NONRESIDENTIAL SPC M&V CASE STUDY REPORT

FINAL

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EXECUTIVE SUMMARY

In this report, we present 10 case studies of projects conducted under California's 1998 Nonresidential Standard Performance Contract Program (NSPC) and 1999 Large Nonresidential Standard Performance Contract Program (LNSPC), collectively referred to here as the SPC Program. This study focuses on the Measurement and Verification (M&V) component of these projects.

This summary presents a brief overview of the study context and scope, followed by its major conclusions and implications.

E.1 STUDY CONTEXT AND SCOPE

This subsection describes the context for this study and the study's overall scope.

E.1.1 Program Overview

Under the SPC Program, the utility program administrators offered a fixed-price incentive to project sponsors for measured kWh energy savings achieved by an energy-efficiency project. The fixed price per kWh, performance measurement protocols, payment terms, and all other operating rules of the program were specified in a standard contract. The incentive was paid over a 2-year performance period in the 1998-99 programs. During the performance period, the project sponsor, either a customer (self-sponsored) or an energy-efficiency service provider (EESP), was required to measure and verify the energy savings actually achieved using a mutually agreed upon measurement protocol.

The 1998 and 1999 SPC Programs required applicants to submit an M&V plan outlining the proposed method and sampling technique to be used to verify the estimated energy savings from the project. The utility-approved M&V plan was then used to perform M&V over a 2-year period. The results from the average energy savings of the 2 performance years dictated the total incentive amount received by the applicant, but the amount was capped at 10 percent above the contracted amount.

E.1.2 Study Scope and Goal

The overall goal of these case studies was to bring a better understanding of the appropriateness and effects of the M&V required for the SPC Program. The case studies were projects implemented by customers with more than 500kW demand that had completed at least 1 year of M&V. The 10 case studies presented outline the M&V process beginning from the project submittal and savings estimates through the first year (and, in some cases, second year) results. Where possible, we interviewed the customer, the third-party firms sponsoring the project (if applicable), and utility or utility representatives.

Our data collection and analysis were structured to meet the overall goal of this study through a series of research questions that addressed specific study objectives. The research questions were the following:

1. What M&V would participants have done without the 1998-99 SPC Program requirements?
2. What do participants see as the purposes for doing the M&V for the SPC projects and did the M&V fulfill them?
3. What were the positive and negative aspects of the M&V conducted for each project?
4. Have initial attitudes about the M&V changed since the initial phases of the projects? If so, how have they changed?
5. How did the M&V process and results influence the confidence participants had in their ability to estimate energy savings accurately?
6. What market effects and other broader effects did the M&V have?
7. Was the M&V worth the effort and resources it required? Would participants have traded off conservative savings estimates for a simpler method?
8. What do participants think about the M&V changes since the 1999 program?

There are two important points that the reader should keep in mind regarding this study. First, the program and M&V requirements have been modified since the 1998-99 programs. The M&V modifications were made largely to address concerns about the M&V that were raised during the first 2 years of the program. Consequently, an important purpose of this study was to provide a retrospective review of the significance of these original issues and insights into implications of the M&V changes that have been made since 1999. Second, our study was based on information gathered only from 1998-99 program participants who had completed at least 1 year of M&V. No information was obtained from participants who decided to drop out of the program after submitting an application or did not complete their M&V within the program timeframe. Consequently, our results did not reflect the views and experiences of program applicants who did not complete the formal M&V process as intended by the program designers.

E.2 KEY CONCLUSIONS AND IMPLICATIONS

This subsection highlights the key conclusions of this study. It also presents implications from the study that are relevant to the SPC Program.

E.2.1 Key Conclusions

The key conclusions from our study are summarized below. As noted above, these conclusions did not reflect the perspective of participants who had not completed the program application process and at least 1 year of M&V by the time we conducted our participant interviews.

- ***Attitudes toward the M&V process were more positive overall than we had anticipated.*** The 1998-99 program participants that we interviewed provided generally neutral or positive feedback about the original requirements.
- ***Several participants attributed benefits to the M&V that went beyond the energy savings estimates.*** Benefits mentioned included providing a better understanding of production processes and operations, improving energy savings estimation methods; incorporating the M&V results in marketing or energy-efficiency project promotional efforts (internal and external); and increasing confidence in energy-efficiency projects.
- ***Even without the SPC Program, participants probably would have conducted M&V in most of these projects, but it would have been less rigorous.***
- ***Both customers and EESPs indicated that the SPC M&V had significant lasting positive effects on their M&V practices***.
- ***Most participants felt that the M&V provided accurate energy savings information.***
- ***Cost was mentioned most often as a negative aspect of conducting the SPC M&V, followed by the length of the process and its complexity.***
- ***The M&V process had several positive effects on participants' behavior and attitudes.***
- ***Almost every participant interviewed felt that the M&V was worth what it cost to do.***
- ***Although some customers and EESPs said they would have accepted a more conservative energy savings estimate for a less rigorous M&V approach, most said that it would have depended on the tradeoff or nature of the project.***

E.3 IMPLICATIONS

The most significant negative aspects associated with the 1998-99 SPC Program M&V involved cost, timing/time required, and complexity. These issues have surfaced in evaluations of subsequent SPC Programs and efforts should continue to be directed at resolving these issues.

Overall, it appears that modifying the M&V requirements to add a calculated savings option was a suitable response to early concerns about the burden of the M&V requirements. However, our results indicated that these concerns were not universal and that, given a choice, participants in many of these projects would have opted for the original approach to obtain a larger incentive.

Data presented in the most recent evaluation of the SPC Program showed that the characteristics of typical projects have changed in important ways in 2001, and the changes may be related to the introduction of the calculated M&V approach. The most common M&V approach used in 2001 SPC Program projects was the calculated savings approach and larger shares of the 2001 projects were self-sponsored and smaller in scope than in preceding years. Our findings from the 1998-99 M&V case studies and these trends both suggested that the availability of the calculated savings approach has contributed to an increase in self-sponsorship and smaller projects.

Observations by 1998-99 program participants that there were benefits of the M&V in addition to the direct measurement of energy-savings were fairly common. The benefits included providing information about how to improve energy savings estimates, developing a better understanding of production processes or system operations, and equipping participants better to pursue additional energy-efficiency projects. Some of these could be considered "spillover" effects that have resulted in indirect energy savings attributable to the program. From a program perspective, some of these benefits could become part of the strategy for promoting the program—i.e., these benefits could be included in the messages used to market the SPC Program.

Finally, since we collected data and information only from program applicants who successfully completed the M&V process as intended, the findings might not reflect the issues and problems encountered by some applicants for less successful projects. We believe that it would be informative to interview applicants who chose not to go through with their projects and those who did not complete the M&V in a timely fashion.

1 INTRODUCTION AND OVERVIEW

This report presents 10 case studies from projects conducted under California's 1998 Nonresidential Standard Performance Contract Program (NSPC) and 1999 Large Nonresidential Standard Performance Contract Program (LNSPC), collectively referred to here as the SPC Program. In 1998, all large nonresidential customers with a demand of 500 kW or more were eligible for the NSPC Program. In 1999, the program was divided into two components—the Small Business SPC (SBSPC) Program, which accepted customers with less than 500kW demand, and the Large SPC Program, which accepted customers with a demand of 500kW or more. These case studies focus on projects conducted with customers with over 500kW demand. Therefore, no projects from the SBSPC Program or from smaller (<500kW) customers were evaluated.

1.1 STUDY GOAL AND OBJECTIVES

The overall goal of these case studies is to bring a better understanding of the appropriateness and effects of the measurement and verification (M&V) required for the SPC Program. Unlike other types of utility energy-efficiency programs, M&V has been a critical component of the SPC Program. The 10 case studies presented here outline the M&V process beginning from the project submittal and savings estimates through the first year (and, in some cases, second year) results. Where possible, we interviewed the customer, the third-party firms sponsoring the project (if applicable), the M&V reviewer, and utility representatives.

Our data collection and analysis were structured to meet the overall goal of this study through a series of research questions that addressed specific study objectives. The research questions were the following:

- What M&V would participants have done without the 1998-99 SPC Program requirements?
- What do participants see as the purposes for doing the M&V for the SPC projects and did the M&V fulfill them?
- What were the positive and negative aspects of the M&V conducted for each project?
- Have initial attitudes about the M&V changed since the initial phases of the projects? If so, how have they changed?
- How did the M&V process and results influence the confidence participants had in their ability to estimate energy savings accurately?
- What market effects and other broader effects did the M&V have?
- Was the M&V worth the effort and resources it required? Would participants have traded off conservative savings estimates for a simpler method?
- What do participants think about the M&V changes since the 1999 program?

It is important to point out that the program and M&V requirements have been modified since the 1998-99 Programs. The M&V modifications were made largely to address concerns about the M&V that were raised during the first 2 years of the program. These concerns primarily involved the complexity, cost, resources, and time required to meet the original M&V requirements. Consequently, an important purpose of this study was to provide a retrospective review of the significance of these original issues and insights into implications of the M&V changes that have been made since 1999.

1.2 OVERVIEW OF THE SPC PROGRAM

Under the SPC Program, the utility program administrators offered a fixed-price incentive to project sponsors for measured kWh energy savings achieved by an energy-efficiency project. The fixed price per kWh, performance measurement protocols, payment terms, and all other operating rules of the program were specified in a standard contract. Table 1-1 presents the incentive levels per kWh for the 1998 and 1999 SPC Programs[1].

Table 1-1
Incentive Levels for 1998 and 1999 SPC Program

Measure category	1998 cents/kWh	1999 cents/kWh
Lighting	7.5	5
HVAC and refrigeration	21	16.5
Other	11	8

The SPC is a "pay-for-performance" program. In traditional utility rebate programs, the utility pays a predetermined incentive directly to its customer based on estimated of annual savings from a project. However, under the SPC Program, the utility pays a variable incentive amount to a third-party energy efficiency service provider (EESP) or to a customer acting without a third-party EESP, based on measured energy savings and a fixed amount per kWh saved. The SPC also differs from traditional utility rebate programs in that the total incentive is paid over a 2-year performance period (as configured in the 1998-99 programs). During the performance period, the project sponsor must measure and verify the energy savings actually achieved using a mutually agreed upon measurement protocol.

1.3 OVERVIEW OF SPC PROGRAM M&V REQUIREMENTS

The 1998 and 1999 SPC Programs required applicants to submit an M&V plan outlining the proposed method and sampling technique to be used to verify the estimated energy savings from the project. The utility-approved M&V plan was then used to perform M&V over a 2-year period. The results from the average energy savings of the two performance years dictated the total incentive amount received by the applicant, but the amount was capped at 10 percent above

[1] For further information on the SPC Programs, see evaluations on the program performed in 1999 and 2001: *Evaluation of the 1998 Nonresidential Standard Performance Contract Program*. Volume I Final Report. XENERGY. June 1999; *1999 Nonresidential Large SPC Program*. Volume I Final Report. XENERGY. January 2001. *2000 and 2001 Nonresidential Large SPC Evaluation Study*. Final Report. XENERGY. December 2001.

the contracted amount. The following subsections present an overview of an M&V plan, and the chronology of steps involved for a project submitted to the SPC Program.

1.3.1 M&V Plan Requirements

The M&V sections in the SPC procedure manuals provided general guidelines and requirements for preparing an M&V plan. These sections also aided the applicant in submitting all necessary information, choosing an M&V option and method, defining and adjusting baselines, and collecting and submitting M&V data.

Chapter 11 of the 1999 SPC Procedures Manual[2] contains a list outlining the requirements for a complete M&V plan (similar requirements are in the 1998 Section III M&V Procedures, Chapter 2[3]). The M&V plan, at a minimum, must include the items on the list. The following items are discussed in the case studies as part of the M&V process:

- Description of measures
- M&V Option and method
- Party responsible for the M&V activities
- Methods for determining baseline energy consumption and baseline adjustments, if any
- Description of sampling conducted, if any.

The above details, if provided in the project files (i.e., the submitted/approved M&V plan), are discussed in the case studies. Even with a checklist at the end of Chapter 11 of the 1999 Procedures Manual or a list of requirements provided in both years of the program, most applications to the program did not include all the above information. Some flexibility was allowed for project submittals, but, in general, most of the requirements dictated in the Procedure Manuals were necessary for approval of applications.

To assist applicants, the manuals contained detailed M&V descriptions for the following common measure categories:

- Lighting efficiency and controls
- High efficiency motor replacement
- Installation of variable-speed drives (VSDs)[4] on motors
- Chiller replacement
- Installation of VSDs on chillers.

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[2] *California's 1999 Large Non-Residential Standard Performance Contract Program Procedures Manual*. Prepared for Pacific Gas and Electric Company, San Diego Gas & Electric, Southern California Edison by Schiller Associates. Version 2.0 July 1999.

[3] *1998 California Non-Residential Standard Performance Contract Program Procedures Manual*. Prepared for Pacific Gas and Electric Company, San Diego Gas & Electric, Southern California Edison. Version 1.1 January 1998.

[4] We use the terms variable-speed drives (VSDs), variable-frequency drives (VFDs), adjustable-speed drives (ASDs), and adjustable frequency drives (AFDs) interchangeably in this report.

1.3.2 Summary of M&V Process Steps

The steps below reflect the typical M&V process used for the 1998/1999 projects. The steps listed here are particular to the M&V process. Some process steps were modified in subsequent years. In addition, the procedure for reviewing projects varied somewhat among different consultants and across utilities.

1. Detailed project application (DPA)[5] is submitted by applicant. It includes a detailed savings estimate and M&V plan.
2. Technical consultant reviews M&V plan to determine if it satisfies program requirements.
3. Technical consultant requests more information from applicant if paperwork is incomplete (such as missing the information listed under the M&V requirements); this process may require more than one iteration.
4. Project sponsor resubmits DPA or M&V plan.
5. Once the M&V plan and paperwork are finalized, the application is approved for contract.
6. After installation and commissioning occur, applicant submits the Project Installation Report (PIR). In cases where changes occur from the original project description, the applicant must revise the savings estimate and the M&V plan. If the savings estimate or the pre-installation monitoring for M&V show the savings estimate to be below 70 percent of the contracted energy savings, then the contract is amended.
7. After 1 year of M&V is completed, the applicant sends in M&V results and an explanation with any changes that were necessary to complete reporting of performance year results.
8. The technical consultant reviews the submitted results. The consultant may require modifications to the calculations to reflect the original M&V plan or to address any changes made during the process.
9. In some cases, the M&V plan may be simplified or require additional work for the second year of M&V.
10. The applicant submits the second year M&V report or ASR.[6] Steps 7 and 8 are repeated.

[5] While there is some description of the M&V plan in the Basic Project Application (BPA), it typically does not include much information to make a thorough review of the M&V plan.
[6] In the 1998 Program, the reports submitted with M&V results were called M&V Reports. In 1999, the name of this submittal was changed to the Annual Savings Report (ASR).

1.3.3 M&V Options

The options and methods used in California's SPC Program are adapted from the International Measurement and Verification Protocol (IPMVP) and the Federal Energy Management Program M&V Guideline. Table 1-2 outlines the four options described in the IPMVP.

Table 1-2
M&V Options from the IPMVP

Option	Name	Description
A	Stipulated Savings	No measurements are made, just calculated savings. THIS OPTION WAS NOT ALLOWED IN THE 1998 or 1999 SPC PROGRAM.
B	Metered Savings of Equipment or Systems	This is the recommended option because it required short-term or continuous monitoring. The measurements are used to calculate the energy savings at measure level.
C	Building Analysis Using Regression Models	This method involves comparing monthly bills for the whole building and sub-metering. This option also includes analyzing data to account for variables that affect energy savings (adjusted to post-installation conditions).
D	Computer Simulation	This option involves using software to create a simulation model. The model is calibrated using billing or end use monitoring data. For this M&V option, only non-proprietary software is appropriate.

Most, if not all, applications included one of the options as their proposed M&V strategy or addressed why the applicant thought the option would not be appropriate. Under Option B, the most commonly used option for SPC Program projects, there are many metering methods depending on the measure technology. In eight of the following case studies the projects used M&V Option B. This option is used for common measures such as lighting efficiency and controls, high efficiency motor replacement, installing a VSD on motors, chiller replacement, and installing a VSD on chillers. One method under Option B is the GVL-B-01 (GVL is general variable load), which includes direct metering and regression analysis. This method should encompass most energy retrofits that can employ direct monitoring and for which savings can be verified.

1.4 CASE STUDY SAMPLING PROCEDURE

The 10 projects analyzed were chosen from the pool of projects submitted by customers with >500kW demand that had completed at least the first performance year of M&V by June 2001, which included 11 from PG&E, 26 from SCE, and 15 from SDG&E territory. In total, there were 52 projects. However, because some of the applicants did the same type of projects in the same or different utility areas, there were only 40 unique project/customer applications. We selected 10 projects for the case studies to ensure a representative mix by utility, project size, project/measure type, end-user type, and sponsor type. Section 2 provides additional information on the characteristics of the 10 projects chosen.

It is important to point out that many of the projects for which applications were submitted had not completed their first year of M&V by June 2001. A total of 318 applications were filed in 1998 and 1999, representing 212 unique projects/customers. Therefore, our sample frame included only 19 percent of the unique project applications files. We did not have data indicating which applications were withdrawn and which projects had taken much longer than anticipated and had not completed their M&V within the expected timeframe. This is critical because the information we collected for the case studies and our resulting conclusions are, therefore, based on a subset of the original applications. For this reason, our findings cannot be assumed to be representative of all the initial applicants and some of those not included in our sample frame might have withdrawn from the program because of the M&V requirements or been unable to complete the M&V within the allotted time because of complexities or problems that arose.

Generally, the combinations of the M&V plan, technical review, and the application for the projects were all unique. Therefore, while some of the case studies had similar measures, such as lighting retrofits, their circumstances often differed and they did not necessarily follow the same M&V methodologies or sample M&V plan in the manual. This was because an M&V plan typically was tailored specifically to the project submitted. In addition, the technical reviewers took different approaches to similar projects, leading to variations among and within the projects in the utilities' service areas. Table 1-3 shows the 10 projects selected for our case studies.

Table 1-3
Summary of Projects Chosen for Case Studies

Project Number	Utility	Year	Type of Project
1	SCE	1998	Lighting
2	SCE	1999	Lighting
3	PG&E	1998	High-efficiency chiller with VSD
4	SDG&E	1998	Compressed air
5	SCE	1998	Compressed air
6*	All	1998	Anti-sweat door heaters, refrigeration optimization, and VSDs on fans
7	PG&E	1998	Refrigeration controls and equipment removal
8	PG&E	1999	Oversized evaporative condenser, refrigeration controls, and refrigeration upgrades
9	PG&E	1998	Additional process equipment
10	SDG&E	1998	Lighting, HVAC EMS and upgrades

*This project also has gas savings, which were not paid for in the PY 1998 SPC Program.

1.5 CASE STUDY REPORTS

Appendix A presents the interview guides we used to collect information for these case studies through telephone interviews. The individual case studies are presented in Appendices B-K.

They include summaries of the M&V process from submittal to approval of the M&V plan to the approval by the utility or their technical consultant of the performance year results. The case studies also include the gross realization energy savings rate. The gross realization energy savings rate is calculated by dividing the performance year kWh (and if there are 2 years of data, their average) by the contracted energy savings (the DPA kWh savings amount). Most of each projects' relevant players were interviewed with their comments and reactions included.

2 CASE STUDY SUMMARIES

This section summarizes information on each of the 10 projects reviewed for this study. The appendixes provide in-depth case study write-ups for the 10 projects, which include summaries of the M&V process from the project files received from the utilities and from project participants that we were able to interview.

2.1 PROJECT CHARACTERISTICS

We chose the 10 projects for the case studies to ensure a cross-section of various project and customer types. The projects were distributed fairly evenly across customer types—industrial, institutional, and commercial—as shown in Table 2-1.

Table 2-1
Type of Customer

Customer Type	Number
Industrial	4
Institutional	3
Commercial	3

We also tried to select projects with a variety of sponsorship types and amount of assistance received by customers. Table 2-2 shows the number of projects in each of three categories: self-sponsored, self-sponsored with EESP help, and EESP-sponsored.[1]

Table 2-2
Type of Project Sponsor

Sponsor Type	Number
Self	3
Self with EESP help	2
EESP	5

Table 2-3 displays specific information for each project in terms of sponsorship, customer type, and the type of project measures implemented. The projects are listed in order from the simplest to the most complex in terms of the M&V implemented (see Section 2.2).

[1] These categories were developed through previous evaluations of the SPC Program. Self-sponsored customers act as their own sponsor of record on the SPC application. "Self-sponsored with EESP help" covers applications where an EESP, while not sponsoring the application, plays a significant role in the decision-making process or the implementation of the project. EESP-sponsored applications are where the EESP elects to act as the sponsor of record.

Table 2-3
Project Characteristics

Project Number	Type of Project	Customer Type	Project Sponsor
1	Lighting	Institutional	EESP
2	Lighting	Commercial	EESP
3	High efficiency chiller with VSD	Institutional	EESP
4	Compressed air	Institutional	Self w/help
5	Compressed air	Industrial	EESP
6	Anti-sweat door heaters, refrigeration optimization, and VSDs on fans	Commercial	EESP
7	Refrigeration controls and equipment removal	Industrial	Self
8	Oversized evaporative condenser, refrigeration controls, and refrigeration upgrades	Industrial	Self
9	Additional process equipment	Industrial	Self
10	Lighting, HVAC EMS and upgrades	Commercial	Self w/help

Table 2-4 provides the measured energy savings and gross realization rate for each project. The kWh savings varied by almost a factor of 100, from about 340,000 kWh to over 30 million kWh per year. We extracted these values from the project files received from the utilities. We calculated the gross realization rate for each project. The gross realization rate is the actual energy savings determined from the M&V performed divided by the contracted energy savings. The contracted kWh is the approved amount at the DPA phase of the project. After the DPA is approved, a contract is delivered by the utility to the applicant. The gross realization rate varied from project to project, ranging from 70 percent to nearly 20 percent. The rate did not appear to be correlated with project measures implemented, project size, or customer type. For the 10 projects, the average gross realization rate was 111 percent. The high gross realization rate possibly signifies that the participants estimated savings conservatively. Because the required data were not available for all projects that had completed at least 1 year of M&V by June 2001, we could not calculate the gross realization rate for all the projects. One utility did provide both the DPA and actual energy savings (M&V performance year results) approved amounts, which resulted in a 100 percent gross realization rate.

Table 2-4
Energy Savings and Gross Realization Rate

Project Number	Type of Project	kWh savings	Gross Realization Rate
1	Lighting	16,962,599	84%
2	Lighting	5,157,795	93%
3	High efficiency chiller with VSD	338,005	70%
4	Compressed air	380,667	142%
5	Compressed air	343,699	82%
6*	Anti-sweat door heaters, refrigeration optimization, and VSDs on fans	6,722,979	83%
7	Refrigeration controls and equipment removal	373,895	164%
8	Oversized evaporative condenser, refrigeration controls, and refrigeration upgrades	6,853,980	195%
9	Additional process equipment	30,609,050	95%
10	Lighting, HVAC EMS and upgrades	2,737,265	98%

* This project was conducted in all three utility areas. The kWh is the sum and the gross realization rate is the average across the three utilities.

2.2 M&V METHODS

Table 2-5 shows the M&V method used for each project and provides a description. We ranked these projects in order of complexity (from least to most complex) based on the M&V method employed. Eight of the 10 projects discussed in this report used M&V Option B. Since Option B (as described in Section 1) was used most frequently, the Procedure Manual has templates or methodologies on how to pursue certain measures using this M&V option. The two lighting projects and the chiller replacement project with VSD (projects 1-3) are examples of projects that used the Option B method. They implemented an M&V plan that can and did follow the methodology suggested in the Procedure Manual. The other projects using Option B used the General Variable Load method that does not have a template or specific methodology to follow, but can be made unique to the measures implemented.

Table 2-5
M&V Method and Description

Project Number	Type of Project	M&V Method	M&V Description
1	Lighting	LE-B-01	Lighting Efficiency: Monitoring Operating Hours
2	Lighting	LE-B-01	Lighting Efficiency: Monitoring Operating Hours
3	High efficiency chiller with VSD	CH-B-02	Chiller Replacement: Metering Chiller kW and Cooling Load
4	Compressed air	GVL-B-01	General Variable Load: Continuous Monitoring
5	Compressed air	GVL-B-01	General Variable Load: Continuous Monitoring
6	Anti-sweat door heaters, refrigeration optimization, and VSDs on fans	LC-B-01; VSD-B-01; GVL-B-01	Lighting Circuits*: Measuring Power Draw or Current Flow; Variable-Speed Drive: Constant Baseline; General Variable Load: Continuous Monitoring
7	Refrigeration controls and equipment removal	GVL-B-01	General Variable Load: Continuous Monitoring
8	Oversized evaporative condenser, refrigeration controls, and refrigeration upgrades	GVL-B-01	General Variable Load: Continuous Monitoring
9	Additional process equipment	Option C	Billing Analysis Using Regression
10	Lighting, HVAC EMS and upgrades	LE-B-01; Option D	Lighting Efficiency: Monitoring Operating Hours ; Computer Simulation

* Even though this M&V option was designed to be applied to lighting measures, it was chosen for the door heaters (see Appendix G).

2.3 CASE STUDY SUMMARIES

The following summaries provide an introduction to the 10 projects we analyzed. For more detail, we refer the reader to the appendixes.

2.3.1 Project 1: County Lighting Retrofit

Project 1 involved lighting retrofits at various county facilities (and traffic lights). The EESP sponsor used the M&V plan prescribed in the Procedures Manual for lighting in multiple buildings. Two important M&V issues in the project were aggregating project sites and developing an appropriate sampling plan. The EESP and the technical consultant reached an

agreement on these issues. The customer was allowed to substitute project sites if sites dropped from the program, and the technical consultant attempted to keep the number of sites monitored to a minimum. The customer found that the M&V was useful, and it has become a general requirement for their energy-efficiency projects. They felt that the M&V provided them with valuable information about the contractor's performance in achieving their guaranteed savings contract amount and about the operating hours in their various locations. The customer used the M&V results to sell more projects to the county decision-makers. The EESP felt that less rigorous M&V could have been used and would have produced results similar to those from the SPC M&V protocol. The EESP has used the M&V results as an information source for their library and for their marketing materials.

2.3.2 Project 2: Lighting Retrofit in Office Buildings

This EESP-sponsored project conducted lighting retrofits in a large number of office buildings. The M&V plan used was based on the plan provided in the Procedures Manual. The problems that arose were that some loggers did not record properly (probably because they were not installed correctly), and some items were not monitored as required. In general, the EESP felt that the M&V was worth the cost. Because they had a good understanding of lighting energy saving estimation and the M&V process, the EESP felt there was no difficulty in doing the required M&V. The EESP used the results for marketing materials. One concern emphasized by the EESP was that the energy crisis prompted customers to reduce their lighting usage and, because of the way the energy savings were calculated (operating hours were measured during the period when voluntary curtailments were occurring), this reduced the estimated savings and their incentive level.

2.3.3 Project 3: Chiller Retrofit

An EESP submitted an SPC Program application for a chiller retrofit at a state university building. They installed a smaller VSD chiller in place of an oversized chiller without a VSD. The variable control allowed the chiller output to match the loads better. The EESP employed the M&V plan provided in the manual for this type of project, and it cost between $10,000 and $13,000. No comments were available from the customer on this project because the contact person had retired and the interim replacement did not know the particulars of the project. The EESP, however, was interviewed. The EESP said that benefits of doing the M&V included learning the dynamics of the system and operations and also gaining insights for future projects, particularly in estimating the energy savings. This interviewee said that the results were being used in marketing materials.

2.3.4 Project 4: Air Compressor System Retrofit

This project is a total air compressor system retrofit at a distribution facility for an institution. The customer self-sponsored but received help from an EESP with the M&V and administrating the paperwork for the program. The customer replaced an air compressor with two smaller, more efficient ones. The old air compressor remained in place for backup. Two more receivers and other devices that reduced total system energy use were added. They did some baseline

monitoring and continuously monitored the air compressors' energy use and recorded process throughput during the performance years. From the customer's perspective the purpose of the M&V was simply to receive the incentive. The M&V cost $7,500 for this project. The EESP that assisted with the project believed that there were advantages from the M&V that the customer did not recognize. Since the monitoring system would remain in place, according to the EESP, the M&V provided information for troubleshooting and preventive maintenance of the air system.

2.3.5 Project 5: Air Compressor Retrofit at a Wheel Manufacturer

An EESP-sponsored wheel manufacturer submitted an application to the SPC Program to do an air compressor retrofit. The project was to install a new air compressor to replace three less efficient compressors and to interconnect two air systems. There were disagreements between the EESP and the utility's technical consultant on the way to implement the M&V for this project. Additionally, the EESP felt that the utility and its technical consultant were not sufficiently knowledgeable about air compressor systems. The EESP mentioned that they wanted to assume the air compressor energy use was constant, but it was discovered that production levels were highly variable and, consequently, so was the air compressor system energy use. As a result, the technical consultant recommended a baseline regression model, which the EESP approved. When the project completed 1 performance year, the technical consultant discovered that the regression model did not appropriately model the system. The M&V methodology used to determine energy savings resulted in using constant energy use in two shifts of operation, weekdays and weekends. With this approach, no correlation to production levels was needed.

The customer and EESP had some differing views on the overall assessment of the M&V. One reason was that the customer wanted no role and had no role in the M&V process. This was the reason they hired an EESP. The customer said the M&V showed that they were on the right track and provided more accuracy than just using billing data because their production fluctuations were large. On the same note, they felt that due to these fluctuations and periodic design changes in their production process, only 1 year of M&V might have been sufficient. The EESP had a more negative view of the M&V. As stated above, the EESP felt that the technical consultant did not understand the project. In their opinion, this resulted in a costly and difficult M&V plan. They reported the M&V for this project cost $12,000.

2.3.6 Project 6: Grocery Store Retrofits

One EESP-sponsored customer with sites in all three utility territories submitted applications for doing one, two, or all three of the following retrofits: anti-sweat door heater controls, VFDs for air handling unit fans, and refrigeration optimization. They employed a different M&V plan for each one. Some revisions were required by the utilities to these M&V plans, which were implemented. The utilities did not allow any sampling of the stores for any of the measures, i.e., they had to monitor every installation. The customer liked that the M&V verified the energy savings and allowed them to receive the incentive. The EESP did not have very positive views about the M&V but recognized that it was necessary to receive the incentive. The EESP typically used billing data and their analytical software for M&V for their guaranteed savings projects.

The customer had confidence in the EESP and trusted them, so they had not reviewed any of the results from the EESP. The EESP had used the results to improve their own analysis tools but felt that using assumptions to estimate energy savings could have minimized the M&V necessary.

2.3.7 Project 7: Dairy Products Manufacturing

A self-sponsored project was done at a refrigerated warehouse that manufactures dairy products. The retrofit included using existing excess cooling capacity from one process in another. This eliminated the need for the existing cooling equipment. The removal of the equipment resulted in energy savings. According to the customer, their submitted and approved M&V plan was appropriate. They felt that if projects had higher levels of complexity than the project they implemented, then the SPC M&V requirements could become unreasonable. One lesson they learned from the process was that M&V and SPC Program participation took longer than expected. If they do M&V in the future, they would know better what to expect.

2.3.8 Project 8: Carrot Processing Refrigeration

A carrot processor self-sponsored a retrofit of their refrigeration system by installing new controls, changing their single-stage system to a two-stage compressor system and installing two new oversized evaporative condensers. This project incorporated continuous monitoring of the energy-using equipment while monitoring the production levels. They experienced high efficiency levels with their new system that resulted in lower energy consumption per pound of carrot product. They were able to complete their second year of M&V in less than 1 year to reach their incentive cap, which was 10 percent above the contracted amount.

The customer felt that the difficulty and costs of M&V were worth it. The M&V showed them the importance of baseline data, and they stated that, in the future, they would like to develop a better baseline by monitoring for a longer period. They felt that the M&V provided benefits to the company by allowing production staff to do a better job managing their production and allowing them to operate more efficiently.

2.3.9 Project 9: Manufacturing of Industrial Gases

A self-sponsored customer submitted an application to shut down an inefficient facility and expand production capabilities at another, more efficient facility. The customer chose to proceed with the SPC project internally. One reason was that they had proprietary technologies, and it would have been difficult to have people outside their industry understand their technology. They developed a regression analysis of billing data and production levels with some sub-metering data. They predicted and actually saved more than 30 million kWh. This company felt that the M&V was worth it despite the complicating and resource intensive aspects of the M&V.

2.3.10 Project 10: Total HVAC and Lighting Retrofit in an Office Building

This is the only case study to use Option D, Computer Simulation. The self-sponsored customer (a commercial office building) had two EESPs provide substantial help on the project, which was

a lighting retrofit and a large retrofit to their HVAC system. The lighting part of the project followed the LE-B-01 M&V plan as outlined in the Procedures Manual. The HVAC retrofit consisted of installing direct digital controls, a VSD chiller, and an oversized cooling tower; upgrading their variable air volume distribution system; and installing VSDs on pumps and fans. Due to the complexity of sub-metering all equipment affected by the project and interactive HVAC effects (pointed out by the HVAC EESP), the EESP decided that using the DOE-2 simulation model would be their most reliable M&V method. The utility program administrators did not generally recommend this option because of its cost unless the potential and estimated savings were high. This project was large enough to justify the additional M&V work. The customer, nevertheless, felt the M&V was not worth the cost because they believed that analysis of the utility bills would have been good enough. The HVAC EESP, on the other hand, believed that the M&V was worth the cost, but felt that it was close to the threshold of what was acceptable. The M&V process made the EESP spend more time fine-tuning the building system efficiency, hence increasing the potential energy savings.

3 M&V FINDINGS

We investigated differences in the responses that might have resulted from various factors. We examined whether there were differences between the responses of customers and EESPs; if there were differences, they are summarized here. We also anticipated that the degree of complexity of the M&V required by a project would affect participants' perceptions about M&V. We used the M&V options shown in Table 1-2 as a measure of complexity and defined two subcategories within Option B that represented different complexity levels. The categories are shown in Table 3-1. Each project was assigned to one of these categories depending on the type of M&V conducted. We examined differences in participants' responses across these complexity categories and, where evident differences occurred, we report them in the following subsections.

Table 3-1
M&V Complexity Categories

Option	Name	Description
B1	Metered Savings of Equipment or Systems	This method involves end-use metering. B1 in this paper refers to M&V plans that are based on the Procedure Manuals methodologies.
B2	Metered Savings of Equipment or Systems	This method is referred to as GVL-B-01. It requires end-use monitoring, mostly with a combination with an independent variable.
C	Building Analysis Using Regression Models	This method involves comparing monthly bills for the whole building and sub-metering. This option also includes analyzing data to account for variables that affect energy savings (adjusted to post-installation conditions).
D	Computer Simulation	This option involves using software to create a simulation model. The model is calibrated using billing or end-use monitoring data. For this M&V option, only non-proprietary software is appropriate.

We also anticipated that customers' attitudes and perceptions might be affected by the degree to which they had help in conducting their SPC project. The range varied from self-sponsored projects, in which the customer had no help, to projects sponsored and implemented completely by an EESP. We compared customer responses across three categories representing different levels of help (self-sponsored, self-sponsored with help, and EESP-sponsored) provided to participating customers and reported differences that appeared to be related to this factor.

3.1 BASELINE M&V PRACTICES

It was useful to determine what the baseline M&V practices were for each participant. Doing so helped identify how much of a change the SPC M&V requirements represented from typical practice. To determine baseline practices, we asked each participant what type of M&V, if any,

they typically did in prior energy-efficiency projects similar to the one conducted under the 1998-99 SPC Program.

Of the six customers who responded, all said that they had conducted M&V in some of their projects, but only five indicated that they did M&V on a regular basis (one said they only did it when required by a utility program). All said that the M&V they conducted was typically less rigorous (usually based on billing data) than that required by the 1998-99 SPC Program. For those customers who elaborated on the reasons they conducted M&V, the most common reason was to confirm the expected energy savings. One customer whose plant produced compressed gases noted that the M&V conducted was more extensive than what they typically did, but it was especially important to them because their energy consumption was significant—

> *We had never done M&V this extensive before, but we monitor energy use very closely—70 percent of our production cost is electricity, and we will monitor use before and after upgrades to determine the effect on energy use. We had never done 2-year monitoring before and this was a big change. We had done about six utility projects before and had to do some verification, but this was by far the most complex.*

All seven EESPs indicated that they regularly conducted M&V as part of their efficiency projects. Consistent with the customers' responses, the M&V conducted by the EESPs was usually less rigorous than what was required by the SPC, often relying on billing data alone. However, the EESPs, in general, were more committed to doing M&V and seemed to appreciate its benefits more. Two stated that their M&V usually involved logging end-use energy data (sometimes through EMS systems). Two indicated that the level of M&V was driven by customer requests. One EESP stated, "[If it's not required for a utility incentive,] then we do a light M&V to confirm savings to customers." Another EESP noted, "We have included M&V pretty routinely since we started efficiency projects. The main reason initially was we were doing shared-savings projects and needed to know the savings."

3.2 SPC PROGRAM M&V PURPOSES AND PERFORMANCE

It is important to determine participants' overall understanding and assessment of the SPC M&V process. To establish what purposes the participants thought the SPC M&V served, we asked each two questions. The first was what purpose the participants thought the program designers had for including the M&V requirements. The second was what the participants saw as the purpose of the M&V from the perspective of their company's needs. We also asked participants how well they thought the M&V satisfied those purposes.

As shown in Table 3-2, the most common reason customers and EESPs gave for the program designers including the M&V requirements was to verify the energy savings, thus ensuring that the investment was cost-effective. Some elaborated that it was incumbent on the utilities to demonstrate that their revenues were providing a suitable return. The second most common reason was a similar one—ensuring that the funds were spent appropriately. The third most common reason was also similar—avoiding giveaways and keeping participants honest—but

reflected a more negative view that past programs had given funding for less worthy projects. One customer offered the view that the M&V requirements were designed by engineers to keep them employed.

Table 3-2
Participants' View of Why Program Designers Required M&V

Participants	Verify Savings/Good Return on Investment	Spending Money Appropriately	Avoid Giveaways/Keep Participants Honest	Keep Engineers Employed
Customers, n=8[1]	63% (5)	38% (3)	25% (2)	13% (1)
EESPs, n=6	83% (5)	33% (2)	33% (2)	0%
Note: Numbers in parentheses are the number of respondents in the category.				

According to most of the customers and EESPs, the M&V satisfied the purposes that they felt the program designers had in mind (see Table 3-3). Those respondents who disagreed generally commented that the M&V was too complex and expensive, implying that it wasn't worth its cost.

Table 3-3
Did M&V Satisfy Program Designers' Purposes?

Participants	Yes	No
Customers, n=7	71% (5)	29% (2)
EESPs, n=4	75% (3)	25% (1)
Note: Numbers in parentheses are the number of respondents in the category.		

As shown in Table 3-4, almost all the customers and most of the EESPs indicated that, from their perspective, the purpose of the M&V was primarily to receive the incentive. The second most common purpose was to meet their need for verified energy savings. Two of the eight customers said that one purpose was to show that the EESP had done its job properly. Interestingly, two of the five EESPs saw expanded benefits of the M&V in providing the customer with information about their facility that could be used to improve overall operations.

Table 3-4
M&V Purposes from Company's Perspective

Participants	Obtain Program Incentive/Required by Program	Verify Energy Savings	Show that EESP Did Their Job	Shows How to Improve Operations
Customers, n=8	88% (7)	63% (5)	25% (2)	0%
EESPs, n=5	60% (3)	50% (3)	0%	40% (2)
Note: Numbers in parentheses are the number of respondents in the category.				

[1] Note that the "n" reported in this and subsequent tables is the number of interviewees who provided a response.

As shown in Table 3-5, all the customers said that the M&V satisfied their needs. For most customers, this meant at least that the M&V led to receipt of the program incentive. For several others, the M&V succeeded by providing verified energy savings. One customer observed additional benefits of the M&V, "We were able to go back to the production people and demonstrate for them what the savings were and how operations affected energy use. [In addition], we found the energy savings were actually more than our initial estimates." One customer commented that the M&V provided useful operations data, but it was more extensive than they really needed.

Table 3-5
Did M&V Satisfy Participant's Purposes?

Participants	Yes	No
Customers, n=7	100% (7)	0%
EESPs, n=5	80% (4)	20% (1)
Note: Numbers in parentheses are the number of respondents in the category.		

Almost all the EESPs echoed the customers' positive views. One EESP commented that the M&V was especially useful because it provided ongoing verification of performance. Another stated that the M&V was particularly beneficial because it showed that the savings were larger than predicted by engineering calculations. One EESP, however, said that the M&V did not meet their needs because the program implementers did not understand their technology (air compressors) and the M&V was unnecessarily complex.

3.3 POSITIVE AND NEGATIVE ASPECTS OF M&V

To assess the overall experiences and satisfaction with the M&V, we asked each participant to provide their overall comments about the positive and negative aspects of the M&V performed under the program. We also focused on specific characteristics of the M&V that could have involved either negative or positive effects. These characteristics included the appropriateness of metering, sampling, and accuracy requirements; cost; schedule; and overall attitude towards measures installed and the SPC Program in general.

3.3.1 Overall Satisfaction

When asked to rate their overall experience with the measures installed, all customers and EESPs interviewed said that they were satisfied with the measures.[2]

We also asked participants to comment on their overall experience in the SPC Program. All but one of the customers were satisfied with their experience in the program. Two customers said that their experience was good because they did not have to do any of the work. One self-

[2] Keep in mind that participants from only 10 projects were interviewed. As noted earlier, the responses about these projects could be biased positively compared to the experiences of all program participants because these projects completed their M&V in the allotted time .

sponsored customer said that the M&V process was a learning experience, and they were able to compare the measured savings with theoretical estimates. The one dissatisfied customer rated their experience as just “mediocre.”

The EESPs gave a more mixed view of their experiences with the SPC Program. Two of the six EESPs said that their experience was fairly positive. Three were neutral about it. One of these EESPs said that they did not like the non-uniformity across the three utilities. The one EESP who provided negative remarks said that it was a little difficult, saying that it took "too long to do M&V," and they felt that the utility was scrutinizing every nickel spent. It is interesting to note that this EESP worked on the same project where the customer reported that their overall view of their experiences with the SPC Program was only mediocre.

3.3.2 Positive Aspects of M&V

Table 3-6 summarizes responses to the question asking the customers and EESPs to identify the positive aspects of the M&V. Two interviewees, one EESP and one customer from different projects, responded that there were no positive aspects to the M&V. The customer felt that analyzing the utility bill would have been sufficient for the M&V. For the project where the EESP said there were no positive aspects to the M&V, the customer felt differently. This customer commented that the M&V results could show that they were saving money and were on the right track by providing more accuracy than the utility bills. This customer also noted that production fluctuations could result in variations in the energy savings that would not be reflected accurately in a utility bill analysis.

Table 3-6
Positive Aspects of M&V

Participants	Measured Savings	Incentive	Accuracy	Non-Energy Benefits	None
Customers, n=8	75% (6)	25% (2)	25% (2)	13% (1)	13% (1)
EESPs, n=6	50% (3)	17% (1)	33% (2)	33% (2)	17% (1)
Note: Numbers are the number of respondents in the category (multiple responses were given).					

Providing measured savings results was the overwhelming positive aspect of M&V. Several respondents felt that it was important to have actual measurements as opposed to theoretical calculations or assumptions. Some commented that utility bills were a poor way to measure energy savings. One EESP said that there was value in real-time data to back up analysis tools used to guarantee savings to customers. Three of the respondents mentioned receiving the incentive as a positive aspect of M&V.

Two EESPs and one customer mentioned non-energy benefits as a positive aspect of the M&V. The two EESPs said that the M&V data allowed the customer to ensure that the system was running efficiently. One of these EESPs said that the data acquisition system allowed the operations engineer to continuously tune the building. One customer said that the M&V results were fed back to the production staff and the data helped them improve operations.

3.3.3 Negative Aspects of M&V

We asked the participants what they thought the negative aspects were of the 1998-99 SPC Program M&V. We then asked each respondent about specific elements of the M&V that had been identified as problematic in previous SPC Program evaluation interviews. This subsection first presents the issues identified by the interviewees in response to the general question. It then presents data on the specific elements about which we inquired.

No correlations were found between the negative M&V aspects discussed here and the M&V type or how much help customers received in their project. This was probably due, in part, to the small number of projects reviewed.

Issues Raised by Respondents

Table 3-7 summarizes the responses to the general question about negative aspects of the M&V. The customers' responses tended to be spread over several aspects rather than concentrated on a few. The negative aspect most commonly mentioned by customers was the cost of doing the M&V. EESPs also frequently mentioned cost as a negative factor.

Table 3-7
Negative Aspects of M&V Raised by Participants

Participants	Cost	Time Involved	Level of Effort/ Complexity	Customer Inconvenience	Lack of Utility/ Consultant Understanding	None
Customers, n=8	38% (3)	25% (2)	13% (1)	13% (1)	13% (1)	25% (2)
EESPs, n=6	50% (3)	0%	67% (4)	17% (1)	17% (1)	50% (3)
Note: Numbers are the number of respondents in the category (multiple responses were given).						

The second negative aspect mentioned most often by customers was the time involved to do the M&V. Two of eight customers said that they did not like that it took 2 years to do M&V and to receive the incentive. One of these customers (self-sponsored industrial customer), however, indicated that the 2-year monitoring was worth it because their production rate varied quite a bit over time and a longer monitoring period was needed to capture these changes.

The negative aspect mentioned most often by EESPs was the level of effort or complexity required by the M&V. Two-thirds of the EESPs raised this issue. One EESP who mentioned this issue also stated, however, that the "benefits of the M&V outweighed the costs." Only one customer raised complexity as a negative issue.[3]

Another interesting negative aspect to M&V was mentioned during interviews about two different lighting projects; one comment came from an EESP and one came from a customer.

[3] Although the relative lack of concern by customers about the complexity of the process could have been due to less involvement in the M&V process, there was no clear correlation between customer involvement and their identification of complexity as an M&V issue.

Both mentioned that installing lighting loggers was an inconvenience to the customer because installation occurred during working hours and it was distracting to the employees.

Two interviewees mentioned that the utility or technical consultant did not understand the project technology, and this created communication difficulties. One self-sponsored industrial customer said that few people outside their industry understood their process. This customer also stated that they typically do not hire EESPs or contractors but do most of the work internally because of the specialized knowledge required. One EESP criticized the technical consultant for not knowing enough about air compressors. The same EESP also said that "a combination of calculating and metering would have been good enough" for M&V, indicating that they thought the level of effort required was excessive.

One EESP mentioned a negative aspect that is not shown in Table 3-7 because it was primarily a consequence of unusual market circumstances. This EESP for one of the lighting projects mentioned that some of the M&V results would have been adversely affected by voluntary curtailments that resulted from the 2000-01 energy crisis. For M&V purposes, operating hours for lighting measures that did not include controls as part of the retrofit were measured in the post-installation period. These hours were then applied to both pre- and post-installation periods to estimate energy savings. Since the energy crisis happened during the performance years and resulted in less than typical operating hours, the effect would be an underestimate of the average long-run energy savings. This EESP said that they would like to see the SPC Program allow an adjustment factor for such cases as was done in the PG&E Power Saving Partners Program.

Costs

We asked each participant how much the M&V cost, either as a share of project cost or the incentive amount. Even though cost was among the most often mentioned negative aspects of the M&V, few participants were able to provide very good estimates of the cost. One EESP said that the cost was more than 10 percent of the total project cost. Estimates based on the incentive amount ranged from about 3 to 40 percent, with most in the 10 to 25 percent range. The appendices presenting the case study write-ups provide more insights on the M&V costs.

Timing Issues

The time required to conduct the M&V and delays in the process were raised by several participants as a negative aspect of the M&V. One self-sponsored customer said the M&V process and SPC requirements took longer than expected. Five other participants said that the utility and/or technical consultant caused some schedule delays. Two of these said that changes in utility personnel caused some delays. One said that the utility lost track of their submittal. One respondent said that they ran into problems getting responses from the utility consultant, and another said that it took too much time to get the M&V plan approved. The participants, however, indicated that none of these delays had an effect on the M&V costs.

Accuracy

Four (of 14) participants who responded felt that the accuracy requirements were excessive. One EESP said that they needed to sample a bigger population than what they would have done on their own and, in their opinion, this did not increase the level of accuracy. Only one customer, however, said the accuracy requirements were excessive. He said that looking at the utility bill would have been adequate to indicate energy savings.

Over half the interviewees, nevertheless, believed that the level of accuracy was appropriate. Four of these respondents, however, felt that there were projects in which the required level of accuracy could be excessive. One respondent said that the accuracy requirements would be inappropriate for their relatively simple lighting projects, but would be suitable for their air compressor project, which was a "sophisticated upgrade." Two said that the requirements were appropriate for their project, but should be less strict for smaller projects.

Sampling Approach and Metering Equipment Requirements

Three EESPs felt the sampling approach and/or metering requirements were inappropriate. One EESP said that the number of sampling points was too large. Another said that hourly monitoring was excessive. The third EESP complained that the utility did not want to depend on the VSD readout, even though they felt that its accuracy was proven in theory. One EESP said that they agreed with the sampling requirements for a lighting project but did not like that the number of sampling points required was inconsistent across the utilities. The rest of the EESPs and none of the customers had problems with the M&V sampling and metering requirements.

Data Analysis Problems

None of the respondents said that they had run into significant M&V data analysis problems. Some EESPs said that they built into their cost estimates contingencies for such problems if they arose. One self-sponsored customer noted that the M&V made them realize that they did not have enough baseline data. Another self-sponsored customer said that the only data problem was collecting historical data. None of these problems had an effect on the costs of M&V.

3.4 CHANGES IN ATTITUDES TOWARDS M&V

Previous SPC Program evaluations identified several concerns that participants had about the M&V requirements during the 1998-99 program. These concerns were one of the reasons the requirements were reviewed and revisions were made in the M&V requirements in subsequent years. However, it was possible that initial negative perceptions changed over time as participants gained more experience with the program.

We had hoped to compare observations from our current interviews with those from prior interviews of the same participants to determine if any changes were evident. Unfortunately, there was not adequate overlap between the two samples to derive meaningful results.

3.5 M&V EFFECTS ON CONFIDENCE IN SAVINGS ESTIMATES

The thorough M&V approach required by the 1998-99 SPC Program was intended to provide sufficiently accurate estimates of project energy savings. One possible effect of the more rigorous M&V was education of participants about the validity of energy savings estimates provided by more traditional approaches such as the M&V typically conducted outside the SPC Program. To address the effect of the M&V on perceptions about the accuracy of energy savings estimates, we asked participants several questions about the SPC Program M&V and their confidence in energy savings estimates.

3.5.1 Confidence in Original Savings Estimates

Generally, the EESPs and customers felt fairly confident in their initial energy savings estimates. One customer at an institution responded that they always needed to have considerable confidence in their initial energy savings estimates since energy-efficiency retrofits competed with other capital investment projects. The EESP that assisted with this project, however, said that they did have a high level of confidence in the initial savings estimates since "air compressors are a bit of an art" and this was the first time they had implemented such a project.

Lighting project participants, in particular, typically said that they were quite confident in the energy savings estimates because lighting was relatively straightforward. One self-sponsored customer whose project involved more complex systems said that they were confident in their savings estimates because they understood their processes and energy use very well.

3.5.2 Original Savings Estimates, M&V Results, and Future Effects

All the participants who responded indicated that they felt confident after participating in the SPC M&V process that a priori estimates of energy savings for future energy-efficiency retrofits would be sufficiently accurate. In some cases, the M&V affirmed their estimating approach and, in others, it provided useful insights about fine-tuning their methodologies.

One customer whose measured savings were less than those estimated by their EESP commented that the M&V results made them think that maybe their EESP had been too aggressive in their original estimate.[4] The participating EESP for this project, on the other hand, felt "extremely more confident to go forward." They said that they had learned a lot from participating in the SPC Program about how to calculate savings accurately. Additionally, they said that the data helped true up their own analysis tools to a one percent correlation with billing data.

In another project with lower savings (where the EESP was not satisfied with the project and the customer found the experience to be "mediocre"), the customer said that the savings were acceptable even though less than anticipated. They felt that a difference of ±10 to15 percent was

[4] However, from our review of this situation, we believe that the customer did not consider that some measures and sites dropped from the project after the DPA approval would have lowered the total savings.

acceptable as long as there were savings and the project did not negatively affect the production process.

For the two lighting projects, the EESPs said that their savings estimates were quite close to the M&V results and their future estimates would not change significantly as a result of the M&V. The customer in one of these lighting projects said that some facilities showed lower savings than expected due to possible changes in occupancy; however, the EESP met its guaranteed savings and the results did not shake the customer's confidence in the EESP. The other lighting project's EESP noted that lighting savings of an individual site can often differ from the estimate, but, over several sites, the savings are "easily within 10 percent of the expected amount." According to this EESP, lighting projects over the years have been shown to be very predictable, so estimating lighting energy savings should be straightforward and accurate.

One EESP noted that their overall M&V savings were close to the original estimate, but that their baseline was wrong. The baseline errors, however, were offset by other factors. They stated that every project was a learning experience. With the M&V experience, they were able to refine their future estimates for similar projects. As a result of this project, this EESP now uses two perspectives to develop energy savings estimates. One is to use the same load profile for old and new equipment; the second is to make adjustments to the estimates taking into account what they learned from past M&V results. For them, the M&V has become a reality check.

One customer offered a different view. He said that the M&V results were after-the-fact (after project implementation), so they had little to do with the implementation and would be of little use for estimating savings in future projects.

3.6 M&V MARKET EFFECTS AND OTHER EFFECTS

The SPC Program M&V was expected to have several possible effects beyond providing more accurate energy savings estimates. In addition to effects on participants' confidence in energy savings (discussed in the prior subsection), other possible effects included changes in customers' behavior regarding energy-efficiency projects, the type of M&V conducted on non-SPC projects, and marketing approaches used by EESPs. Many of these effects could be viewed as market transformation effects.

We explored a range of potential market effects and other effects of the M&V by asking participants about generic and specific effects of the M&V.

3.6.1 Use of M&V Information with Decision-Makers

As shown in Table 3-8, half the customers we interviewed said that they had shared the M&V results internally with managers, decision-makers, and others. Those customer representatives who said they shared the information usually did so to demonstrate the success and benefits of the project. One customer noted, "The information was fed to the company's management decision-makers. They then informed the production people, and it led to more efficient operations. The M&V allowed them to do a better job of managing their production for improved

efficiency." Those customers who did not share the information usually did not do so because it would have been of little interest to others internally or would have been confusing.

Table 3-8
Were M&V Results Shared Internally?

Participants	Yes	No
Customers, n=8	50% (4)	50% (4)
EESPs, n=6	83% (5)	17% (1)
Note: Numbers in parentheses are the number of respondents in the category.		

Over 80 percent of the EESPs, on the other hand, said they had shared the M&V results internally. The EESPs appeared to perceive significant benefits from having the M&V results. Typical EESP comments included the following:

- "We have used the M&V results internally to update our savings estimate approaches. We really try to leverage what we learn."
- "We added it to our library of information, and we publish case studies on projects. We use [M&V results] as marketing material."

We also asked the EESPs whether their customers had shared the M&V results internally. Although most said they thought the customers had, when we interviewed both the customer and EESP for several specific projects, we found that EESPs were often wrong about whether the customers had shared the information internally so their observations were probably not very reliable.

3.6.2 Use of M&V Information to Promote Other Projects

As shown in Table 3-9, both the customers and EESPs usually indicated that they had used or planned to use the M&V results to sell other energy-efficiency projects. Three of the seven EESPs who responded indicated specifically that they had used the results in their marketing materials.

Table 3-9
Have M&V Results Been Used to Sell Other Projects?

Participants	Yes	No
Customers, n=8	63% (5)	37% (3)
EESPs, n=7	71% (5)	29% (2)
Note: Numbers in parentheses are the number of respondents in the category.		

3.6.3 Approach to Energy-Efficiency Projects

The findings about how the M&V affected each company's general approach to energy-efficiency projects were mixed. A slight majority of customers reported that the M&V had a clear effect. The effects identified included the following:

- "It increased our comfort level for other projects."
- "It validated the benefits from our desire to be energy efficient and trying to qualify for available rebates."
- "It shows the financial people and decision-makers that [the project] is worthwhile."

The EESPs were evenly split on whether or not the M&V affected their general approach to energy-efficiency projects. Those EESPs who reported an affect primarily stated that the M&V led to improvements in the way they estimated energy savings.

3.6.4 Perceptions about M&V Costs and Difficulties

Most customers indicated that the M&V for their project helped give them a more realistic idea of the difficulty and costs of conducting M&V. One noted that he had reviewed the M&V documentation and that was adequate to prepare him for the level of effort that would be required. One stated that the M&V process showed that it was "extremely burdensome and would be too expensive without the financial incentive." The EESPs typically felt that the M&V conducted on their projects confirmed their preconceptions about the cost and effort that would be required.

In projects where more complex M&V was required, participants were more likely to have negative perceptions about the cost and difficulty of conducting M&V. The relationship we observed was not very strong, however, and was difficult to establish given the small number of projects analyzed. Those customers who self-sponsored their projects were generally able to comment knowledgeably about the costs and difficulties of conducting the M&V, and they tended to say that the experience gave them a good understanding of the relatively large effort required. One of the two customers who self-sponsored, but had significant assistance, commented that the M&V was excessive. The three customers whose projects were sponsored by EESPs offered some comments about the costs and difficulties of the M&V, but their comments suggested that they really had little direct knowledge of these issues.

3.6.5 Use of M&V in Future Projects

As shown in Table 3-10, a majority of the customers and EESPs that we interviewed indicated that they would use M&V comparable to what was done in the 1998-99 SPC Program for future, similar projects. One customer's response suggested that the M&V led them to develop a good understanding of the benefits of having valid baseline data and, as a result, baseline data would be stressed in future project M&V. One EESP stated, "The SPC has pushed us to learn about M&V and now we've incorporated it in our regular business so we will do it in all our future projects."

Table 3-10
Likelihood of Using Similar M&V in Future Projects

Participants	Likely	Not Likely/Driven by SPC
Customers, n=8	63% (5)	37% (3)
EESPs, n=5	80% (4)	25% (1)
Note: Numbers in parentheses are the number of respondents in the category.		

There did not appear to be much relationship between the complexity of the M&V required in each SPC project and the likelihood that similar M&V would be conducted in future projects. If anything, there was some evidence that participants who were required to conduct more complex M&V saw the value of it and were slightly more likely to use similar M&V in future projects.

For the customers who self-sponsored, there was evidence that doing the M&V was likely to lead to an increased emphasis on M&V in future projects. As one customer put it, "The M&V did show it was useful to do something more complicated on complex projects and the 2-year monitoring proved to be useful, so we might actually use a similar approach in future projects of this type." Of the five customers who had assistance or whose projects were sponsored by an EESP, only two indicated an interest in using similar M&V in future projects as a way to verify the performance of their contractor or EESP.

In short, some customers would do M&V in absence of the SPC Program. Their reasons for doing the M&V included satisfying an internal requirement, satisfying requirements of the EESP contract, and the inaccuracy of using billing data.

3.6.6 Participation in Future SPC Projects

None of the eight customers who responded indicated that the M&V would deter them from doing future SPC Program projects. Two of the customers, however, cautioned that the M&V gave them an idea of how complex it could become, and, if the M&V became more of a burden, it might dissuade them from doing future projects.

Only one of seven EESPs said that the M&V had been so burdensome that they would not participate in future SPC projects involving the same type of systems. This EESP had a generally negative experience with M&V on an air compressor project and commented, "The utility does not trust anybody—so there is lots of back and forth. The [technical consultant and utility] do not really understand air compressors. Air compressors are very difficult and costly to M&V."

3.6.7 Assessment of Project Implementer

The customers provided little feedback about the effect of the M&V on their perceptions of the contractor or staff who implemented their project. One customer who offered a specific comment

said that the M&V results increased their confidence in the EESP who did their project. Another customer said they already trusted the EESP and had no need to review the M&V results.

3.6.8 Measures Not Included Because of M&V Requirements

None of the customers said that they knew of measures that were not included in their project because the M&V requirements would have been too burdensome. One customer noted that they had wanted to make additional changes to their control system to increase efficiency; they did not make the changes, however, because they had already reached their SPC incentive cap, not because of the M&V requirements. One customer whose project was done by an EESP offered that there might have been measures the EESP chose not to include because of the M&V, but he was only speculating about this.

Similarly, none of the EESPs said they excluded measures because of the M&V requirements. A few did note, however, that they could envision situations where this would happen (and one, in fact, gave an example from another project involving HVAC equipment).

3.6.9 Other Effects

One customer and one EESP specifically indicated that the M&V was useful in helping them improve their energy savings estimation tools. In a couple of cases, the participants found the M&V beneficial because it showed that the savings were larger than their initial estimates based on conservative engineering estimates, and this led to larger incentives and more confidence in the project.

In two projects, participants noted that the M&V had another specific benefit, which was to better inform them about their operation. In one of these cases, the M&V information was used to inform production staff about how to optimize the production process. In several cases, participants mentioned that 2 years of monitoring were very useful because having the monitoring equipment for the longer period gave them better information about performance, possibly increased the incentive amount, and helped them understand their system better. One commercial customer specifically noted that the M&V permitted them to “tune the building.”

3.7 VALUE OF M&V

A key question about the M&V process was whether the resources it required were worth the improved accuracy and certainty of energy savings it produced. Motivated in part by the feedback received initially on the 1998-99 M&V requirements, the SPC M&V changes that have occurred since then included providing options to participants that reduced the rigor (and resources) required. We asked participants several questions to examine whether they felt that the higher accuracy and certainty resulting from the 1998-99 M&V were worth the resources required.

Table 3-11 shows that a large majority of both the customers and EESPs interviewed believed that the M&V was worth the cost. The affirmative responses ranged from, “I got paid it for it, so

it was worth it," to an enthusiastic, "Oh yeah!" One customer noted that his opinion changed over the course of the project: "In retrospect, the M&V was probably worth the cost. However, I felt like we were blind-sided by the complexity and need for 2-year monitoring. We had no idea how much work it would take and how much it would cost, and we almost [dropped it] at one point." A few participants noted that the M&V helped them improve their savings analyses and, in some cases, led to larger savings estimates and incentives.

Table 3-11
Was M&V Worth the Cost?

Participants	Yes	No
Customers, n=8	75% (6)	25% (2)
EESPs, n=6	83% (5)	17% (1)
Note: Numbers in parentheses are the number of respondents in the category.		

One customer whose project was implemented by an EESP provided an insight about the value of the M&V when someone else implements the project: "This M&V was a good verification and tool gauge, which is good to have in place, especially if somebody else manages the project for you."

The three participants we interviewed who didn't think the M&V was worth its cost made a couple of observations. One was that adequate results could have been obtained with 1 year of monitoring. The other was that billing data would have been adequate to measure the savings.

One EESP (not included in the tabulations) gave a conditional response about the value of the M&V. He noted that, "[The M&V would be worth it] if the customer looked at [the M&V] as a way to understand energy consumption and see what measures are worth the improvements."

We also asked the participants how much they would have been willing to spend on M&V if they had the choice.[5] The responses ranged from 2 to 20 percent of the total project cost, with the most frequent response around 10 percent. The one respondent who said they would be willing to spend 20 percent, and one of the respondents who said they would spend 10 percent noted that if the M&V cost that much they would have to look very carefully at whether it was worth it.

Given that the M&V requirements have been modified since 1999 to provide the option of using less resource-intensive, more conservative estimating approaches, we asked each respondent whether they would have been willing to accept more conservative estimates of the energy savings on their project in exchange for less rigorous, less costly M&V. As Table 3-12 shows, the most common response of both customers and EESPs was that they were unsure; their decision would depend how conservative the estimates were and what the effect would have been on the incentive, or their decision was project-specific.

[5] Some respondents gave answers based on the incentive amount or actual dollars so they could not be compared.

Table 3-12
Would Participant Have Been Willing to Accept Less Rigorous but More Conservative M&V?

Participants	Yes	Depends/Unsure	No
Customers, n=8	25% (2)	63% (5)	13% (1)
EESPs, n=6	33% (2)	50% (3)	17% (1)
Note: Numbers in parentheses are the number of respondents in the category.			

One EESP who said they would have been willing to accept a more conservative estimate felt, in general, that the savings in M&V costs would have been worth it: "It is often a good alternative to accept a more conservative approach to reduce the M&V costs. The benefit of M&V is that you learn about the dynamics of the process, but this takes effort and resources."

We examined whether the willingness to accept a more conservative M&V approach varied by the complexity of the M&V conducted for the project. The responses showed no clear relationship between the complexity and willingness to use a less rigorous M&V approach.

3.8 ASSESSMENT OF RECENT M&V CHANGES

Finally, we investigated how participants viewed the changes that have been implemented in the M&V requirements since 1999. Since these changes were made, in part, because of early concerns about the original M&V requirements, it was informative to determine how participants who had met the original requirements reacted to the changes.

Although a few participants were not aware of these changes and several were unable to offer opinions based on the information they had, some of the most thoughtful responses we received during these interviews were to the question about participants' views on the M&V changes. Virtually every interviewee responded positively to the changes, but most also said that there were conditions under which the original M&V approach would be beneficial. As one customer noted, "It would really depend on the size of the project and the complexity." The primary benefits of the changes that were identified included the following:

- Added flexibility to better match the needs of different projects
- Reduced M&V costs
- Simplification of the M&V process
- Fewer disagreements about the energy savings
- Increased feasibility of doing simpler ("standard package") projects that might not have been done with more complex M&V
- Reduced difficulty for the technical experts (EESPs) to communicate the results to customers
- Reduced reporting requirements.

Several participants, however, indicated that, even though they saw benefits from the revised approach, there were reasons why they might prefer the more complex M&V (measured savings approach) in some projects. These included the following:

- Higher energy savings estimates that, in turn, result in larger incentives (one EESP noted that this was especially important to them because they had learned to do more complex M&V at minimal cost)
- More accurate energy savings estimates
- Better understanding of how savings change over time and relate to production/operating processes
- Increased education of participants about the value of energy savings, which does not occur to any extent in basic rebate programs (such as the Express Efficiency Program).

Overall, these comments suggested that both customers and EESPs favored having the option of doing less rigorous M&V; however, they saw merit in conducting more complex M&V in certain projects. For relatively straightforward projects, a simpler M&V approach might make pursuing them economical, and there was little benefit (in terms of a possibly higher incentive) from implementing more complex M&V. On the other hand, more complex projects could benefit from more complex M&V, which might demonstrate higher energy savings and provide insights into production and operations that could be useful in other ways.

The utility representatives we interviewed stated that they saw this new approach to M&V for the SPC Program as being more doable and allowing companies without engineering staff to be self-sponsored and participate in the program when they would not have before. The utility representatives noted that, at the same time, some EESPs complained about having their bread and butter taken away. One utility representative stated that M&V should not be conducted when there is documentation available and there is a high level of understanding with certain measures.

4 CONCLUSIONS AND IMPLICATIONS

This section presents our major conclusions about the M&V process in the 1998-99 SPC Program and discusses implications of this study. These conclusions are based on primarily the information presented in Section 3. As noted earlier, the conclusions presented here reflect projects that followed the prescribed process but do not reflect those projects that were discontinued or not conducted in a timely fashion. Issues related to the M&V process might have contributed to discontinuations or delays in those projects, but because none of those projects were included in our case study sample (or sample frame) our findings are not necessarily representative of the entire set of projects for which applications were submitted. In addition, we did not include any projects done by small business (less than 500kW demand) customers.

4.1 MAJOR CONCLUSIONS

Attitudes toward the M&V process were more positive overall than we had anticipated. Since 1999, the original SPC M&V requirements have been modified because of concerns expressed by participants about perceived negative aspects of the M&V process.[1] The 1998-99 program participants that we interviewed for this study, however, provided generally neutral or positive feedback about the original requirements. Although some concerns about the requirements and process remained, both customers and EESPs that we interviewed identified many benefits of the original requirements; some of these benefits may not have been very obvious to participants in the early stages of their projects. As noted throughout this report, the projects covered in our study included only those that had completed the M&V in a timely manner.

Several participants credited the M&V with providing benefits to them that went beyond the energy savings estimates. Some of the customers and EESPs explicitly mentioned ways in which the monitoring that was done gave them a better understanding of production processes or operations that permitted them to improve operations. Other benefits of the M&V included improving energy-savings estimation methods; incorporating the M&V results in marketing or energy-efficiency project promotional efforts (internal and external); and increasing confidence in energy-efficiency projects.

Even without the SPC Program, participants probably would have conducted M&V in most of these projects, but the SPC M&V was significantly more rigorous than the M&V typically implemented. Both customers and EESPs generally indicated that their practice prior to the SPC Program was to implement M&V in their energy-efficiency projects to satisfy internal customer

[1] For further information on the SPC programs, three evaluations have been done on these programs for 1998, 1999, and 2000 and 2001 combined: 1) *Evaluation of the 1998 Nonresidential Standard Performance Contract Program*. Volume I Final Report. XENERGY. June 1999; 2) *1999 Nonresidential Large SPC Program*. Volume I Final Report. XENERGY. January 2001; and 3) *2000 and 2001 Nonresidential Large SPC Program*. Final Report. XENERGY. December 2001.

requirements or fulfill the EESP contract requirements, but the usual approach involved using only billing data. Some of those participants who typically had used billing data said that after their SPC M&V experience they recognized that end-use monitoring resulted in more accurate savings and a better measure of the actual performance of the measures installed.

Participants indicated that the M&V required by the SPC had significant lasting positive effects on the M&V practices of both customers and EESPs. More than half the EESPs and customers said that they would use comparable M&V in subsequent projects similar to those included in our case studies.

Most participants felt that the M&V provided accurate energy savings information. Most customers and EESPs mentioned the measured energy savings and accuracy of the savings estimates as pluses of the M&V process.

Cost was mentioned most often, across the complete set of participants we interviewed, as a negative aspect of conducting the SPC M&V. The M&V cost was estimated to be between 3 and 40 percent of the incentive amount.

The second most often mentioned negative aspect of the M&V was how long the process took. Although there were some comments that the process basically consumed too much time, most of the concerns resulted from delays that were encountered in the process. Some delays were attributed to the utility and others to the project technical consultant. Almost half the participants had one or more negative comments about the M&V schedule and delays.

Complexity and the level-of-effort required were the third most frequently mentioned negative aspect of the M&V process. This issue was mentioned by about one-third of the participants we interviewed.

Although participants identified drawbacks to the M&V requirements, no customer or EESP said that they did not implement an energy-efficiency measure because of the M&V requirements.

The M&V process influenced participants' behavior and attitudes in several important ways. A majority of both customers and EESPs stated that they were likely to use similar M&V in future projects of the same type. This result suggested that the M&V had a market effect because most participants said that their historical M&V approach had been less rigorous than that required by the SPC. About half the participants said that the M&V had had a positive effect on their overall approach to energy-efficiency projects. The EESPs, in particular, leveraged the M&V results by sharing them internally to update energy savings estimation techniques and using them to sell other projects.

Almost every participant interviewed felt that the M&V was worth what it cost to do. On balance, a large majority of both the customers and EESPs interviewed believed that the M&V was worth what they had to spend on it. However, this assessment was based on the availability

of the SPC Program financial incentives, which more than offset the M&V costs in all these cases.

Although some customers and EESPs said they would have accepted a more conservative energy savings estimate for a less rigorous M&V approach, most said that it would have depended on the tradeoff or nature of the project. Willingness to forego possible incentive dollars in return for using a less demanding M&V approach was limited. The willingness to make this tradeoff did not appear to depend on the complexity of the M&V that had been required in each project.

4.2 IMPLICATIONS

The most significant negative aspects associated with the 1998-99 SPC Program M&V involved cost, timing/time required, and complexity. These issues have surfaced in evaluations of subsequent SPC Programs and efforts should continue to be directed at alleviating concerns with these issues.

Overall, it appears that modifying the M&V requirements to permit a calculated savings option, along with a measured savings option, was a suitable response to early concerns about the burden of the M&V requirements particularly for smaller, simpler projects. However, our results indicated that these concerns were not universal and that, given a choice. many of the customers (five the six interviewed) and EESPs (all seven interviewed) interviewed for the case studies would have opted for the original approach to obtain a larger incentive. Given the case study findings, we believe that the M&V options allowed in the 2001 SPC Program, including permitting the utility to require M&V for any project they deem necessary, represents an appropriate change given that M&V can add value in some cases.

Data presented in the most recent evaluation of the SPC Program showed that the characteristics of typical projects have changed in important ways in 2001, and the changes may be related to the introduction of the calculated M&V approach. The most common M&V approach used in 2001 SPC Program projects was the calculated savings approach and larger shares of the projects were self-sponsored and smaller in scope than in preceding years. Our findings from the 1998-99 M&V case studies and these trends both suggested that the availability of the calculated savings approach has contributed to an increase in self-sponsorship and smaller projects.

Observations by 1998-99 program participants that there were benefits of the M&V in addition to the direct measurement of energy savings were fairly common. The benefits included providing information about how to improve energy savings estimates, developing a better understanding of production processes or system operations, and equipping participants better to pursue additional energy-efficiency projects. Some of these could be considered “spillover” effects that have resulted in indirect energy savings attributable to the program. From a program perspective, some of these benefits could become part of the strategy for promoting the program—i.e., these benefits could be included in the messages used to market the SPC program.

Finally, since we collected data and information only from program applicants who successfully completed the M&V process as intended, the findings might not reflect the issues and problems encountered by some applicants for less successful projects. We believe that it would be informative to interview applicants who chose not to go through with their projects and those who did not complete the M&V in a timely fashion.

A

INTERVIEW INSTRUMENTS

This appendix contains full text versions of the following interview instruments used in this study:

- M&V Case Study Interview Guide: Customers
- M&V Case Study Interview Guide: EESPs

M&V Case Study Interview Guide: Customers

Type[C]

Background Information

Fill out all possible information below before call

Project_Name/Description[ ]		
Contact_Name[ ]	Title[ ]	
Phone_Number[ ]	Fax[ ]	E-mail[ ]
Company[ ]	Street_Address[ ]	
City[ ]	State[ ]	
Zip[ ]	Interviewer[ ]	
Call_Dates[ ]	Complete_Date[ ]	

Introduction and Contact Information

Explain who we are and that we are calling about the 1998-99 SPC Program and the monitoring and verification (M&V) component in particular. Thank them for their past cooperation. Determine whether he/she is the best person to talk to about 1) the M&V process for this project and 2) the effects that the M&V had on the ***customer's*** *decisionmaking, attitudes, and actions regarding energy-efficiency investments. If another person should be contacted to respond to either area, get contact information. If they would like a callback, record callback time.*

QB1: How familiar are you with the M&V process that was used in this project and what was your role in it?
B1[ ]

Project Description

QPD1: *Confirm specifics of the project we have in our case study information including the type of facility, measures done through the SPC, status. Record any changes*.
PD1[ ]

QPD3: *Confirm who was involved in the project and the roles they played, including the M&V. Record any changes*.
PD3[ ]

Overall Assessment of 1998-99 M&V

QOA0: Do you typically include M&V as part of your energy-efficiency projects? In which ones? Why or why not?
OA0[ ]

QOA1: How would you describe the purposes of the M&V for the SPC project in terms of your own company's needs?
OA1[ ]

QOA2: Did the M&V meet your needs in this SPC project? Why or why not?
OA2[ ]

QOA3: Why do you think Program designers required M&V in the 1998-99 SPC Program?
OA3[ ]

QOA4: Do you think the M&V met these programmatic needs? Why or why not?
OA4[ ]

QOA5: Do you think the level of accuracy required by the SPC M&V in this project was appropriate? Why or why not?
OA5[ ]

QOA6: What measures, if any, were not implemented in this project because the M&V requirements were too burdensome? If any were excluded, why?
OA6[ ]

QOA7: What do you believe the positive aspects were of the M&V conducted for this project?
OA7[ ]

QOA8: What do you believe the negative aspects were?
OA8[ ]

QOA9: How did the M&V process affect your interest in participating in future SPC projects?
OA9[ ]

Confidence in Energy Savings

QCS1: How confident were you in the estimated energy savings of this project before you started it? How concerned were you that the actual savings might be less?
CS1[ ]

QCS3: What did the M&V results show about the actual energy savings compared to what you anticipated?
CS3[ ]

QCS4: How is the comparison between the estimated savings and the M&V results likely to affect your confidence in projected energy savings in subsequent projects? Why?
CS4[ ]

If respondent is not very familiar with specifics of the M&V process go to questions on M&V effects.

M&V Process

Describe the M&V process based on our case study information (approach, types of measurements, changes at different SPC milestones, etc.).

QMP1: *Verify that our information is accurate. Ask for any corrections.*
MP1[ ]

QMP2: How much did the M&V cost for this project as a percent of total project cost? As a percent of the SPC incentive?
MP2[ ]

QMP3: How appropriate were the M&V sampling approach and metering equipment requirements? Did they have significant effects on your costs?
MP3[ ]

QMP4: Did you encounter any M&V data analysis problems? If so, what were they and how did they affect costs?
MP4[ ]

QMP5: Did any M&V timing issues arise (such as the flexibility of due dates, adequate time to complete tasks, and timeliness of responses from other parties)? What were they? How did they affect the project schedule and costs?
MP5[ ]

QMP6: Were any M&V revisions required? If so, what were they and why were they required?
MP6[ ]

QMP7: Did the technical reviewer or utility provide you with assistance with the M&V? How useful was their assistance?
MP7[ ]

If respondent is not very familiar with the effects of the M&V inside the customer's organization go to questions on the value of M&V.

M&V Effects

QME1: How did the M&V process and results affect your confidence in the organization that implemented this project (either an EESP or their own staff)?
ME1[ ]

QME2: Did your company's project manager provide the information from the M&V to audiences or decisionmakers within your company? Which ones? How was the information used?
ME2[ ]

QME3: Does your company plan to use or has it used the M&V results to sell additional energy-efficiency improvements to management or other decisionmakers in your company?
ME3[ ]

QME4: How have the M&V process or results for this project affected your company's overall approach to energy-efficiency projects?

ME4[ ]

QME5: What effect has the M&V for this project had on your perceptions about the difficulty and costs of conducting M&V for energy-efficiency projects?
ME5[ ]

QME6: What effect has the M&V for this project had on your likelihood of using M&V in similar energy-efficiency projects and why?
ME6[ ]

QME7: If your company conducts M&V in future projects will it be more or less rigorous than that required by the SPC program? Why and in what ways?
ME7[ ]

Value of M&V

QV1: Do you think that the M&V for this project was worth the cost? Explain.
V1[ ]

QV2: As a percent of the total project cost, how much would you have been willing to spend on M&V for this project?
V2[ ]

QV3: Would you have been willing to accept more conservative estimates of the energy savings on this project in exchange for less rigorous, less costly M&V requirements? Why?
V3[ ]

Awareness of M&V Changes

QMC1: Are you aware of the changes that have been made in the SPC M&V requirements since the 1998-99 Programs? *If not, describe them.*
MC1[ ]

QMC2: Do you see any advantages or disadvantages resulting from these M&V changes? If yes, which ones?
MC2[ ]

Overall Performance

QOP1: How do you rate your experience overall with the energy-efficiency measures that were installed and why?
OP1[ ]

QOP2: How do you rate your experience overall with the 1998-99 SPC Program and why?
OP2[ ]

Thank and terminate.

M&V Case Study Interview Guide: EESPs

Type[E]

Background Information

Fill out all possible information below before call
Project_Name/Description[ ]

Contact_Name[ ]	Title[ ]	
Phone_Number[ ]	Fax[ ]	E-mail[ ]
Company[ ]	Street_Address[ ]	
City[ ]	State[ ]	
Zip[ ]	Interviewer[ ]	
Call_Dates[ ]	Complete_Date[ ]	

Introduction and Contact Information

Explain who we are and that we are calling about the 1998-99 SPC Program and the monitoring and verification (M&V) component in particular. Thank them for their past cooperation. Determine whether he/she is the best person to talk to about 1) the M&V process for this project and 2) the effects that the M&V had on the ***customer's*** *decisionmaking, attitudes, and actions regarding energy-efficiency investments. If another person should be contacted to respond to either area, get contact information. If they would like a callback, record callback time.*

QB1: How familiar are you with the M&V process that was used in this project and what was your role in it?
B1[ ]

Project Description

QPD1: *Confirm specifics of the project we have in our case study information including the type of facility, measures done through the SPC, status. Record any changes.*
PD1[ ]

Overall Assessment of 1998-99 M&V

QOA0: Do you typically include M&V as part of your energy-efficiency projects? In which ones? Why or why not?
OA0[ ]

QOA1: How would you describe the purposes of the M&V for the SPC project in terms of your own company's needs? How about in terms of the needs of your client for this project?
OA1[ ]

QOA2: Did the M&V meet your needs for this SPC project? Why or why not?
OA2[ ]

QOA3: Why do you think Program designers required M&V in the 1998-99 SPC Program?
OA3[ ]

QOA4: Do you think the M&V met these programmatic needs? Why or why not?
OA4[ ]

QOA5: Do you think the level of accuracy required by the SPC M&V in this project was appropriate? Why or why not?
OA5[ ]

QOA6: What measures, if any, were not implemented in this project because the M&V requirements were too burdensome? If any were excluded, why?
OA6[ ]

QOA7: What do you believe the positive aspects were of the M&V conducted for this project?
OA7[ ]

QOA8: What do you believe the negative aspects were?
OA8[ ]

QOA9: How did the M&V process affect your interest in participating in future SPC projects?
OA9[ ]

Confidence in Energy Savings

QCS1: How confident were you in the estimated energy savings of this project before you started it? How concerned were you that the actual savings might be less?
CS1[ ]

QCS3: What did the M&V results show about the actual energy savings compared to what you anticipated?
CS3[ ]

QCS4: How is the comparison between the estimated savings and the M&V results likely to affect your confidence in projected energy savings in subsequent projects? Why?
CS4[ ]

If respondent is not very familiar with specifics of the M&V process go to questions on M&V effects.

M&V Process

Describe the M&V process based on our case study information (approach, types of measurements, changes at different SPC milestones, etc.).

QMP1: *Verify that our information is accurate. Ask for any corrections.*
MP1[ ]

QMP2: How much did the M&V cost for this project as a percent of total project cost? As a percent of the SPC incentive?
MP2[ ]

QMP3: How appropriate were the M&V sampling approach and metering equipment requirements? Did they have significant effects on your costs?
MP3[ ]

QMP4: Did you encounter any M&V data analysis problems? If so, what were they and how did they affect costs?
MP4[ ]

QMP5: Did any M&V timing issues arise (such as the flexibility of due dates, adequate time to complete tasks, and timeliness of responses from other parties)? What were they? How did they affect the project schedule and costs?
MP5[ ]

QMP6: Were any M&V revisions required? If so, what were they and why were they required?
MP6[ ]

QMP7: Did the technical reviewer or utility provide you with assistance with the M&V? How useful was their assistance?
MP7[ ]

If respondent is not very familiar with the effects of the M&V inside the customer's organization OR effects on the EESP's business go to questions on the value of M&V.

M&V Effects

QME2A: Did the customer's project manager for your project provide the information from the M&V to audiences or decisionmakers within the customer's company? Which ones? How was the information used?
ME2A[ ]

QME2B: Did your company's project manager provide the information from the M&V to audiences or decisionmakers within your company? Which ones? How was the information used?
ME2B[ ]

QME3: Does your company plan to use or has it used the M&V results to sell additional energy-efficiency improvements to management or other decisionmakers in the customer's company? What about on projects with other customers?
ME3[ ]

QME4: How have the M&V process or results for this project affected your company's overall approach to energy-efficiency projects?
ME4[ ]

QME5: What effect has the M&V for this project had on your perceptions about the difficulty and costs of conducting M&V for energy-efficiency projects?
ME5[ ]

QME6: What effect has the M&V for this project had on your likelihood of using M&V in similar energy-efficiency projects and why?
ME6[ ]

QME7: If your company conducts M&V in future projects will it be more or less rigorous than that required by the SPC program? Why and in what ways?
ME7[ ]

Value of M&V

QV1: Do you think that the M&V for this project was worth the cost? Explain.
V1[ ]

QV2: As a percent of the total incentive amount, how much would you have been willing to spend on M&V for this project?
V2[ ]

QV3: Would you have been willing to accept more conservative estimates of the energy savings on this project in exchange for less rigorous, less costly M&V requirements? Why?
V3[ ]

Awareness of M&V Changes

QMC1: Are you aware of the changes that have been made in the SPC M&V requirements since the 1998-99 Programs? *If not, describe them.*
MC1[ ]

QMC2: Do you see any advantages or disadvantages resulting from these M&V changes? If yes, which ones?
MC2[ ]

Overall Performance

QOP1: How do you rate your experience overall with the energy-efficiency measures that were installed and why?
OP1[ ]

QOP2: How do you rate your experience overall with the 1998-99 SPC Program and why?
OP2[ ]

Thank and terminate.

B

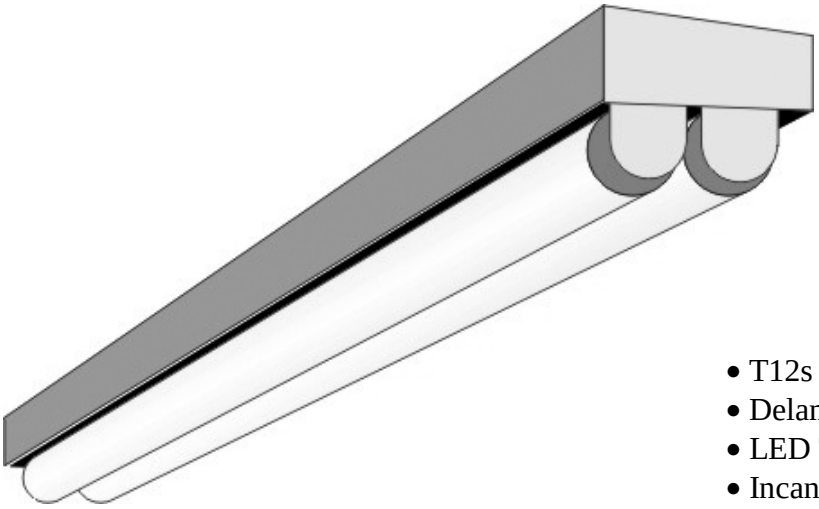
CASE STUDY 1: COUNTY LIGHTING RETROFIT

This case study is a lighting retrofit for a county government entity in the 1998 SPC Program. The customer hired an EESP to do all the SPC paperwork and M&V and sponsor the project. This project covers many energy-saving lighting projects at several different types of facilities in the county. The customer submitted five applications in 1998. Four lighting projects are covered here; the fifth is an HVAC project.[1] We interviewed both the customer and the EESP for this case study.

B.1 PROJECT DESCRIPTION

The EESP submitted four applications on behalf of the government entity, including lighting retrofits throughout the customer's territory. The site types varied widely, including courthouses, hospitals, police stations, LED traffic lights, and more. Most of the retrofits changed standard T12s and magnetic ballasts to T8s and electronic ballasts (see Figure B-1). The combined incentives for this customer's projects (i.e., the sum of BPA approved amounts) were capped at 15 percent of the total 1998 SCE SPC funding, or $1,995,000.[2] Table B-1 summarizes the process and energy savings estimates for this project.

Figure B-1
Lighting Retrofit for a Government Entity



- T12s to T8s
- Delamping
- LED Traffic Lights
- Incandescents to CFLs
- LED Exit Signs
- Lower wattage HIDs

[1] The M&V report review for the HVAC retrofit project was not complete at the time we received the project files from the utility.
[2] This total includes the HVAC retrofit, which is not discussed here.

Table B-1
History of County Lighting Retrofit Project

		Submitted		Approved		
Document	#	*kWh*	*Incentive*	*Days Until Approval**	*kWh*	*Incentive*
BPA	*A*	2,748,379	$ 206,128	46	not assessed	$ 206,128
	B	6,846,896	$ 672,656	41	not assessed	$ 672,656
	C	11,770,993	$ 882,824	41	not assessed	$ 882,824
	D	1,800,022	$ 135,001	40	not assessed	$ 121,376
Total						$1,882,984
DPA	*A*	3,339,372	$ 250,453	not available	3,404,277	$ 255,321
	B	5,418,301	$ 406,372	not available	5,506,931	$ 413,019
	C	6,455,990	$ 484,199	not available	7,897,598	$ 592,319
	D	3,296,665	$ 247,249	not available	3,405,016	$ 255,376
Total						$1,516,035
PIR	*A*	3,312,040	$ 248,403	45	3,184,959	$ 238,871
	B	4,387,303	$ 329,048	34	4,357,726	$ 326,829
	C	7,652,083	$ 573,906	49	7,897,598	$ 592,319
	D	3,149,971	$ 236,248	54	3,149,971	$ 236,248
Total						$1,394,267
M&V1	*A*	3,155,458	$ 300,068	70	3,155,458	$ 236,660
	B	3,965,719	$ 297,430	59	3,965,719	$ 294,430
	C	7,006,902	$ 525,513	59	7,006,902	$ 525,518
	D	2,817,287	$ 211,297	48	2,834,520	$ 212,589
Total						$1,269,197

Note: Letters A-D refer to the four different projects.
* The number of calendar days from document submittal to approval.

B.2 ESTIMATED ENERGY SAVINGS

The EESP has conducted the M&V for this project as part of an energy performance contract for the county. The EESP had to guarantee the savings and demonstrate them through the M&V.

The utility's technical reviewer and the utility initially raised concerns about this project.[3] The project sites were not aggregated according to the program aggregation rules.[4] In addition, the EESP submitted 67 alternate sites with the BPA.

[3] "Technical reviewer" and "utility" are interchangeable here. The utility in most cases uses the reviewer's recommendations for revising applications.

[4] See page 16 of the 1999 SPC Program Procedures Manual.

The energy savings calculations estimated that each project site would save 50 percent of the maximum billing demand and annual electricity usage. The technical reviewer considered this initial savings estimate to be too high. The technical reviewer was concerned about the possibility that an excessive initial savings estimate might lead the customer to try to add some of the alternate sites supplied with the BPA to the project in order to reach the estimated amount, which would contravene the SPC Procedures Manual.[5] The technical reviewer made an exception to the aggregation rules for this project, but the addition of alternate sites would have made this violation more severe. The utility, however, chose not to regulate the substitution or addition of sites or to enforce the aggregation rules, and decided instead to limit the overall incentive for all five BPAs to the maximum payable to the EESP.

The DPA savings estimate was revised according to the results of the detailed walk-through audits. However, in the project files, the letter approving the DPA and the technical reviewer's notes was missing.

B.3 THE M&V PLAN

Proposed M&V Plan

The four lighting DPAs were reviewed together for consistency and correctness. Sampling across all sites as a whole was allowed for inspections, but not for the designation of monitoring points,.

The four applications submitted contained multiple sub-applications. These sub-applications in the DPA phase had project sites aggregated according to the program rules (fixed from the earlier BPA). Project sites were aggregated together if their functions were similar across sites.

The aggregated project sites employed a multiple-building M&V plan. The SPC Procedures Manual provides rules for aggregating project sites. The rules include: 1) up to 10 project sites with different energy usage profiles may be aggregated to meet a minimum savings requirement or 2) any number of similar project sites with identical measures, usage profiles, and M&V plans may be included in one application. In addition, for a single measure-specific M&V plan to be sufficient for multiple project sites, the sites must have the same measures, the same occupancy schedule, the same functional use, and the same energy consumption patterns. Lighting projects with no aggregatable sites were evaluated with the single-facility M&V plan.[6]

This proposed M&V plan was based on option LE-B-01 in the SPC Procedures Manual. A variation to this plan was designed and agreed upon by all parties to reduce complexity and M&V costs due to the size and number of sites included across all applications. The M&V strategies for each site were determined based on whether aggregation was involved.

[5] "No substitutions or additions to project sites within a project may be made after the BPA is approved."
[6] These sites were any miscellaneous sites and hospitals, which have different load profiles

Revised M&V Plan

The EESP proposed that the M&V sampling points be "clustered" into given sites and not spread across all sites in a group. The utility accepted this approach as long as 1) at least 40 percent of the sites had monitoring points and 2) different sites were used each year over the 2-year M&V process. In addition, the utility recommended that no less than five monitoring points be gathered per site. The EESP created sampling groups that grouped together rooms with similar, but not necessarily identical, operating hours (e.g., bathrooms and closets). These differ from the usage groups recommended in the Procedures Manual's prescriptive M&V plan, which place rooms of similar function and operating hours together. All sampling groups were used to determine monitoring points,[7] part of the program requirements for lighting.

The applicant proposed a method to randomly select monitoring points and still meet the program requirements. The utility randomly selected the sites and points where the EESP was to place loggers for M&V.[8] It was unclear from the files whether the utility followed the proposed or the SPC Program-approved method of selecting the monitoring points. The sample size was apportioned to the usage types within each sampling group by considering the average of the population size and the relative kW per type. Precision and confidence level requirements also determined the number of points. The utility calculated the requirements using an Excel spreadsheet developed specifically for the SPC Program. The monitored data in a sampling group were applied to all usage groups in that sampling group.

The rest of the M&V, which included measuring operating hours and kW used for the pre- and post- fixtures and calculating savings all followed the LE-B-01 M&V method as described in the Procedures Manual.

B.4 ACTUAL M&V RESULTS & GROSS ENERGY SAVINGS REALIZATION RATE

Based on the M&V analysis, the total annual energy savings for the four lighting projects were 16,962,599 kWh, a realization rate of 84 percent. Table B-2 shows the gross realization rate for each project and all projects together.

Table B-2
Gross Energy Savings Realization Rate for County Lighting Retrofit

Application #	Gross Realization Rate
A	93%
B	71%
C	89%
D	83%
Total	*84%*

[7] Monitoring points are the fixtures where light loggers are to be placed.
[8] The utility administrator must select the monitoring points, not the applicant.

The M&V plan was followed as specified in the contract and resulted in expected and reasonable hours of operation. For one of the four projects, however, the EESP did not analyze the monitoring data completely. Eighteen days beyond the required 3 weeks were monitored. The technical reviewer used the full monitoring period to determine the building operating hours, which resulted in increased savings.

B.5 Overall Assessment of M&V

Customer Perspective

The customer said that they generally chose to have energy performance contracts, even without the SPC Program. One reason was that the more projects successfully completed with shared energy savings and incentives, the better chance their staff had of selling future projects to the county board. Therefore, from the customer's viewpoint, the M&V did satisfy their needs for both receiving the incentive and satisfying the contract with the EESP.

The customer felt the M&V accuracy requirements were reasonable. The customer's requirements mirrored those of the program. They would have imposed basically the same rigor in their M&V if they did the project outside of the SPC Program.

They were sheltered from any M&V costs and difficulties because the EESP was responsible for both. However, they felt that the M&V was a major effort and that they needed help from an EESP.

To the customer, one positive aspect of M&V was being able to demonstrate what the energy-efficiency measures were saving because they felt that using utility bills was a poor way to measure savings. The only negative aspect the customer mentioned was the distraction when people came to their facilities to install light loggers.

EESP Perspective

The EESP said that they did M&V on projects when their customers requested it. The lighting and HVAC retrofits (done for this particular customer) typically involved M&V, especially if a utility rebate were involved. The M&V they did generally included logging of operating hours, using standard wattages for lighting and checking trends on an EMS with end-use metering for HVAC.

For this particular SPC Program project, the EESP did the M&V they usually did, which was not much different from what the program required. According to the EESP, for lighting there is "not a whole lot to it;" they just needed to log operating hours. However, the SPC Program requirements were more stringent than the EESP's in terms of sampling. Their normal approach was to combine similar type of buildings as one population. The SPC Program required more sampling than what they would have done on their own. The increase in sampling, in the EESP's opinion, did not increase the level of accuracy and merely added expense. Due to the M&V requirements, some HVAC measures, but no lighting retrofits, were eliminated from the project.

The EESP felt that the main positive aspect of the program M&V was getting the incentive if the M&V was not cost-prohibitive. They did believe that the M&V was more stringent than necessary. The EESP participated in the 2000 SPC Program and said that the M&V lighting requirements were less demanding. The EESP will continue to participate in the program in the future but only if their customers want the incentive money.

According to the EESP, they followed the SPC Procedures Manual's lighting M&V plan, except for the LED traffic signals, where they developed their own plan. In general, the EESP believed that they did not deviate too much from the guidelines. According to the technical reviewer this was true; the DPA corrected the discrepancy in the BPA submittal to be consistent with the Procedure Manual's protocol for lighting M&V and site aggregation.

The EESP felt that the metering equipment used for the project was appropriate since the time-of-use loggers were typical. The EESP wanted to reduce the sample size; instead they agreed with the utility to reduce the number of sites.

One timing issue arose during the second performance year, but it was not prohibitive. When the utility provided the required monitoring list to the EESP, the utility failed to include one usage group to be monitored. The EESP did not blame the utility for this, but they would have done the monitoring earlier for those points in that usage group if they had been on the required monitoring point list. Because of this mishap, the EESP had to rent some loggers to complete the project on time.

B.6 CERTAINTY ABOUT ENERGY SAVINGS

Customer Certainty

When the customer first decided to implement the project, they were extremely certain of the estimated energy savings. After the performance years were completed, they felt that the EESP had provided conservative estimates because they easily met their guaranteed savings amount. Because the comparison between the estimated savings and actual M&V results was good, the M&V helped the customer maintain confidence in their EESP. The savings results met their criteria based on their anticipated amount of the contract. The customer stated that some facilities had lower savings than planned, which provided the customer with the opportunity to investigate the facilities for any operational problems. The lower energy savings possibly occurred because of changes in occupancy. Overall, the customer met the savings goal.

EESP Certainty

The EESP felt fairly confident about the projected energy savings and had no concern that the savings might be lower than projected. The EESP said that when a project was completed, they always compared the estimated and actual energy savings. According to the EESP, the savings for this project were slightly lower than anticipated because some sites were dropped from the proposed project. This statement contradicts what the customer said about savings being lower at

some sites. One probable explanation is that the EESP felt that the lower savings were justified by the reduction in project scope (some sites dropped from the project) and the customer felt differently about the results.

B.7 USE OF M&V RESULTS

Use by Customer

Because the EESP was under a guaranteed savings contract, the county used the M&V results to verify that the EESP met the contract terms. The results have been tracked for each performance year to check if any operating hours have changed. The customer then used the results and modified them based on occupancy and other factors to estimate future savings. This used to be done by tracking utility bills, but the customer realized that there were too many other variables for this to be sufficiently accurate.

The county representative said that they used the M&V results inside the division of internal services and the chief administrative office and did not distribute them to other decision-makers. The county used the M&V results to sell more energy-efficiency projects and show success to the chief administrative office. The M&V results were also used to validate the need to do more energy-efficiency projects by showing the financial staff and board of supervisors that these projects were worthwhile. They also used the M&V data to determine the operation and occupancy of their building spaces. They used the data to determine if anything appeared to be out of the ordinary; if they found variations, they tried to fix the problem.

Use by EESP

The EESP used the M&V results by adding the data to their library of information on energy-efficiency projects. They have used this library to publish case studies of their projects and make them into marketing materials.

B.8 EFFECT OF PARTICIPATION IN THE SPC PROGRAM

Customer Perspective

The customer felt the M&V cost was manageable and that they were always able to stay within their payback period criteria. They observed that the costs of M&V might preclude them from doing smaller projects, however. Overall, the SPC Program M&V process would not dissuade this customer from participating in future SPC projects.

EESP Perspective

The M&V process had no significant effect on the EESP's overall approach to energy-efficiency projects. For future non-SPC projects, they said that because of their experience with this project they would change their M&V approach to use more calculations than end-use monitoring.

B.9 VALUE OF M&V

Customer Perspective

The customer felt that the M&V for this project was worth the cost. They were willing to pay because of the value received from positive outcomes of doing M&V on energy-efficiency projects. They said that they would be willing to pay approximately 10 percent of project costs for M&V, but they would be willing to pay more if there were increased benefits.

When asked if they would be willing to accept more conservative savings estimates in return for using a less rigorous M&V approach, the customer said they would not accept such an option for two reasons. First, if the energy savings estimate were too conservative, it would have an unacceptably negative effect on the calculated payback. Second, they would need to ensure that the EESP satisfied its contracted guaranteed savings requirement, and rigorous M&V was needed to document this.

EESP Perspective

The EESP, however, believed that they could have gotten similar results with less effort in the M&V process. They felt that the recent changes in the M&V requirements were evidence that the utilities had come to recognize this as well.

The EESP for this project was more open to trading off a more conservative savings estimation for a less rigorous M&V requirement but said that it would depend on how conservative the estimates were.

B.10 VIEW OF RECENT CHANGES TO M&V IN 2001 SPC

Customer Perspective

The customer was not familiar with the changes to M&V in the 2001 SPC Program. When the changes were described during the interview, the customer found the offer of a calculated option to applicants unattractive. They planned to continue doing M&V as it was done in 1998.

The EESP was aware of the M&V changes and felt that the changes were improvements because they scaled down the M&V requirements and their respective costs to make it easier for participants to match projects of different sizes.

C

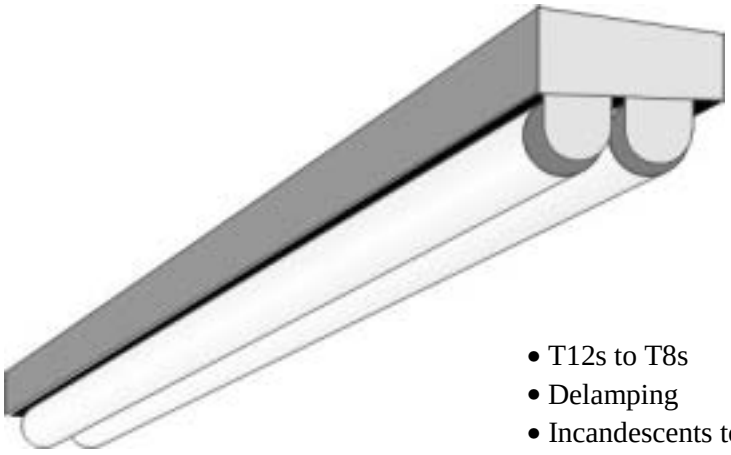
CASE STUDY 2: OFFICE LIGHTING RETROFIT

This case study project consisted of lighting retrofits under the 1999 SPC Program at several office buildings owned by a property management company. The EESP sponsored the project and handled the M&V plan, installation, data acquisition, and data analysis. In the past, the customer for this project was interviewed on multiple occasions about their 1998 SPC project, but they were not reinterviewed for this case study. However, we were able to interview the EESP sponsor, which was also the EESP for the chiller retrofit in Appendix D.

C.1 PROJECT DESCRIPTION

The EESP applied for an SPC Program incentive on behalf of a property management company. The company's buildings are multi-story office buildings. As shown in Figure C-1, the lighting efficiency upgrades in the buildings included converting T12s to T8s (de-lamping with reflectors), incandescent to compact fluorescent lamps (CFLs), and incandescent to LED exit signs. The EESP also installed lighting controls in open and private offices. The buildings were divided into four groups and put into four different SPC applications. They were submitted in this way to accommodate project construction schedules. Table C-1 summarizes information on the projects. Some of the projects were temporarily suspended, which means they were put on hold pending more information from the EESP, but all three were later resubmitted.

Figure C-1
Lighting Retrofit for Office Buildings



- T12s to T8s
- Delamping
- Incandescents to CFLs
- LED Exit Signs
- Lighting Controls

The energy savings estimated for the BPA were based on audits done on similar buildings for the management property company. Savings were estimated to be 303,556 kWh per 100,000 square feet. An additional 20 percent of savings were added as an estimate of the occupancy sensors savings.

Table C-1
History of Office Lighting Retrofit Project

		Submitted		Approved		
Document	#	*kWh*	*Incentive*	*Days until Approval**	*kWh*	*Incentive*
BPA	*A*	1,337,776	$66,589	22	1,337,776	$66,589
	B	3,431,401	$171,570	22	3,431,401	$171,570
	C	2,825,259	$141,263	22	2,256,273	$112,814
	D	568,986	$28,449	1	568,986	$28,449
DPA	*A*	768,742	$38,437	98	872,037	$43,602
	B	1,615,002	$80,750	98	1,842,693	$92,135
	C	1,583,120	$79,156	98	1,865,898	$93,295
	D	583,721	$29,186	71	703,911	$35,196
PIR	*A*	846,864	$42,343	76	Suspended**	
	B	1,646,039	$82,301	70	Suspended	
	C	2,131,286	$106,564	42	1,865,898	$93,295
	D	377,305	$18,865	29	Suspended	
PIR resubmitted	*A*	782,251	$39,112	56	872,037	$43,602
	B	1,535,267	$76,763	51	1,535,267	$76,763
	C	No Resubmittal				
	D	697,112	$34,885	29	697,112	$34,885
ASR	*A*	681,189	$34,506	61	645,242	$32,262
	B	1,712,528	$85,626	71	1,523,526	$76,177
	C	2,131,286	$106,564	22	2,392,615	$102,625
	D	621,500	$31,075	27	596,412	$29,821

Note: Letters A-D refer to the four different projects.

***** The number of calendar days from document submittal to approval.

** Three PIR submittals were suspended; therefore, the three were resubmitted.

C.2 ESTIMATED ENERGY SAVINGS

The savings estimated for the DPA for all four applications were based on complete building audits. The DPA was submitted twice because the EESP discovered, after the first submission, that the lighting equipment spreadsheet for the SPC Program did not calculate lighting control savings properly. The revision increased the estimated savings. The method of calculating the

savings estimate in the resubmittal was appropriate, and led to the "correct" calculation of realized savings.[1]

C.3 THE M&V PLAN

The proposed M&V plan was accepted as submitted. The M&V plan employed the multiple building method, LE-B-01. The usage groups where occupancy sensors were placed in private and open offices were monitored for a minimum of 3 weeks for determining the baseline hours in these areas. The line items chosen for monitoring from the lighting equipment (LE) survey were randomly selected by the utility.

Even though some of the selected areas were unoccupied during the pre-installation inspection, the technical reviewer required these areas to be metered anyway. In addition, the technical reviewer noted that alternate items for monitoring were indicated for backup from the lighting survey that had been supplied to the EESP. The reviewer insisted that if the alternate line items were employed, the EESP had to provide a reason for that substitution. Also, the reviewer commented that the EESP did not clearly specify the location of each line item in the "Area Description" column of the LE table. For future submittals, the EESP needed to clarify the area description. The inspection passed only because the person who had performed the audit was familiar with the situation and conducted the inspection with the technical reviewer.

M&V Issues

Some projects' PIR submittals were suspended because the installed equipment found during the pre-inspection differed significantly from the lighting equipment survey. The utility required a re-audit of sites with significant differences. In the resubmittal of these projects, the technical reviewer agreed with the EESP's assessment of baseline operating hours, with the exception of application C, which was accepted as originally submitted. Although some operating hours and kWh savings differed from the amounts calculated by the utility, the difference was not significant enough (i.e., the differences were less than 10 percent) to merit changing the energy savings amount.[2] The technical reviewer attributed these discrepancies to rounding error or other minor sources. One application was suspended due to faulty data logging of pre-installation hours. A resubmittal was made after the logging was corrected.
Some projects' savings estimates were reduced because of a reduction in the scope of work from the original project submittal. Sample sizes for monitoring operating hours depend on the size of project and the amount of savings per usage group. Therefore, minimum sample sizes were reduced because of the revised usage group populations (based on the reduced project scope) given by the updated lighting equipment survey.

Another M&V issue was that the EESP used alternate monitoring points without providing supporting documentation. As a result, the technical reviewer requested that for all future monitoring of alternate points proper documentation be submitted or they could be deemed to be

[1] The utility representative clarified the miscalculation on the lighting equipment spreadsheet. There was only a difference in the calculation methodology and in how the SPC lighting tables interrelate with each other.
[2] These differences occurred for the PIR submittals (or resubmittals).

invalid and require more monitoring. The technical reviewer also recommended that additional points be monitored during the performance year in case of logger failure and consequent undersampling.

For application C, the approved savings amount exceeded the submitted estimate. This was because the baseline monitoring resulted in higher operating hours than had been estimated in areas where controls were placed.

One more M&V issue was that the technical reviewer found inconsistencies in most applications from one form to the next and in the transfer of operating hours from monitoring data to the forms. This generally increased the amount of time taken by the technical reviewer, not because of the complexity of the M&V requirements but from the difficulties of data reporting.

C.4 ACTUAL M&V RESULTS AND GROSS ENERGY SAVINGS REALIZATION RATE

The gross realization rate results differed across the four applications. Table C-2 summarizes the gross realization results for the four applications.

Table C-2
Gross Realization Rate for Office Building Lighting Retrofits

Application #	Gross Realization Rate
A	74%
B	83%
C	128%
D	85%
Average	*92.5%*

The EESP did a time-of-use (TOU) analysis of the operating hours for some of the projects, but the technical reviewer found it unacceptable under the SPC Program requirements; this method resulted in savings overestimates. According to the SPC methodology, the usage group's annual operating hours should have been based on runtime and used to reconcile the kWh savings. The technical reviewer used the following equation (conforming to the SPC methodology) instead of a TOU analysis to extrapolate the hours to annual hours reported for each logger.

$$OH_{Annual} = \left(\frac{OH}{HR_{Total}} \right) \times 8{,}760$$

where:

OH_{Annual} = annual operating hours for a given monitoring period
OH = reported burn - time for a logger in the monitoring period
HR_{Total} = total available hours that the logger was recording data

For one application, the submittal did not use the same LE table as the one submitted with the PIR. Fixture counts were higher, but an increase in scope was not appropriate and acceptable at

the ASR. The PIR-accepted LE table was used by the utility reviewer for determining the assessed, and hence the approved, energy savings estimate. For some applications no line items were monitored, or undersampling occurred in specific usage groups. In these cases, the technical reviewer adjusted the submitted savings by attributing no savings to the groups not monitored.

In one project ASR submittal, the EESP incorrectly assigned baseline operating hours for the usage group with control measures to the estimated values in the DPA instead of to the pre-monitoring results. The M&V for control measures requires monitoring both before and after installation. Therefore, the pre-installation monitoring, not the estimated amount made in the DPA, determines the pre-installation operating hours. For those usage groups with no controls, the technical reviewer assigned the baseline hours as the DPA estimated values instead of the hours monitored during the performance year.

C.5 OVERALL ASSESSMENT OF M&V

Customer Perspective

We were unsuccessful in our attempts to re-interview the customer for this case study. Hence, we have no information on customer perceptions of M&V.

EESP Perspective

The EESP for this project has routinely included M&V since they started doing energy-efficiency projects. The main reason initially was that they had shared-savings contracts. They felt that their main purpose for doing the M&V was to verify savings, and they believed this need was met in this project. They believed that the utilities' need for M&V was to allocate program dollars fairly for savings.

A positive aspect of M&V from the EESP's perspective was to acquire a very accurate estimate of the energy savings; however, they felt that sometimes the SPC Program required an excessive level of accuracy. They said that the customer (the building managers) often told them that the M&V was designed to keep engineers employed.

A negative aspect of the program M&V noted by the EESP was that it did not take into account the conservation efforts of customers during the energy crisis. This had an impact because energy savings for areas without occupancy sensors were based on operating hours after the retrofit, but the energy crisis caused people to drop their usage, which meant that the savings estimated by M&V were much lower than they would have been when compared to the pre-retrofit baseline. The EESP noted that the PG&E Power Savings Partners Program made an adjustment for this that gave more credit for the energy savings.

One other negative aspect identified by the EESP was that building tenants reacted negatively to having people come in and install the monitoring equipment when they were working.

The EESP felt that the M&V sampling approach was generally appropriate. They noted, however, that the loggers were rather expensive (at least $100 each), and that costs could therefore be significant if many were needed at one time.

The EESP also noted that there were significant differences in the requirements across the utilities. They stated that one utility was unreasonable in not allowing flexibility in the requirements. The other two utilities were willing to adjust the metering requirements if the change was justified.

For this project, no data analysis problems occurred. One problem that delayed the M&V process was that the intended equipment was sometimes not installed or counted properly.

C.6 CERTAINTY ABOUT ENERGY SAVINGS

Because lighting was very straightforward, the EESP felt confident about the energy savings before implementing the project,. The only hitch (as noted above) was that the fixtures had to be counted correctly, and the planned equipment had to be installed.

The EESP stated that, for individual sites, the measured savings could vary substantially from the estimated savings. However, averaged over multiple sites, the project savings were easily within 10 percent of the expected amount (shown in Table C-2 over all four applications). Savings were lower than initially estimated, perhaps because of faulty installation or installation of unplanned equipment, including incorrect use of light loggers.

C.7 USE OF M&V RESULTS

The EESP was unsure what the customer's corporate facilities director did with the M&V results. Two building managers requested the M&V results from the EESP.

The EESP said that they distributed the M&V results internally. Additionally, they used the M&V results in marketing materials for potential projects and customers.

C.8 EFFECT OF PARTICIPATION IN SPC PROGRAM

The EESP stated that the M&V process and results did not affect their approach to energy-efficiency projects. There was also no effect on the EESP's way of doing M&V in similar projects because of its perceptions of the difficulty and costs of doing M&V as prescribed by the 1998-99 program. They felt that lighting M&V could be done in a simpler and more straightforward way than the program required.

In general, the EESP felt that the M&V process did not affect their decisions to participate in SPC projects. They had been and continued to be interested in doing them.

This EESP said that they would continue doing M&V to verify energy savings. In the future, they thought they would like to use the new SPC M&V requirements for lighting (the 2000

program approach). However, since no results were available yet with the new approach, they wanted to look at how the new method affected the savings estimates before deciding how to proceed with future lighting M&V projects.

C.9 VALUE OF M&V

The EESP felt emphatically that the M&V was worth the cost for this project.

The EESP was not sure if they would accept less rigorous M&V in exchange for a more conservative estimate of savings. Their biggest concern would be the stipulated hours of on-time since this number could have a significant effect on their savings estimate and dollars earned.

C.10 VIEW OF RECENT CHANGES TO M&V IN 2001 SPC

The EESP did not comment on the recent changes to the M&V approaches in 2001.

D

CASE STUDY 3: CHILLER RETROFIT

This case study involved a chiller retrofit project at a state university for the 1998 SPC Program. An EESP sponsored the project for the customer. The EESP has a larger contract with the institution and has implemented other projects for them in the past, such as lighting retrofits. The EESP developed the M&V plan, installed the equipment, collected the data, analyzed the data, and submitted the required reports to the utility. According to the EESP, the original chiller was oversized for the load, so there were efficiency gains from decreasing the chiller size. The customer was interviewed previously for this project, and we were unsuccessful in contacting a person who was familiar with the project for this case study. However, we were able to interview the EESP sponsor (the same EESP for Case Study 2).

D.1 PROJECT DESCRIPTION

The EESP submitted an application on behalf of a university to replace a 320-ton chiller with a 250-ton variable-speed drive (VSD) chiller for the student union building at a cost of $241,740. It is a 67,000-sq.-ft. building with student lounge and administrative offices, open 24 hours a day year-round.

The EESP indicated that the old chiller was oversized for the peak load. There is only a 50-ton base load year-round in the cafeteria. The original chiller ran at a low part-load level to meet this base load and therefore ran very inefficiently. The VSD with the new chiller also increased efficiency because it allowed the operators to vary the chiller output to match different loads.

According to results from customer participation surveys done in 1999 for the SPC Program evaluation, the customer proposed this chiller project to save energy. The SPC incentive amount was very significant in the institution's decision to pursue the project—without the incentive, the VSD chiller probably would not have been installed.

D.2 ESTIMATED ENERGY SAVINGS

The EESP was the party responsible for conducting the M&V. Table D-1 summarizes the events and history of estimated energy savings.

Table D-1
History of Chiller Retrofit Project

	Submitted		Approved		
Document	*kWh*	*Incentive*	*Days Until Approval**	*kWh*	*Incentive*
BPA	574,000	$120,540	139	574,000	$120,540
DPA	284,521	$59,749	77	454,708	$95,489
PIR	454,708	$95,489	43	454,708	$95,489
M&V1	336,754	$70,718	50	300,815	$63,171
M&V2	338,005	$70,980	8	338,005	$70,980

* The number of calendar days from document submittal to approval.

The estimated energy savings for this project differed greatly between the BPA (574,000 kWh) and the DPA (submitted value of 284,521 kWh) and during the technical reviewer's DPA review (approved value of 454,708 kWh).

The estimated energy savings in the BPA assumed full load operation of both baseline and proposed chillers and the calculation assumed the chiller's equivalent full-load hours (7,000 hours). The DPA calculation, on the other hand, used part-load efficiency values at 100-, 75-, 50- and 25-percent load for both the baseline and proposed chillers and used the Title-24 minimum efficiency level for the baseline chiller.

According to the technical reviewer, there were several errors in the EESP calculations. For example, one error in the savings calculation was that the same equivalent full-load hours (7,000 hours) were used for the original DPA submittal calculation as were used for the BPA. The technical reviewer and EESP agreed that the chiller operating hours were to be estimated to be 8,760 hours annually (continuous operation). Another error in the original DPA submittal was that the load projected for the new chiller was different, without good reason, from the existing chiller's load. The revised calculation assumed continuous operation (8,760 hours) and a similar load for both the baseline and proposed chillers because no changes to the building load were considered or planned.

D.3 PROPOSED AND REVISED M&V PLAN

D.3.1 Proposed M&V Plan

The M&V plan submitted with the DPA was based on the CH-B-02 option. The Procedures Manual recommends this option for chiller projects that have both an efficiency improvement and changes in performance characteristics such as those from installing a VSD. It is referred to as the "complex method" because it requires measurements of kW, chilled-water flow, entering chilled-water temperature, leaving chilled-water temperature, and condenser water temperature.

The technical reviewer determined, however, that the submitted M&V plan did not adequately follow the methodology presented in the Procedures Manual for this option.

D.3.2 Revised M&V Plan

In the draft review of the DPA, the technical reviewer indicated that the applicant should specifically state how the measured variables would be used in the M&V process. In addition, the reviewer requested that the M&V plan be modified to include a statement saying at what interval the savings estimate would be computed or if averaged values would be used. The technical reviewer also wanted the applicant to use all variables measured as required by the Procedures Manual methodology for M&V plan CH-B-02.

It was unclear from the project files whether a modification of the M&V plan occurred after this request was submitted. The revised M&V plan from the DPA phase was missing from the project file, as was correspondence indicating revisions to first year M&V results.

D.4 ACTUAL M&V RESULTS AND GROSS ENERGY SAVINGS REALIZATION RATE

The average of the approved M&V results across both years was a saving of 319,410 kWh per year. The gross energy savings realization rate was 70 percent.[1]

The technical reviewer for the first performance year made some changes to the submittal that lowered the estimated savings, but the documents were not available in the files to explain what was done. The second year's results were accepted as submitted. The technical reviewer noticed a miscalculation but did not believe that the effect was significant enough to justify changing the estimated savings amount. The reviewer believed a "good faith effort was made to document energy savings."

D.5 OVERALL ASSESSMENT OF M&V

D.5.1 Customer Perspective

Based on the customer's comments during a previous interview, the fact that the EESP was required to have a contract for measured savings with the utility greatly increased the customer's confidence in the EESP's estimates of savings. Additionally, the university was extremely satisfied with the project and saw that their energy bills had decreased. The chiller performed well; the customer has saved 1.5 GWh so far, and the savings continue to accrue.

As noted earlier, we were unable to interview anyone with the customer for this case study who was knowledgeable about the project. The contact person for this customer recently left the organization, and the interim facilities director was not familiar with the project. The customer had not received any M&V results so they could not make any comments on their perceptions of M&V or respond to the effects of M&V results.

[1] One note of interest is that when savings fall below 70 percent at the PIR, the SPC contract is amended to reflect a revised contract amount.

D.5.2 EESP Perspective

The EESP said that they typically did M&V in all their projects. Many of their projects were done under incentive-based utility programs that required M&V. Doing M&V as part of the SPC and other utility programs had also carried over into their non-SPC Program projects.

From the EESP's perspective, the value of the M&V was that it allowed them to verify the energy savings and to demonstrate to the customer that the savings did occur. For this project, the M&V met these needs by showing that the savings from the efficiency improvement were higher than predicted. The project files, however, suggest that the savings were lower than predicted. This discrepancy may have been caused by the EESP including the savings from the oversized evaporative condenser and the actual efficiency of the old chiller (not Title 24), neither of which were part of the DPA submittal for the project. The project was to install a smaller chiller with a VSD in place of the old one. Additionally, the SPC Program only pays for savings above the Title-24 efficiency level.

The EESP saw the M&V requirements as being very consistent with the nature of the SPC Program. They felt the M&V allowed the utilities to get away from standard rebates. They thought that the M&V requirements for this project were appropriate. They had had problems with prior programs, such as the Power Saving Partners Program, which required much more extensive M&V for measures such as lighting where the savings could be pre-calculated or verified with simple metering.

The M&V requirements did not keep the EESP from installing other measures in this project, but only the chiller changes were considered for this customer at the time. According to the EESP, the M&V confirmed the original engineering estimate and brought $20,000 of added incentives compared to what they would have received in the Power Saving Partners program. The EESP also preferred the SPC Program because the incentives were paid over 2 years instead of 6 years.

The EESP felt that the monitoring was helpful since it showed that savings were twice as much as they would have been if a Title-24 chiller had been installed instead.

The M&V cost for this project was between $10,000 and $13,000, or about 16 percent of the incentive. The only cost-related problem highlighted by the EESP was that the installation of monitoring equipment required time and effort. Nevertheless, the EESP stated that the M&V benefits outweighed their added costs.

There were no M&V data analysis problems with the project. However, there were timing problems during the second year of M&V because the utility lost track of their submittal. Generally, this was a very simple project, and timing should not have been an issue. The EESP stated, however, that even with simple projects the utility takes 3 months to process the submittals.

The utility's technical reviewer helped the EESP with their M&V approach early on in the program through a seminar on M&V.

D.6 CERTAINTY ABOUT ENERGY SAVINGS

Customer Perspective

Although we were unable to interview the customer for this case study, the customer indicated in an earlier evaluation interview that energy savings uncertainty was an important issue for them. They felt somewhat certain of the energy savings prior to implementation.

EESP Perspective

The EESP felt fairly confident before this project that they would achieve at least 80 percent of the savings estimated. The actual savings were very close to the estimated value, but there were two offsetting factors. First, the original estimate of the annual cooling load was too high. This was based on short-term metering that did not hold true over a whole year (a common error for extrapolating energy consumption). Second, the equipment efficiency improvement was much more than they had predicted and so offset the effect of the lower cooling load.

In estimating energy savings for future projects, the EESP indicated that they felt that every previous project was a learning experience that helped them improve for the next one. The M&V requirements for this project provided them with significant learning opportunities because they allowed them to refine their future estimates for similar projects. They said they now use the same load profiles for old and new equipment and adjusted estimates to take into account what they had learned from M&V. Therefore, the M&V provided a reality check that made them better at predicting savings in future projects.

D.7 USE OF M&V RESULTS

The EESP had used the M&V results internally to update their savings estimate approaches. The EESP stated that they make a real effort to leverage what they learn with each project.

The EESP had used this project in their regular marketing materials, but the materials did not focus on the M&V process. They had used the M&V from this project in a training course. The M&V process and results had affected the EESP by improving the way they estimated energy savings.

D.8 EFFECT OF PARTICIPATION IN THE SPC PROGRAM

The difficulty and costs of conducting M&V resulted in mixed reactions inside the EESP's organization. The interviewee said that he "grew up on the SPC Program," so he did not have anything to compare it to and he had been quite optimistic about the M&V process. Others at the company, however, were pessimistic, anticipating that M&V would be very costly, especially for

projects involving mechanical systems. The interviewee thought that with good planning, M&V could be accomplished cost-effectively.

Because of the SPC Program, the EESP had begun using M&V in their regular business. They used about the same rigor in accuracy and metering requirements as the SPC Program required.

D.9 VALUE OF M&V

The EESP believed that the benefits of M&V outweighed the costs. The M&V showed that the equipment they installed was more efficient than they had assumed. However, the EESP would accept a more conservative approach if it reduced their M&V costs on projects. On the other hand, the EESP saw the M&V as way to learn about the dynamics of the measures installed. They noted, though, that learning this took effort and resources.

The EESP observed during the interview that the information gathered through the SPC Program M&V gave valuable indications about how to simplify the M&V and adjust calculated savings estimates. They suggested that the utilities compile information on what had been learned, to save each contractor from having to relearn these shortcuts and adjustments. They felt that knowing how to do M&V cost effectively would be valuable in future projects However, they noted that EESPs probably would not want to share this information since it was part of their competitive advantage.

D.10 VIEW OF RECENT CHANGES TO M&V IN 2001 SPC

The EESP was aware of the changes to M&V in the 2001 SPC Program. The interviewee thought that the calculated savings method was an appropriate approach for some projects.

In some cases, however, the EESP would prefer to do the M&V. The reason was that they knew how to do M&V with little incremental cost and the added incentive usually made it worthwhile.

E

CASE STUDY 4: AIR COMPRESSOR SYSTEM RETROFIT

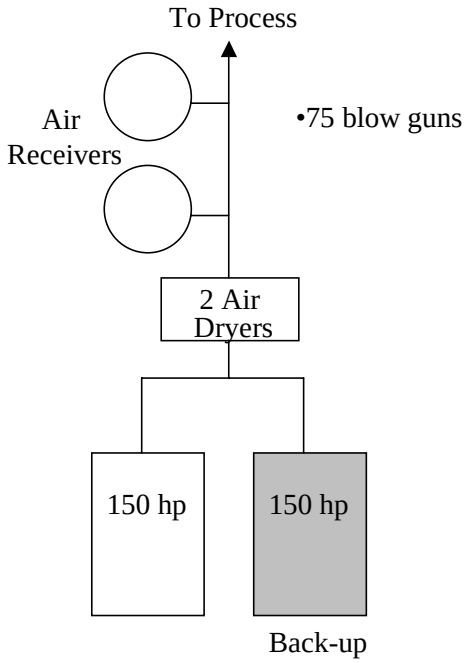
This case study involved an air compressor project at an institution under the 1998 SPC Program. This applicant was self-sponsored, but received help from an EESP. We have tried contacting the person who submitted the last documentation to the utility, but he was unavailable for an interview. Instead, we interviewed the former project manager from the institution, who resigned in March 2001. We also interviewed the EESP for this project. Another contractor, who was not interviewed, helped with the physical activities associated with M&V.

E.1 PROJECT DESCRIPTION

A government agency applied for an SPC Program incentive for a compressed air improvement project. The facility is used for mail processing and distribution. Compressed air is used for mail processing and distribution functions and for cleaning equipment. The baseline equipment was two 150-hp air compressors (one was a backup), two dryers, and two air receivers.

In the baseline system, there was inadequate storage capacity and no separation of supply from demand, causing the compressor to follow system pressure fluctuations. Constant system pressure was difficult to maintain, and consequently there were equipment problems. The retrofit equipment and operations installed two new air receivers, an isentropic air expander, an air flow meter, and three zero-loss drain traps. The project also replaced 75 blow guns with nozzle guns. In addition, two new smaller air compressors of 60 and 100 hp (the DPA stated that 60- and 85-hp compressors would be the proposed equipment) replaced one 150-hp air compressor (the other one remained for backup). Figures E-1 and E-2 are schematics showing the pre- and post-installation configuration of the project completed at this customer's facility.

Figure E-1
Pre-Installation Schematics of Air Compressor Systems



E.2 ESTIMATED ENERGY SAVINGS

Table E-1 shows the history of the project process for this case study.

Table E-1
History of Air Compressor Project

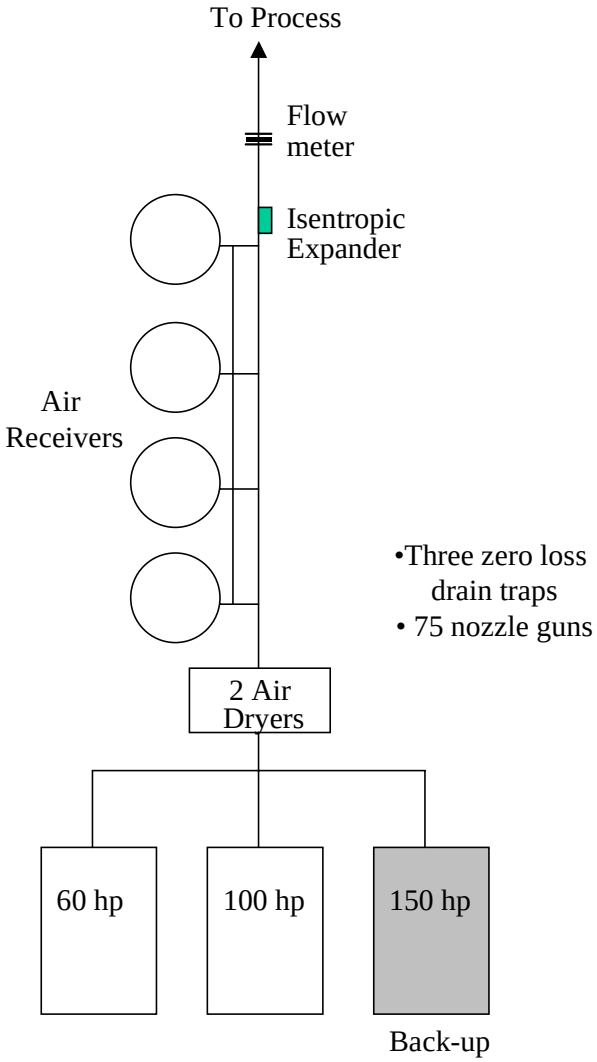
	Submitted		Approved		
Document	*kWh*	*Incentive*	*Days Until Approval**	*kWh*	*Incentive*
BPA	271,134	$29,825	5	271,134	$29,825
DPA	279,243	$30,717	176	271,134	$29,825
PIR	271,134	$29,825	35	271,134	$29,825
M&V1	380,667	$41,873	28	380,667	$29,825
M&V2	391,767	$43,094	Not complete as of June 2001		

***** The number of calendar days from document submittal to approval.

The estimated energy savings were based on the pre-installation energy use from logging both compressors over a 3-day period in both loaded and unloaded mode for all three shifts of operation. Monitoring over a 7-day period a year later resulted in a 99-percent correlation of the two data sets.

The post-installation energy use was estimated for the two new compressors, as were the hours Figure E-2 of operation in both loaded and unloaded modes.

Figure E-2
Post-Installation Schematics of Air Compressor Systems



E.3 THE M&V PLAN

E.3.1 Proposed M&V Plan

Before the DPA was submitted, the applicant and their EESP met with the utility to determine what was required from them for M&V. It was determined that they needed to provide a plant schematic, an inventory of air consuming equipment, mass balance of flow and energy, and baseline monitoring for 1 week. A ratio of kWh per pound of mail processed was determined and used to adjust the baseline energy use from the total mail processed in the performance year.

The applicant submitted an M&V plan consisting of M&V option CLM-B-01. They recognized that this M&V method did not directly apply to this project and, hence, modified it. They proposed to do baseline monitoring of energy consumption for 1 week. After installation, they continuously monitored the energy use (kW of the air compressors) and the volume of mail processed.

E.3.2 Revised M&V Plan

The applicant submitted the mass flow accounting description and analysis requested by the utility after the original submittal. This calculation showed that there should be a higher savings estimate than that submitted with the original DPA, but the original submitted amount was still used as the contract amount. The revisions to the application from this later submittal were approved by the utility.

The mass flow accounting required the installation of pressure transducers. These data loggers were installed on the primary air compressor, demand expander, and receiver tanks. The loggers also monitored continuously throughout the performance years.

E.4 ACTUAL M&V RESULTS AND GROSS ENERGY SAVINGS REALIZATION RATE

The average of the two annual M&V results showed that the new system saved about 386,217 kWh, a gross realization rate of 142 percent compared to the contract amount. The new system increased air supply by over a third and the measured energy use was up compared to the baseline because production increased. Savings were realized because production efficiency improved. The post-installation compressed air output in pounds per kilowatt-hour was higher than predicted and, thus, more efficient than the baseline. Higher monthly production efficiency was calculated with the new system, and therefore the production efficiency exceeded expectations.

Compressed air flow and pressure, power, and production were measured every 20 minutes. The applicant used the pre-installation production level to estimate energy savings, but produced above this amount, hence resulting in a lower calculated energy savings. The M&V plan was based on using the performance year production (post-installation) levels. No comments were made by the utility on the second year of M&V because it had not been reviewed (pre-approved by the utility) by the time we did our analysis, but the submittal was similar to the one for the first performance year.

At the PIR stage, there was a problem with the new installed system. The compressed air supply pressure was slightly higher than proposed, but a small design change was made to solve the problem. The applicant proposed that any increase in interim energy use would be subtracted out of the first year savings. The utility approved this proposal. The PIR also indicated that the customer decided to install a 100-hp compressor in place of the 85-hp compressor originally proposed (but not installed at the time of PIR submittal). The 60-hp unit was itself adequate to meet the normal load and the 150-hp compressor would be turned on to meet the daily peak load

before the 100-hp air compressor was installed. The 150 hp unit is now being used as backup, with the 100-hp air compressor used to meet the peak load.

E.5 OVERALL ASSESSMENT OF M&V

E.5.1 Customer Perspective

This customer felt that the retrofit as a whole was working better than expected, but they found the M&V too expensive. They had done M&V only to verify savings on projects if it were required for an incentive or if they had a shared savings contract. Consequently, the M&V for this project was done exclusively to get a higher yield on the project. The utility, in the customer's opinion, required the M&V to provide the appearance of a good return on public benefits funds. He did not think the M&V met this need because the M&V was burdensome on the customer.

The customer thought that the level of accuracy required was appropriate for this project because it was a sophisticated upgrade. For simpler project, such as lighting retrofits, the customer did not think the level of accuracy required would be appropriate.

No measures were eliminated from the project due to the burden of M&V. The incentive was high enough to cover the M&V costs on the measures implemented.

The customer said that the only positive aspect of M&V was receiving the incentive money. To them, the main negative aspect of the M&V was the cost involved. The cost included the monitoring equipment, labor to retrieve the data, and the maintenance of the monitoring equipment. Despite this negative aspect, the customer said they would continue to participate in future SPC Program projects. They will continue to do so as long as the program remains lucrative and the M&V burden remained reasonable. For future projects, the M&V implemented will be the minimum required to get an incentive.

E.5.2 EESP Perspective

The EESP also said that the retrofit was going better than expected and that their decision to do M&V without the SPC Program depended on their client's needs. They thought that the level of accuracy required was appropriate for this project. They saw the M&V process in 1998 as onerous, especially for the non-standard technologies. However, they knew the program had gotten better over the years. They felt that there had been a lot of scrutiny by the utility, but now they felt comfortable doing air compressor projects and that the utility trusts them.

According to the EESP, the M&V method used for this project had potential for assisting with troubleshooting and preventive maintenance that would benefit the client. The EESP believed in doing M&V as a benefit to the customer. Despite the customer's negative comments on the M&V, according to the EESP, the customer had decided to continue doing M&V on this project even after the 2 performance years required by the SPC Program were complete because it

allowed them to operate the equipment more efficiently with the diagnostic tools used to do M&V.

E.6 CERTAINTY ABOUT ENERGY SAVINGS

Customer Perspective

The customer felt very confident about the estimated energy savings and was not at all concerned that the actual savings might be lower. They were not surprised when the savings turned out to be higher than they had predicted. The higher savings, however, did not affect their confidence that they could estimate savings for future projects accurately.

The customer said that they have to feel very confident in the payback period for a retrofit before pursuing it. They have to compete for capital money with other essentials in this institution nationwide. Now that they have the results from this project and it was successful, the customer will look at facilities nationwide for opportunities to implement similar projects. However, their organization is currently in debt, so they will not consider any new projects in the near future.

EESP Perspective

The EESP expressed a little more uncertainty about estimating energy savings for air compressor projects. They were not involved at the beginning of this project, so they did not know if there was any concern then that the savings would be lower than predicted. This project was the first of its type for the EESP, customer, and vendor (who helped with implementation). They felt that estimating air compressor savings was a bit of an art.

E.7 USE OF M&V RESULTS

The customer and the EESP had contradictory comments on the use of M&V results and the value of M&V.

Customer Perspective

The customer shared the preliminary energy savings calculations with their decision-makers, but did not provide them with the M&V results. The customer said that they would not use the M&V results to promote or assess future energy-efficiency projects.

EESP Perspective

The EESP, on the other hand, provided the M&V results to other facilities of the customer's organization. They also showed them to other clients to demonstrate the value of doing air compressor system retrofits.

Doing the M&V for this project did not affect the EESP's approach to energy-efficiency projects. However, they now believed that air compressor retrofits are a huge opportunity for clients because of the short payback period.

E.8 EFFECT OF PARTICIPATION IN THE SPC PROGRAM

As a result of this project, the EESP is now more confident about estimating savings for this type of project and they expect that similar retrofits will be easier to approve and implement. The SPC Program did not adversely affect the EESP's desire to participate in future SPC projects.

The EESP said they did not rely on the program incentive money to do projects, but the incentive made them look good. From their perspective, the cost of M&V can be high. The total M&V cost for this project was $7,500 ($4,000 to 5,000 for the metering equipment), which was greater than 10 percent of the project cost ($60,000). Despite the relatively high M&V costs, the payback was still less than 1 year for this project. The EESP said that if the M&V cost were close to the incentive amount then the SPC Program would be unattractive to them.

E.9 VALUE OF M&V

The customer saw value in the M&V only because it allowed them to receive an incentive. They were not willing to spend very much to do M&V. If they were given the opportunity to provide a more conservative savings estimate in exchange for less M&V, they would definitely do so. The customer felt that avoiding having to do the M&V was worth it, even if it meant they received a smaller incentive.

The EESP believed that the M&V process was worth the cost. They said they typically would be willing to spend up to 20 percent of the incentive amount on M&V, but generally they would not be willing to spend more than $10,000 on M&V. For this project, they felt that the level of rigor for M&V was appropriate and effective. Although they were generally satisfied with the M&V requirements for this project, on other projects they might accept having more conservative estimates in exchange for less rigorous M&V. They believed that reducing reporting requirements would be helpful. In general, they saw the M&V as an added-value service they could provide to their clients.

E.10 VIEW OF RECENT CHANGES TO M&V IN 2001 SPC

The customer was aware of the 2001 SPC changes to the M&V requirements. They believed that the changes to not require M&V for simpler projects were good. However, they felt that the new requirements for more complicated projects like their air compressor project were still likely to be burdensome (similar to the past requirements).

The EESP also was aware of the 2001 SPC Program changes to the M&V requirements. They felt that over time the program had become more manageable as a result of reduced M&V requirements and more standardization such as allowing the use of industry-acceptable variables (standard wattages, operating hours, etc.). They believed that the calculated savings option represented a positive move for the SPC Program. In addition, the reduction in reporting requirements, the clarity of the program expectations, and the additional flexibility afforded by the existence of the two M&V approaches all made sense to them and made it easier for applicants. Even with these changes, the EESP believed that most utility customers were not sophisticated enough to understand the SPC Program, which made it primarily a job for consultants.

F

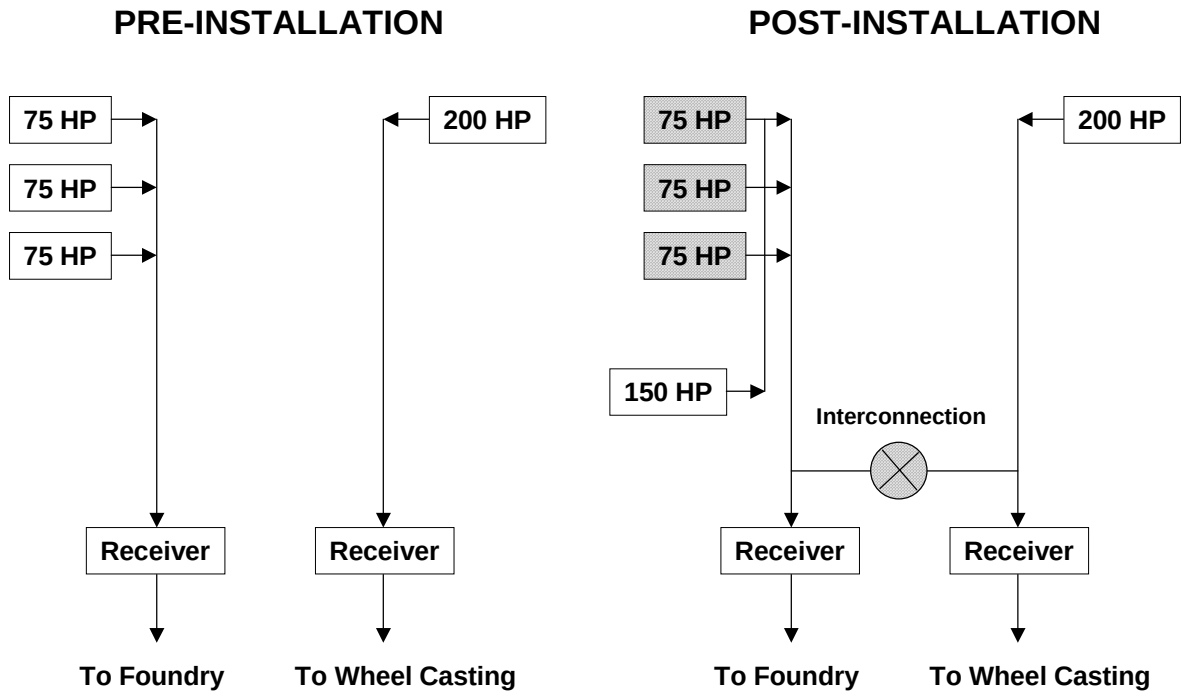
CASE STUDY 5: WHEEL MANUFACTURING

A wheel manufacturer had an EESP sponsor submit an application on its behalf under the 1998 SPC Program for a retrofit of its air compressor system. We interviewed both the customer and the EESP for this case study.

F.1 PROJECT DESCRIPTION

Compressed air runs the manufacturing lines for the company's aluminum wheel production. The air compressors are also used for the melting and molding of new wheels. Figure F-1 is the schematic of the pre- and post-installation systems. The project involved connecting two air compressor systems and replacing three 75-hp compressors with a new 150-hp screw compressor. The cost for this project was estimated to be $115,000.

Figure F-1
Pre- and Post-Installation Systems



F.2 ESTIMATED ENERGY SAVINGS

The EESP was the party responsible for selecting the compressor, putting the paperwork together, and conducting the M&V. Table F-1 summarizes the project events and history of estimated energy savings.

Table F-1
History of Air Compressor Project

	Submitted		Approved		
Document	*kWh*	*Incentive*	*Days until Approval**	*kWh*	*Incentive*
BPA	420,000	$46,200	169	420,000	$46,200
DPA	420,000	$46,200	211	420,000	$46,200
PIR	420,000	$46,200	22	420,000	$46,200
M&V1	256,193	$28,181	21	343,699	$37,807

***** The number of calendar days from document submittal to approval.

According to results from customer participation surveys done in 1999 for the SPC Program evaluation, the customer proceeded with the project to save energy and to replace older equipment. They probably would not have installed the new compressor system without the incentive and help from the EESP. The customer chose to use the EESP because they did not have enough knowledge internally, and because the EESP specialized in this type of work.

F.3 THE M&V PLAN

Proposed M&V Plan

The original M&V plan proposed monitoring for 3 days, using the average kWh used per wheel produced during the 3 days in both pre- and post-installation monitoring periods, and then multiplying by the total wheels produced in the year. A major assumption here was that the air compressors were running at constant load and that wheel production was directly correlated to air compressor electrical energy use.

This proposed plan did not comply with the requirements of the SPC Procedures Manual, and the technical reviewer rejected it. One reason was that the 3 days proposed for monitoring in the original M&V proposal were not enough to show whether the motor load was constant. Other reasons included conclusions based on the pre-inspection that showed different operating hours than stated in the application and showed a variable loading pattern of the compressors.

The technical reviewer provided a detailed report of what was required for approval of the M&V plan in the resubmittal. The main points of concern were these:

- The manufacturing process was not predictable (possible variable production rate) and hence a variable load was probably present;

- The monitoring period was not long enough to ensure capture of the full range of compressor operation—4 weeks are required according to the Procedures Manual, Chapter 6,[1] and anything less must be on the condition that production rate did not vary.
- If baseline monitoring did show that the system had a variable load, then the M&V plan should be method GVL-B-01 (general variable load), not the proposed CLM-B-01 (constant load motors).
- The savings calculation should be limited to baseline production levels (i.e., not include any increased production).
- The standard minimum efficiency levels from California's Title 24 and National Electric Manufacturers Association's table (approved SPC values[2]) for the baseline should be used for calculating energy savings.
- It was necessary to show that the number of wheels produced was a statistically valid variable for use in determining energy consumption (e.g., using regression analysis).

Revised M&V Plan

The EESP had problems agreeing with the technical reviewer about the M&V plan. It submitted its revised M&V plan, but it too was rejected. The plan still assumed a constant load, even though the measured baseline data submitted with the revised M&V plan showed that the compressors did not run at a constant load. In addition the EESP agreed to only 14 days of monitoring because of concerns about keeping the electric panel open and exposing the workers to danger.

The technical review of this resubmittal resulted in the reviewer developing and recommending a baseline regression model (method GVL-B-01) to the EESP and customer if the independent variables "made sense." The plan was accepted by the EESP for 14-day monitoring both pre- and post-installation.

F.4 ACTUAL M&V RESULTS AND GROSS ENERGY SAVINGS REALIZATION RATE

The M&V report submitted by the EESP used the M&V plan (baseline regression model) developed and approved by the technical reviewer and the utility.[3] When the technical reviewer reviewed the results, however, he discovered that the regression model did not appropriately model the system's baseline energy consumption and, therefore, underestimated it. The submitted value of 256,193 kWh of savings corresponded to a realization rate of 61 percent, which was not consistent with the understanding of the project's energy savings intentions. The

[1] *1998 California Non-Residential Standard Performance Contract Program Procedures Manual*. Prepared for Pacific Gas and Electric Company, San Diego Gas & Electric, Southern California Edison. Version 1.1 January 1998.
[2] The SPC Program pays for the energy savings of retrofits that are made above the standard efficiency.
[3] The utility and technical reviewer are typically interchangeable. Normally, the utility proceeds with the technical reviewer's recommendations and notes concerning the submittal.

reviewer decided to recalculate the savings by assuming a constant load baseline for weekdays (average of weekday kWh) and the minimum energy use in a weekend day for weekend energy use, and then extrapolating to yearly consumption. This method was also used to estimate the post-installation energy consumption.

The annual energy savings were then calculated as the difference in energy consumption per day, multiplied by the number of days per year of compressor operation. As a result of these changes, the energy savings approved by the utility were higher than the amount submitted. The calculated approved annual energy savings after the first year of M&V were 343,699 kWh. The revised gross energy savings realization rate was 82 percent.

F.5 Overall Assessment of M&V

Customer Perspective

The customer felt that the level of M&V was reasonable. Without the SPC program, however, they would not have conducted such extensive M&V. In general, when this customer purchases equipment, they make sure some kind of performance guarantee is included in the contract. They would be willing to pay 1 to 2 percent of total incremental high-efficiency project cost for M&V. From their perspective, the reason for doing the M&V was to show that they were saving energy and because it was a mandatory requirement for receiving an SPC incentive. The M&V process met these needs by confirming the energy savings.

The customer felt that the only problem with the M&V was that they did not have the appropriate equipment or understanding to do the M&V easily. The positive aspects were that the M&V showed the company that they were on the right track and that the M&V produced more accurate results than just using billing data to estimate air compressor energy use. This was primarily because their production fluctuations were large. However, this company did not typically do very many energy-efficiency projects. Their focus was more on improving the production process, while keeping energy usage in mind.

EESP Perspective

The EESP thought the M&V process and requirements were complicated. They also felt that the technical reviewer did not really understand air compressors. The EESP believed that the M&V process would have been smoother if the reviewer had understood the project better. There were disagreements between the EESP and the technical reviewer about the M&V plan, primarily because the EESP felt that it should have been much simpler.

F.6 Certainty of Energy Savings

Prior to installation, the customer felt very certain about the energy savings produced by this project. They felt that the M&V results would not affect their level of certainty. However, after the first year's results were available and the savings were less than anticipated, the customer

noted that they were only 70 to 80 percent certain about the energy savings. For this reason, the customer felt that the next time they should do better research before the project.

The customer stated, though, that the disparity "d[id] not rock my confidence." They felt that a deviation of 10 to 15 percent in the savings was acceptable.

F.7 USE OF M&V RESULTS

In a June 2000 interview,[4] the customer said that they would use M&V results to sell additional projects to management. They found the results useful for comparing the EESP's prediction to actual results. Furthermore, they also said they believed the M&V results could serve as a useful reference point for deciding whether an EESP's saving estimate could be trusted for future projects. Such reference points also could make future projects easier to sell to management. In this year's interview, the customer said he had presented the M&V results to management. He referred to the results as being "like a report from a mutual fund."

F.8 EFFECT OF PARTICIPATION IN THE SPC PROGRAM

Customer Perspective

Generally, the customer felt that the M&V process had no effect on future SPC participation because, if the potential to save energy existed, they would implement the project regardless of the M&V requirements.

EESP Perspective

In part because of the M&V burden, the EESP said they would not continue to participate in the SPC Program. The EESP felt that a combination of measurement and calculations without production data requirements would have been sufficient for this project.[5]

F.9 VALUE OF M&V

Customer Perspective

The customer said they were willing to pay 5 to 10 percent of the incentive for M&V. The customer did not know the cost of the M&V for this project because the EESP took care of the M&V so the customer was uncertain whether this project met the criterion. Without an incentive, the acceptable level of M&V costs would depend on the project. The customer also felt that there was not much value in doing M&V for more than 1 year. This was because their production process undergoes design changes often, so conditions might vary too much from year to year to get meaningful estimates of energy savings (especially if compared to the baseline).

[4] The customer was interviewed as part of the 1998 SPC follow-up evaluation.

[5] According to the utility representative, despite the EESP's comments during the case-study interview, this EESP has continued to participate in the SPC Program.

EESP Perspective

The EESP's views on the M&V were quite negative. They said that their experience in this project validated their negative perceptions of the cost and difficulty of doing M&V. They said it cost $12,000 to do the M&V, or 25 to 30 percent of the incentive.

F.10 VIEW OF RECENT CHANGES TO M&V IN 2001 SPC

Customer Perspective

The customer was reluctant to provide feedback on the SPC Program M&V changes in 2001 because they had no time for M&V and that was why they hired a third party to do the work. After we described the M&V changes, they said that it was "important to know that some projects do not need M&V;" reducing the M&V requirements will cost them less money in any future projects.

EESP Perspective

The EESP was generally pleased with the M&V changes. They liked the idea of the calculated savings method.

G

CASE STUDY 6: GROCERY STORE RETROFITS

This case study addresses retrofits conducted at several grocery stores throughout California. This customer participated in the 1998 SPC Program in all three utility territories and hired an EESP to conduct the M&V activities, do the analyses, sponsor the project, and prepare the documentation for submittal to the SPC Program administrators.

The EESP for this project was an ESCO specializing in refrigeration and HVAC upgrades for major grocery store facilities and had a contract with the grocery chain to sell power and provide energy services.[1] Due to the volatility of the energy markets, the customer will no longer buy energy from ESCOs. The EESP was extremely important in implementation of the project, according to the customer. Both the customer and the EESP were interviewed for this case study.

We have reviewed all the files for all three utilities. Different information was received from each utility. Utility 1 sent all their files. Utility 2 sent only one of the four project applications (all were similar, but were submitted in multiple applications). Utility 3 sent only the technical consultant's review comments from their files.

G.1 PROJECT DESCRIPTION

The EESP submitted an application for various efficiency measures in retail supermarket sites in all three IOU territories. The supermarkets sell fresh, frozen, and dry goods. The operating hours for all measures are 24 hours per day, 365 days per year. The business hours at the stores range from 18 to 24 hours per day. The energy consumption pattern of each site is similar in magnitude, but varies due to size, location, and year of construction. The EESP conducted all M&V activities and analyses and prepared the documentation for submittal to the SPC program.

As proposed in the BPAs, the projects were to implement one or more of several different measures from store to store, such as installing variable-frequency drives (VFDs) for air handling units (AHUs), upgrading the HVAC energy management systems, installing exhaust fan controls, implementing extensive fixture upgrades, and more.

The DPAs, however, proposed a different scope and included only one, two, or all three of the following measures in each of the stores: anti-sweat heater controls on display cases, a VFD for AHU fans, and measures to optimize refrigeration that varied from site to site (variable set point controls, floating head pressure, condenser VFDs, new condensers and compressors, subcoolers, refrigerant change-outs to R408a, and refrigeration EMS upgrades).

[1] This EESP has since been bought and will no longer be an ESCO.

G.2 ESTIMATED ENERGY SAVINGS

Table G-1 summarizes the documentation history, energy savings and incentive amounts.

Table G-1
History of Grocery Store Retrofits Project

	Submitted		Approved		
Utility 1	*kWh*	*Incentive*	*Days to Approval**	*kWh*	*Incentive*
BPA	41,900,513	$7,306,009	42	10,303,311	$1,986,458
DPA	9,709,307	$1,580,883	283	4,200,545	$882,114
PIR	4,200,525	$882,110	53	4,200,545	$882,110
M&V1	4,094,085	$859,758	32	4,094,085	$859,758
Utility 2	*kWh*	*Incentive*	*Days to Approval**	*kWh*	*Incentive*
BPA	1,292,000	$271,320	7	1,292,000	$271,320
DPA	1,377,093	$289,190	100	1,203,312	$252,696
PIR	1,203,312	$252,696	42	1,203,312	$252,696
M&V1	1,005,597	$211,175	133	1,005,597	$211,175
Utility 3	*kWh*	*Incentive*	*Days to Approval**	*kWh*	*Incentive*
BPA	6,552,491	$1,345,937	36	3,153,450	$1,359,000
DPA	2,805,294	$657,912	293	2,379,935	$499,786
PIR	2,332,215	$489,765	36	2,379,935	$489,765
M&V1	1,623,297	$340,892	67	1,623,297	$340,892

***** The number of calendar days from document submittal to approval.

One technicality arose in the estimated energy savings calculation for this project submittal. The EESP used proprietary software to calculate energy savings for the refrigeration optimization measure. Proprietary software was not usually allowed in the SPC Program for M&V. The technical consultant for utilities 1 and 3 granted an exception to the SPC rules for the EESP and approved this method for estimating energy savings because the M&V would verify the savings.

Baseline measurements were required to determine if any adjustments to the energy savings estimate were necessary for the PIR submittal for this measure. It was determined that they were not because the measured baseline came within 10 percent of the baseline calculated by the software.

G.3 PROPOSED AND REVISED M&V PLAN

Proposed M&V Plan

The same basic M&V plans were submitted to utilities 1 and 2. The original M&V plan for utility 3 was not included in the files submitted to us by the utility, but a revised plan was provided instead. The essential components for the M&V plans were similar across the utilities; variations among them included such information as the type of loggers used. According to the information in the files, utility 2 did not comment on the M&V plan, but a revised M&V plan was submitted to the utility and the revision was approved as submitted. Utilities 1 and 3 had several comments about the M&V plan.

The M&V options differed by measure, but the M&V option for each measure was the same in the proposed M&V plans for all utilities.

The anti-sweat heater controls measure used option LC-B-01. Although this option was designated for lighting circuits, it appeared to be suitable for this technology as well. Under this M&V option, the post-installation operating hours of the heaters were to be measured. The operating hours were stipulated for the baseline. Spot measurements were made to determine the load of the heaters. Under the option as submitted, the addition or removal of refrigerated display cases (and the corresponding number of anti-sweat heaters) would alter the baseline and a baseline adjustment would be required if the savings would change by ±5 percent.

M&V option VSD-B-01 was proposed for the AHU fan VFD measure. This option required a spot measurement for the baseline and monitoring of operating hours and kWh for the post-installation measurement. The EESP proposed using the VFD kWh readout. However, the technical reviewer discovered that the accuracy of the kWh consumption logged by the VFD would be ±10 percent, based on manufacturer specifications; this accuracy level was too low to satisfy the requirements of the SPC Program. The technical consultant for utility 1 recommended an alternate plan, discussed below. The M&V plan submitted to utility 3 did not use the VFD kWh readout as the form of monitoring, but instead used a kWh logger (possibly because of review comments from the other utilities).

The M&V plan for the third measure, refrigeration optimization, was submitted under option GVL-B-01. The EESP wanted to assume a constant conservative baseline instead of proposing a complex and potentially costly M&V plan. The baseline was based on one month of monitoring during non-summer months. The plan proposed that post-installation energy use would be monitored continuously. The addition or removal of refrigerated display cases would alter the baseline. If the total display case refrigeration baseline load increased more than 7 percent as a result, the baseline energy use for the refrigeration optimization measure would be recalculated according to the changes in number or size of the display cases.

Revised M&V Plan

For the anti-sweat heaters, no revisions were necessary for utilities 1 or 2. Utility 3, however, criticized the assumption of 8,760 hours of operation because of the defrost cycle. They determined that most stores failed pre-installation inspections for the anti-sweat heater control measures because some display cases had them already or the heaters were cycling. Therefore, the assumed hours of operation for the existing system were incorrect. The technical reviewer gave the EESP/customer two options: remove the measure from the application or provide a plan to pre-meter the existing door heaters to quantify the baseline hours of operation. As a result, in the revised DPA to utility 3 some stores that originally had anti-sweat controls as a retrofit measure were removed from the application.

For the AHU fan VFD measure, the technical consultant for utility 1 recommended additional monitoring. This required installing more accurate current or kW sensors at 25 percent of the stores to reach 90/20 confidence and precision levels and to trend the VFD readout with the loggers. This would allow the EESP to calculate a correction factor for the VFD readout. The information for the project for utility 2 gave no indication of changes to the submitted M&V plan and the revised M&V plan submitted to utility 2 did not include this revision to the AHU fan VFD measure. As noted earlier, the DPA submitted to utility 3 included this change.

For utility 1, the approach for the third measure, refrigeration optimization, was revised in response to the technical consultant's review. The changes required factoring in the days, specifically in the summer months, when the energy use exceeded the baseline. The days that exceeded the constant baseline would not be included in the savings calculation, but instead would be zeroed out, thus eliminating the summer season effect. The utility did not allow sampling of stores for this measure.

G.4 ACTUAL M&V RESULTS AND GROSS ENERGY SAVINGS REALIZATION RATE

The realization rate differed among the utilities. The realization rates for utilities 1 through 3 were 97.5 percent, 83.6 percent, and 68.2 percent, respectively. There are two main reasons the realization rates differed so much and the rate was so low for utility 3 locations. First, some stores dropped from the project after the contract was signed. Second, some measures in participating stores were not implemented.

From the files reviewed, it was determined that one utility had one store drop out after the contract was issued and another store closed in the middle of the performance year. Because some data files were incomplete or erroneous (e.g., data logging equipment was not properly installed in all cases), utility 1 could not completely assess the data and the technical consultant, therefore, could not replicate the submitted savings amount. Utility 3's review indicated that several sites/measures were removed from the project scope.

Generally, the EESP adhered to the approved M&V plans. As noted earlier, utility 1's technical consultant recommended a variation to the M&V plan for the AHU fan VFD measure. The adjustments required calibrating the kWh trend from the VFD with the metering from the loggers

with a curve in place of a correction factor. This approach would produce a more statistically valid relationship (a higher R^2), according to the technical consultant. There was no indication in the files whether the EESP and/or customer agreed to the proposal.

G.5 OVERALL ASSESSMENT OF M&V

Customer Perspective

The customer stated that the main benefit of the M&V was that it was part of the process to receive an incentive. To the customer, the M&V was also a way to make sure their EESP did its job. They recommended the EESP to others and would use them again. They believed that the state required the M&V to verify that the energy savings were being achieved.

The M&V done under the program met the customer's needs, but they felt that some aggregation of stores could have been done to allow for sampling. There was limited sampling for determining the accuracy of the kWh meters on the VSDs. Without the SPC Program, the customer would have just used utility bills to verify the kWh savings[2].

Though the customer believed that the M&V process had the positive effect of verifying the energy savings and leading to them receiving the incentive, they did not like having to wait to receive the money over a 2-year period. They said they would participate in future SPC Program projects because they valued the energy savings and they would hire an EESP to do the work for them.

EESP Perspective

According to the EESP, the only reason they saw for doing the M&V was that it was needed to get the SPC Program incentive. Nevertheless, the EESP found the M&V data useful for backing up the billing data results they used to verify savings under their guaranteed savings contract with the customer. The M&V results brought the savings amount up to date with real time data within 1 percent of their contracted amount. The EESP felt that the M&V was needed by the state to check the theoretical estimates, and this was especially important because the program was new to the state. They felt that the M&V did not meet these needs, however, because it was unnecessary to do 2 years of M&V, and calculated savings estimates should have been good enough.

When the EESP was asked about the level of accuracy required, they felt it was too extensive and costly. They added that the cost of M&V was too high and that this continued to be a problem because incentives have decreased since the 1998 program. The M&V requirements had not prevented them from implementing any of the measures that they had wanted to.

[2] The customer however was not completely aware of the reduced accuracy provided with utility bill savings analysis.

They felt that the M&V's positive aspects were that it provided real-time data to back up analysis tools (that the EESP developed) and it demonstrated the energy savings to customers and gave the customers a better understanding of the value of energy efficiency.

The EESP had some comments on the M&V sampling approach and metering requirements. They thought that sampling the VFD equipment should have been acceptable, along with relying on the VFD readout, which they felt had been proven in theory. The EESP encountered data analysis problems, and they had to extrapolate missing data. The associated costs were minimal since they had anticipated the need to do some of this analysis. Generally, the EESP had no problems working with the utilities except handling the change of program managers at two utilities.

G.6 CERTAINTY OF ENERGY SAVINGS

Customer Perspective

The customer was extremely confident in the energy savings estimate prior to project implementation. The confidence was rooted in the fact that they were conservative with the estimate. Additionally, at stores where the return on investment was questionable, they did not plan to do a retrofit. However, when the customer discovered that the actual savings were lower than the predicted amount, they commented that maybe the EESP was too aggressive in their estimates and that, in the future, they should be more realistic. The customer may have been unaware, however, that the estimated realization rate they were responding to was based on the DPA submittal, which included savings from sites that were later dropped from the project.

EESP Perspective

The EESP needed to have confidence in the initial estimate of energy savings because the project was done under a guaranteed savings contract. However, before the baseline adjustments, the EESP was worried that savings would be less than anticipated. Afterwards, the estimate proved to be acceptable. Additionally, when the project was completed, the EESP felt good about the comparison of the actual energy savings with anticipated savings. The M&V data helped true up their own analysis to a 1-percent correlation against billing data.

G.7 USE OF M&V RESULTS

Customer Perspective

In general, after going through this project and the M&V, the grocery chain felt confident about the EESP. The customer has not reviewed the M&V results, however, because they were too busy and felt that they could trust the EESP. They wanted to use the EESP again, but the contract with the EESP was being modified due to the uncertainty of the energy markets.

The customer saw no real need to use the M&V results to sell more energy-efficiency improvements to management. This was because the management knew that the SPC Program

was available and that it paid a good incentive for projects. The customer also knew that the upper management was receptive to reducing costs, so there was no need to try to convince them to do more efficiency projects.

EESP Perspective

The EESP saw several uses for the M&V results. The EESP shared M&V results with various internal groups in their organization. The data were used to verify savings estimated from the billing information and to determine if they reached the guaranteed savings amount.

The M&V approaches used in this project helped the EESP improve their own analysis tools used for estimating savings on all measures. They felt that the M&V data helped to verify their models. Consequently, they felt that the M&V process could have been simpler while giving sufficiently accurate results. This would have helped them to avoid some M&V costs and difficulties.[3]

G.8 EFFECT OF PARTICIPATION IN THE SPC PROGRAM

Customer Perspective

The customer was extremely satisfied with the project and planned to implement these measures company wide. If they were to conduct M&V in future projects, it would probably be with rigor similar to that required by the SPC Program.

EESP Perspective

The EESP said that they would continue participating in the SPC Program so long as the cost of M&V relative to the incentive per kWh was reasonable. The results from this project made them more confident about savings estimates for subsequent projects. They learned a lot from the SPC Program M&V process about calculating savings more accurately.

Based on their experience in this project, they would change the sampling requirements in future projects. The M&V for this project did not affect the likelihood that they would do M&V on similar projects in the future.

G.9 VALUE OF M&V

Customer Perspective

The grocery chain has always been interested in doing energy-efficiency projects. The customer felt that the real value of the M&V to them was just to make it possible for them to get the incentive, although it helped them satisfy their curiosity about the energy consumption effects of

[3] According to the technical reviewer for one of the utilities, the EESP spent a lot of time developing this analytical tool for both estimating energy use and for M&V use. This project was used to develop the tool, which subsequently allowed them to use the software tool for the SPC Program M&V.

measures. The M&V results validated the benefits of energy efficiency and ensured that they received the incentives. If they did a similar project, the customer felt that the M&V would be a good gauge to have in place especially if another company managed the project for them, as was the case with this project. The customer felt that the M&V for this project was worth its cost and would have been willing to spend up to 5 percent of project cost on M&V.

EESP Perspective

The EESP felt, similar to the customer, that the M&V was worth what it cost because it provided the information on kWh savings and allowed the customer to receive the incentive. They thought that the data gave the customer a way to understand consumption in stores and actually see which measures were worth pursuing. The EESP would have been willing to spend up to 10 percent of the project cost for M&V.

The EESP would have been willing to accept more conservative savings estimates in return for conducting less rigorous M&V.

G.10 VIEW OF RECENT CHANGES TO M&V IN 2001 SPC

Customer Perspective

The customer was not aware of the new M&V options available in the 2001 SPC Program. After we described the changes, they said that they believed these options were good. The customer said that having the calculated approach to M&V was a positive change, but it might not be beneficial to get a lower incentive if the calculated savings were excessively conservative. They felt that the original longer M&V monitoring period was good because it ensured that any energy use fluctuations were covered; they felt that, in some cases, doing the M&V for only 1 year might result in lower savings estimates if unusual fluctuations occurred during that year.

EESP Perspective

The EESP believed that the M&V changes were a definite improvement. The EESP noted, however, that the refrigeration optimization measure would still be metered. They also mentioned that VFDs and anti-sweat heaters were eligible under the Express Efficiency Program as of 2001 and this program required no M&V. They saw a downside to programs like Express Efficiency, however, in which the incentive was a mere equipment rebate. They said that the customer in these cases would not understand the value of the energy savings from retrofits. The SPC Program, on the other hand, made applicants aware of the association between costs, incentives, and kWh savings. They believed that there was great benefit in customers seeing these connections.

H

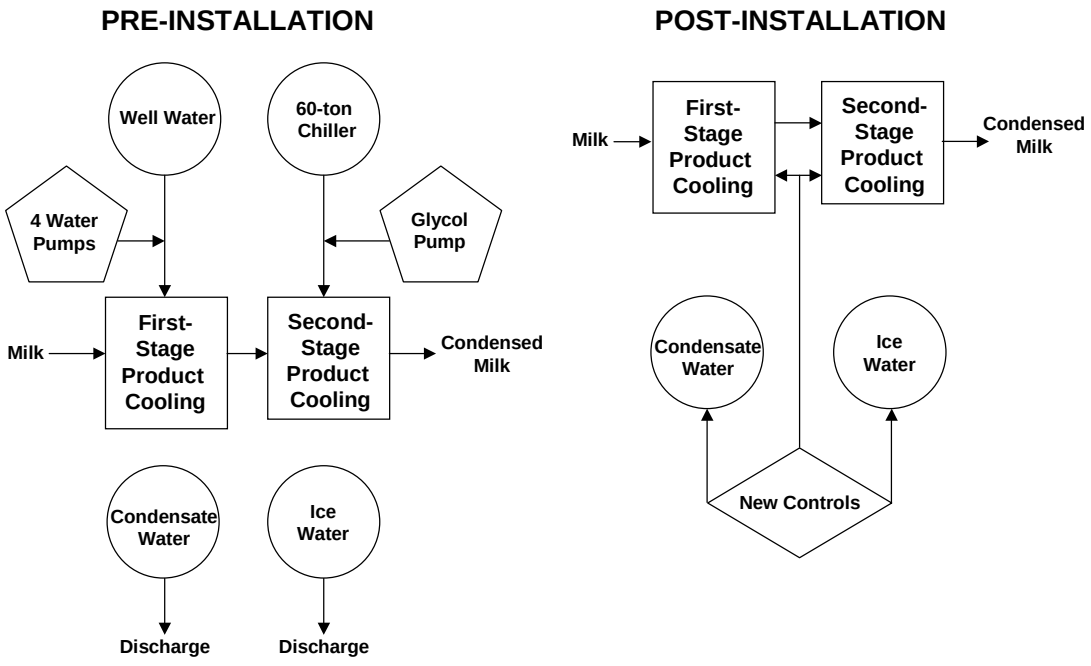
CASE STUDY 7: DAIRY PRODUCTS MANUFACTURING

The customer's facility is a manufacturing plant that produces milk and ice cream products. The products made are whole, instant, and nonfat milk, cheese, and ice cream. The customer self-sponsored this project under the 1998 SPC Program. They were also responsible for the M&V, with some metering help from a local consultant.

H.1 PROJECT DESCRIPTION

The project replaced a 60-ton chiller by using condensate water and 15 tons of available chilled water. The condensate water comes from water that evaporates during the heating of milk. Then, the resulting steam is used to preheat the milk, which condenses the steam back to water. The chilled water is a by-product of another process. The baseline and retrofitted system included two steps of cooling for the condensed milk product. The baseline system used well water in one section and the chiller in the other. The new system uses condensate water and ice water for the first and second stages, respectively. To summarize, energy savings resulted from removal of the refrigeration system for chilling the milk, which included the 60-ton chiller, the glycol pump, and four well-water pumps. In addition to the components that provide and utilize the condensate water and ice water, the retrofit includes a new heat exchanger and a new dual-temperature control system. A schematic of the pre- and post-installation systems is shown in Figure H-1.

Figure H-1
The Pre- and Post-Installation Systems



H.2 ESTIMATED ENERGY SAVINGS

Table H-1 summarizes the events in the project and the history of energy savings estimates.

Table H-1
History of Dairy Project

Document	Received		Approved		
	kWh	*Incentive*	*Days Until Approval**	*kWh*	*Incentive*
BPA	285,000	$59,850	35	285,000	$59,850
DPA	227,472	$47,769	50	227,472	$47,769
PIR	227,472	$47,769	29	227,472	$47,769
M&V1	340,367	$71,477	56	373,895	$78,518

***** The number of calendar days from document submittal to approval.

H.3 THE M&V PLAN

There is no evidence in the files indicating that any revisions were made to the original M&V plan.

The M&V approach required data on the production rates and the pounds of production of the various milk products. The production rates were based on the time it takes to move solids to the evaporator. Measurements of the weight of solids (pounds) present in the product before evaporation were based on average values of solid non-fat test and solid fat test results of the various products (tests that determine the solids content in the product). Therefore, the production hours could be calculated for each product by multiplying production in pounds by the production rate.

The electricity demand of the equipment taken out of service was determined by a simple calculation converting horsepower to kW. From these data, the energy savings due to the elimination of equipment were calculated. Use factors were developed to reflect actual use of the various motors in the existing system. Using this approach, the only data that had to be collected during the performance period was the weight in pounds of each product produced. The operating hours were determined from the production hours (based on the pounds of product and production rate) then multiplied by the use factors and kW of each motor put out of service to determine overall kWh savings. It was not clear from the documents available whether any additional energy was needed to power the new system.

H.4 ACTUAL M&V RESULTS AND GROSS ENERGY SAVINGS REALIZATION RATE

After the first performance year, the approved energy savings were 373,895 kWh, for a gross realization rate of 164 percent. The consultant reviewed the M&V calculations and increased the estimate of energy savings beyond the level submitted by the applicant due to a discrepancy in pounds of production.

The savings in the submitted report and the amount calculated by the technical consultant were well above the contracted energy savings. Therefore, the initial savings estimate was too conservative. Since the SPC Program paid only up to 10 percent above the contracted amount of $227,472 kWh, this cap limited the incentive.[1]

H.5 OVERALL ASSESSMENT OF M&V

This customer typically used M&V in earlier projects to justify their implementation and verify performance. According to the customer, the M&V for this project was successful in providing the information needed for verifying energy savings. In general, the customer felt that there were no negative aspects to doing the M&V for this project. They believed that the M&V satisfied the utility's broader needs by providing data to demonstrate that the incentive money was money well spent.

For this project, the customer believed that their project was simple and, hence, the accuracy requirement was fine, but they also believed that at some point the requirement could become unreasonable and should be correlated to the complexity of the project. For this reason, if M&V became too complicated, some measures might not be implemented in future projects.

They felt that the M&V process was appropriate and that the costs were not prohibitive for this project. No data analysis problems arose during project implementation. However, M&V timing problems occurred because the process took longer and the overall SPC requirements took more time than they had expected. Now, they have a better idea about timing issues for any future projects.

The customer felt the level of utility assistance was good. The utility provided them with some monitoring equipment and technical feedback on their project ideas and M&V plan.

H.6 CERTAINTY OF ENERGY SAVINGS

The customer felt very confident about the likely performance and energy savings based on the estimate from the vendor who provided the heat exchanger. The actual savings were slightly

[1] At the end of 2 performance years, the SPC Program will limit the incentive to 10 percent above contracted (DPA approved) amount. In this case, the most the customer can receive in incentives is $52,546. Second invoice (paid after 1 performance year) was only paid based on the contracted amount, not the M&V-approved amount.

higher than projected. These results increased the customer's comfort level for pursuing future projects.

H.7 USE OF M&V RESULTS

The M&V results were shown to the customer's upper management to verify the energy savings and performance. Additionally, the results were used to make a case for other projects.

H.8 EFFECT OF PARTICIPATION IN THE SPC PROGRAM

From seeing the M&V results, the customer felt more comfortable about investing in future energy-efficiency projects. Their M&V experience in this project will probably have no effect on their likelihood of using M&V in future projects. It did give them confidence to do M&V on future projects with a better sense of the time and effort required for it.

H.9 VALUE OF M&V

The customer believed that this project's M&V was worth the cost. The customer was not able to quote the M&V cost for this project, but the company would be willing to spend up to 20 percent of the total project cost. At this level of project cost, however, they would carefully examine whether the M&V was worth the cost.

At the same time, the customer said that they would have been willing to accept a conservative estimate of the energy savings of this project in exchange for a simpler M&V process.

H.10 VIEW OF RECENT CHANGES TO M&V IN 2001 SPC

The customer was not aware of the recent changes in the SPC Program that provided a calculated option along with the measured savings approach. When asked about the benefits and disadvantages of those changes, the customer responded that it would really depend on the size and complexity of the project.

I

CASE STUDY 8: CARROTS AND REFRIGERATION

This case study is a self-sponsored agricultural customer's project conducted under the 1999 SPC Program. The customer is a large producer of fresh and frozen carrot products that retrofitted the refrigeration system for a refrigerated warehouse to allow for increased production with a small incremental increase in energy use. The customer contracted with an installation contractor and a refrigeration consultant for assistance in the project but did their own M&V.

I.1 PROJECT DESCRIPTION

The customer decided to retrofit the refrigerated system for the following prioritized reasons: to increase production capacity, to reduce capital expenditure, and to save energy. The project replaced two 700-ton single-stage compressors with two 800-ton high-stage compressors to be used in conjunction with the remaining single-stage compressors, now used as low-stage compressors. In addition, they installed two new oversized evaporative condensers (in the BPA and DPA only one condenser was to be added) and computer controls for load/unload and start/stop operation. The new system greatly increased production rates from 25,000 pounds per hour to 40,000 pounds per hour in their three individual, quick-freeze tunnels. This resulted in a slight increase in energy consumption and greatly increased overall system efficiency. Figure I-1 and Figure I-2 show the pre- and post-installation systems according to the project file documentation.

I.2 ENERGY SAVINGS ESTIMATE

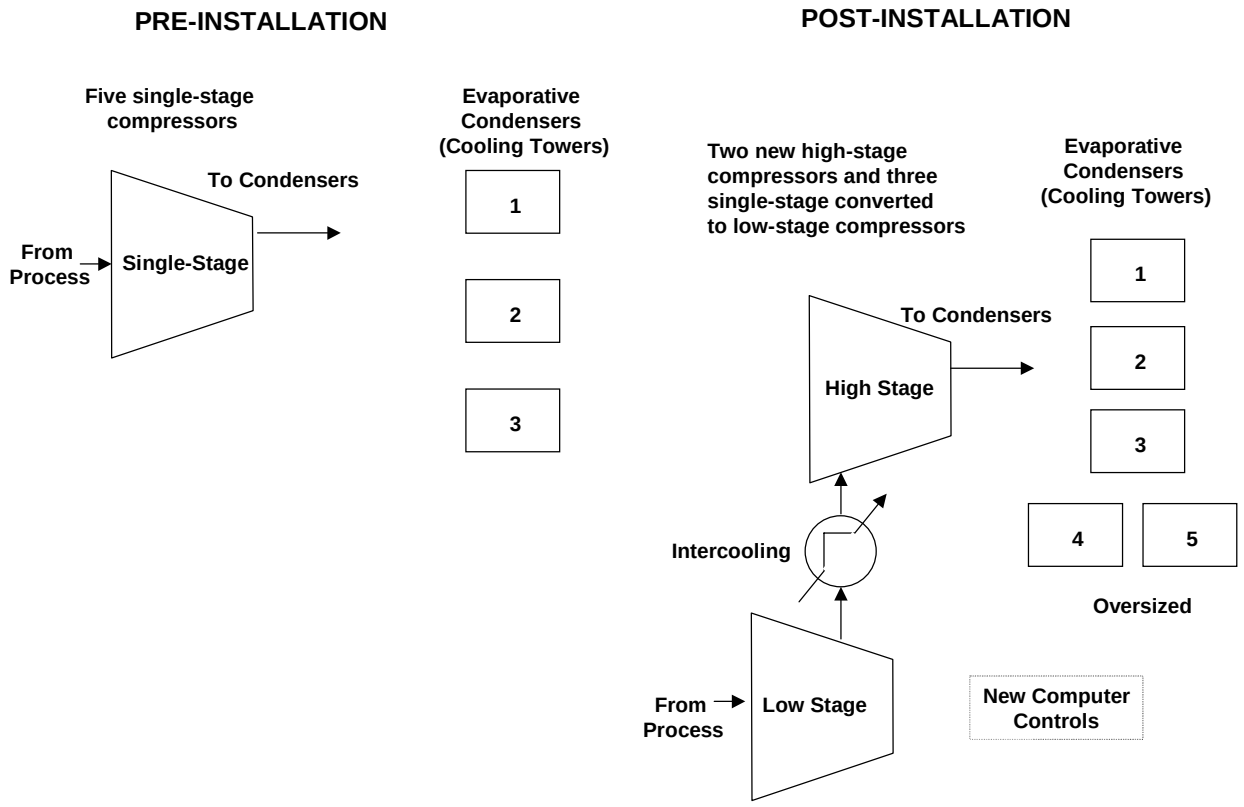
The energy savings estimate was calculated differently for the BPA and the DPA. The BPA estimate was based on crude calculations using the total brake horsepower and tons of refrigeration required along with the specific freezing load of the product. Table I-1 summarizes the project events and history of energy savings estimates.

Table I-1
History of Refrigerated Warehouse Project

	Submitted		Approved		
Document	*kWh*	*Incentive**	*Days Until Approval***	*kWh*	*Incentive**
BPA	9,764,298	$400,000	33	9,764,298	$400,000
DPA	3,350,593	$400,000	146	3,350,593	$400,000
PIR	3,350,593	$400,000	86	3,350,593	$400,000
M&V1	6,853,980	$400,000	73	6,853,980	$400,000
M&V2* **	3,251,889	$400,000	91	3,251,889	$400,000

* Capped at program limit.
** The number of calendar days from document submittal to approval.
*** Submitted before completing one full performance year.

Figure I-1
The Pre-Installation Schematics of the Refrigeration Upgrade



The DPA used a month-to-month analysis (incorporating weather data) to estimate the compressor savings. Savings from the installation of an additional condenser (from the DPA submittal) were calculated separately from the savings attributed to the two-stage compressor retrofit. The lower condenser water temperature entering the process from the evaporator condenser, which allowed the compressors to run at a lower average compressor head pressure, provided some of the energy savings for the compressor. In addition, the use of 1-week baseline monitoring to calibrate their analysis provided more insight. The DPA's calculation showed a big decrease in the estimated savings amount when the applicant pursued a more detailed evaluation and incorporated actual monitoring data.

I.3 THE M&V PLAN

There is no evidence in the files that any revisions were made to the original M&V plan.

The proposed M&V approach for this project was option GVL-B-01.[1] Five weeks of short-term baseline monitoring (submitted with the PIR) was done prior to the retrofit. The results of the monitoring of electricity consumption and pounds of product through the plant were extrapolated

[1] The option was mistakenly referred to in the customer submittal as CH-B-01.

to determine the refrigeration system's annual energy consumption. The customer would have preferred to monitor longer to establish a better baseline. One concern with the procedure outlined above is that typically the GVL-B-01 M&V option requires regression analysis with statistically significant independent variables. There might have been an oversight in approving the M&V plan without including this requirement.

For the retrofitted system, the baseline energy consumption was adjusted for the post-installation (performance year) pounds of product. The M&V data collection consisted of kWh of compressor and condenser system consumption and pounds of production on a daily basis; a figure for kWh per pound of product per week was then calculated. The post-installation energy use was measured (daily) and subtracted from the baseline adjusted to post installation production levels to calculate the energy savings.

I.4 ACTUAL M&V RESULTS AND GROSS ENERGY SAVINGS REALIZATION RATE

The calculated annual energy savings after the first year of M&V were 6,853,980 kWh. Because they had exceeded the incentive cap, in the second year the customer decided to submit its M&V results 23 weeks early showing a kWh savings amount of 3,251,880 kWh at the end of that period. Because the average savings for these two periods was much more than the contracted annual energy savings of 5,052,935 kWh, the customer did not bother analyzing the savings for the full second year and easily met the savings level required to reach the program incentive cap with less than 2 years of monitoring.

If the savings had been estimated for the full second year, the extrapolated savings for the second year would have been 7,153,087 kWh, which would be comparable to the first-year results.

I.5 OVERALL ASSESSMENT OF M&V

The customer had customarily done some M&V for their energy-efficiency projects, which they found helpful to verify their energy and cost savings. They felt that it was very important to get actual energy savings instead of relying on calculated savings, which sometimes could be too conservative. For this project, the M&V was important to ensure that they received an SPC incentive. The M&V for this project met their basic needs by showing the actual energy savings and it also helped them demonstrate energy savings to the production staff and show them how operations affected energy use.

The customer felt overall that the M&V requirements were appropriate.[2] They appreciated that the program requirement for M&V necessitated that they measure actual, rather than rely on theoretical, energy savings amounts. They felt that monitoring for 2 years was difficult, but they discovered it was worth it because of the production variation that occurred.

[2] If the M&V plan had been modified to follow exactly the Procedure Manual's requirements for GVL-B-01, then the customer might have commented differently.

The M&V monitoring requirements were not very burdensome for the customer since they already had systems installed collecting most of the data. Energy data loggers were the only new equipment needed, and they were easy to install and use.

The M&V cost for this 1999 SPC project was about 12.5 percent of the incentive, or about $50,000. The customer did not feel that this was excessive.

The only M&V timing problem they had was the need to begin installation prior to project approval to stay on the plant's operation schedule, which includes harvesting the carrots. Additionally, the utility caused some delays because of long response times caused by constantly changing program administrators. However, the customer felt that the technical reviewer was helpful and responsive.

They also commented that the M&V requirements did not deter them from doing more SPC projects, and they subsequently had four or five more projects (applications) in the program. They decided, however, to use a third party for administration and M&V activities in their active SPC applications.[3]

I.6 CERTAINTY ABOUT ENERGY SAVINGS

The customer was extremely certain about the energy savings prior to implementation of the project. They actually saved more energy than predicted.

Given that the M&V showed the benefits were larger, they felt that next time they would be able to use the M&V results from this project do a better job estimating savings.

I.7 USE OF M&V RESULTS

The M&V results have been helpful to the customer in several ways. The results informed the production staff about how to operate more efficiently. The results also allowed them to do a better job managing their production. Additionally, the results were shown to decision makers and helped play a role in the decision to conduct more projects under the SPC program.

I.8 EFFECT OF PARTICIPATION IN THE SPC PROGRAM

Generally, the customer felt the benefits outweighed the difficulty and costs of doing M&V in this project. Prior to beginning the project, they read the SPC documentation and understood the commitment necessary. They noted, however, that a smaller company would probably find the requirements not "friendly enough" and too burdensome. After this project, they would probably use the same level of M&V on similar projects, but with a better baseline.

[3] The customer is considering doing the M&V on their own again for future projects.

I.9 VALUE OF M&V

The customer felt the M&V was valuable, especially because it showed higher savings than estimated. For this particular project, they felt the M&V level was appropriate.

The customer believed that the value of getting accurate savings estimates and a good model of their process made the M&V worth its cost. They would probably not choose to do less rigorous M&V in exchange for more conservative (lower) incentives in future projects, but at the same time their decision would depend on the extent of the M&V required.

I.10 VIEW OF CHANGES TO M&V IN 2001 SPC

The customer was not aware of the 2001 program requirement changes. When we described the changes, they said that they sounded great for simple measures like lighting. In projects like the one here, however, they felt that using calculated savings would be inappropriate.

They felt that the shorter monitoring period specified in the 2001 program generally would be good. In cases where production varied, however, they believed that longer monitoring periods would be needed to provide a better, more accurate savings estimate.

J

CASE STUDY 9: MANUFACTURING OF INDUSTRIAL GASES

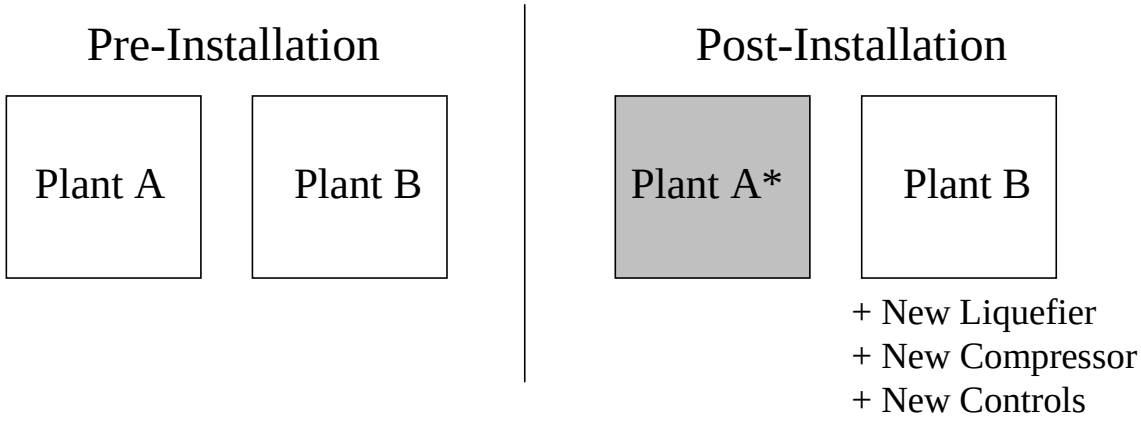
This case study involved a self-sponsored industrial project, which shut down most of the production at one plant while upgrading the production capacity and process at another, more efficient plant for the 1998 SPC Program. The company developed and implemented the M&V plan internally. Most work of this type is done internally because the business uses proprietary technology. Additionally, this company has had a difficult time finding people outside their industry who understand their technology and processes.

J.1 PROJECT DESCRIPTION

This manufacturer of industrial gases applied for an SPC Program incentive to do a large retrofit project at a cost of $7 million. The participating company entered into a joint venture agreement with another company also producing industrial gases. The project placed Plant A from the non-participating company in "standby" mode and replaced its output through an expansion of the participating company's Plant B. Plant B was more efficient than Plant A before the retrofit. This agreement allowed Plant A to be operated at a greatly reduced level that lowered its energy consumption significantly.

This expansion included an additional energy-efficient liquefaction capability and air separation capacity. The project also included the installation of a high-efficiency refrigeration nitrogen compressor for production of refrigerants with a new liquefier and control system. The project also gave the customer better control over the facility. Figure J-1 is a schematic of the project.

Figure J-1
The Pre- and Post-Installation Schematics of the Plant Upgrade Project



* Plant A was put in standby mode as a part of the retrofit.

J.2 ESTIMATED ENERGY SAVINGS

Table J-1 summarizes the history and energy savings information on the project.

Table J-1
History of the Plant Upgrade Project

	Received		Approved		
Document	*kWh*	*Incentive*	*Days Until Approval**	*kWh*	*Incentive*
BPA	19,710,000	$5,109,930	79	19,710,000	$400,000
DPA	32,232,577	$400,000	170	32,232,577	$400,000
PIR	32,232,577	$400,000	7	32,232,577	$400,000
M&V1	28,578,722	$400,000	9	30,609,050	$400,000

* The number of calendar days from document submittal to approval.

At the beginning of this project, there were concerns about its eligibility. One big concern was how to determine an energy consumption baseline. When the post-installation production levels were reported, there was no simple way to distribute the baseline between the two plants. The final decision was to allow this project into the SPC Program under the condition that a well-documented baseline would be developed.

The calculation of the savings estimate was based on baseline models of production in the two plants. The baseline model was a correlation of energy consumption to production levels (by volume of each product produced at each of the plants) for a 27-month billing period. The multivariate regression analysis of the data yielded statistically significant results.

A new model was developed to estimate the monthly energy use. The physical process for both plants drove the model design. For each month, the estimated energy use from the process-driven physical model and historical billing data (the regression analysis) were compared and shown to be within 2 percent. The post-installation energy use was calculated using the existing physical-based model of Plant B, but with the added liquefier energy use and at baseline combined production levels, taking into account the actual mix of gases produced.

J.3 THE M&V PLAN

Proposed M&V Plan

The files did not contain a formal M&V plan. The plan was embedded in an Excel spreadsheet. We inferred what the proposed M&V plan was from our prior knowledge of the project.

The files contained enough information to enable us to describe the basic M&V approach. The proposed M&V plan as described by the technical reviewer was a hybrid of Option C—billing analysis using regression models. This option is only feasible, accurate, and appropriate for

relatively large, complex projects, such as in this case where the predicted energy savings were 19 percent of the total electrical annual energy use of Plant B.

The M&V plan used the physical-based models for the energy savings estimate developed for each plant to calculate the aggregate baseline energy consumption, using actual measured post-implementation levels of each gas produced by Plant B. The post-implementation production levels of gases at Plant B were allocated to each plant's process-driven physical baseline model and based on the actual share of sales for each plant in the year prior to the retrofit. The Plant B model incorporated modules to analyze the added systems (equipment). These were quite well understood based on the performance curves of the new systems.

Revised M&V Plan

In the notes to the DPA approval, the technical reviewer required the submittal of the billing data for both plants during the performance year as part of the M&V. Additionally, the technical reviewer required that if the amount of any gas produced exceeded that for Plant A's pre-implementation capacity mix of gases, then the applicant would have to allocate the excess to the more efficient Plant B to determine the adjusted baseline.

If there was any increase in the energy use shown in the performance-year bills at Plant A, the excess would be subtracted from the total energy savings claimed by the applicant due to use of the less efficient Plant A equipment.

J.4 ACTUAL M&V RESULTS AND GROSS ENERGY SAVINGS REALIZATION RATE

The annual energy savings after the first year of M&V were 30,609,050 kWh for a gross realization rate of 95 percent. The project incentive was capped at the program maximum of $400,000, which would be equivalent to 3,636,364 kWh of energy savings at an incentive of $0.11/kWh. Consequently, the energy savings far exceeded the amount that was covered by the program incentive.

The customer adhered to the approved M&V plan, which was the proposed plan as revised in response to the reviewer's comments. The difference shown in Table J-1 between the kWh savings submitted and the kWh savings approved in the M&V report was because the customer did not originally include the last month of M&V in the first performance year data.

J.5 OVERALL ASSESSMENT OF M&V

The participating company had never done M&V this extensive before and over a 2-year period. Because electricity is 70 percent of their production costs, however, they had always tracked energy use before and after upgrades to determine effects on energy use. By providing monitored energy use data, the M&V met their needs, but the M&V exceeded what they would have done otherwise.

They felt that the SPC Program required the M&V to make sure projects did what they set out to do. They saw the M&V as a way for the utilities to make sure the money was well spent, unlike past incentive program that they considered to be giveaways.

The M&V requirements did not restrict the measures that were implemented in the customer's project. The customer would have wanted to make additional improvements to their control system, but decided not to because of the payback period and incentive cap. Moving ahead with the additional improvements was not prevented by the M&V requirements.

The main positive aspect of the M&V, according to the customer, was that they came to realize that 2 years of monitoring was a good idea. It improved their confidence in the savings and showed that the savings persisted.

On the other hand, they felt that the M&V required was complex. They had to develop a new method to estimate efficiency gains to account for operation of the whole facility, i.e., the two plants combined. This was more difficult for them because they had to work the approach out with the utility's technical reviewers, whom they felt did not understand their process and, overall, did not provide them with any real technical assistance.

The customer did not know how much they spent on M&V, but the whole M&V process took at least 400 labor hours. The metering costs were not significant because they would have collected the data anyway. Collecting historical data was the only analytical problem they encountered. Generally, the process was not a big problem since they knew the performance of their equipment well.

J.6 CERTAINTY OF ENERGY SAVINGS

The customer was fairly confident about the savings estimates before implementing this project because they felt they understood their processes and energy use well. Historically, they had been able to predict savings to within 1 percent of the actual amount.

However, this was the first time they had done this type of project, and the M&V showed more savings than they anticipated. They felt that doing the M&V for this project would help them estimate savings more accurately in future projects.

J.7 USE OF M&V RESULTS

The customer said that they did not share the M&V results internally because they would confuse their managers. Their managers were used to seeing the energy consumption data in a different format.

The customer planned to use the M&V results to sell future projects, but only if the results were appropriate to the projects. Their M&V experiences in this project did not affect their approach to energy-efficiency projects because they felt they already knew what opportunities existed.

J.8 EFFECT OF PARTICIPATION IN THE SPC PROGRAM

The customer noted that, since this project, they wanted to use a utility program to install a compressor seal they had developed to reduce their need for blow-by and improve efficiency. The utility would not approve the project, however, insisting that it was a maintenance issue. As a result, the company did not proceed with the project.

J.9 VALUE OF M&V

In retrospect, the customer felt that the M&V was probably worth its cost. However, they initially had no idea how much time and money it would take to do the M&V and, at one point, they almost gave up on the project because of the effort required.

The customer saw the complexity and resource intensiveness of the M&V as potential barriers to using similar M&V in similar projects in the future. The customer would have been willing to spend 1 to 2 percent of the incentive amount for M&V on this project. On the other hand, the customer saw benefits to doing such complicated M&V over a 2-year period on complex projects. Consequently, they felt they might actually use a similar approach in future projects of this type. The amount they would be willing to spend on future projects would vary depending on the project type and incentive funds.

J.10 VIEW OF CHANGES TO M&V IN 2001 SPC

The customer believed that the 2001 SPC Program's M&V revisions were a good idea and provided needed flexibility.

With these changes they will probably do some "standard package" projects, which were not worth the hassle and administrative costs under the earlier M&V requirements.

K CASE STUDY 10: HVAC AND LIGHTING RETROFIT

This case study covers a self-sponsored project from the 1998 SPC Program. It was a major HVAC and lighting retrofit in an office building. Two different EESPs, one for HVAC and one for lighting, helped the self-sponsored customer with the M&V and SPC paperwork. We interviewed the customer and the EESP that helped with the HVAC project.

K.1 PROJECT DESCRIPTION

The facility is a 25-year-old, 24-story commercial office building with about 380,000 square feet of floor space. The existing HVAC system had one time clock to control the air-handling units on every two floors. The air handling system was essentially constant volume. The chillers were low-efficiency units. Most lights were T12s.

The project consisted of installing the following:

1. A direct digital controls (DDC) system to sequence operations, including optimum start/stop, temperature control, demand limiting, temperature and pressure reset for the chilled water, condenser water and air distribution systems
2. Variable-speed drives (VSDs) for the chilled and condenser water pump systems
3. A more efficient, oversized cooling tower equipped with a VSD to lessen the chiller load
4. An upgrade to the variable air volume air distribution system
5. A new VSD chiller
6. More efficient lighting equipment.

Figure K-1 illustrates the project measures, except the lighting. Two EESPs aided the applicant with M&V. One worked on the HVAC measures and the DOE-2 model, and the other handled the lighting retrofit and its respective M&V. The total project costs were estimated to be $1.4 million. The customer estimated the costs of M&V to be 40 percent of the incentive, but the HVAC contractor estimated the costs at 25 percent of the incentive amount.

Figure K-1
The Chiller and HVAC Upgrade in the Office Building

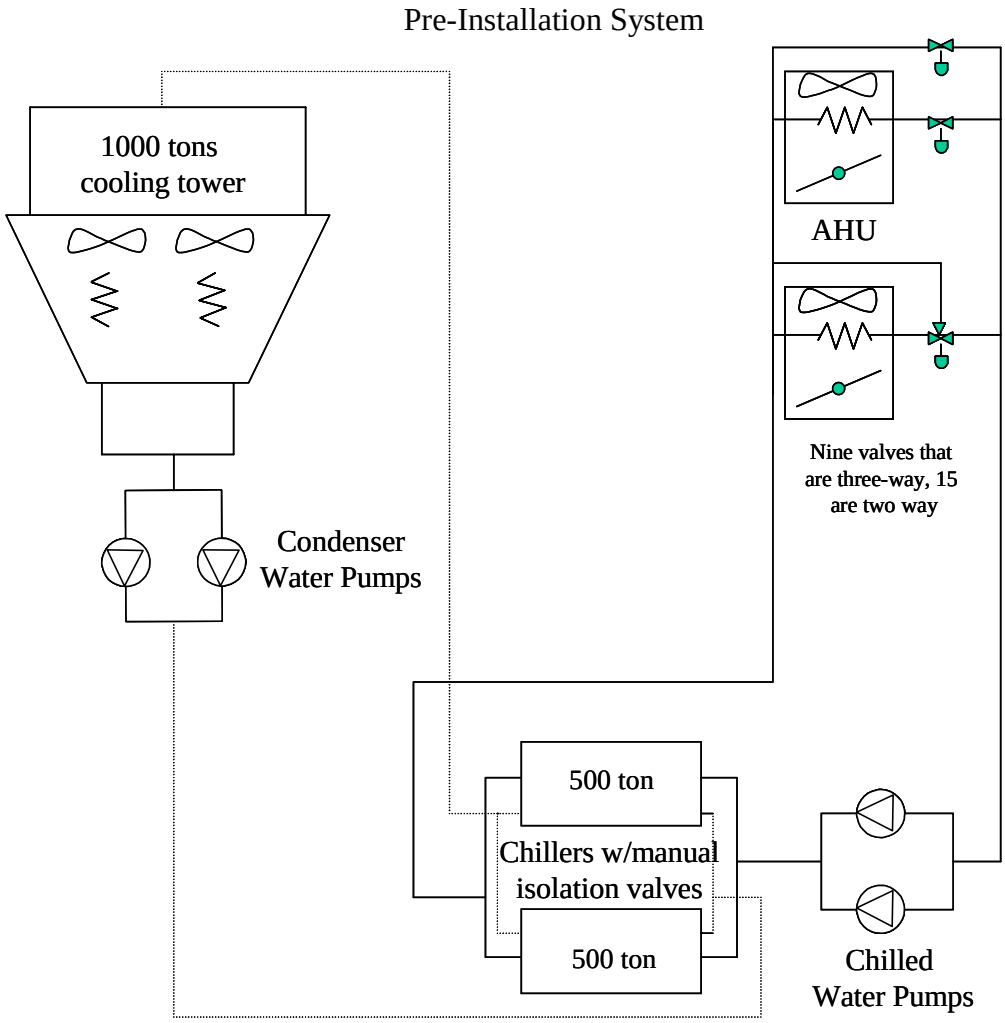
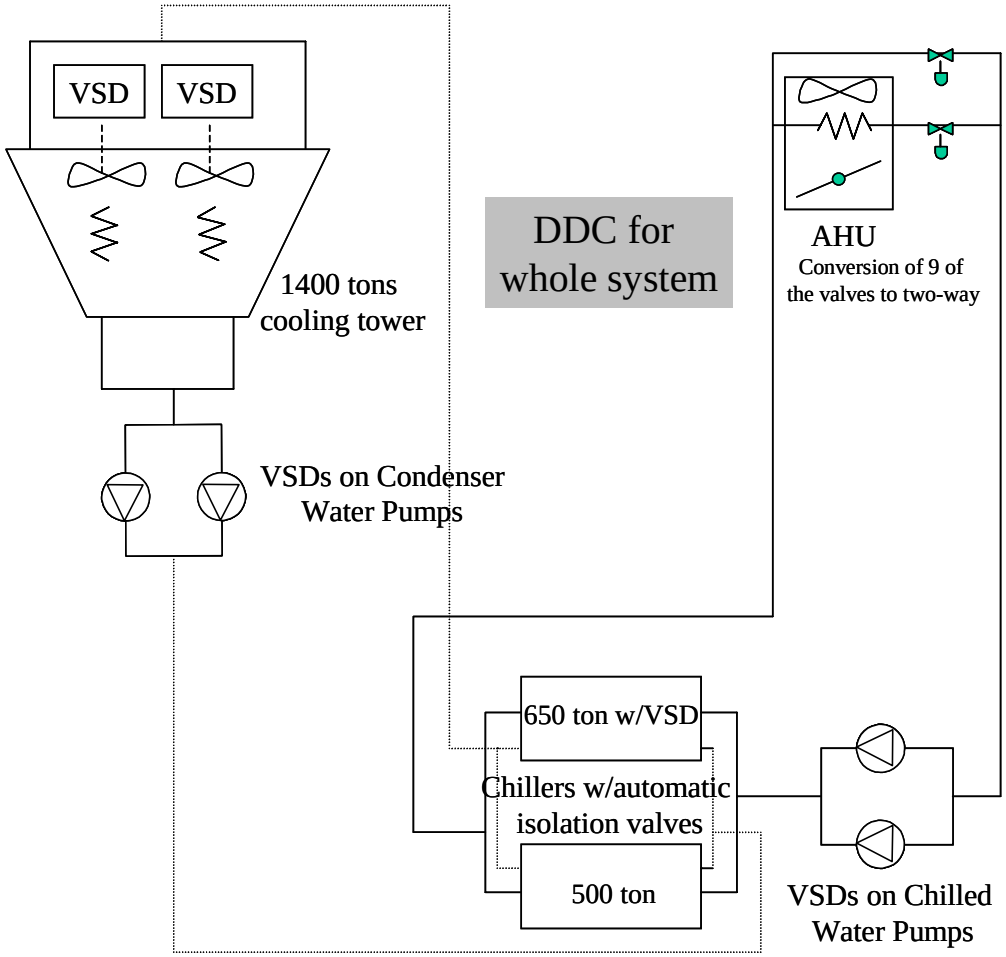


Figure K-2 (cont.)

Post-Installation System



K.2 ESTIMATED ENERGY SAVINGS

Table K-1 summarizes the schedule of SPC activities, energy savings estimates, and incentive amounts.

Table K-1
History of HVAC and Lighting Project Process

Document	Received		Approved*	
	kWh	*Incentive*	*Days Until Approval***	*Incentive*
BPA	2,193,234	$374,149	14	$400,000
DPA	2,795,910	$498,159	54	$400,000
PIR	2,795,910	$498,159	15	$400,000
M&V1	2,737,265	$453,502	18	$400,000

* The files did not include any approved kWh values. ** The number of calendar days from document submittal to approval.

K.3 THE M&V PLAN

Proposed M&V Plan

Two M&V plans were used—one for the HVAC portion and one for lighting. The option used for the HVAC retrofit did not specifically follow the suggested method from the Procedures Manual. The records differ as to whether the customer followed its proposed M&V plan. They did, according to the HVAC EESP interview, but the performance year documentation in the utility files suggests that another M&V plan was followed. The utility approved the paperwork as submitted anyway.

The applicant noted the complexity of their measures and the difficulties they would present for conducting appropriate M&V in their BPA submittal. They indicated that there were two major problems associated with trying to accurately measure energy savings through M&V. One was that the proposed measures were likely to interact with one another. The second was that performing M&V with an adequate level of certainty in the results would cost more than the incentive amount. The customer's proposed M&V plan, therefore, was Option D (GVL-D-01), calibrated computer simulation analysis. Projects with measures whose energy usage depends heavily on the weather and on other building conditions generally opt for this type of M&V plan. The applicant proposed using DOE-2 to model their building with the energy-efficiency measures. This option was not typically recommended, according to the SPC Procedures Manual, because of its cost to implement. We believe that the M&V plan was chosen appropriately, given the nature of this project. The M&V chosen for the lighting retrofit was LE-B-01, the measurement of operating hours, which followed the procedures in the manual.

The proposed M&V plan for the HVAC (non-lighting) measures included the following steps:

1. Develop a DOE-2 computer simulation based on historical data and partial occupancy (levels during pre-retrofit) using the kWh consumption of the actual facility within 10 percent of the monthly bills
2. Re-run the DOE-2 model assuming full occupancy
3. Re-run the DOE-2 model at California's Title 24 minimum efficiency standards and designate this as the base case for energy savings estimates (T-24 Baseline)
4. Input the energy efficiency measures to the DOE-2 analysis and develop the "ECM case model."

In addition, the applicant proposed to run the developed model with the lighting retrofit to determine any interactive effects so they could be subtracted from the estimated energy savings.

The DDC system of this building trends, monitors, and tracks many systems of the building. The DOE-2 model's prediction of energy consumption and operating hours was compared to the trend outputs from the DDC system. Any variations would be accounted for in the M&V results. If the DDC system trend log (of the actual energy consumed for various systems) was not

comparable to the DOE-2 computer model outputs, discrepancies would be investigated and the system performance would be tuned accordingly.

Revised M&V Plan

No revisions were made to the M&V plan after its submittal.

According to the Procedures Manual, however, the M&V plan should have been revised. The M&V plan revisions should have included:

1. The trends for the DDC (i.e., submetering) entered into the DOE-2 model
2. Adjustment of the model to performance year weather
3. The model's output of building energy consumption compared to performance year billing data.

K.4 ACTUAL M&V RESULTS AND GROSS ENERGY SAVINGS REALIZATION RATE

The energy savings calculated for this project were not determined from the DOE-2 models, but from comparing billing data over a 2-year period and lighting M&V results. In addition, before the end of the first performance year, the building acquired new data centers. The energy savings calculation was, therefore, adjusted to reflect the new electric load. The energy use of these data centers affected the overall building energy use. This new energy end-use was added to the baseline utility bill energy consumption to account for the increased building demand.

The lighting energy savings were determined from M&V results (by the second EESP) to be 898,691 kWh. These calculated lighting savings were subtracted out of the utility bill calculated baseline plus data center energy consumption. This left the adjusted baseline energy consumption for the HVAC equipment. The estimated electrical energy consumption for the performance year was subtracted from the adjusted baseline energy consumption for HVAC measures to calculate the savings achieved by the HVAC measures. Based on the electricity bill analysis and these adjustments, the HVAC energy savings were estimated to be 1,838,574 kWh.

The applicant also submitted energy savings based on the DOE-2 model, but no changes to the model were made as of the DPA submittal in response to the comments discussed in Section K.3. It was assumed that the original model was a good representation of the actual building conditions. Typically, the DOE-2 model should be adjusted to current weather conditions, and there was no indication in the files that this was done.

The M&V results for the first year showed combined savings of 2,737,265 kWh for lighting and HVAC measures. This resulted in a 98-percent realization rate. The slight decrease from the estimated savings did not affect the incentive amount because the project was capped at an incentive of $400,000.

K.5 OVERALL ASSESSMENT OF M&V

Customer Perspective

The customer's typical M&V approach was to read the electric meter. The only purpose for the extensive, complicated, and costly M&V, according to them, was to get the incentive. Whether from the customer's perspective (and benefit) or the utility's, the customer felt that looking at the utility bills would have been as accurate as the more complex M&V process. However, despite their comments about the complications and the cost for this project, they chose to participate later in the 2000 SPC program and conduct similar M&V on one project.

EESP Perspective

The purpose of the M&V, in the HVAC EESP's opinion, was to make sure the building owner was getting what they paid for. The EESP felt that a "light M&V" should be done to confirm savings to customers and that it should be a part of the commissioning for their projects. Additionally, the EESP felt that the M&V provided additional benefit by meeting the owner's needs because there was continuous verification even after the 2 years of M&V. The EESP felt that the M&V was necessary, on the utility's behalf, because it was too easy to project savings that never materialized.

The EESP did not eliminate any measures because of the M&V requirements. They felt that the M&V had positive aspects because it demonstrated they had met their expectations of energy savings and allowed the operations engineer to continuously tune the building. On the other hand, they felt that the cost of implementing the M&V and its paperwork trail were negative aspects of the M&V. The EESP felt that having more lenient M&V requirements for smaller projects would be appropriate and would provide a suitable level of accuracy. The EESP said the M&V requirements would not keep them from participating in the SPC Program, especially since the revisions that had been made to the program M&V requirements.

K.6 CERTAINTY ABOUT ENERGY SAVINGS

Customer Perspective

The customer was minimally concerned about the possibility of getting lower savings than predicted. Overall, the savings were larger than anticipated.

EESP Perspective

The EESP also was not concerned much about the actual savings being less than predicted. However, the first year results showed less savings than estimated in the DPA; this was because much time was spent fine-tuning the system during the first year. The EESP noted that the second year showed more savings as a result of these efforts during the first year.

K.7 USE OF M&V RESULTS

The customer used the utility bills to sell additional projects to management. They continued to participate in the SPC Program with a similar project and similar M&V in the 2000 program. In the future, for projects outside the SPC Program, they would just use utility bills, weather, occupancy level, and operating hours to verify savings for M&V.

K.8 EFFECT OF PARTICIPATION IN THE SPC PROGRAM

Customer Perspective

The customer said that the M&V results increased their confidence in those companies that did M&V. The customer compared the M&V results with the utility bills to verify their consistency.

EESP Perspective

The EESP viewed the M&V process in various positive ways. The EESP felt that this M&V experience helped them become more rigorous in proving out the savings, especially when they had a guaranteed savings contract, so the M&V benefited their company. They thought that M&V was a good idea for large projects only and that smaller applications needed no metering, but only some spot measurements and calculations. The EESP used the M&V results as a marketing tool.

K.9 VALUE OF M&V

Customer Perspective

The customer did not see the value of M&V for this project. They did not think it was worth the cost because, in their opinion, using the utility bills would have been good enough.

EESP Perspective

In contrast, the EESP did think the M&V was worth it. The process made them be more rigorous and they saw this as a benefit to the customer. They believed the customer was saving more money as a result because the EESP spent more time adjusting the system efficiency. Although they thought the M&V cost was acceptable, they felt that it was at their threshold limit.

K.10 VIEW OF CHANGES TO M&V IN 2001 SPC

The EESP was aware of the revised 2001 M&V requirements. They liked the fact that options were available. They believed that conducting the M&V allowed the tuning of systems and, although this took time and added costs, it increased energy savings. Therefore, having the options would be good for giving participants the choice of having a well-tuned system or spending less money.

The EESP also believed that the incentives should be higher for the measured savings option to encourage people to do M&V. The utilities could then show the value of M&V to the SPC participants. This EESP indicated, however, that they generally would opt for the lower incentive dollars and no M&V (the calculated savings option) for future projects despite the additional benefits observed in this project.

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KEY DEFINITIONS

Annual Savings Report (ASR) – (in 1998, called M&V Report) – The ASR documents the results of M&V activities. Two reports are submitted for each performance year.

Basic Project Application (BPA) – The BPA are standard forms submitted by an organization wanting to participate in the SPC program. The applicant provides information about itself, the Project Sponsor (if there is one), the site information, description of the project including energy savings amount, and a preliminary M&V plan (for 1999 projects only).

Contracted Energy Savings – The contracted energy savings is the amount by which the SPC Agreement expects the applicant to provide.

Detailed Project Application (DPA) – The DPA are standard forms submitted by the Project Sponsor following approval of the BPA. The DPA provides detailed information about the proposed project, including equipment surveys, projected energy savings with detailed calculations, and a detailed M&V plan.

Measurement and Verification (M&V) – An M&V plan is required for DPA approval. The M&V plan is the detailed description of how energy savings are the to be verified. The M&V plan must comply with the M&V guidelines in the manual.

Project Installation Report (PIR) – The PIR includes the commissioning report and any supporting documentation of the equipment installed or changes to the contracted savings estimate.

Project Sponsor – The project sponsor is the organization that executes the SPC agreement with the utility. The project sponsor can either be the customer of the utility or a third party.

Technical Reviewer/Consultant (TC) – Some of the utilities hired technical consultants to review the project submittals to the SPC program.

Utility/Program Administrator – The program manager at each utility.