5	442.8	253.2	55.0%	151.7	189.6	99.7%	184.0
07/01/1999 20:00	63.08	57.04	55.5	308.8	30.7%	25	155.9	441.4	252.4	61.2%	154.5	189.0	81.7%	147.8
07/01/1999 21:00	62.57	56.86	55.1	297.0	30.5%	25	155.9	440.7	252.0	58.9%	148.0	188.7	78.7%	141.5
07/01/1999 22:00	62.75	57.08	50.6	288.9	28.0%	25	153.5	440.0	251.5	57.4%	141.6	188.4	76.7%	135.3
07/01/1999 23:00	62.97	57.34	51.6	302.6	28.5%	25	153.5	440.7	252.0	60.1%	151.9	188.7	80.2%	145.2

Table 6
Ex Ante Model (Sample) – Existing Energy Use, continued

CT Discharge Temp.	Cond. Load Total TR plus kBtu's added from compressors	Cap Fac Capacity of CT based on Suction Temp and Wetbulb. Lookup table.	Rated Tower Cap	Net Tower Cap Rated CT Cap/Cap factor	Cond1 Fan Energy	Cond1 Pump Energy	Cond2 Fan Energy	Cond2 Pump Energy	Cond3 Fan Energy	Cond3 Pump Energy	Total Condensor Energy	Compressor Energy	Total Energy
90	5,350	0.96	5,206	5,444	12.9	1.4	5.1	1.8	4.9	1.8	27.8	353.1	380.9
90	5,277	0.96	5,206	5,444	12.9	1.4	5.1	1.8	4.7	1.8	27.7	353.1	380.7
90	5,257	0.96	5,206	5,444	12.9	1.4	5.1	1.8	4.7	1.8	27.6	350.1	377.7
89	5,231	0.96	5,206	5,400	12.9	1.4	5.1	1.8	4.7	1.8	27.6	346.1	373.7
89	5,262	0.96	5,206	5,400	12.9	1.4	5.1	1.8	4.8	1.8	27.7	349.0	376.7
88	5,091	1.00	5,206	5,222	12.9	1.4	5.1	1.8	4.8	1.8	27.7	336.4	364.1
90	5,253	0.96	5,206	5,444	12.9	1.4	5.1	1.8	4.6	1.8	27.6	351.2	378.8
91	5,484	0.93	5,206	5,598	12.9	1.4	5.1	1.8	4.8	1.8	27.8	365.3	393.0
91	5,300	0.96	5,206	5,396	12.9	1.4	5.1	1.8	4.9	1.8	27.8	355.3	383.1
93	5,552	0.91	5,206	5,721	12.9	1.4	5.1	1.8	4.7	1.8	27.7	373.8	401.4
93	5,391	0.94	5,206	5,553	12.9	1.4	5.1	1.8	4.7	1.8	27.7	365.5	393.2
94	5,507	0.92	5,206	5,659	12.9	1.4	5.1	1.8	4.8	1.8	27.7	371.6	399.3
95	5,764	0.88	5,206	5,916	12.9	1.4	5.1	1.8	4.8	1.8	27.7	394.7	422.4
95	5,683	0.88	5,206	5,916	12.9	1.4	5.1	1.8	4.6	1.8	27.5	385.7	413.3
95	5,772	0.87	5,206	5,968	12.9	1.4	5.1	1.8	4.7	1.8	27.6	394.7	422.3
93	5,397	0.94	5,206	5,553	12.9	1.4	5.1	1.8	4.7	1.8	27.7	366.7	394.4
94	5,589	0.91	5,206	5,750	12.9	1.4	5.1	1.8	4.7	1.8	27.7	376.1	403.8
93	5,574	0.91	5,206	5,721	12.9	1.4	5.1	1.8	4.8	1.8	27.7	375.1	402.9
93	5,822	0.87	5,206	5,984	12.9	1.4	5.1	1.8	4.8	1.8	27.7	389.9	417.6
91	5,538	0.92	5,206	5,655	12.9	1.4	5.1	1.8	4.8	1.8	27.8	365.3	393.0
90	5,359	0.96	5,206	5,444	12.9	1.4	5.1	1.8	4.9	1.8	27.9	355.0	382.9
89	5,169	0.99	5,206	5,235	12.9	1.4	5.1	1.8	5.0	1.8	27.9	343.1	371.0
90	5,397	0.96	5,206	5,444	12.9	1.4	5.1	1.8	5.0	1.8	28.0	359.1	387.1

Table 7
Ex Ante Model (Sample) – Proposed Energy Use

Date & Time	Dry Bulb	Wet Bulb	$Load_{-40}$ Load in terms of tons refrig. (TR) of low temp system	$Load_{25}$ Load in terms of tons refrig. (TR) of med. temp system	Comp3 Load % of compressor full load capacity	Sat. Int. Temp	Comp3 HP % of BHP at given TR load from specs.	Hi Stage Cap Combined comp. 1&2 Max Cap.	Comp1 Max Cap Adj. Total TR Capacity of Comp.	Comp1Load Uses control strategy to determine loads on Comp 1&2	Comp1HP % of BHP at given TR load from specs. @ 73 F Suction Temp	Comp2 Max Cap Adj. Total TR Capacity of Comp.	Comp2 Load Uses control strategy to determine loads on Comp 1&2	Comp2 HP % of BHP at given TR load from specs.
07/01/1999 1:00	62.49	56.92	52.3	299.6	28.9%	25	99.6	438.9	250.6	59.8%	108.7	188.3	79.6%	102.7
07/01/1999 2:00	62.58	56.82	50.3	295.5	27.8%	25	100.6	438.9	250.6	58.9%	108.7	188.3	78.5%	102.7
07/01/1999 3:00	62.59	56.73	53.6	291.3	29.6%	25	99.0	438.9	250.6	58.1%	108.7	188.3	77.4%	100.1
07/01/1999 4:00	62.31	56.48	52.1	291.7	28.8%	25	99.7	438.9	250.6	58.2%	108.7	188.3	77.5%	100.1
07/01/1999 5:00	62.21	56.21	50.7	294.9	28.0%	25	100.4	438.9	250.6	58.8%	108.7	188.3	78.3%	102.7
07/01/1999 6:00	62.30	56.16	53.4	281.3	29.5%	25	99.1	438.9	250.6	56.1%	105.9	188.3	74.7%	97.5
07/01/1999 7:00	62.57	56.55	49.4	294.9	27.3%	25	101.0	438.9	250.6	58.8%	108.7	188.3	78.3%	102.7
07/01/1999 8:00	64.05	57.50	54.8	305.0	30.3%	25	98.5	438.9	250.6	60.8%	111.6	188.3	81.0%	105.4
07/01/1999 9:00	66.08	58.89	49.4	297.7	27.3%	25	101.0	438.9	250.6	59.4%	108.7	188.3	79.0%	102.7
07/01/1999 10:00	69.07	60.48	57.0	306.2	31.5%	25	97.5	438.9	250.6	61.1%	111.6	188.3	81.3%	105.4
07/01/1999 11:00	70.00	61.13	52.5	299.5	29.0%	25	99.5	438.9	250.6	59.7%	108.7	188.3	79.5%	102.7
07/01/1999 12:00	71.90	62.05	58.1	301.9	32.1%	25	97.0	438.9	250.6	60.2%	111.6	188.3	80.2%	105.4
07/01/1999 13:00	71.50	61.73	58.0	317.3	32.1%	25	97.0	438.9	250.6	51.9%	100.5	188.3	99.4%	126.6
07/01/1999 14:00	71.30	61.68	54.4	316.5	30.1%	25	98.7	438.9	250.6	51.6%	100.5	188.3	99.4%	126.6
07/01/1999 15:00	70.90	61.43	57.3	318.7	31.7%	25	97.3	438.9	250.6	52.4%	100.5	188.3	99.4%	126.6
07/01/1999 16:00	70.50	61.27	48.8	303.4	27.0%	25	101.3	438.9	250.6	60.5%	111.6	188.3	80.6%	105.4
07/01/1999 17:00	69.24	60.78	53.6	312.1	29.6%	25	99.0	438.9	250.6	62.3%	111.6	188.3	82.9%	108.3
07/01/1999 18:00	67.73	59.81	51.8	312.9	28.6%	25	99.9	438.9	250.6	62.4%	111.6	188.3	83.1%	108.3
07/01/1999 19:00	65.03	58.14	52.9	328.5	29.3%	25	99.3	438.9	250.6	56.4%	105.9	188.3	99.4%	126.6
07/01/1999 20:00	63.08	57.04	55.5	308.8	30.7%	25	98.1	438.9	250.6	61.6%	111.6	188.3	82.0%	105.4
07/01/1999 21:00	62.57	56.86	55.1	297.0	30.5%	25	98.3	438.9	250.6	59.2%	108.7	188.3	78.9%	102.7
07/01/1999 22:00	62.75	57.08	50.6	288.9	28.0%	25	100.4	438.9	250.6	57.6%	108.7	188.3	76.7%	100.1
07/01/1999 23:00	62.97	57.34	51.6	302.6	28.5%	25	100.0	438.9	250.6	60.4%	111.6	188.3	80.4%	105.4

Table 8
Ex Ante Model (Sample) – Proposed Energy Use, continued

CT	Cond. Load	Cap Fac	Rated Tower Cap	Net Tower Cap	Cond Fan-1 Energy	Cond Pump-1 Energy	Cond Fan-2 Energy	Cond Pump-2 Energy	Total Condensor Energy	Compressor Energy	Total Energy
Discharge Temp.	Total TR plus kBtu's added from compressors	Capacity of CT based on Suction Temp and Wetbulb. Lookup table.		Rated CT Cap/Cap factor							
73	5,015	1.70	14,921	8,765	16.4	6.3	2.4	6.3	31.3	247.9	279.2
73	4,944	1.70	14,921	8,765	16.4	6.3	2.1	6.3	31.0	248.7	279.7
73	4,922	1.70	14,921	8,765	16.4	6.3	2.0	6.3	30.9	245.3	276.2
73	4,911	1.61	14,921	9,275	16.4	6.3	1.0	6.3	29.9	245.9	275.7
73	4,941	1.61	14,921	9,275	16.4	6.3	1.1	6.3	30.0	248.5	278.5
73	4,786	1.61	14,921	9,275	16.4	6.3	0.5	6.3	29.4	241.1	270.5
73	4,927	1.70	14,921	8,765	16.4	6.3	2.0	6.3	30.9	249.0	280.0
73	5,120	1.73	14,921	8,629	16.4	6.3	3.1	6.3	32.0	251.4	283.4
73	4,960	1.85	14,921	8,060	16.4	6.3	3.8	6.3	32.7	249.0	281.7
73	5,159	1.89	14,921	7,908	16.4	6.3	5.0	6.3	33.9	250.6	284.5
73	5,015	2.01	14,921	7,432	16.4	6.3	5.7	6.3	34.6	247.9	282.5
73	5,119	2.04	14,921	7,302	16.4	6.3	6.6	6.3	35.5	250.2	285.7
73	5,329	2.04	14,921	7,302	16.4	6.3	7.5	6.3	36.4	258.3	294.8
73	5,280	2.04	14,921	7,302	16.4	6.3	7.3	6.3	36.2	259.7	295.9
73	5,338	2.01	14,921	7,432	16.4	6.3	7.2	6.3	36.1	258.6	294.6
73	5,036	2.01	14,921	7,432	16.4	6.3	5.8	6.3	34.7	253.7	288.4
73	5,200	2.01	14,921	7,432	16.4	6.3	6.5	6.3	35.4	254.1	289.6
73	5,190	1.89	14,921	7,908	16.4	6.3	5.1	6.3	34.0	254.8	288.8
73	5,421	1.73	14,921	8,629	16.4	6.3	4.2	6.3	33.1	264.5	297.6
73	5,174	1.70	14,921	8,765	16.4	6.3	3.0	6.3	31.9	251.2	283.0
73	5,014	1.70	14,921	8,765	16.4	6.3	2.4	6.3	31.3	246.9	278.2
73	4,861	1.70	14,921	8,765	16.4	6.3	1.8	6.3	30.7	246.4	277.1
73	5,057	1.70	14,921	8,765	16.4	6.3	2.5	6.3	31.4	252.6	284.0

Table 9
Ex Ante Model Lookup Tables

Comp #1
Suct Temp 25°F

	TR_{Adj}	BHP_{Adj}
73	250.6	169.5
74	250.2	172.6
75	250.1	175.7
76	249.9	179.2
77	249.7	182.6
78	249.5	186.0
79	249.3	189.5
80	249.1	192.9
81	249.2	196.4
82	249.5	200.0
83	249.5	203.4
84	249.8	207.1
85	249.9	210.7
86	250.3	214.7
87	250.7	218.7
88	251.1	222.7
89	251.5	226.7
90	252.0	230.7
91	252.4	234.7
92	252.8	238.8
93	253.2	242.9
94	253.6	246.9
95	254.0	251.0
96	254.3	255.2
97	254.6	259.3
98	254.8	263.4
99	255.1	267.6
100	255.4	271.8
101	254.7	275.0
102	251.1	275.0
103	247.7	275.0
104	244.3	275.0
105	241.0	275.0
106	237.8	275.0
107	234.7	275.0
108	231.7	275.0
109	228.8	275.0
110	225.9	275.0
111	223.1	275.0
112	220.4	275.0
113	217.7	275.0
114	215.1	275.0
115	212.6	275.0

Comp #2
Suct Temp 25°F

	TR_{Adj}	BHP_{Adj}
73	188.3	129.9
74	188.1	132.4
75	188.0	134.7
76	187.8	137.5
77	187.6	140.2
78	187.3	143.0
79	187.1	145.7
80	186.9	148.5
81	186.9	151.2
82	187.1	154.2
83	187.1	156.9
84	187.2	159.9
85	187.2	162.8
86	187.5	166.0
87	187.8	169.2
88	188.1	172.4
89	188.4	175.6
90	188.7	178.9
91	189.0	182.1
92	189.3	185.4
93	189.6	188.7
94	189.9	192.0
95	190.2	195.3
96	190.4	198.6
97	190.5	201.9
98	190.7	205.2
99	190.8	208.6
100	191.0	211.9
101	191.2	215.3
102	191.3	218.7
103	189.7	220.0
104	187.0	220.0
105	184.3	220.0
106	181.8	220.0
107	179.4	220.0
108	177.1	220.0
109	174.8	220.0
110	172.5	220.0
111	170.3	220.0
112	168.2	220.0
113	166.1	220.0
114	164.0	220.0
115	162.0	220.0

Comp #3
Suct Temp -40°F

	TR_{Adj}	BHP_{Adj}
-20	199.2	113.2
-15	197.5	123.3
-10	195.7	133.3
-5	193.8	144.7
0	191.9	156.0
5	190.0	169.4
10	188.0	182.8
11	187.5	185.7
12	187.1	188.5
13	186.6	191.4
14	186.1	194.2
15	185.7	197.0
16	185.2	199.7
17	184.7	202.4
18	184.2	205.1
19	183.8	207.8
20	183.3	210.4
21	182.8	213.0
22	182.3	215.6
23	181.8	218.1
24	181.3	220.6
25	180.9	223.1
26	180.4	225.6
27	179.9	228.0
28	179.4	230.4
29	178.9	232.8
30	178.4	235.1

Table 10
Ex Post Billing History

Month	Days	Meter kWh	kWh/day	Adjust Post kWh/day (5%)
08/31/01	31	325,814	10,510	
10/01/01	33	385,974	11,696	
11/01/01	30	350,416	11,681	
12/02/01	33	336,920	10,210	
01/02/02	33	326,074	9,881	
02/02/02	29	292,318	10,080	
03/05/02	29	306,049	10,553	
04/05/02	30	324,926	10,831	
05/06/02	31	337,278	10,880	
06/05/02	30	338,856	11,295	
07/05/02	30	347,672	11,589	
08/05/02	31	342,087	11,035	
09/05/02		missing		
10/05/02		missing		
11/05/02		missing		
12/05/02		missing		
01/07/03	33	268,169	8,126	
02/05/03	29	282,774	9,751	
03/07/03	30	289,905	9,664	
03/28/03	31	309,140	9,972	
05/06/03	29	262,272	9,044	
06/05/03	30	296,058	9,869	
07/07/03	32	323,715	10,116	
08/05/03	29	291,001	10,035	
09/04/03	30	290,433	9,681	
10/03/03	29	276,621	9,539	9,062
11/04/03	32	295,636	9,239	8,777
12/05/03	31	269,720	8,701	8,266
01/07/04	33	273,006	8,273	7,859
02/05/04	29	276,387	9,531	9,054
03/09/04	33	330,321	10,010	9,509
04/06/04	28	253,094	9,039	8,587
05/05/04	29	257,910	8,893	8,449
06/04/04	30	266,078	8,869	8,426
07/06/04	32	282,314	8,822	8,381
08/04/04	29	272,745	9,405	8,935
09/02/04	29	259,564	8,950	8,503
10/04/04	32	280,082	8,753	8,315
11/04/04	31	289,002	9,323	8,857
12/06/04	32	267,720	8,366	7,948

Blackout period during which project was implemented

Table 11
Evaluation Findings

Billing Analysis Findings (no post adjustment)	
Average daily kWh 8/2001 - 8/2002	10,853
Average daily kWh 01/2004 - 12/2004	9,020
Average daily kWh impact	1,834
Annual kWh impact	**669,373**

Billing Analysis Findings (with post adjustment)	
Average daily kWh 8/2001 - 8/2002	10,853
Average daily kWh 01/2004 - 12/2004 w/ 5% adjustment	8,569
Average daily kWh impact	2,285
Annual kWh impact	**833,979**

SITE 24 IMPACT EVALUATION
SAMPLE CELL: ORIGINAL TIER: 3 END USE: HVAC

Measure	***Install Energy Management System***
Site Description	***Vacation Time Share Apartments***

Measure Description

Install an energy management system that sets back the thermostat controlling the space temperature when the apartment unit is unoccupied or vacant.

Summary of Ex Ante Impact Calculations

An energy management system was installed to control the air conditioning unit and some of the lighting in each apartment. Upon entering an apartment unit, a guest inserts a room key into the master wall control switch. This triggers a radio frequency transmitter that sets the energy management system to the "occupied mode". In the occupied mode, the guest has full control over the space temperature set point. If the patio sliding glass door is opened, a door sensor sends a signal and the apartment air conditioning unit in turned off. When the guest removes the room key and leaves the apartment, the energy management system takes control of the air conditioning unit thermostat and adjusts the space temperature to 82 °F if the unit is left in the cooling mode, and to 60 °F if the unit is left in the heating mode.

The Ex ante calculations were performed using an eQuest simulation. The simulation was performed for a typical 833 ft^2 unit for three different scenarios that are briefly described below:

Scenario 1: Baseline
This scenario calculates the energy consumption of the property for a full year assuming that the air conditioning units are enabled continuously whether the unit is occupied, unoccupied or vacant. The documentation seems to imply that the space temperature set point would be 72 °F.

Scenario 2: Occupied - Energy Management System Installed
This scenario calculates the energy consumption of the property assuming that the units are occupied for a full year and that the air conditioning units are enabled continuously. Occupancy is assumed to be from 8 PM to 8 AM. The documentation seems to imply that the space temperature set point would be 72 °F when occupied. When the unit is unoccupied, the assumption is that the air conditioning unit has been left in the auto mode, and the energy management system takes control of the unit thermostat and adjusts the space temperature to 82 °F if the unit is left in the cooling mode, and 60 °F if the unit is left in the heating mode.

Scenario 3: Vacant - Energy Management System Installed
This scenario calculates the energy consumption of the property assuming that the units are vacant for a full year. When the property is vacant, the air conditioning units have been left in the auto mode, and the energy management system takes control of the unit thermostat and adjusts the space temperature to 82 °F if the unit is left in the cooling mode, and 60 °F if the unit is left in the heating mode.

The project sponsor then subtracted the energy consumption of Scenario 2 from Scenario 1 to estimate how much energy would be saved by the energy management system if the property was occupied for a full year, and then multiplied the result by the assumed occupancy rate for the property to determine the savings when occupied.

Similarly, Scenario 3 was subtracted from Scenario 1 to estimate how much energy would be saved by the energy management system if the property was vacant for a full year and then multiplied the result by the assumed vacancy rate for the property to determine the savings when vacant.

The results were added together and the sum is the expected savings for the measure. The occupancy rate is assumed to be 75%, and the vacancy rate is 25%.

KWh_{saved} = Occupancy % x(Scenario 1- Scenario 2) + Vacancy % x (Scenario 1- Scenario 3)

The application reviewer accepted the calculation methodology but did make some changes to the assumptions used in the eQuest simulations. The Project application documents that the EER for the air conditioning units was changed from 7.5 to 10.33, the occupied schedule was changed from 8 PM to 8 AM (12 hours daily) to 6 PM to 8 AM (14 hours daily), plug loads were added at a value of 0.65w/ft^2, and some other values were adjusted. The project sponsor estimated that before accounting for occupancy, 35 % of the energy savings would occur in scenario 2 and 65% would occur in scenario 3. Table 1 is a summary of the Ex Ante Savings that include the changes to the eQuest simulation made by the application reviewer.

Table 1 Summary of the Ex Ante Savings

	kW	kWh
Energy Management System	-	55,703

Comments on Ex Ante Calculations

The inputs for the eQuest simulation were not provided. Some of the inputs are discussed in the application review and installation review, and it appears that the reviewers did a thorough job of assessing the accuracy of the physical parameters used in the eQuest model.

The energy savings are based upon assumptions of guest and management behavior before and after the retrofit. The savings are based on the premise that the guests and management leave the air conditioning units on continuously, when the space is occupied, unoccupied or vacant. There is no consideration for seasonality in this assumption- that perhaps in Spring or Fall the occupant or management may decide to turn the air conditioning off some or all of the time, or the possibility that facility housekeeping may set back the thermostats when the units are vacant.

The eQuest model also assumes that when rented, each unit is unoccupied for 14 hours continuously. Since this is a time share it seems that some guests, especially the elderly or those with children, may not be away for such a long continuous period. Also it is possible to defeat the energy management system. Guests are offered more than one room key, and could conceivably leave one key in the energy management system controller when they leave the space, thereby keeping the system in the occupied mode.

Evaluation Process

The evaluation process consists of a review of the application form and supporting documentation, conducting an on-site survey and then computing impacts using the data collected on site.

The site survey was conducted on November 18, 2004. Information on the energy management system was collected by interviewing the facility representative and verifying the operation of the system. We also obtained 12 months of occupancy data from the facility representative.

Data obtained from the site visit indicates that the occupancy rate is different than what was used in the Ex Ante savings analysis. The Ex Ante savings analysis and the sponsor submitted savings analysis assume that the occupancy rate is 75% and the vacancy rate is 25%. Data from the site visit indicates that for the past 12 months, the occupancy rate was approximately 60%. Table 2 is a summary of the monthly occupancy data and the weighted average occupancy for the past 12 months.

Table 2 Occupancy Data

Month	% Occupied	Days	Weight
Oct '04	59.7%	31	18.5
Sept '04	30.1%	30	9.0
Aug '04	63.4%	31	19.7
July '04	59.6%	31	18.5
June '04	69.0%	30	20.7
May '04	59.7%	31	18.5
Apr '04	72.2%	30	21.7
Mar '04	72.7%	31	22.5
Feb '04	57.2%	28	16.0
Jan '04	29.9%	31	9.3
Dec '03	71.6%	31	22.2
Nov '03	72.1%	30	21.6
Total		365	218.2
Average			59.8%

Table 3 summarizes the results of the eQuest analysis submitted by the project sponsor.

Table 3 Results of Sponsor Submitted e Quest Analysis

Scenario		eQuest* kWh	Occupancy %	Vacancy %	Savings kWh
2	Occupied Savings	71,340	75%		53,505
3	Vacant Savings	130,960		25%	32,740
	Total	202,300			86,245

* Total annual savings calculated from the eQuest simulation.

The reviewer made some changes to the input of the eQuest analysis as described above and recalculated the Ex Ante energy savings to be 55,703 kWh annually. Unfortunately, we did not receive the reviewer's revised breakdown of the energy consumption associated with each scenario. To estimate the savings associated with each scenario, we have assumed that the savings for each scenario are proportional to the ratio of the Ex Ante savings and the sponsor submitted savings. The Ex Ante savings associated with each scenario were calculated as follows:

Ex Ante Savings
$kWh_{scenario2}$=
Sponsor $kWh_{scenario2}$ x Ex Ante Total kWh Savings /Sponsor Total kWh Savings
$kWh_{scenario2}$= 71,340 x 55,703/86,245
$kWh_{scenario2}$= 46,076 kWh

$kWh_{scenario3}$=
Sponsor $kWh_{scenario3}$ x Ex Ante Total kWh Savings /Sponsor Total kWh Savings
$kWh_{scenario3}$= 130,960 x 55,703/86,245
$kWh_{scenario3}$= 84,583kWh

Table 4 is a summary of the Ex Ante Savings calculated by the proportional method above.

Table 4 Summary of the Ex Ante Saving Analysis

Scenario		eQuest* kWh	Occupancy %	Vacancy %	Savings kWh
2	Occupied Savings	46,076	75%		34,557
3	Vacant Savings	84,583		25%	21,146
	Total	130,659			55,703

* Total annual savings calculated from the eQuest simulation extrapolated from Sponsor submitted data.

We calculated the Ex Post savings based on the occupancy rates obtained during the site visit and the annual Ex Ante energy savings determined for each scenario shown in Table 4 above using the following formula:

KWh_{saved} = Occupancy % x Scenario 2 Annual Savings + Vacancy % x Scenario 3 Annual Savings

Table 5 is a summary of the Ex Post savings analysis.

Table 5 Ex Post Savings Summary

Scenario		eQuest* kWh	Occupancy %	Vacancy %	Savings kWh
2	Occupied Savings	46,076	59.8%		27,543
3	Vacant Savings	84,583		40.2%	34,023
	Total	130,659			61,565

* Total annual savings calculated from the eQuest simulation extrapolated from Sponsor submitted data.

Installation Verification

We confirmed the installation of the energy management system in 36 apartment units with the facility representative. We verified the operation of the system in one unit. A verification summary is shown in Exhibit 1 below.

Scope of Impact Assessment

The impact evaluation includes the installation the energy management system for the air conditioning units. The energy management system also controls a limited amount of lighting. Control of the lighting was not evaluated.

Additional Notes

The Ex Post savings are greater than the Ex Ante savings because the occupancy rate is lower than what was used to calculate the Ex Ante savings. The eQuest simulation indicates that savings are greater during vacant periods than occupied periods, so increasing the portion of vacant time, increases the savings estimate.

The amount of time allowed for this site was not adequate to accurately determine the savings associated with this project. There are far too many assumptions about the occupied hours and the behavior of the occupants and management which form the basis of the savings calculations. Long term monitoring would be required to more accurately verify the savings associated with this project. We estimate an additional 32 hours plus the rental of logging equipment would be required to complete this task.

Economic Information

An economic summary for the installation of the energy management system controlling the air conditioning units is shown in Table 6 below. An engineering realization rate calculation is shown in Table 7.

Impact Results

Table 6 Economic Summary of the Project

Description	Date	Project Cost	Estimated Demand Savings, kW	Estimated Energy Savings, kWh	Estimated Gas Savings, therms	Estimated Annual Cost Savings ($0.13/kWh), $	SPC Incentive, $	Simple Payback w/ incentive, yrs	Simple Payback w/o incentive, yrs
Application Submitted Amount	6/11/2003	$12,060	-	86,245	0	$11,212	$6,030	0.54	1.08
Application Approved Amount	7/9/2003	$12,060	-	55,703	0	$7,241	$4,456	1.05	1.67
Installation Approved Amount (Ex Ante)	9/9/2003	$12,060	-	55,703	0	$7,241	$4,456	1.05	1.67
SPC Program Review (Ex Post)	11/30/2004	$12,060	-	61,565	0	$8,003	$4,456	0.95	1.51

Table 7 Realization Rate Calculation

	KW	KWh	Therm
SPC Tracking System or Application	0	55,703	0
Adjusted Engineering	0	61,565	0
Engineering Realization Rate	NA	111%	NA

Exhibit 1 Installation Verification Sheet

Measure Description	End-Use Category	HVAC Measure Description	Lighting Measure Description	Process Measure Description	Count	Equipment Description	Installation Verified (Explain)	Notes
Lighting Controls- EMS	L		Install energy management system that turns off selected lights when the unit is unoccupied or vacant.		36	Room key activated radio frequency transmitter that controls the energy management system "occupied" and "unoccupied" modes.	Installation verified in one room. Facility representative verified that 36 units have EMS installed.	
EMS (Space Conditioning)	H	Install energy management system that sets back the thermostat controlling the space temperature when the unit is unoccupied or vacant.			36	Room key activated radio frequency transmitter that controls the energy management system "occupied" and "unoccupied" modes.	Installation verified in one room. Facility representative verified that 36 units have EMS installed.	

SITE 25 IMPACT EVALUATION
SAMPLE CELL: ORIGINAL TIER: 3 END USE: HVAC

Measure	***Install VFD's on three 225 ton centrifugal chillers***
Site Description	***High Tech Office, Computer Rooms, Labs***

Measure Description

Install variable frequency drives on three 225 ton centrifugal chillers.

Summary of Ex Ante Impact Calculations

The Ex Ante calculations were performed using engineering calculations. Data was obtained from short term trend logs from an energy management and control system. Chiller performance data was provided by the chiller manufacturer. A mechanical contractor performed the analysis submitted with the project application. A load profile for the chiller plant was created from local weather data. The chiller performance data for chiller operation with and without a VFD installed was used to estimate energy consumption.

According to the documentation in the application, only two chillers are required to meet the peak load of the chiller plant. The third chiller is redundant. The application reviewer identified that the analysis submitted with the application did not account for economizer operation associated with 75 % of the capacity requirements of the chiller plant. The reviewer recalculated the savings by performing a temperature bin analysis that accounts for economizer operation.

Table 1 summarizes the Ex Ante Savings Analysis

Table 1 Summary of the Ex Ante Savings

	Pre-retrofit kWh	Post-retrofit kWh	Savings kWh
Chiller VFDs	797,521	575,651	221,870

Comments on Ex Ante Calculations

The Ex Ante calculations were performed using a temperature bin analysis. The bin analysis performed by the mechanical contractor and application reviewer only show percent hours at percent load. The temperatures in each bin are not shown. The application reviewer recalculated the savings after identifying that the original calculations do not account for economizer operation. Interestingly, the reviewers calculations estimated a greater annual savings for the chiller plant with economizer operation. Incorporating economizer operation into the model should have reduced the annual ton-hours and the savings associated with the operation of the chiller plant.

Evaluation Process

The evaluation process consists of a review of the application form and supporting documentation, conducting an on-site survey and then computing impacts using data collected on-site.

The on-site survey was conducted on December 2, 2004. Information on the retrofit equipment and operating conditions was collected by inspecting the chiller motor VFD's and by interviewing the facility representative. The facility representative provided access to mechanical system design drawings and operating hours for the equipment.

The chiller plant serves computer room air conditioning units that operate continuously as well as air handling units that serve labs, production and office areas. Approximately half of the air handling units operate continuously, the others are on 12 hours per day, 5 days per week. There are economizers on all the air handling units. There are no economizers on the computer room units. The facility representative stated that the minimum chiller load is approximately 65 tons in cool weather when the air handling units are in economizer mode and not using chilled water. The maximum chiller plant load is approximately 380 tons. The second chiller is required to operate when the outside air temperature reaches 70 °F - 72 °F.

Chiller VFD's

We elected to perform a temperature bin analysis to generate a load profile for the chiller plant. The temperature bin analysis used weather data from a nearby airfield. The load profile is generated assuming that the chilled water load varies linearly from a minimum of 65 tons in the 50°F/54°F bin and below, to a maximum of 380 tons in the 90°F/94°F bin. Using the load profile created by this method and chiller performance data submitted with the SPC application, we used a spreadsheet analysis to estimate the pre and post retrofit energy consumption of the chillers.

The chiller performance data is shown below in Table 2 and graphically in Exhibit 2.

Table 2 Summary of Chiller Performance Data

		Pre Retrofit		Post Retrofit (VFD)	
% Load	Tons	kW	kW/ton	kW	kW/ton
100%	225	118	0.524	120	0.533
90%	203	104	0.514	102	0.504
80%	180	92	0.511	83	0.461
70%	158	81	0.514	67	0.425
60%	135	72	0.533	54	0.400
50%	113	62	0.551	42	0.373
40%	90	53	0.589	33	0.367
30%	68	44	0.652	24	0.356
20%	45	34	0.756	16	0.356
10%	23	26	1.156	12	0.533

We used the chiller performance data provided in the application and interpolated the chiller kW at the various load points determined from the temperature bin load profile. Chiller kWh was calculated as follows in each temperature bin:

kWh= kW x bin hours.

The kWh calculated in each temperature bin were summed together and the result is the annual kWh estimated for the chillers before and after the VFD retrofit. Table 3 is a summary of the Ex Post analysis. A more detailed analysis is presented for the pre and post retrofit energy consumption in Exhibits 3 and 4 below.

Table 3 Summary of the Ex Post Savings Analysis

	Pre-retrofit kWh	Post-retrofit kWh	Savings kWh
Chiller VFDs	591,760	443,673	148,087

Installation Verification

We physically verified the installation of VFD's on three 225 ton chillers. A verification summary is shown in Exhibit 1 below.

Scope of Impact Assessment

The impact evaluation includes the installation of VFD's on three 225 ton chillers. This is the only measure for this SPC application.

Additional Notes

The Ex Post savings are less than the Ex Ante savings because the Ex Ante savings were based on a higher peak load and a lower minimum load than the Ex Post analysis. The Ex Ante analysis estimates 1,437,073 annual ton hours for the chiller plant. The Ex Post calculation estimates 1,065,371 ton- hours for the chiller plant, a 35% difference.

Review of Exhibit 2 indicates that the greatest savings are achieved when the chiller is operating lightly loaded. Although the Ex Ante documentation states that the minimum chiller load is approximately 65 tons, the Ex Ante analysis shows loads as low as 10% and 20 % (23 tons and 46 tons respectively). The facility representative stated that the maximum chiller load does not exceed 380 tons, however the Ex Ante analysis shows the chillers to be fully loaded (450 tons) for a small percentage of the year.

A temperature bin analysis is not a very satisfactory method to accurately determine the impact of a chiller VFD retrofit. The chiller load profile in this type of facility would be more accurately modeled using a detailed simulation such as DOE 2. We estimate an additional 40 hours would be required to more accurately assess the savings for this project.

The facility representative stated that the chillers were experiencing operational problems in low load conditions before the retrofit. The chillers were surging and had even stalled on occasion. The installation of VFD's has eliminated this problem, and chiller operation has been improved.

Economic Information

An economic summary for the installation of the VFD's is shown in Table 4 below. An engineering realization rate calculation is shown in Table 5.

Impact Results

Table 4 Economic Summary of the Project

Description	Date	Project Cost	Estimated Demand Savings, kW	Estimated Energy Savings, kWh	Estimated Gas Savings, therms	Estimated Annual Cost Savings ($0.13/kWh), $	SPC Incentive, $	Simple Payback w/ incentive, yrs	Simple Payback w/o incentive, yrs
Application Submitted Amount	5/8/2003	$138,553	-	221,870	0	$28,843	$31,062	3.73	4.80
Application Approved Amount	5/23/2004	$138,553	-	221,870	0	$28,843	$31,062	3.73	4.80
Installation Approved Amount (Ex Ante)	3/9/2004	$138,553	-	221,870	0	$28,843	$31,062	3.73	4.80
SPC Program Review (Ex Post)	12/7/2004	$138,553	-	148,087	0	$19,251	$31,062	5.58	7.20

Table 5 Realization Rate Calculation

	KW	KWh	Therm
SPC Tracking System or Application	0	221,870	0
Adjusted Engineering	0	148,087	0
Engineering Realization Rate	NA	66.7%	NA

Exhibit 1 Installation Verification Sheet

Measure Description	End-Use Category	HVAC Measure Description	Lighting Measure Description	Process Measure Description	Count	Equipment Description	Installation Verified (Explain)	Notes
HVAC ADJUSTABLE SPEED DRIVE	H	Install ASD on centrifugal chillers.			3	Trane ASD's for centifugal chillers.	Physically verified the installaltion of ASD's on three 225 ton chillers.	

Exhibit 2 Chiller Performance Data

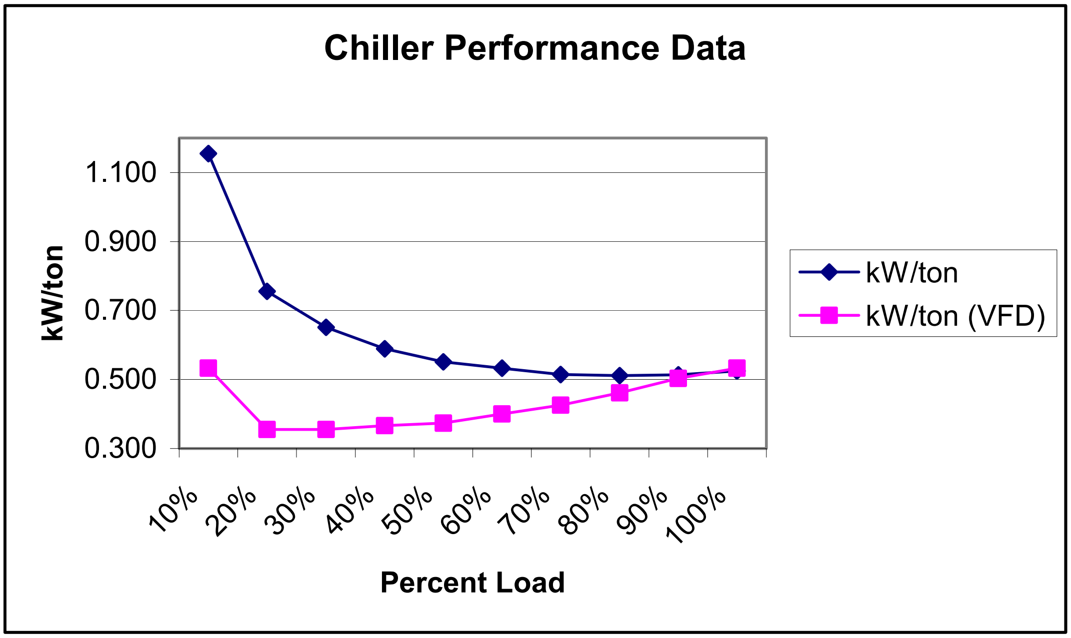


Exhibit 3 Ex Post
Pre Retrofit Energy Analysis

Minimum Tons	65
Maximum Load Tons	380
Maximum Capacity	450
Maximum Tons/chiller	225

				Lead Chiller					Lag Chiller						
	Annual	Chiller Plant			% Maximum					% Maximum				Total Chiller	
Temperature	Hours	% Max Load	Total Tons	Tons	Chiller Tons	kW/ton	kW	kWh	Tons	Chiller Tons	kW/ton	kW	kWh	kW	kWh
90/94	6	100.0%	380	190	84%	0.512	97.3	584	190	84%	0.512	97.3	584	195	1,168
85/89	24	89.6%	341	170	76%	0.512	87.3	2,094	170	76%	0.512	87.3	2,094	175	4,189
80/84	84	79.3%	301	151	67%	0.520	78.3	6,573	151	67%	0.520	78.3	6,573	157	13,146
75/79	207	68.9%	262	131	58%	0.536	70.2	14,530	131	58%	0.536	70.2	14,530	140	29,061
70/74	535	58.6%	223	223	99%	0.523	116.4	62,298	-	-	-	-	-	116	62,298
65/69	1,076	48.2%	183	183	81%	0.511	93.7	100,785	-	-	-	-	-	94	100,785
60/64	1,754	37.8%	144	144	64%	0.525	75.5	132,427	-	-	-	-	-	76	132,427
55/59	1,975	27.5%	104	104	46%	0.563	58.8	116,031	-	-	-	-	-	59	116,031
50/54	1,545	17.1%	65	65	29%	0.660	42.9	66,263	-	-	-	-	-	43	66,263
45/49	934	17.1%	65	65	29%	0.660	42.9	40,058	-	-	-	-	-	43	40,058
40/44	451	17.1%	65	65	29%	0.660	42.9	19,343	-	-	-	-	-	43	19,343
35/39	138	17.1%	65	65	29%	0.660	42.9	5,919	-	-	-	-	-	43	5,919
30/34	24	17.1%	65	65	29%	0.660	42.9	1,029	-	-	-	-	-	43	1,029
25/29	1	17.1%	65	65	29%	0.660	42.9	43	-	-	-	-	-	43	43
Total	8,754							567,978					23,782		591,760

1. Temperature data from a nearby airfield.
2. Chiller performance data submitted by the contractor, and claimed to be obtained from the chiller manufacturer.

Exhibit 4 Ex Post
Post Retrofit Energy Analysis

Minimum Tons	65
Maximum Load Tons	380
Maximum Capacity	450
Maximum Tons/chiller	225

				Lead Chiller					Lag Chiller						
	Annual	Chiller Plant			% Maximum					% Maximum				Total Chiller	
Temperature	Hours	% Max Load	Total Tons	Tons	Chiller Tons	kW/ton	kW	kWh	Tons	Chiller Tons	kW/ton	kW	kWh	kW	kWh
90/94	6	100.0%	380	190	84%	0.481	91.4	549	190	84%	0.481	91.4	549	183	1,097
85/89	24	89.6%	341	170	76%	0.447	76.1	1,827	170	76%	0.447	76.1	1,827	152	3,653
80/84	84	79.3%	301	151	67%	0.418	63.0	5,294	151	67%	0.418	63.0	5,294	126	10,589
75/79	207	68.9%	262	131	58%	0.396	51.8	10,730	131	58%	0.396	51.8	10,730	104	21,459
70/74	535	58.6%	223	223	99%	0.530	118.0	63,130	-	-	-	-	-	118	63,130
65/69	1,076	48.2%	183	183	81%	0.468	85.6	92,147	-	-	-	-	-	86	92,147
60/64	1,754	37.8%	144	144	64%	0.411	59.1	103,583	-	-	-	-	-	59	103,583
55/59	1,975	27.5%	104	104	46%	0.371	38.8	76,531	-	-	-	-	-	39	76,531
50/54	1,545	17.1%	65	65	29%	0.356	23.1	35,707	-	-	-	-	-	23	35,707
45/49	934	17.1%	65	65	29%	0.356	23.1	21,586	-	-	-	-	-	23	21,586
40/44	451	17.1%	65	65	29%	0.356	23.1	10,423	-	-	-	-	-	23	10,423
35/39	138	17.1%	65	65	29%	0.356	23.1	3,189	-	-	-	-	-	23	3,189
30/34	24	17.1%	65	65	29%	0.356	23.1	555	-	-	-	-	-	23	555
25/29	1	17.1%	65	65	29%	0.356	23.1	23	-	-	-	-	-	23	23
Total	8,754							425,274					18,399		443,673

1. Temperature data from a nearby airfield.
2. Chiller performance data submitted by the contractor, and claimed to be obtained from the chiller manufacturer.

APPENDIX B
END-USER PARTICIPANT SURVEY

2003 Nonresidential SPC Study
End-User Participant Survey

Prepared for SCE by
Quantum Consulting and KEMA-XENERGY

March 3, 2005

Interview Tracking Information

Completion Date		**Survey Length (min.)**	

Customer Information

Company Name	
Contact Name	
Contact Title	
Phone	
Alt info (email, cell)	

Database Application Information

# of Appl. by Utility	PGE SCE SDGE	**Size Stratum**	❑ 1 ❑ 2 ❑ 3
Calculation Type	❑ Calculated ❑ M&V ❑ Both ❑ Unclear/Other:		
Status of Applications	❑ All completed ❑ M&V stage ❑ Mixed ❑ Other:		
Sponsor Status	❑ EESP ❑ SELF ❑ BOTH *Name of EESP:*		
Site information	❑ Single Site ❑ Multi Site *Notes:*		
Recent SPC Participant	❑ 2001 ❑ 2002	**Interviewed recently**	❑ 2001 ❑ 2002

Impact Data Collection Information (if Impact Onsite has been completed)

Onsite Tracking #		**Onsite Surveyor**	
Date of Onsite		**Onsite Interviewee**	
Projects/Measures reviewed:			
Installation status			

Interviewer Notes:

END-USER PARTICIPANT INTERVIEW GUIDE – POSSIBLE LEAD IN MATERIAL

May I please speak with [CONTACT__________________]? [**Confirm this person is responsible for participation decision.]**

Hello, my name is ______ and I am calling about your participation in **[UTILITY's]** Large Standard Performance Contract Program. I am with KEMA, we are an energy research firm hired to conduct a interviews on behalf of the California Public Utilities Commission and with the cooperation of **[your local utility].**

We are interviewing firms that participated in the 2003 Large Standard Performance Contract program to discuss a number of topics about the program. We **[have already visited/will also be visiting]** your site to get information on the measures installed. This call is to follow up to gain information on the decision making process. **[If available: One of our engineers spoke to [Onsite Interviewee Name] on [date of onsite]**.]

Your input to this research is extremely important. The interview will take ***approximately 15 minutes*** and any information that is provided will remain strictly confidential. We will not identify or attribute any of your comments or organization information. Is this a good time, or can we schedule a convenient time in the next couple of days to talk?

IF HESITANT: It is important that we speak with the same customers who participated in the first phase of the evaluation to be able to match the data collected onsite with the information we will request today. Your input to this survey is very important for ensuring the long-term success of these programs. Without input from the participants, we will have difficulty conducting a fair and complete evaluation of the program.

Thank you for taking part in this survey. The major purposes of this study are

(1) to obtain feedback on the design and administrative aspects of the program, and
(2) to understand the characteristics of participants in the program and the types of activity the program has generated. This interview is focused on experiences with the program to date.

[If they request a contact at their local utility, the following are the appropriate MAE representatives, not the program managers]

PGE	Rafael Friedmann	415-972-5799
SCE	Pierre Landry	626-302-8288
SDGE	Henry De Jesus	858-654-1723

RESPONDENT INFORMATION

[ONLY ASK IF HAVE NOT ALREADY BEEN ANSWERED AT ONSITE INTERVIEW.]

RI1. First, I'd like to confirm the following information regarding your application.

RI1m. Could you please describe your role (regarding your firm's participation in the SPC Program)?

____

[BASED ON DATABASE DETERMINE IF SINGLE OR MULTI-SITE SPC APPLICATION]

RI2. How many applications did you submit under the 2003 SPC Program? a.__________

b. Are any still active (in M&V stage, or waiting for final payments)?

Yes 1
No.. 2
Don't Know/Refused **[CONFIRM RIGHT CONTACT]** 99

c. If so, what stage are they at?________________________________

RI3. Were any cancelled?

Yes 1
No.. 2
Don't Know/Refused **[CONFIRM RIGHT CONTACT]** 99

b. **If any cancelled probe reason(s)**

____
____
____

RI3c. Are any of the 2003 SPC measures still waiting to be installed?

Yes 1
No.. 2
Don't Know/Refused 99

d. If any not yet installed probe reason(s) [original deadline was 6/1/04]

____
____
____

****IF SELF-SPONSOR ASK RI4, IF EESP SPONSOR ASK RI5, IF COMBO ASK BOTH****

RI4. [ONSITE] According to our records, you are your own sponsor for your 2003 SPC project(s) : Is this information correct?

Yes .... 1 SKIP TO EC1
No, information appears incorrect .... 2 ASK RI5
Don't Know / Refused **[CONFIRM RIGHT CONTACT]** 99

RI5. [ONSITE] According to our records, the energy services firm that sponsored your SPC program application is: **STATE SPONSOR NAME [FROM DATABASE]**

Is this information correct?

Yes 1
No.. 2
Don't Know / Refused **[END, CONFIRM RIGHT CONTACT]**.... 99

IF NO, ENTER CORRECT EESP NAME:________________________

ESTABLISHMENT CHARACTERISTICS

[ONLY ASK IF HAVE NOT ALREADY BEEN ANSWERED IN AN ONSITE INTERVIEW.]
I'd like to ask you a few questions about your organization .

EC1. [ONSITE] What is the primary business of the **company/organization**?

[CHECK APPROPRIATE CODE] __ Comm __ Ind __Inst __ Agric __ Other

[ENTER VERBATIM]____

EC2. [ONSITE] [IF SINGLE-SITE PARTICIPANT ASK] Approximately how large is **your organization's** space in this facility? [ELSE IF MULTI-SITE ASK] What is the **average size** of your organization's space **among participating facilities?** ___________sq. ft.
CODE 98 FOR DON'T KNOW; 99 FOR REFUSED, ROUGH ESTIMATE IS OK

THIRD-PARTY FIRMS

[ONLY ASK IF HAVE NOT ALREADY BEEN ANSWERED IN AN ONSITE INTERVIEW.]
****IF SELF-SPONSOR ASK PE1, EESP SPONSORS SKIP TO NEXT SECTION ****

PE1a. Are you receiving assistance third party firms to implement the 2003 SPC project?

Yes 1
No.. 2
Don't Know/Refused 99

PE1b. Could you please specify the Name of the firm(s)

Primary Firm 1______________________ Secondary Firm 2______________________

PE1c. And what role did they play in your decision to implement the project? (how significant were they in your decision to do the project?) Did they provide…. [select one]

- ❑ Sponsorship of project application
- ❑ Significant decision-making assistance (e.g. advice on design, specification)
- ❑ Only limited assistance (e.g. only installation of equipment)

Notes:

____

____

____

FOR SELF-SPONSORS, DECIDE HERE IF THEY ARE SELF-SPONSORS DOING ALL WORK THEMSELVES OR SELF-SPONSORS WITH SIGNIFICANT HELP IN THE DECISION MAKING PROCESS.

SPC PARTICIPATION - ID/CONFIRM MEASURES

DISCUSS WITH INTERVIEWEE THE MEASURES YOU ARE GOING TO ASK QUESTIONS ABOUT AS PER THE MEASURES INVESTIGATED FOR IMPACT EVALUATION. FIRST PRIORITY IS TO CONDUCT THE NET-TO-GROSS BATTERY FOCUSED ON THE END USE PROJECTS SELECTED AS "PRIMARY" FOR THE ON-SITE IMPACT EVALUATION.

[DETERMINE WHETHER THEY OR SOMEONE ELSE IS THE MORE APPROPRIATE PERSON TO ANSWER THE QUESTIONS. IF NECESSARY, CONDUCT ADDITIONAL INTERVIEWS WITH OTHERS TO ACCURATELY ANSWER THE QUESTIONS ON THE FOLLOWING PAGES.]

WHEN MULTIPLE END USES ARE PRESENT FIND OUT IF DECISION MAKING PROCESS DIFFERED BY MEASURE. – IF DIFFERS, FIRST ADDRESS "PRIMARY" END USE FROM SAMPLE PLAN. IF POSSIBLE, OPTAIN RESPONSES FOR OTHER SECONDARY OR TERTIARY END USE PROJECTS, BUT NOT AT EXPENSE OF REMAINDER OF INTERVIEW .

Sample Text: My understanding that you are doing [End Use/Measure X] and [End Use/Measure Y], is that correct? Ok, for the next series of questions we are going to focus on [Measure X] which has the larger incentives.]

List Measures by type, Describe as Necessary. Or attach and reference sheet with measures currently tracked in program database. [MEASURE DETAIL TO BE PROVIDED BY ON-SITE TEAM]
1.
2.
3.
4.

PROGRAM-RELATED DECISION MAKING SECTION - NET-TO-GROSS

[INFORM THE INTERVIEWEE THAT THE FOLLOWING QUESTIONS PERTAIN TO THE PARTICULAR ENERGY EFFICIENCY EQUIPMENT INSTALLED AS PART OF THE 2003 SPC PROGRAM. REMIND AS NEEDED WHICH MEASURE(S) YOU ARE ADDRESSING. ASK THEM TO LET YOU KNOW IF THE RESPONSES VARY BY EQUIPMENT TYPE. USE MULTIPLE COLUMNS FOR ANSWERS IF ANSWERS VARY BY EQUIPMENT TYPE FOR THIS SECTION.]

PD1a Why did you decide to install ***Program-Related Equipment***? What other reasons? [DO NOT READ; check all that apply]

To replace old or outdated equipment 1
To allow remodeling, build-out, or expansion 2
To gain more control over how the equipment was used. 3
To improve measure performance... 4
To get a rebate from the program.. 5
To protect the environment... 6
To reduce energy costs 7
To reduce energy demand/likelihood of blackouts....................... 8
To respond to the energy crisis 9
To acquire the latest technology 10
Don't Know/Refused 99
Other 77
PD1a1. Describe________________________ ....

PD1b Which of the following statements best describes the performance and operating condition of the equipment you replaced as part of the 2003 program?

New equipment installed, did NOT replace pre-existing equipment 1
Existing equipment was fully functional 2
Existing equipment was fully functioning, but with significant problems 3
Or, existing equipment had failed or did not function..................... 4
Not applicable, ancillary equipment (VSD, EMS, controls, etc.)….. 5
Don't Know/Refused 9
Other_________ PD1b1. Describe________________________ 7

PD2 If this is the first time you're installing ***Energy Efficiency Equipment,*** where did you first hear about it (or have you installed it before)? [READ ONLY AS NEEDED]

1 Contractor
2 Architect / Engineer
3 Equipment Vendor
4a *PG&E representative or program literature (confirm, regulated distribution co.)*
4b SCE representative or program literature (confirm, regulated distribution co.)
4c SDG&E representative *or program literature (confirm, regulated distribution co.)*
5 Other non-utility literature, including trade publications
6 Self-knowledge / Education
7 Business colleague / Professional association / Trade show
8 From parent company
9 **Previous installation**
10 Energy Services Company, often referred to as ESCOs (performance contract)
11 An unregulated company that provides electricity supply
12 Energy Efficiency Program (non-utility)
11 OTHER **[SPECIFY, OK TO PUT NAME OF COMPANY]**
____
12 DON'T KNOW / REFUSED

PD3 How did you first learn of the SPC Program? [DONT READ CHOICES; PROBE IF SAME SOURCE AS PD2] CIRCLE CLOSEST CATEGORY

Specify name of company/source:_______________________________

1 Contractor
2 Architect / Engineer
3 Equipment Vendor
4a *PG&E representative or program literature (confirm, regulated distribution co.)*
4b SCE representative or program literature (confirm, regulated distribution co.)
4c SDG&E representative *or program literature (confirm, regulated distribution co.)*
5 Other non-utility literature, including trade publications
6 Self knowledge/Education
7 Business colleague / Professional association / Tradeshow
8 From parent company
9 Previous participation in SPC
10 Energy Services Company, often referred to as ESCOs
11 An unregulated company that provides electricity supply
12 Energy Efficiency Program (non-utility)
11 OTHER **[SPECIFY, OK TO PUT NAME OF COMPANY]**
____
12 DON'T KNOW / REFUSED

[FOR THE FOLLOWING QUESTIONS, FOCUS ON THE SPECIFIC EQUIPMENT WITH THE EFFICIENCY LEVEL INSTALLED THROUGH THE PROGRAM]

R6 Did you hear about the financial assistance available from the SPC program **BEFORE** or **AFTER** you began to actually look at or collect information about the ***Energy Efficient Equipment***)? Was it …

1 BEFORE you first looked at installing the equipment
2 SAME TIME
3 AFTER had begun researching the equipment, but before final decision
4 AFTER had decided to install the equipment
5 DON'T KNOW / REFUSED TO ANSWER

PD4c Which of the following best describes the process by which <u>you decided to install</u> the ***Energy Efficiency Equipment?***

1 Developed the idea ourselves and decided solely on our own to pursue installation
2 Developed the idea ourselves but were convinced by a third-party to pursue installation
3 Received the idea from a third-party and were also convinced by this party to pursue installation
4 Received the idea from a third-party but decided on our own to pursue installation
5 Other ➨PD4c1. Describe________________________________
9 DON'T KNOW / REFUSED
[RECORD ANY EXPLANATORY COMMENTS] ________________________

____

PD4d Have you received an energy efficiency audit from [UTILITY] in the past three years?

Yes 1
No.. 2
Don't Know/Refused 99

PD4e When were the audit results received? (month, year)

____

PD4f Were any of the utility audit recommendations implemented through the SPC program?

Yes 1

If yes, list measures implemented and SPC program year.

____

No.. 2
Don't Know/Refused 99

REMIND AS NEEDED WHICH MEASURE(S) YOU ARE ADDRESSING.

****IF SELF-SPONSOR DOING ALL WORK THEMSELVES (as determined on Page 5), SKIP TO PD6c,**
IF SELF SPONSOR WITH EESP HELP, SKIP TO PD6a, ELSE CONTINUE**

PD4d. Who initiated contact? Did **SPONSOR** approach you or did you approach them to discuss installing the ***Energy Efficiency Equipment?***

1 Customer initiated contact
2 EESP initiated contact
3 Other ➨PD4d1. Describe ________________________________
9 DON'T KNOW / REFUSED

PD6a. How significant was the overall value of the services provided by **SPONSOR/FIRM** in influencing your decision to install the ***Energy Efficiency Equipment***? Would you say the value of their services was very significant, somewhat significant, somewhat insignificant or very insignificant?
[RECORD PD6a and PD6b BY MEASURE OR END USE IF NEEDED]

Very significant	1
Somewhat significant	2
Somewhat insignificant	3
Very insignificant	4
Don't know	98
Refused	99

PD6b. Please describe the specific ways in which **SPONSOR/FIRM** contributed, if at all, to your decision to install the ***Energy Efficient Equipment***?

____

____

____

PD6c. How significant was the SPC program financial incentive in influencing your decision to install the ***Energy Efficiency Equipment***? Would you say the program's financial incentive was very significant, somewhat significant, somewhat insignificant or very insignificant?

Very significant	1
Somewhat significant	2
Somewhat insignificant	3
Very insignificant	4
Don't know	98
Refused	99

PD6d. [Please explain, include any payback information you have]

____

____

____

REMIND AS NEEDED WHICH MEASURE(S) YOU ARE ADDRESSING.

PD7a. Without the SPC program, [**READ NEXT CLAUSE FOR CUSTS WORKING WITH 3rd PARTY FIRMS**:] including both the incentive **and** the contribution from **SPONSOR/FIRM,** how likely is it you would have installed the ***Energy Efficient Equipment***? Would you say that you…

1 Definitely would NOT have installed SKIP TO PD 9a
2 Probably would NOT have installed SKIP TO PD 9a
3 Probably would have installed
4 Definitely would have installed
9 DON'T KNOW / REFUSED

PD8 Without the SPC program, how likely is it that the equipment you purchased would have been *as energy efficient* as the equipment you did install? Would you say . . .

1 Probably NOT as efficient
2 Probably as efficient
3 Not applicable for measure (e.g. VSD)
4 Less energy efficient equipment would have been installed (e.g. fewer sites) of the same efficiency
9 DON'T KNOW / REFUSED

PD8b Without the SPC program, would you have installed the ***Energy Efficient Equipment*** at about the same time as currently planned or over a year later?

1 within 6 months of when it actually was installed?
2 6 months to one year later?
3 one to two years later?
4 two to three years later? **SKIP TO PD10a**
5 three to four years later? **After any response**
6 four or more years later?
7 Never
9 DON'T KNOW / REFUSED TO ANSWER

PD9a Without the SPC program, [READ NEXT CLAUSE FOR CUSTS WORKING WITH **3rd PARTY FIRMS**:] including both the incentive **and** the contribution from **SPONSOR**, what type of equipment would you have most likely installed? Would you say. . .

1 Standard efficiency equipment
2 Equipment with above-standard efficiency but with lower efficiency than the equipment that was actually installed
3 Would not have installed anything
9 DON'T KNOW / REFUSED

PD9b Would you have installed the ***Energy Efficient Equipment*** at a later date? (How many years later?) [If over 1 year later, probe for best estimate of how many years later.]

1 within 6 months of when it actually was installed?
2 6 months to one year later?
3 one to two years later?
4 two to three years later?
5 three to four years later?
6 four or more years later?
8 Never
9 DON'T KNOW / REFUSED TO ANSWER

ENERGY CRISIS EFFECTS

Now I would like to ask you a few questions about the State's energy crisis in 2001.

P6a Did California's 2001 energy crisis affect your decision to install this equipment? If so, how?

___

___

P6b What, if any, other energy efficiency OR demand reduction actions have you taken in the past year in response to the energy crisis?

___

___

SPILLOVER

Now I would like to ask you a few questions about other energy efficiency measures you may have installed since deciding to participate in the 2003 SPC Program for the ***[Measures].***

R1 Have you implement any other high efficiency measures since you participated in the 2003 SPC Program that <u>was not part of the 2003 program or any other utility or government energy efficiency incentive program</u>?

Yes	1	
Yes, we submitted for 2003 SPC	2	SKIP TO NS1
No	3	SKIP TO NS1
DON'T KNOW/REFUSED	9	SKIP TO NS1

R2 What type(s) of measures were added, of what size (if applicable), and how many? [Probe as necessary to ensure that measures are really high efficiency, i.e., if equipment, ask efficiency level to confirm exceeds minimum standards]

____

____

R4 How significant was your experience in the 2003 SPC program in your decision to install the additional energy efficiency measures (that was not part of the PY2003 SPC program)?

[**CLARIFY PROGRAM EXPERIENCE REFERS TO ALL FEATURES INCLUDING INCENTIVES, M&V, EXPERIENCE WITH ESCOs THAT WOULD NOT HAVE OCCURRED OTHERWISE, ETC**.]

Extremely significant	1
Somewhat significant	2
Somewhat insignificant	3
Extremely insignificant	4
Don't Know/Refused	99

And why is that? (Point here is to try to establish whether there is any causal relationship between experience in the program and installation of additional measures outside of programs.)

____

R5 Why didn't your organization purchase this equipment through a retrofit or incentive program?

____

NS1 Do you plan to implement any additional energy efficiency measures elsewhere at this facility or at other facilities of your organization in the future as a result of your participation in the PY2003 SPC program?

Yes, plans more measures as result of participation	1	
Yes, plans more measures, NOT as a result of participation	2	
No, no plans for more measures	3	SKIP TO MV1
Don't Know/Refused	99	SKIP TO MV1

NS2 **PROBE**: How has program participation affected your plans? Please describe which measures, how many, and why?

____

____

____

NS3 And how significant was your 2003 SPC program experience in your plans to pursue additional energy efficiency measures? [**CLARIFY PROGRAM EXPERIENCE REFERS TO ALL FEATURES INCLUDING INCENTIVES, M&V, EXPERIENCE WITH ESCOs THAT WOULD NOT HAVE OCCURRED OTHERWISE, ETC**.]

Extremely significant	1
Somewhat significant	2
Somewhat insignificant	3
Extremely insignificant	4
Don't Know/Refused	99

NS4 Do you plan to apply for program incentives (SPC or Express or other) for assistance in installing this additional energy efficient equipment?

Yes, Already have	1	
Yes, Probably	2	
Undecided	3	SKIP TO MV1a
No	4	SKIP TO MV1a

SPC PROCESS-RELATED EXPERIENCE

P2 What do you like about the 2003 SPC program? (what do you view as the primary strengths?) [Note any differences mentioned across program years]

____

____

____

P3 What don't you like about the program? (what do you view as the primary features that need to be improved?)

____

____

____

P4 What do you think about the current incentive structure of the program? (Such as the payout schedule, end use incentive levels, cap on percent of project costs paid by incentives, incentive levels for measured vs. calculated savings)

____

____

____

P5a Please describe your experiences with the payment process for your SPC projects. Are payment procedures and timing of payments reasonable?

Yes 1
No 2
Don't Know/Refused 99

P5b. Please explain.

____

____

P6 Did you use any of the program tools and supporting materials, such as the savings calculator or the website?

P6a. Used calculator?

Yes 1
No 2
Don't Know/Refused 99

P6b. Used website?

Yes 1
No 2
Don't Know/Refused 99

P6c. Where they helpful?

Yes, very helpful 1
Yes, Somewhat 2
No, did not help me 3
No, did not use 4
Don't Know/Refused 99

P6d. Please explain:

____

____

____

P6e. Did you receive assistance from **[UTILITY**] staff with performing energy savings calculations?

Yes 1
No, but requested assistance 2
No, but did not request assistance 3
Don't Know/Refused 99

P6f. Did you receive assistance from **[UTILITY]** staff with filling out SPC project applications?

Yes 1
No, but requested assistance 2
No, but did not request assistance 3
Don't Know/Refused 99

P7a. How would you say that the overall program experience with **[UTILITY]** staff has been to date? Would you say…

Excellent.. 1
Good 2
Acceptable, about what expected 3
Somewhat poor 4
Very Poor 5
No contact with utility 6
DON'T KNOW/NOT APPLICABLE... 9

P7b. Why do you say that? [RECORD VERBATIM]

____

P7c. What, if any other types of assistance that the **[UTILITY]** staff could provide that would be useful to you? [What else could they have done?]

____

____

____

P8. Did you work directly with one of the utilities' technical support contractors during your project? (Clarify if necessary, the firms contracted with the utility to review applications, estimate savings, assist with M&V planning, and perform site visits. Nexant, SBW Engineering, , AESC, KW Engineering; SDG&E uses internal staff only)

Yes 1
No 2
Don't Know/Refused 99

P9a. How would you say that your experience with the **[UTILITY]** technical assistance contractor has been to date? Would you say…

Excellent 1
Good 2
Acceptable, about what expected 3
Somewhat poor 4
Very Poor 5
No contact with technical support contractor 6
DON'T KNOW/NOT APPLICABLE 9

P9b. Why do you say that? [RECORD VERBATIM]

____

P10Aa. If you have participated in the SPC program with more than one utility, did you notice any differences in how the program was designed or administered by those utilities?

P10b. Please elaborate [make sure to specify what utilities are discussed and assign the comments correspondingly.]

____

____

____

P11. How would you rate your OVERALL satisfaction with the 2003 SPC program? Would you say that you are:

Very Satisfied 1
Somewhat Satisfied 2
Neither Satisfied nor Dissatisfied 3
Somewhat Dissatisfied 4
Very Dissatisfied 5
No contact with technical support contractor 6
Don't Know/Not Applicable 9

PROGRAM NON-SPONSORS EXPERIENCE WITH 3RD PARTY FIRMS

THIS SECTION FOR CUSTOMERS WORKING WITH 3rd PARTY FIRMS ON 2003 SPC
****SELF-SPONSORS DOING <u>ALL WORK THEMSELVES</u> SKIP TO NS6 ON NEXT PAGE****

NS3 Had you worked with **SPONSOR**/**FIRM** before you participated in the Program?

Yes 1
No 2
Don't Know/Refused 99

NS7. Do you plan to do future work with **FIRM**(s) as a result of your experience with them as part of the PY2003 SPC?

Yes 1
No 2
Don't Know/Refused 99

Please elaborate.

____

____

ENERGY-RELATED DECISION MAKING

Now I'd like to ask a question about how your organization generally makes energy-related decisions.

DM3a As a result of your participation in the 2003 SPC, have you made any changes in the ways in which your organization makes decisions about whether to implement energy-efficiency projects? [PROVIDE EXAMPLES such as mandatory EE specification policy, internal reward system for reducing energy costs, increased payback threshold, etc.]

Yes 1
No 2
Don't Know/Refused 99

DM3b Please Describe. **[RECORD VERBATIM]**

____

CLOSING

DM4 Are there any other positive or negative effects of your participation in the 2003 SPC that you would like to mention that we have not asked about?

____

____

THANK YOU FOR YOUR PARTICIPATION IN THIS STUDY.

OTHER INTERVIEWER NOTES :

(Please briefly describe your overall impression of the customer's decision-making process. Include any comments on the net-to-gross story, program effects, other input, not clear in the structured questions):

____

____

____

APPENDIX C
SPC PARTICIPANT EESP
INTERVIEW GUIDE

FINAL PY2003 SPC Participant EESP Interview Guide

NAME	PHONE:
TITLE	FAX
COMPANY	E-MAIL
STREET ADDRESS	
CITY	INTERVIEWER
STATE	CALL DATES
ZIP	COMPLETE DATE

Hello, my name is ________, with Quantum Consulting, an energy research firm, and I am calling on behalf of the California Public Utilities Commission and the program evaluation staff at the California Investor-owned Utilities. May I please speak with ______________?

[AFTER REACHING CORRECT CONTACT] We are conducting an evaluation study on behalf of the California Public Utilities Commission. We are contacting energy service companies who participated in California's Standard Performance Contract (SPC) program in the 2003 program year. Your input to this research would be very valuable and, if possible, we would like to interview you. The interview will provide you with an opportunity to provide feedback on your experience with the 2003 SPC program. The interview will take about 20 minutes, and any information that is provided during the interview will remain strictly confidential. We will not identify or attribute any of your comments or company information. Is this a good time, or can we schedule a convenient time in the next couple of days to talk?

[IF HESITANT:] Your input to this survey is very important for ensuring the long-term success of these programs. Without input from industry representatives such as you, we cannot guarantee that the program will receive a fair and complete evaluation.

[IF RELUCTANT BECAUSE THEY WERE A SURVEY RESPONDENT IN PREVIOUS YEARS]: Thank you very much we appreciate your prior participation in an SPC evaluation interview. However, the program has changed significantly over the past few years, as has the market environment in California, and it is critical that we obtain up-to-date information from participating firms on the program as implemented in 2003. Your input is critical to this process.

[IF SCHEDULED:] Callback date/time:

Thank you for taking part in this survey. The major purposes of this study are to provide feedback to the utilities and CPUC on the design and administrative aspects of the program. This interview is focused on experiences with the program to date.

Utility Reference Numbers for Interviewees Wanting to Confirm

PGE	Rafael Friedman	415-972-5799
SCE	Pierre Landry	626-302-8288
SDGE	Henry De Jesus	858-654-1723

I. BACKGROUND INFORMATION (fill out before starting interview)

I'd like to start by reviewing some of the information we have received from the California utilities on your participation in the 2003 and previous years' nonresidential performance contract programs.

(POPULATE FROM DATABASES AHEAD OF TIME and CONFIRM/UPDATE WITH INTERVIEWEE)

A. Our records show that the customers with which your firm worked on the 2003 SPC were:

____

____

____

____

B. Our records show your firm participated in the SPC Program with the following utilities:

PG&E………………………………………………… 1
SCE…………………………………………………… 2
SDG&E……………………………………………… 3

II. FIRMOGRAPHICS

Now I have a few questions on the general characteristics of your company.

A. What type of energy services firm is your firm? Would you say:

[IMPORTANT: NOTE ANY UNIQUE "SELF-CLASSIFICATION" TERMS.]

1. **"Traditional" ESCO** *(predominantly performance based contracts)*
2. **Energy Efficiency Services Company** *(EESP, mostly efficiency services)*
3. **Retail Energy Service Co. (RESCO)** *(selling both energy commodity and efficiency services)*
4. **Architecture / Engineering / Design Engineering**
5. **Building Maintenance and Operations**
6. **Equipment Vendor/Distributor**
7. **Other** *(please describe)*

What are the primary products and service provided by your firm:

____

____

B. Which of the following best describes the geographic focus of your operations?

1. Local – What area? ______________________________
2. Regional – What area? ___________________________
3. Statewide (California)
4. National
5. International

C. How many years has your company been providing energy efficiency services in California?
____

D. Approximately how many full-time equivalent employees (FTEs) do you employ, including all in-house contractors?

___ # FTEs in California?

III. SPC PROCESS-RELATED INFORMATION

Now I am going to ask you a few questions about your firm's experience with the <u>2003</u> SPC program, including your perspective on the program, opinions on how savings and incentives are determined, and your overall satisfaction with the program experience.

A. Please describe your experiences with the 2003 program rules and requirements, including the application process and the program milestones. [CLARIFY WHICH PART OF THE PARTICIPATION PROCESS IS BEING DISCUSSED, I.E. APPLICATION, PARTICIPATION, MEASURED SAVINGS, PAYMENT]

____

____

B. Did your 2003 projects use the "calculated savings" vs. "measured savings" approach for program payment?

Calculated Savings……………………………………………1
Measured…………………………………………………….2 [SKIP TO Question E]
Both………………………………………………………. 3

C. Please describe your perspective on the use of the "calculated savings" approach. What are the advantages and/or drawbacks to that approach based on your experience?

____

____

[IF PARTICIPATING WITH MULTIPLE UTILITIES ASK D (SEE I.B); ELSE SKIP TO E]

D. If applicable, please compare how the "calculated savings" approach was used by different utilities. Did you notice any differences in approach, types of projects allowed to use the "calculated savings" approach or any other differences? Please explain.

____

____

[IF USING MEASURED SAVINGS METHOD ASK E; IF PARTICIPATED BEFORE 2003 (BETWEEN 1998 & 2002) ASK F; ELSE SKIP TO G

E. If applicable, please describe your experiences with the "measured savings" process for your **SPC** projects.

____

____

F. If applicable, please describe your experience with any measured savings reports associated with projects your firm was associated with for program years 1998 to 2002.

____

____

G. Please describe your experiences with the installation requirements and payment process for your 2003 SPC projects. Are installation requirements and payment processes reasonable? Please explain.

____

____

H. What do you think about the incentive structure of the 2003 SPC Program, specifically, end use incentive levels, the payout schedule, payments for calculated vs. measured savings, and the incentive caps?

____

____

I. Please describe any other aspects of the Program that you think were better or worse than in prior years?

____

____

J. How would you rate your OVERALL satisfaction with the 2003 SPC program? Would you say that you are:

1. Very Satisfied
2. Somewhat Satisfied
3. Neither Satisfied nor Dissatisfied
4. Somewhat Dissatisfied
5. Very Dissatisfied
6. Don't Know / Not Applicable

And why is that?____

____

K. How would you say that your experience with the UTILITIES administering the program has been to date? Would you say…

Excellent.. 1
Good... 2
Acceptable, about what expected.. 3
Somewhat poor 4
Very Poor 5
DON'T KNOW/NOT APPLICABLE 99

Why do you say that? [RECORD VERBATIM]

____

L. Did you work directly with one of the utilities' technical support contractors during your project? (Clarify if necessary, they firms contracted with the utility to review applications, estimate savings, assist with measured savings plans, and perform site visits.)

Yes 1
No 2
Don't Know/Refused 99

[IF L=1, ASK M, ELSE SKIP TO N]

M. How would you say that your experience with the TECHNICAL ASSISTANCE CONTRACTORS has been to date? Would you say…

Excellent.. 1
Good.. 2
Acceptable, about what expected... 3
Somewhat poor 4
Very Poor 5
No contact with technical support contractor...................... 6
DON'T KNOW/NOT APPLICABLE 99

Why do you say that? [RECORD VERBATIM]

____

N. Did you use any of the SPC program tools and supporting materials, such as the savings calculator or the website?

Used calculator?

Yes 1
No 2
Don't Know/Refused 99

Used website?

Yes 1
No 2
Don't Know/Refused 99

Where they helpful?

Yes, very helpful 1
Yes, Somewhat... 2
No, did not help me.. 3
No, did not use 4
Don't Know/Refused 99

Please explain:

___

___

IV. SPC-RELATED MARKET AND PROGRAM EFFECTS

Now I have a couple of questions about how the SPC program has affected your firms' business, if at all.

A. Please describe how you use the incentive funds you've received from the 2003 SPC program. Are the funds passed through to the customer, retained completely, or shared between your firm and the customer?

Passed through to completely to customer... 1
Retained completely.. 2
Shared.. 3

B. What effect, if any, has your participation in the 2003 SPC had on your business? For example, has it lead to any improvements in your firms' efficiency-related business development, marketing approaches, costs of serving customers, or product and service offerings?

___

___

C. How important is the SPC program to the energy efficiency portion of your California business? Would you say…

1. Very Important
2. Somewhat Important
3. Not very important
4. Don't Know / Not Applicable

And why is that?

___

___

D. Do you have any examples of particularly innovative, comprehensive, or emerging technologies or projects that the 2003 SPC program made possible? (TRY TO GET CUSTOMER NAME)

___

___

E. You may be aware that the commitment by the CPUC to capture energy savings has increased. Do you have any recommendations on how the SPC program could be modified to capture additional energy savings? Do you see untapped potential that the SPC program could target? (Probe – e.g., emerging technologies)

____

____

F. Based upon your experiences, what do you view as the primary strengths and weaknesses of the 2003 program.

Strengths:____
____
____

Weaknesses:____
____
____

V. OTHER ISSUES

Now I have just a few more questions before we wrap up.

A. Thinking about your sales efforts with customers in California, in what percentage of your sales efforts with them do you promote participation in the SPC?

__________%

B. ***[IF >0% and <100%]*** What criteria do you use to decide whether to promote participation in the SPC program?

____

C. Of your SPC projects ***[discussed on page 2],*** what percentage do you think you would have been able to sell without the SPC incentive payments?____________ (# or %)

And why is that? (Note if project size would have been reduced or if changes by year)

____

D. With regards to who sponsors the SPC application with the utility, does your firm prefer to:

Sponsor SPC applications itself 1
Have the customer sponsor the application... 2

No preference 99

And why is that?

E. Thinking about some of the kinds of things we've been discussing about the 2003 SPC program, are there any major differences in your experience with or opinion about the 2004 SPC program?

F. Are you familiar with the utilities' nonresidential audit program? Yes/No

Has your firm been involved in any SPC work that results from utility audits? If yes, please describe:

Do you have any suggestions for how to improve the audit programs or improve linkages with SPC and other incentive programs?

VI. WRAP-UP

A. Finally, do you have any other comments or suggestions regarding your experience with the SPC Program?

That concludes the interview, thank you very, very much for your participation in this evaluation effort.

THE END