Customer Energy Efficiency Program
Measurement and Evaluation Program

IMPACT EVALUATION OF PACIFIC GAS & ELECTRIC COMPANY'S 1996 COMMERCIAL SECTOR ENERGY MANAGEMENT SERVICES PROGRAM

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1. EXECUTIVE SUMMARY

This section presents a summary of the impact results for energy management surveys that were completed under the Pacific Gas & Electric Company's (PG&E's) 1996 Commercial Energy Management Services (CEMS) Programs, referred to in this report as the CEMS Programs. The CEMS Programs present energy management recommendations to PG&E's customers that are designed to reduce energy consumption (electric kWh and gas therms) and system peak loads (coincident demand kW). This evaluation includes indoor lighting and HVAC technologies that were affected by PG&E's survey recommendations, for all CEMS surveys completed in 1996. These CEMS Programs are presented to customers using four different survey-based approaches: the Business Edge Mail survey, the Energy Efficiency Resource Center (EERC) Telephone survey, the On-site Energy survey for large customers, and a similar On-site Energy survey for medium and small commercial customers. The evaluation also included an impact assessment of the CustomNet Program. The results are presented in three parts: evaluation results summary (covering the numerical results of the study), major findings, and major recommendations.

1.1 EVALUATION RESULTS SUMMARY

The evaluation results are summarized in terms of energy savings (kWh), demand savings (kW), therm impacts, and realization rates (defined as the ratio of the ex post evaluation results to the ex ante program design estimates). These results are presented on a gross and net basis (i.e., before and after accounting for customer actions outside the program). Exhibit 1-1 presents the gross energy, demand and therm savings results (ex post and ex ante), together with each applicable gross realization rate. Ex ante estimates were only reported at a net level, therefore no mention is made to gross ex ante impacts.

Exhibit 1-1
Summary of Gross Evaluation and Program Design Results
for Commercial Sector EMS Surveys

		Gross Realization	Net-To-Gross				Net Realization
	Gross Savings	Rate	1-FR	Spillover	NTG Ratio	Net Savings	Rate
			EX ANTE				
kW	-	-	1.00	0.00	1.00	5,185	-
kWh	-	-	1.00	0.00	1.00	26,340,646	-
Therms	-	-	1.00	0.00	1.00	502,610	-
			EX POST				
kW	11,939	-	0.70	0.00	0.70	8,349	1.61
kWh	79,864,550	-	0.68	0.00	0.68	54,017,903	2.05
Therms	-5,372,440	-	0.28	0.00	0.28	-1,496,549	-2.98

The ex ante numbers presented above in Exhibit 1-1 were obtained from PG&E's Profitability Analysis Model (PAM), which in-turn feeds PG&E's filed estimates, as reported in Table E-3 of

the Technical Appendix of the Annual Summary Report on Demand Side Management Programs.

These results illustrate the following key points about the gross impacts achieved by the CEMS Programs:

Small and Medium On-Site Surveys - Overall, the vast majority of the electric energy and peak demand savings come from recommendations that were made during implementation of the small and medium customer-size on-site surveys, where gross impacts exceed 60 percent of the total CEMS Program savings, and net impacts exceed 75 percent of the total program savings. Research into the reasons for such large differences has shown that the adoption rates following recommendations to this group of customers are much higher than previously thought, and that the retrofits made outside of the rebate programs were more sophisticated (and thus sustained a larger impact). The added value perceived by customers when they receive a personalized report (that is based on a carefully gathered customer energy use profile), should not be underestimated when the program design is updated.

Large On-Site Surveys – The net ex ante per-unit impact estimates for large customers are equal to those attributed to small and medium sized customers, because previous M&E results were not available. The net ex post results clearly indicate that the savings achieved by large customers are more than 8 times larger than the estimates for small and medium sized customers. This is not surprising, given that a large customer's energy consumption is typically on an order of magnitude (i.e. ten times) larger than their Medium/Small counterparts. Assuming, for example, energy savings is consistently ten percent of total usage (regardless of customer size), the larger customer would experience a significantly larger energy impact.

Net Energy Impacts - The ex post net energy impacts exceed the ex ante estimates by a significant margin. In fact, the ex post impacts are more than two times the size of the ex ante estimates. This is due in part to the underestimation of the impacts that result from PG&E's On-site surveys, and also the significant energy impacts that were achieved by the CustomNet Program. No ex ante savings were filed for that pilot program.

Net Demand Impacts - The ex post net demand impacts were one and a half times as large as the ex ante estimates. These differences are mostly due to the much larger than expected impacts achieved by the On-site surveys.

Net Therm Impacts - The heating penalty attributed to the installation of lower-wattage lighting by customers with gas heat was not considered in the ex ante impact estimates, and therefore large negative realization rates have resulted.

1.2 MAJOR FINDINGS

The key findings are summarized as follows:

- The ex ante estimates of savings should be updated to reflect the figures supported by this evaluation. PG&E is underestimating the achievements of this program in terms of electricity savings and far overestimating the therm benefits.

- The impacts achieved by the CEMS Programs rival those achieved under the more traditional Commercial Energy Efficiency Incentives (CEEI) Programs, while also serving as a conduit to those programs. The evaluation found many customers retrofitting lighting and HVAC technologies that were just as sophisticated as the rebate program participants.

1.3 MAJOR RECOMMENDATIONS

Sustainable Markets – This evaluation has shown that providing customers with information designed to save energy is an effective technique for educating those customers regarding the benefits of energy conservation investments. Roughly 54 percent of the customers that participated in the on-site survey supported surveys went on to adopt energy conservation Practices or Measures; approximately 30 percent of those customers went on to participate in a rebate-driven Energy Efficiency Incentive Program, while the other 70 percent took action (or adopted Measures or Practices) on their own. This observed customer behavior suggests that these surveys are an effective means for transforming customer behavior in the energy efficiency market place. The question is, are these market actions sustainable? That is, will those same customer continue to make energy conscious decisions in the future, based upon the information they received during CEMS participation under the 1996 programs.

PG&E should continue to study the market effects of CEMS programs to see if the sustainable market goals of the California Board for Energy Efficiency (CBEE) can be achieved using this traditional utility approach. First signs indicate that these programs are an effective tool for use in modifying customer behavior in the energy marketplace.

2. INTRODUCTION

This report summarizes the impact evaluation of Pacific Gas & Electric Company's (PG&E's) Commercial Energy Management Services and information programs (CEMS Programs) for commercial sector technologies (the CEMS Evaluation). PG&E provides free energy management services and information to nonresidential customers through its CEMS Programs. An overview of the CEMS Programs are presented next.

2.1 OVERVIEW OF THE EMS PROGRAMS

The CEMS Programs are designed to provide energy efficiency information and energy conservation recommendations that are tailored to each participating customer. Customer-specific information is first gathered using telephone, mail, or on-site surveys. This data is in turn used to make individual energy conservation recommendations for each customer, culminating in the preparation of a tailored report for each participant.

Energy conservation recommendations can be classified into two distinct groups: low cost/no cost behavioral measures ("Practices") and capital intensive technologies ("Measures"). The Measures are oftentimes installed through a rebate program, thereby eliminating any associated impact from the CEMS Programs (as all of the impact is being claimed under the EEI program). This CEMS Evaluation has determined the frequency with which those recommendations are adopted by customers, the reasons for non-adoption, customer plans in the future to adopt, and the related program first-year gross and net impacts (kW, kWh, and therms) from a representative sample of 1996 CEMS participants.

2.1.1 Program Descriptions

All of the surveys available within PG&E's CEMS Programs recommend either Measures or Practices that customers can implement to help reduce their energy consumption. These are often "feeder" programs that ultimately lead to participation in one of PG&E's rebate programs. Many of the survey recommendations emphasized are rebated energy efficiency measures. Each of the CEMS Programs evaluated as part of this study are described next.

Exhibit 2-1
PG&E's CEMS Program Descriptions

PROGRAM	DESCRIPTION
On-Site Energy Surveys by Division Account Representatives	On-site surveys are targeted to medium and large commercial customers, particularly in segments with substantial potential savings. These segments include, but are not limited to, offices, food handling businesses, hospitals, and non-food retail establishments. Though medium and large commercial customers are targeted, small customers who request an on-site survey are accommodated.
Customer Technical Services (CTS) Surveys	For large or complex facilities, Division Account Representatives may request a CTS engineer to provide an in-depth energy survey of a customer facility. The primary targets for CTS surveys are large industrial and commercial customers. Energy-saving recommendations offered as a result of CTS survey may be eligible for PG&E's customized rebate programs rather than standard prescriptive measure rebate programs such as the Retrofit Express program.
Business Edge Mail Surveys	Business Edge direct-mail surveys are designed for small business customers who do not necessarily want or need an on-site survey. The Business Edge surveys take about 15 minutes to complete. Once PG&E receives the completed survey in the mail, a software program compiles and analyzes the customer's responses to the energy survey. The customer then receives a detailed report filled with suggestions on how to lower costs related to energy, solid waste, and water.
Energy Efficiency Resource Center (EERC) Telephone Surveys	The EERC offers customers information and advice on product performance, equipment maintenance, energy efficiency, and PG&E's products and services. In 1995 the EERC began offering commercial customers telephone energy surveys as an alternative to mail energy surveys or on-site surveys. Trained energy specialists guide customers to answer approximately 15 questions pertaining to energy-consuming equipment and usage patterns. The collected information is then entered into the BEST tool and a report generated and mailed to the customer with suggestions on how to lower energy costs.

CustomNet	CustomNet is an energy benchmarking service offered to chain accounts. The CustomNet services identify energy savings potential available from bringing the relatively high-consumption sites up to the performance of the best customer facility, and also provides comparisons with typical competitor facilities. CustomNet allows the multi-site customer to prioritize energy efficiency projects to get the most impact for each investment dollar. There was one pilot CustomNet participant in 1996: a medium-size clothing and jewelry store chain.

2.1.2 Program Survey Implementation and Recommendations

Data on the recommendations made as part of each energy survey resides on PG&E's Marketing Decision Support System (MDSS). The MDSS tracking system stores minimal, and often incomplete, data on the energy survey recommendations. To receive credit for accomplishing an energy survey, a division representative is required to enter only two recommendations into the system. The remaining data is often left on the survey instrument used to complete the energy audit.

More detailed records, then, surrounding the survey recommendations and results can be found on the hardcopy surveys, which consist of calculations and/or customer reports. Hard copy reports used in this evaluation were obtained for a select group of customers (who, through the telephone survey were found to have taken action regarding one or all of the recommendations), through requests submitted to the CTS group, PG&E's Marketing Processing Center (MPC), and requests directed to the individual Division offices.

These hard copy survey records/reports are prepared by the CTS engineers, PG&E's customer representatives, the EERC, and selected contractors to PG&E. Medium to large commercial customers typically receive detailed on-site energy surveys performed by either Division Account Representatives or CTS engineers from PG&E's General Office. Small or medium commercial customers typically receive site surveys performed by Division Account Representatives, or mail or phone surveys performed by contract staff.

Although PG&E is moving towards standardization of analysis tools on the Business Energy Survey Tool (BEST) and the Performance Modeling Tool (PMT), many other tools are still in use including various spreadsheets, standard calculations, and audit checklists. The detail and thoroughness of each audit and the analysis tool used is determined by the Account Representatives, whose choice is based upon their level of training, their assessment of the customer's savings potential, and the time available to complete the survey.

The CustomNet program was implemented using a different strategy than the aforementioned programs. This unique program is a benchmarking analysis, where a chain account's comprehensive energy savings is forecasted by examining each individual store's square footage, annual energy usage, and peak demand consumption. A profile of energy savings is calculated for each store, and aggregated to the corporate level for an estimate of total energy

savings. Then, based on an assessment of competitor consumption, the chain account can prioritize energy efficiency projects to maximize their investment. There was one CustomNet participant in 1996.

2.1.3 1996 Commercial Sector Survey Completes

The accomplishments for the CEMS Program are tracked in the MDSS and reported in the E-Tables that are filed with the California Public Utilities Commission (CPUC). Exhibit 2-2 presents a comparison between these filed accomplishments and those found in the MDSS databases that were submitted to PG&E's evaluation contractor.

Exhibit 2-2
1996 CEMS Programs
Completed Surveys

Category	Service Code	Surveys
PG&E		
Business Edge (Mail)	R5J	3,406
Phone Surveys	R5G	933
Pump Test	R7A	610
Large On-Site Surveys	R5D	116
Small On-Site Surveys	R5D	5,658
TOTAL		10,723
Evaluation		
Business Edge (Mail)	R5J	3,411
Phone Surveys	R5G	934
Pump Test	R7A	612
Large On-Site Surveys	R5D	122
Small On-Site Surveys	R5D	5,823
TOTAL		10,902

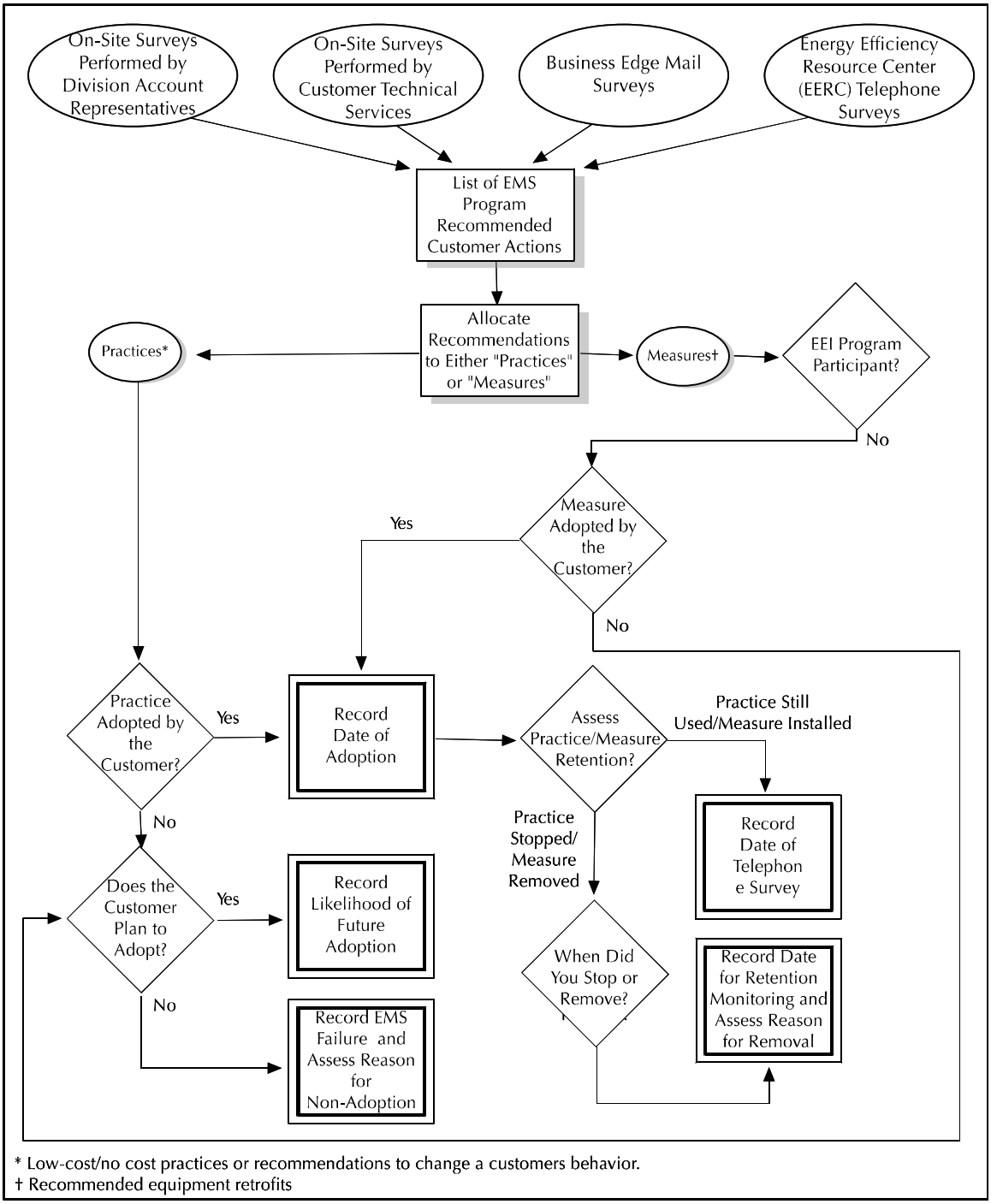
The data used to derive the results shown in Exhibit 2-2 originated from a variety of databases including the on-site and telephone accomplishments, the Business Edge database, and the pump test database. Because these databases are not "frozen" like the records stored in the MDSS for the Energy Efficiency Incentives (EEI) programs, additional program accomplishments were entered for 1996 after the E-Tables were completed.

It should be noted that this evaluation does not cover the Pump Test category, as it is more applicable to the Agricultural sector. There were over 4,500 pump tests conducted for the Agriculatural sector. It was believed that a more accurate assessment of pump tests would be made through the evaluation of the Agricultural EMS Program, and the results transferred to the CEMS Program.

2.2 OVERVIEW OF RESULTING CUSTOMER ACTIONS

Exhibit 2-3 provides an overview of customer actions following participation in the CEMS Programs, and the effect these customer actions have on the resulting program impacts.

Exhibit 2-3
Customer CEMS Program Actions



Practice/Measure adoption rates following participation in a CEMS Program appear to be approximately 54 percent. That is, a little over half of the respondents claimed they took some

action regarding a recommendation they received during an on-site, telephone, or mail survey. After removing all customers who went on to a Commercial Retrofit Program (i.e. those who received a rebate for their actions), a total of 39 percent of the CEMS participants contribute to the program impacts, while the remaining 46 percent take no action surrounding the recommendations made.

2.3 EVALUATION OVERVIEW

The impact evaluation described in this report covers all surveys conducted in calendar year 1996, for commercial sector accounts, as determined by the contents of the MDSS.

The impact evaluation results in both gross and net impacts (ex post), and as discussed earlier, these estimates are compared against the ex ante estimates .

2.3.1 Objectives

The research objectives are as follows:

- Determine, consistent with the Protocols, the First Year Gross and Net Impacts (kW, kWh, and Therms) attributable to CEMS Programs in 1996.

- Assess gross and net impacts amongst the following survey methods: Large on-site surveys, Medium/Small on-site surveys, Telephone surveys, and Business Edge mail surveys.

- Assess free ridership rates by the following survey methods: Large on-site surveys, Medium/Small on-site surveys, Telephone surveys, and Business Edge mail surveys.

- Provide PG&E and the Office of Ratepayer Advocates (ORA) with all datasets and programs used to derive the gross and net impact results. The purpose of this task is to provide detailed documentation in support of ORA replication efforts.

- Complete Tables 6 and 7 of the Protocols.

- Determine the gross and net energy (kWh and therms) and demand (kW) impacts of the 1996 CustomNet pilot program.

To achieve this list of objectives within the limited time available, analyses were conducted in a manner that maximizes the use of current PG&E results derived from other evaluation efforts. In particular, existing PG&E impacts and forecasting methods were applied to evaluate customer/end-use impacts for the sample of CEMS participants who took action regarding an CEMS recommendation. PG&E has already put considerable effort into developing and maintaining these methods, which have been carefully scrutinized by evaluation contractors, the Office of Ratepayer Advocates, and other State agencies.

While gross impacts account for program participant actions (and the fuel use benefits and secondary costs associated with each Practice/Measure decision), net impacts account for customers that would have installed energy-efficient measures in the absence of the program (free-riders).

The evaluation investigated and, where possible, explained differences between ex ante estimates and ex post results.

2.3.2 Timing

The 1996 CEMS Evaluation began in July 1997, completed the planning stage in September 1997, executed data collection between October and November 1997, and completed the analysis and reporting phase in February 1998.

2.3.3 Role of Protocols

This evaluation was conducted under the rules specified in the "Protocols and Procedures for the Verification of Cost, Benefits, and Shareholder Earnings from Demand Side Management Programs" (the Protocols).[1] The Protocols control most aspects of the evaluation. They specify the minimum sample sizes, required precision, data collection techniques, certain minimum analysis approaches, and formats for documenting and reporting results to the CPUC. This evaluation has endeavored to meet all Protocol requirements.

2.4 EVALUATION APPROACH – AN OVERVIEW

This overview of the integrated evaluation approach begins by presenting the data sources used for the CEMS Evaluation. An overview of how the engineering and statistically adjusted engineering (SAE) estimates are used together to derive gross energy, demand and therm impacts follows. The final section discusses how the net-to-gross estimates are used to derive net program impacts.

2.4.1 Data Sources

One of the keys to obtaining the greatest accuracy from any evaluation is an appropriate use of available data sources. Applicable data available from PG&E and other industry sources were used in conjunction with primary data collected specifically for use in completing this evaluation.

Existing Data

All available data supplied by PG&E were used in the analysis of the CEMS Programs. Of particular importance were PG&E's historical billing data, program participant data (MDSS), paper copies of customer surveys, and other program-related data. Each of these existing data sources are described briefly below.

Program Participant Tracking System - The participant tracking system data, maintained in the PG&E MDSS, contains customer program and technical information surrounding each recommendation.

[1] California Public Utilities Commission Decision 93-05-063, Revised January 1997 Pursuant to Decisions 94-05-063, 94-10-059, 94-12-021, 95-12-054, and 96-12-079.

Program Marketing Data - PG&E program marketing data contain detailed descriptions of program marketing and application procedures, together with details on the customer conservation actions most frequently recommended.

PG&E Billing Data **-** The PG&E commercial billing database contains monthly energy-consumption information for all commercial customers in PG&E's service territory. It also contains demographic data for all customers, and the on-peak and off-peak monthly energy usage for customers who receive services on demand or time-of-use (TOU) rates. This information is used to calibrate the engineering estimates to actual pre- and post-installation energy usage.

PG&E 1996 Customer Energy Efficiency Programs Advice Filing[2] **-** This report documents the ex ante earnings claims, including specific information on the derivation of per-unit ex ante savings estimates and the assumptions that go into those estimates. This documentation often includes assumptions such as operating hours and operating factors, by fixture type. This document supplies the best information available on ex ante estimates and assumptions, thus facilitating knowledge-based comparisons to ex post estimates.

Industry Standards/Information **-** In order to establish baseline levels and new equipment performance levels, industry standards information from organizations such as the American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE) and American National Standards Institute (ANSI) was used, together with information from manufacturers.

1994-1995 Commercial Sector EEI Evaluation Results. Annual hours of operation, on-peak coincident diversity factors, and other lighting, HVAC and refrigeration parameters that were derived during the 1994 and 1995 Commercial sector evaluations were applied to the identified population to the customers that adopted Practices and Measures.

Primary Data Collected

In addition to the above sources, the evaluation team gathered data from the following sources:

Telephone Survey Data. A total of 903 participant telephone surveys, and 462 nonparticipant surveys were completed to gather customer profiles used in each of the analyses. The nonparticipant sample was similar to the participant sample, and served as a control group in the SAE analysis.

Hard Copy Surveys, A total of 354 hard copy surveys were requested from PG&E's MPC and used as supplemental information contributing to the engineering analyses. These 354 surveys correspond to the 354 customers that were found to adopt measure from the telephone survey.

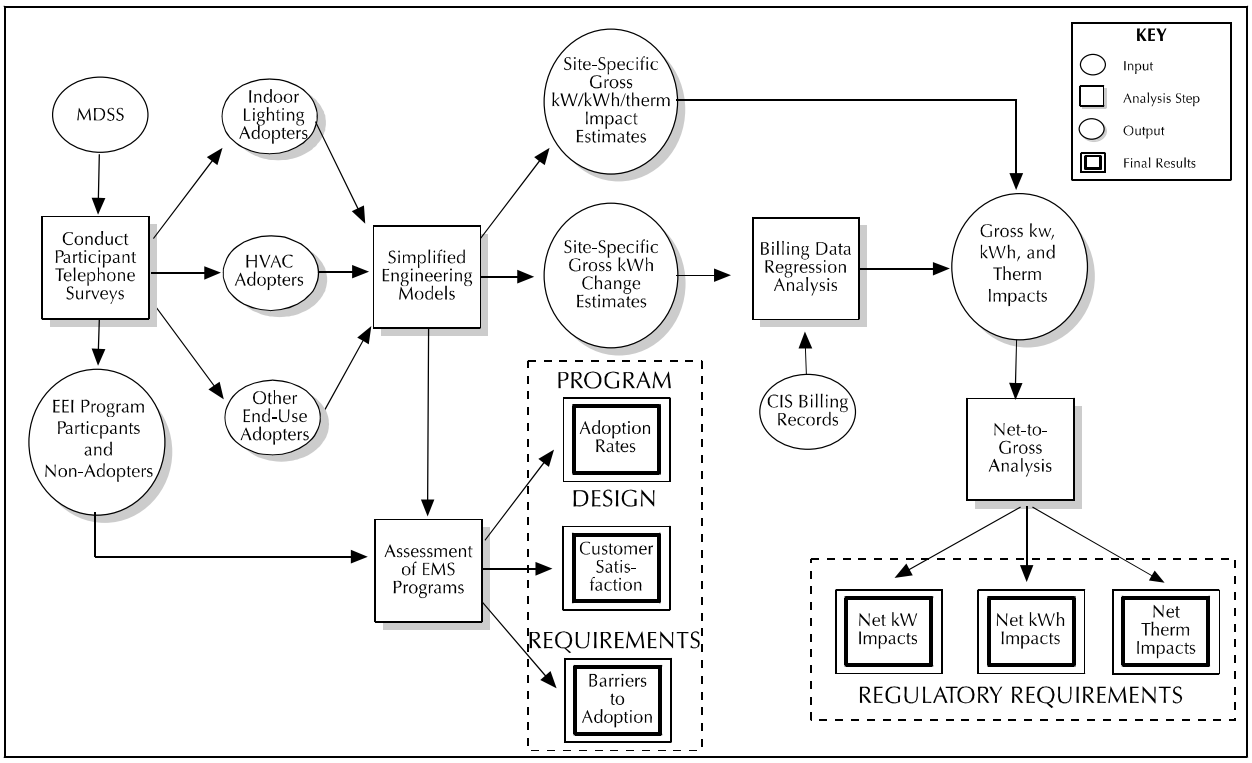
2.4.2 Analysis Elements

This sub-section describes the general approach used to estimate both the gross and net demand and energy impacts for the CEMS Evaluation. The application and program design

[2] Advice Letter No. 1921-G/1540-E, October 1995.

data were used to create a data collection plan, which in turn guided the evaluation data collection efforts.

Exhibit 2-4
Overall Impact Analysis Approach



The analysis approach illustrated in Exhibit 2-4 consisted of two key analysis paths driven by two unique needs, 1) to meet the regulatory requirements associated with the CEMS Evaluation and 2) to provide PG&E with additional program design information/recommendations. The focus of this report is to document the derivation of this evaluation's regulatory requirements.

The regulatory objectives are met using three primary analysis components: the engineering analysis, the billing regression analysis, and the net-to-gross analysis. This integrated approach reduces a complicated problem into manageable components, while incorporating the comparative advantages of each method. This approach describes per-unit net impacts as:

$$\text{Net Impact} = [\text{Gross Impacts}] * [\text{SAE Realization Rate}] * [\text{Net - to - Gross}]$$

Where,

Gross impact is defined as the diversified load impact for a particular customer, measure, or some other segment of the participant population.

The Statistically Adjusted Engineering (SAE) Coefficient will be estimated for those cases in which an engineering model estimate is not used as the final result. This term is defined as the

percentage of savings estimate that is detected, or realized, in the statistical analysis of actual changes in energy usage. The SAE coefficient is applied to an impact estimate based upon the program baseline, non-rebated equipment purchased following a survey, and typical weather.

The Net-to-Gross (NTG) Ratio adjusts the program baseline derived estimates to account for free ridership.

Engineering Analysis

Gross energy estimates were developed using two distinct analysis steps. Engineering estimates were first developed for each participant. These estimates were then adjusted using billing data-derived SAE coefficients. Gross, unadjusted engineering impacts were developed for each adopted Measure or Practice. The engineering methods used are described in detail in *Section 3.2*. Gross demand estimates are based solely upon unadjusted peak hour engineering estimates. Like gross demand estimates, therm estimates are not adjusted using SAE coefficients.

Billing Analysis

Statistical analysis was then used to determine the fraction of the unadjusted engineering estimates actually observed or "realized" in customer billing data. The per-unit engineering energy impacts, combined with the units installed, form the input to the billing regression analysis, or SAE analysis. In the SAE analysis, the engineering estimates are compared to billing data using regression analyses, in order to adjust for behavioral factors of occupants and other unaccounted for effects.

Net-to-Gross Analysis

The NTG analysis is designed to adjust gross program impacts for free ridership (that is, customers that would have proceeded with same adoption actions, before receiving PG&E's recommendations). Self-reported data were used to estimate the percentage of free-riders in the program; that is, the number of participants who would have undertaken the energy efficiency action promoted by the program in the absence of the program.

Application of the final NTG adjustments, by technology, yields net program impacts. *Section 3 – Methodology* describes in explicit detail, each step taken to achieve the final net results, beginning with the sample design, followed by the engineering and SAE analyses, and ending with the Net-to-Gross findings.

2.5 REPORT LAYOUT

This report divided into five sections, plus appendices. *Sections 1 and 2* are the *Executive Summary* and the *Introduction*. *Section 3* presents the *Methodology* of the evaluation. *Section 4* presents the detailed results and a discussion of important findings. *Attachment 1* contains the impact distribution by Time-of-Use costing periods. *Attachment 2* contains Protocol Tables 6 and 7. The *Survey Appendices* provide the survey and on-site data collection instruments, and the survey call dispositions, frequencies, and refusal comments.

3. METHODOLOGY

This section provides the specifics surrounding the methods used to conduct the 1996 Pacific Gas & Electric Company (PG&E) Commercial Energy Management Services Evaluation (CEMS Evaluation). This section begins with a detailed discussion of the sampling plan used to collect all of the necessary data used in the CEMS Evaluation. From there, details regarding the Engineering Analysis (*Section 3.2*), the Billing Analysis (*Section 3.3*), and the Net-to-Gross Analysis (*Section 3.4)* are discussed, culminating with a description of the Integrated Analysis in *Section 3.5*. Finally, a stand-alone evaluation and presentation of results is provided for the CustomNet Program in *Section 3.6*.

3.1 SAMPLE DESIGN

This section presents the sample design for the CEMS Evaluation. The sample design was implemented in such a manner as to ensure significant results for each CEMS Program evaluated. First, the overall sample design approach is discussed, followed by the resulting sample allocation. The section concludes with a discussion of the California Public Utilities Commission (CPUC) Evaluation and Measurement Protocols (the Protocols) requirements.

3.1.1 Existing Data Sources

The participant tracking system for the Business Edge, EERC Telephone, On-Site, and CTS Surveys are maintained as part of PG&E's Marketing Decision Support System (MDSS). The MDSS contains customer contact information and program recommendations, but only very limited technical information regarding the extent of each recommendation (for example the number of T8 lamps that should be retrofit) and no reliable estimates of the savings achieved.

A careful link is maintained in the MDSS between the customer recommendations made and the customer accounts associated with those recommendations. The account location is designated by its account number, or a unique seven-digit identification number (PG&E's control number). Unlike customer accounts, control numbers are used to identify service locations and serve as stable identifiers for linking datasets.

The billing series requested in support of the CEMS Evaluation covers a period from January 1993 to September 1997. PG&E's billing data contain monthly energy-consumption as well as other customer information, such as customer name, service location, rate schedule, and Standard Industrial Classification (SIC) code.

3.1.2 Sample Design Overview

The objectives of the sample design were to:

- Determine the optimal sample allocation for first-year gross impact analysis, based upon sample size and evaluation accuracy requirements of the Protocols. Available project resources were also considered. For example, a census was conducted of all large customers and all CTS surveys, due to the limited available sample frame within those segments and the larger contribution to impact that is expected from that particular group.

- Allocate sufficient sample points to meet net-to-gross (NTG) objectives.

- Reallocate available resources, wherever feasible, to focus on measures and/or program features deemed most important by PG&E staff for future program design while not compromising the overall accuracy of the evaluation.

- Meet the requirements of Tables 5 and C-11 of the Protocols.

3.1.3 Sample Segmentation

Defining the sampling frame sets the stage for all data collection activities that follow and determines availability of hard copy customer reports and billing data for the remainder of the analysis. In addition, it prevents drawing samples outside the sampling frame and allows for an efficient and effective use of available resources. In general, the sampling frame includes only those customers who were 1996 CEMS Program participants.

For this study, the CEMS participant records in the MDSS defined the participant population. In all there were 11,569 commercial sector sites that participated in a 1996 PG&E CEMS Program. Of this, only 9,883 sites could be mapped to the PG&E billing data provided by customer control number. Due to Protocol Table C-11 requirements, analyses began with an assessment of the end uses affected by each recommendation. In most instances, recommendations were made to customers surrounding their indoor lighting or space conditioning (HVAC) usage.

Sample Selection

The sample allocation began by determining the number of surveys conducted in each segment and assessing the recommendations made within those segments. This included the number of CEMS surveys conducted by business type, end use; and also by each PG&E local division office. Results have shown that participation is concentrated within the Office and Retail business types, and the indoor lighting and space conditioning end uses, and that participation is evenly distributed amongst PG&E's eighteen divisional offices.

Assessments were made of the frequency with which each recommendation was selected. For the Business Edge (Mail) program, the evaluation concentrates on several key recommendations that were frequently made to customers, according to records stored in the MDSS database. For the other CEMS Programs, analysis activities were not biased towards any particular recommendation or end use, but span all Measure/Practices that were suggested during the course of each on-site visit or telephone survey.

Another consideration in designing the sample was to comply with the Protocols. For this study, the optimal sample allocation far exceeds the sample size and accuracy requirements as stated in the Protocols. Additionally, the sample allocation reflects feedback from PG&E program staff in support of the future design of the CEMS Programs.

The key analysis segments from which the telephone survey sample was selected are shown in Exhibit 3-1. Of particular interest are the number of CEMS surveys completed and the number of recommendations made by end-use.

Exhibit 3-1
PG&E Commercial Sector EMS Program Accomplishments and the Frequency by End-Use of Recommendations

Survey Category	Unique Sites	End-Use Recommendation Recorded	Number of Recommendations	Percentage of Recommendations
Business Edge	1,968	Indoor Lighting	2,806	29.6%
(Mail Survey)	2,687	Space Conditioning	5,210	55.0%
	-	Refrigeration	-	-
	1,423	Other	1,451	15.3%
Business Edge Total	3,411		9,467	100.0%
Phone Surveys	918	Indoor Lighting	1,073	45.0%
	679	Space Conditioning	841	35.3%
	182	Refrigeration	226	9.5%
	224	Other	243	10.2%
Phone Survey Total	1,165		2,383	100.0%
Pump Tests	-	Indoor Lighting	-	-
	-	Space Conditioning	-	-
	-	Refrigeration	-	-
	573	Other	615	100.0%
Pump Test Total	573		615	100.0%
Small On-Site	6,377	Indoor Lighting	9,722	56.1%
	4,000	Space Conditioning	4,579	26.4%
	1,680	Refrigeration	2,113	12.2%
	821	Other	930	5.4%
Small On-Site Total	7,537		17,344	100.0%
Large On-Site	126	Indoor Lighting	184	57.0%
	96	Space Conditioning	112	34.7%
	9	Refrigeration	11	3.4%
	13	Other	16	5.0%
Large On-Site Total	141		323	100.0%
Program Total	12,739		30,132	

Data Source: 1996 PG&E EMS Database Received On September 12, 1997

The data collection activities conducted as part of this evaluation were directed towards providing concrete information regarding the extent to which each measure recommendation was implemented. That is, the data collected more precise information regarding the technologies replaced, as well as the number of each technology replaced, and/or the behavioral modification implemented.

3.1.4 Selection of Recommendations

Descriptions of the recommendation that were made to each CEMS participant were taken (and sometimes modified for clarity) from the MDSS and used to prompt customers during a telephone interview. Specifically, customers were asked: "Has your company taken action regarding the <Measure Description> recommendation? That is, did you install equipment or modify the way you operate equipment as a result of this recommendation?"

For seventy five percent of CEMS participants, there were three or fewer recommendation recorded in the MDSS. Each customer was asked specifically about the adoption of at most three item records. In addition, customers were asked if they recalled any additional lighting and heating or cooling recommendations that were made, and any subsequent actions that may have resulted from those recommendations.

For all CEMS Program components, with the exception of the Business Edge Mail Surveys, the recommendations selected to prompt customers during the telephone interview were selected randomly, without regard to either the end-use affected or the Measure/Practice. For Business Edge interviews, recommendations were first selected based on the frequency with which each recommendation was made. A total of twenty Measure/Practice descriptions were selected from over eighty possible Business Edge recommendations. These descriptions were selected due to their high frequency of occurrence in the Business Edge report, and because viable impacts could be calculated from the recommendations.

3.1.5 Sample Allocation

Originally, approximately 1,180 customers were planned to be contacted, in order to obtain a sample of 350 adopters. Due to higher-than-anticipated adoption rates outside of the rebate programs, the PG&E CEMS participant telephone sample consisted of 903 customers. A subset of these customers (the 354 adopters) completed a "long" telephone survey. The long survey gathered additional choice information, and outside the program changes at the customer's facility, that served as inputs to the LIRM model. The nonparticipant telephone sample consisted of 462 comparison group sites, who were asked similar change variable questions, that contributed to the LIRM model.

Hard copy survey records were requested for all of the 354 participant sites that adopted Measure/Practices outside of the rebate programs. These records were obtained from PG&E's Division personnel at the completion of the participant survey, and were used in support of the engineering analysis.

Based on the sample segmentation discussed in *Section 3.1.4*, and to meet the objectives of the evaluation, the sample design was based on the following strategy:

- A random sample would be drawn amongst the Telephone and Business Edge surveys; with telephone quotas set so that the total sample collected would be roughly proportional to the 1996 program accomplishments.

- Because sufficient population were available with the Medium/Small On-site survey group, a stratified random sample was selected to support further segmentation of population characteristics.

- Due to the high interest in the accomplishments of the Large On-site survey, and because of the limited population, a census was conducted for this survey group.

Participant Sample

Exhibit 3-2 presents the original telephone survey sample design. The total number of CEMS surveys completed in 1996 are shown in conjunction with the targeted telephone sample quotas

for each analysis group. This sample design complies with the Protocols and meets the program evaluation objectives as described in *Section 2* of this Report.

Exhibit 3-2
Commercial EMS Evaluation Sample Design

Survey Category	EMS Surveys	Relative Percent	Sample Design	Relative Percent.	Sample Drawn
Business Edge	3,406	33%	300	25%	Random
Phone Surveys	610	6%	100	8%	Random
Pump Test	610	6%	0	0%	-
Small On-Site	5,658	54%	720	61%	Stratified/Random
Large On-Site	116	1%	60	5%	Census
Program Total	10,400	100%	1,180	100%	-

Comparison (nonparticipant) Sample

The primary objective of the nonparticipant telephone sample was to provide a control group for the gross billing analyses. The final comparison group sample frame consists of 82,400 commercial customers drawn from an eligible population of over 400,000 commercial controls. Since comparison group surveys were conducted only for customers in the commercial sector, the first step in creating the sample frame is to limit eligibility to only those accounts having SIC codes representing commercial business activities. In addition to the aforementioned criteria, the following screening rules were also used:

Presence of a billing rate for the customer: Customers are required to have a rate schedule code for all years spanned by the billing data.

Quality of usage readings: Customers are required to have non-missing, non-zero usage values for at least 7 month of every billing year spanned by the billing data. Customers with mean zero, or missing billing data, were removed from the sample.

Reasonable usage and miscellaneous data across years: Accounts are screened to ensure that the mean usage on the account for 1995 and 1996 is no more than twice (or less than half) the mean usage on the account for 1994 and 1995, respectively. Accounts are also screened to ensure that they have reasonable phone numbers, meter numbers, and division codes. Any accounts with invalid data are rejected from the sample frame.

In drawing the sample frame, targets are established for each business type and usage segment, so that the nonparticipant distribution, by business type and usage segment, is the same as that of the program participant population. The drawing is conducted in this manner to ensure sufficient representation of each business type/usage segment combination in the sample frame and allows for survey data collection in accordance with the sample design. Exhibit 3-3 below illustrates the business type/usage segments, the available nonparticipant sample, the calculated quota (based on the participant population), and the desired sample size to draw. Gray cells indicated nonparticipant segments where the available population to quota ratio is low. The final sample allocation was randomly selected within each customer segment.

Exhibit 3-3
Nonparticipant Survey Quotas
Telephone Survey Sample

SAMPLE DESIGN																
Small				Medium				Large				Very Large				
Business Type	Avail.	Quota	N	Business Type	Avail.	Quota	N	Business Type	Avail.	Quota	N	Business Type	Avail.	Quota	N	
Office	12,644	52	1,031	Office	1,383	54	1,079	Office	61	7	146	Office	33	8	158	
Retail	13,402	42	849	Retail	1,684	26	522	Retail	52	1	24	Retail	12	1	12	
Col/Univ	211	2	49	Col/Univ	42	0	0	Col/Univ	5	0	0	Col/Univ	10	3	61	
School	619	10	194	School	545	26	522	School	23	2	36	School	5	0	0	
Grocery	3,004	7	133	Grocery	1,370	12	230	Grocery	90	3	61	Grocery	1	0	0	
Restaurant	5,906	12	230	Restaurant	1,273	13	255	Restaurant	5	0	0	Restaurant	0	0	0	
Health Care/Hosp	5,537	13	267	Health Care/Hosp	287	8	158	Health Care/Hosp	22	2	36	Health Care/Hosp	21	7	133	
Hotel/Motel	1,001	7	146	Hotel/Motel	158	9	182	Hotel/Motel	15	5	109	Hotel/Motel	6	1	24	
Warehouse	4,139	15	303	Warehouse	505	18	364	Warehouse	28	1	24	Warehouse	9	1	12	
Personal Service	9,405	21	412	Personal Service	258	7	146	Personal Service	10	1	12	Personal Service	4	0	0	
Community Servic	9,306	38	764	Community Servic	791	18	352	Community Servic	61	2	49	Community Servic	24	2	49	
Misc. Commercial	7,629	18	364	Misc. Commercial	658	8	158	Misc. Commercial	95	4	73	Misc. Commercial	51	4	73	
SUB-TOTAL:		237	4,742	SUB-TOTAL:		198	3,966	SUB-TOTAL:		29	570	SUB-TOTAL:		26	522	
GRAND TOTAL:		490	9,800													

Due to the lack of "very large" commercial customers available in the nonparticipant population, a final quota of 490 sample points was set, with the expectation that only 450 surveys would be completed. Ultimately, 462 points were collected from a draw of 9,214 customers.

3.1.6 Final Sample Distribution

Exhibit 3-4 presents the final participant telephone survey disposition. The total number of CEMS surveys completed in 1996 are shown in conjunction with the number of completes achieved and the percentage achieved by each CEMS portfolio component.

Exhibit 3-4
Commercial EMS Evaluation Participant Telephone Survey Completes

Survey Category	EMS Surveys	Sample Design	Completed Surveys	Relative Percent.	Long Completes Supporting the LIRM	Non-Rebated Adoption Rate
Business Edge	3,406	300	263	29%	101	38%
Phone Surveys	610	100	138	15%	48	35%
Small On-Site	5,658	720	463	51%	193	42%
Large On-Site	116	60	39	4%	12	31%
Program Total	9,790	1,180	903	100%	354	39%

By applying the criteria mentioned at the beginning of this section (observed customer participation patterns, Protocol requirements, and program design considerations) a comprehensive, yet robust sample was achieved to meet both the regulatory and program design objectives of this evaluation.

It is noteworthy to mention that the long survey completes supporting the LIRM model were all customers that reported the adoption of at least one Measure or Practice recommendation. It is those particular customers that are anticipated to show a reduction in energy usage following adoption, and serve as the group of participants that act as inputs to the LIRM model.

3.1.7 Relative Precision

Given a sample design, the relative precision, based upon total annual energy usage, reflect the uncertainty regarding the extent to which the allocated sample sizes are large enough to control for the population variance in terms of annual energy usage. Precision for the telephone sample is calculated using the following procedure. First, the 1994 annual energy consumption is computed for all participants and nonparticipants in the analysis dataset.

Next, five strata are constructed based on a customer' annual usage using the Delanius-Hodges procedure. Exhibit 3-5 present the stratum-level sample size, corresponding sample weight (as a proportion of the total population), sample mean usage, and the estimated standard errors for each survey group evaluated.

Then, the program level mean and standard error are calculated using classic stratified sample techniques[3]. Finally, the relative precision at a 90 percent confidence level is calculated as a two-tailed test. The very large customers (with annual energy usage greater than 3,000,000 kWh) were excluded from these calculations since they were not included in the final billing analysis.

By survey, the following relative precisions were achieved: For nonparticants, the relative precision is 6.3 percent based upon a survey sample of 451 customers. For CEMS participants that served as inputs to the LIRM model (i.e. the adopters), the relative precision is 7.1 percent based upon a survey sample of 346 customers.

[3] Cochran, W.G., *Sampling Techniques,* Third Edition, John Wiley & Sons, 1997. pp. 91-95.

Exhibit 3-5
Relative Precision

Nonparticipants

Weight	Sample	Mean	STD	Standard Error	Relative Precision
96.1%	385	53,784	52,739	2,681	8.2%
3.0%	42	318,960	166,942	25,513	13.2%
0.8%	18	1,169,320	404,165	93,876	13.2%
0.1%	6	2,237,123	434,312	171,228	12.6%
TOTAL	451	73,630		2,805	6.3%
Large Customers					
Population = 281	11	6,072,193	5,247,728	1,519,643	41.2%

Commercial EMS Adopters

Weight	Sample	Mean	STD	Standard Error	Relative Precision
88.8%	310	47,480	44,516	2,438	8.4%
8.1%	30	317,110	129,715	22,788	11.8%
2.7%	6	966,748	268,906	107,285	18.3%
0.4%					
TOTAL	346	93,848		4,053	7.1%
Large Customers					
Population = 76	8	12,971,767	18,698,724	5,915,103	75.0%

3.1.8 Demonstration of Protocol Compliance

Sampling Procedures Adopted

The sample design follows the rules established by the CPUC in the January 1997 revisions to the "Protocols and Procedures for the Verification of Costs, Benefits, and Shareholder Earnings from Demand Side Management Programs". Specifically, the requirements as stated in Tables 5 and C-11 were met.

Sample Definitions

The following definitions are provided to introduce the primary segments targeted—both a participant sample and a comparison group — to ensure experiment control:

Participants - According to Table 5, part C, paragraph 1 of the Protocols, participants are defined as "those who received services under the appropriate authorized utility DSM program

(e.g., an energy audit with recommendations, or an energy audit with recommendations combined with the offer of a rebate)."

Comparison Group - A control group is defined as a group of customers that represents what would have happened in the absence of the program. According to Table 5, part D, paragraphs 3 & 4, the comparison groups include both "customers who installed applicable measures" and "customers who did not install applicable measures," with no preference for either group (i.e., random or stratified random sample). This sample is therefore representative of the population, excluding only program participants during the evaluation year.

Overall Sampling Procedures

The commercial customer samples are driven by a primary data collection activity; in this case, the telephone surveys serve as the primary site-specific data collection elements that contribute to the analysis dataset. The commercial telephone sample was drawn to achieve a stratified random sample and optimally distribute the allocated sample points.

Detailed Protocol Sample Requirement

The commercial participant and comparison group samples are designed to meet the Protocol requirements in terms of analysis dataset sample size, precision of the results, availability of pre- and post-billing data contributing to the analysis dataset, and in ensuring cost-effective use of measured data.

Analysis Dataset Sample for Commercial Participants: The Protocols require that a program with more than 350 participants has a randomly drawn sample sufficiently large to achieve minimum energy use precision of ±10 percent at the 90 percent confidence level, and at least 350 contributing points in the analysis dataset. This requirement was either met or exceeded.

As illustrated in Exhibit 3-5, the sample collected for CEMS Programs achieve a relative precision of 7 percent at a 90 percent confidence level. This is well below the 10 percent required by the Protocols, Table 5, part C, paragraph 4. Each participant chosen for the telephone sample is required to have at least nine months of post-installation billing data, and 12 months of pre-installation data, as per the Protocols, Table 5, part D, paragraphs 2 and 1, respectively. This requirement is met, with a pre- and post-installation period of 1 year used in the statistical billing analysis.

Analysis Dataset Sample for Commercial Comparison Group - The Protocols require that the comparison group sample "be drawn using the same criteria for participants," as per Table 5, part C, paragraph 6. The nonparticipant sample frame was drawn using the participant population by business type and usage segment.

The analysis dataset meets the sample size requirement in Table 5, part C, paragraph 3. The calculated relative precision meets the precision requirement in Table 5, part C, paragraph 4. Exhibit 3-5 illustrates a relative precision of 6.3 percent at a 90 percent confidence interval, again, well below the 10 percent allowable.

To ensure compliance with comparison group Protocols, the telephone survey sample frame is drawn to meet the billing data requirements of Table 5, part D, paragraphs 3 and 4 of the

Protocols. All customers in the analysis dataset have billing data from January 1993 to September 1997, which ensures an adequate pre- and post-installation billing period for customers who installed applicable measures between 1994 and 1997.

3.2 ENGINEERING ANALYSIS

The comprehensive engineering approach outlined in this section is presented in the following sequence: the evaluation of the lighting and HVAC end uses. The general approach implemented was to reclassify each self-reported Measure or Practice into a predefined measure category that is offered under PG&E's Energy Efficiency Incentive programs. The advantage to mapping measures in this manner was that it allowed for the integration of PG&E's impact forecasting methods, as documented in Advice Filing documents submitted to the CPUC.

Once classified, either a calibrated engineering model and/or a simplified model approach was used to calculate the unadjusted engineering estimate of impact. In general, models supporting the lighting end-use are calibrated engineering (CE) models, making use of the Commercial Energy Efficiency (CEEI) Evaluation results (based on end-use metering and other model calibration techniques) to derive impacts. On the other hand, the model supporting the HVAC end use is typically a simplified engineering model, necessitating the use of a Protocol compliant LIRM model to adjust the engineering estimates.

3.2.1 Overview

The engineering analyses were carried out in a series of discrete steps, beginning with an analysis of program-related data that are available (tracking systems and hard copy surveys). Program data were then used in conjunction with existing PG&E forecasting impact methods to determine participant-specific estimates of indoor lighting and HVAC measures. Where forecasting methods were not available, alternative impact calculations were derived and applied on a site-specific basis. Hard copy surveys were obtained for identified adopters and used in conjunction with telephone survey records to determine impacts on a case by case basis.

Unlike other retrofit program analyses, the CEMS impact calculations required knowledge regarding the measures adopted, because many of the survey recommendations were never implemented. The source for this additional information were telephone survey data, which probed for customer Measure/Practice actions following each CEMS Program survey.

PG&E's need for detailed results at a fine level of segmentation (and the need for clarification regarding customer adoption rates) was ensured by over-sampling customers when completing the Protocol sampling requirements. While defensible impact methods (given adoption outside of a rebate program) were available from PG&E Advice Filing records for most Measures, little was known about the rate of adoption and the impact of Practices. To achieve the desired results, the evaluation team completed a total of 903 participant telephone surveys, 553 surveys in excess of the regulatory requirement of 350 completes.

Measure Impacts. As mentioned previously, the Measure-specific impacts for CEMS adopters are reasonably documented in PG&E's Advice Filings. Wherever possible, these forecasting methods were used to define the expected CEMS Program impacts, given adoption by a

particular customer. To make use of these Measure-specific forecasts, adopters were identified, and the extent of each impact (i.e., how many T8 lamps were retrofit) was determined. Evaluation methods yielded a quantifiable impact for every identified adopter, based in part on the CEMS survey recommendation. Where recommendations were not supported by existing PG&E impact methods, other strategies were implemented including: (1) the use of hard copy survey records, (2) derivation of custom impact methods, (3) impact assessment using alternate published methods, and (4) transfer of estimates from similar participants.

In addition to Measure impacts, the Measure implementation costs (full and incremental) were taken from PG&E Advice Filing records rather than relying upon evaluation resources to gather these costs. There is no reason to believe that Measure implementation costs or impacts for an CEMS participant would differ from the costs and impacts traditionally assigned to PG&E's Commercial Retrofit Programs.

Measure impact details were supplemented using the hard copy surveys, and where necessary, additional engineering data were collected during a follow-up telephone interview. The evaluation engineering staff reviewed both the hard copy survey and the telephone survey responses to assess if there was a need for additional Measure detail.

Practice Impacts. Practice impacts were implemented using a variety of available resources including: (1) the hard copy survey records, (2) derivation of a custom impact methodology, (3) impact assessments using alternate published methods, and (4) transfer of estimates from similar participants.

Measure/Practice Adoption. Information supporting adoption rates were gathered during each telephone interview. The temporal relationship between each recommendation and the subsequent adoptions, and future plans to adopt Measures/Practices were determined.

Demand and Energy Impacts. First-year gross impacts—kW, kWh and therms—were calculated for the commercial indoor lighting, HVAC, and the other end uses. Using the impact calculation methods described above, a gross energy, demand, and therm value was calculated for every adopter identified in the telephone survey sample. Refer to *Sections 3.2.2, 3.2.3* and *3.2.4* for additional details surrounding the derivation of impacts for the lighting, HVAC and other end uses, respectively.

Adoption rates were then applied by survey group to extrapolate results to the general CEMS participant population. Refer to *Section 3.5*, integrated analysis, for details surrounding the extrapolation of gross and net impact results to the full participant population.

CustomNet Pilot Program. Following initial interviews with the retail chain's energy management decision-making personnel, the engineering contribution to an assessment of program impacts was found to be unnecessary. The analyses relied, instead, upon a billing analysis of a selected group of participants and a control group of nonparticipants (comprised of similar department stores). Refer to *Section 3.6*, *CustomNet Analysis*, for the details surrounding the gross impact billing analyses conducted and the net savings attributed to this CEMS Program.

3.2.2 Lighting End-Use Models

By using intermediate results from the 1994 and 1995 CEEI studies that are based upon a Protocol compliant data collection and analysis plan, as discussed below, the 1996 CEMS study meets all Table C-11 analysis requirements.

Pacific Gas and Electric Co. (PG&E) has recently completed both a 1994 and 1995 paid-year evaluation of its Commercial sector Retrofit Programs, including the indoor lighting end use. The data collection and analysis approach employed in PG&E's lighting evaluations has incorporated three key data sources in a nested sample design: lighting logger data, on-site audit data, and telephone survey data. The application of this thorough approach in assessing lighting impacts, and the consistent results achieved in 1994 and 1995, has allowed PG&E to continue using these calibrated engineering results in both the 1996 CEEI Evaluation and this CEMS Evaluation.

A Retroactive Waiver was submitted to the CADMAC and approved on November 21, 1997. This Waiver ensures Protocol compliance for the engineering CE methods that were applied and the LIRM models performed, including the use of end use load shapes developed from the 1994 and 1995 Commercial Lighting studies. The 1994 and 1995 CEEI Evaluation studies were Protocol compliant, including the collection and use of data as per Tables 5 and C-4. The 1996 program CE lighting models incorporate previous evaluation results including full load hours of operation, coincident diversity factors, HVAC interactive effects, and burnout rates.

The general CE lighting model specifications are described next.

General Lighting Model Specifications

The general lighting model used to estimate impacts under the CEMS Programs was founded on the decomposition of lighting impacts into manageable engineering parameters (referred to as the "impact decomposition approach"). This approach was used to develop hourly impacts for each of three daytypes, Weekday, Saturday, and Sunday. The impact decomposition equation that was used to estimate UEIs is displayed below.

$$UEI_t = \left[\left(\Delta UOL * U * OF_t\right) * T\right] * \left[1 + HVAC\right]$$

Where,

ΔUOL = the technology level change in connected kW associated with a particular measure.

U = the number of measure units installed for a particular application.

OF_t = the operating factor which describes the percentage of full load used by a group of fixtures during a prescribed period of time, t.

T = the time interval for which an impact is estimated; for most measures, the OF term is the engineering parameter that changes significantly over time. Time intervals for

lighting estimates were single hours, segmented by hours "on" (open operating factor) and hours "off" (closed operating factor) schedules.[4]

$HVAC$ = the component of impact associated with both the net savings due to cooling (demand or energy) and the net increase due to heating (energy or therm).

Each of the parameters listed above are developed as follows:

ΔUOL - The change in Unit Operating Load (ΔUOL) is derived by adjusting the change in connected load with burned out lamp rates developed using on-site audit data.

U - The number of units (U) of each measure type installed is verified during the post-installation on-site audit.

OF_t - The operating factor (OF_t) consists of two parameters; the probability that a given facility is open for that hour (operating schedule), and the percentage of lights operating during the period (open-period and closed-period operating factors). Operating schedules were developed for each business type using logger data (from the 1994 and 1995 CEEI Evaluation), on-site audit data and telephone survey data. Open-period and closed-period operating factors (OOFs and COFs) were developed, by business type, using logger and on-site audit data.

HVAC - HVAC interactive effects (HVAC) were developed using weather and telephone survey data. An increase in heating loads and a decrease in cooling loads are caused by a reduction in internal heat gains when retrofit technologies are installed.

Next, previous engineering-based evaluation results, taken from PG&E's CEEI Programs, are presented for use in this CEMS analysis.

Summary of Existing Results

Both the 1995 and 1996 CEEI Evaluation reports clearly recommend that the evaluation results be used in support of future forecasting and evaluation efforts.

Specifically it is recommended that PG&E adopt the full load hours of operation, the coincident diversity factors (CDFs), the HVAC interactive effects, the lamp burnout rates and impact by costing period results that were developed as part of the 1994 and 1995 program year evaluation studies. It is these results in particular that were used in support of the 1996 CEMS Evaluation.

The Retroactive Waiver discussed above allows for the use of the full load hours of operation, the coincident diversity factors (CDFs), the HVAC interactive effects, the lamp burnout rates

[4]Although there are periods of time when lights are generally considered off, many lights are either accidentally or purposely left on during these periods. The effective hours of lighting operation captured during these off periods were applied using the operating factor term (the probability that lights operate during a particular time interval).

and impact by costing period results that were developed as part of the 1994 and 1995 program year evaluation studies, for the 1996 CEEI Evaluation for lighting technologies.

Full Load Hours of Operation - Full load hours account only for lighting system operation, not total impact, which isolates the lighting technology impacts from the HVAC program impact contributions. Exhibit 3-6 presents the 1994 and 1995 M&E full load hour results for the indoor lighting end-use element. The 1996 evaluation estimates are the mean adjusted full load hours (an average of 1994 and 1995 M&E results).

Exhibit 3-6
Equivalent Full Load Hours by Business Type
for Commercial Lighting Technologies

	Indoor Lighting Annual Hours of Operation			
	Evaluation Estimates			Program Design Estimate
Business Type	1994	1995	Mean	1995
Office	3,900	4,100	**4,000**	**3,400**
Retail	4,200	4,700	**4,450**	**4,700**
College/Univ	3,700	4,100	**3,900**	**3,500**
School	2,000	2,300	**2,150**	**2,100**
Grocery	6,800	4,800	**5,800**	**7,000**
Restaurant	4,800	4,400	**4,600**	**4,800**
Health Care	4,900	3,900	**4,400**	**4,000**
Hotel/Motel	5,400	5,600	**5,500**	**4,000**
Warehouse	3,100	4,000	**3,550**	**4,000**
Personal Service	NA†	4,100	**4,100**	**4,000**
Community Service	NA†	2,700	**2,700**	**4,000**
Misc.	4,800	4,200	**4,500**	**4,000**

† The Personal Service and Community Service business types were not defined in the 1994 M&E study.

Coincident Diversity Factors (CDFs) - Exhibit 3-7 presents the 1994 and 1995 M&E coincident diversity factor results for the indoor lighting end-use element. The 1996 evaluation estimates are the mean adjusted CDF (an average of 1994 and 1995 M&E results).

Exhibit 3-7
Peak Hour Coincident Diversity Factors by Business Type
for Commercial Lighting Technologies

Business Type	Indoor Lighting Summer On-Peak CDF			
	Evaluation Estimates			Program Design Estimate
	1994	1995	Mean	1995
Office	0.78	0.85	**0.81**	**0.67**
Retail	0.90	0.87	**0.88**	**0.67**
College/Univ	0.61	0.76	**0.68**	**0.67**
School	0.46	0.38	**0.42**	**0.67**
Grocery	0.91	0.71	**0.81**	**0.67**
Restaurant	0.70	0.66	**0.68**	**0.67**
Health Care	0.78	0.70	**0.74**	**0.67**
Hotel/Motel	0.64	0.70	**0.67**	**0.67**
Warehouse	0.78	0.90	**0.84**	**0.67**
Personal Service	NA†	0.79	**0.79**	**0.67**
Community Service	NA†	0.48	**0.48**	**0.67**
Misc.	0.71	0.81	**0.76**	**0.67**

† The Personal Service and Community Service business types were not defined in the 1994 M&E study.

HVAC Interactive Effects - Exhibit 3-8 presents commercial sector mean HVAC energy and summer on-peak demand adjustment factors by business type that describe the ratio of total fixture and HVAC impact to fixture-only impact. These adjustments are applied by business type to estimates of technology-only lighting impacts, yielding estimates of total impact that include the HVAC component. The 1996 evaluation estimates use the mean HVAC adjustments (an average of 1994 and 1995 M&E results).

Exhibit 3-8
Commercial Sector HVAC Adjustments by Business Type
for Commercial Lighting Technologies

Business Type	Interactive HVAC Energy Adjustments (kWh)		
	1994	1995	Mean
Office	1.14	1.19	**1.17**
Retail	1.08	1.13	**1.11**
College/Univ	1.19	1.10	**1.15**
School	1.12	1.18	**1.15**
Grocery	1.12	1.14	**1.13**
Restaurant	1.13	1.16	**1.15**
Health Care	1.12	1.24	**1.18**
Hotel/Motel	1.16	1.11	**1.14**
Warehouse	1.05	1.06	**1.06**
Personal Service	NA†	1.06	**1.06**
Community Service	NA†	1.23	**1.23**
Misc.	1.10	1.06	**1.08**

Business Type	Interactive HVAC Demand Adjustments (kW)		
	1994	1995	Mean
Office	1.24	1.26	**1.25**
Retail	1.16	1.22	**1.19**
College/Univ	1.32	1.11	**1.22**
School	1.22	1.23	**1.23**
Grocery	1.23	1.26	**1.25**
Restaurant	1.26	1.26	**1.26**
Health Care	1.22	1.30	**1.26**
Hotel/Motel	1.07	1.20	**1.14**
Warehouse	1.10	1.07	**1.09**
Personal Service	NA†	1.07	**1.07**
Community Service	NA†	1.31	**1.31**
Misc.	1.16	1.09	**1.13**

Exhibit 3-8 (cont'd)
Commercial Sector HVAC Adjustments by Business Type
for Commercial Lighting Technologies

Business Type	Interactive HVAC Therm Adjustments (therm/GWH)*		
	1994	1995	Mean
Office	NA†	-0.39	**-0.39**
Retail	NA†	-0.26	**-0.26**
College/Univ	NA†	-0.11	**-0.11**
School	NA†	-0.43	**-0.43**
Grocery	NA†	-0.09	**-0.09**
Restaurant	NA†	-0.46	**-0.46**
Health Care	NA†	-0.19	**-0.19**
Hotel/Motel	NA†	-0.05	**-0.05**
Warehouse	NA†	-0.06	**-0.06**
Personal Service	NA†	-0.07	**-0.07**
Community Service	NA†	-0.35	**-0.35**
Misc.	NA†	-0.08	**-0.08**

* Therm impacts represent the impact in annual therm usage per gigawatt hour of technology only impact in annual energy use (therm/GWh).

† The Personal Service and Community Service business types were not defined in the 1994 M&E study.

Burned-Out Lamp Rates - Exhibit 3-9 presents commercial sector mean burned-out lamp rates by pre- vs. post-retrofit technology type for certain key technology group segments. These results were applied to the 1996 pre- and post-retrofit connected load assumptions to account for the higher probability of lamp burnout in the pre-retrofit technologies. The 1996 evaluation estimates use the mean burned-out lamp adjustments (an average of 1994 and 1995 M&E results).

Exhibit 3-9
Commercial Sector Burned-Out Lamp Rates
for Commercial Lighting Technologies

Pre- or Post-Retrofit	Technology Group	Observed Burned Out Lamp Rate		
		1994	1995	Mean
Pre-Retrofit	Incandescent	2.16%	2.10%	2.13%
	Standard Fluorescent	3.05%	1.98%	2.52%
Post-Retrofit	Compact Fluorescent	0.37%	1.39%	0.88%
	Standard Fluorescent	0.26%	0.51%	0.39%

Savings by Costing Period - Exhibit 3-10 presents commercial sector kW Adjustment Factors and kWh Adjustment Factors by PG&E costing period, based on the 1994 and 1995 evaluation results. These results were applied to the 1996 impacts to account for the required allocation of impacts by costing period. The 1996 evaluation estimates use the mean Adjustment Factors (an average of 1994 and 1995 M&E results).

Exhibit 3-10
Commercial Sector Impacts by Costing Period
for Commercial Lighting Technologies

PG&E Cost Period	Time-of-Use Impact Distribution					
	1994 kW Adjustment Factor	1995 kW Adjustment Factor	Mean kW Adjustment Factor	1994 kWh Adjustment Factor	1995 kWh Adjustment Factor	Mean kWh Adjustment Factor
Summer On-Peak: May 1 to Oct. 31 12:00 PM - 6:00 PM Weekdays	1.00	1.00	1.00	0.16	0.14	0.15
Summer Partial Peak: May 1 to Oct. 31 8:30 AM - 12:00 PM & 6:00 PM - 9:30 PM Weekdays	1.01	1.06	1.03	0.14	0.14	0.14
Summer Off-Peak: May to Oct. 31 9:30 PM - 8:30 AM	0.74	0.86	0.80	0.24	0.22	0.23
Winter Partial Peak: Nov. 1 to April 31 8:30 AM - 9:30 PM Weekdays	0.77	0.85	0.81	0.26	0.28	0.27
Winter Off-Peak: Nov. 1 to April 31 9:30 PM - 8:30 AM Other	0.66	0.88	0.77	0.20	0.22	0.21

Selected Per-Unit Lighting End-Use Results

A summary of per-unit impact and cost results are presented in Exhibit 3-11 for selected Measures/Practices that were adopted by CEMS participants. Per-Unit estimates, including those depicted here, were used in conjunction with the existing CEEI models just presented, to determine individual customer kW, kWh and therm impacts for participants that reported Measure/Practice adoption. The impacts are technology-only kW and kWh estimates, before the application of any HVAC adjustment. The incremental and total installation cost figures were taken from PG&E Advice Filing records.

Exhibit 3-11
Per-Unit Impacts and Costs for the Lighting End-Use

PG&E L-Code	Measure Description	Units	Adjusted Per-Unit NC Impact (Watts)	Incremental Cost per Unit ($)	Total Cost per Unit ($)	Per-Unit Annual Energy Impact (kWh)	Per-Unit Coincident Demand Savings (kW)
L14	2 Lamp Electronic Ballasts	Ballasts	17.1	$30.00	$30.00	-	-
L174	Compact Fluorescent 14-25 Watts	Lamps	52.6	$11.50	$21.00	-	-
L19	4' Fluorescent Delamp	Lamps Removed	43.4	$35.00	$35.00	-	-
L21	Replace Lamps and Ballasts 2' T8	Lamps	9.9	$20.00	$20.00	-	-
L22	Replace Lamps and Ballasts 3' T8	Lamps	12.2	$20.00	$20.00	-	-
L23	Replace Lamps and Ballasts 4' T8	Lamps	10.9	$14.68	$14.68	-	-
L24	Replace Lamps and Ballasts 8' T8	Lamps	20.8	$19.50	$19.50	-	-
L26	Interior HID 101-175 Watts	Fixtures	240	$150.00	$150.00	-	-
L27	Interior HID 176-250 Watts	Fixtures	528	$160.00	$160.00	-	-
L28	Exterior HID 0-100 Watts	Fixtures	113	$95.00	$95.00	-	-
L29	Exterior HID 101-175 Watts	Fixtures	240	$150.00	$150.00	-	-
L31	Time Clocks	Timeclocks	NA	$30.75	$30.75	439	0.00
L35	Bypass Timers	Timers	NA			412	0.00
L36	Photocells	Photocells	NA	$10.00	$10.00	99	0.00
L5	Exit Sign Retrofit Incandescent to CF	Fixtures	29	-$43.00	$30.00	254	0.03
L6	Exit Sign Retrofit Incandescent to LED	Fixtures	36	-$49.00	$75.00	315	0.04
L60	Halogen <50 Watts	Lamps	30	$1.50	$7.00	-	-
L61	Halogen >50 Watts	Lamps	50	$2.00	$7.50	-	-
L64	Compact Fluorescent 5-13 Watts	Lamps	43.9	$14.50	$20.00	-	-
L7	Incandescent to T12 Conversion	Fixtures	206.17	-$67.00	$70.00	-	-
L77	High Output T8 Conversion	Fixtures	45	$67.00	$67.00	-	-
L79	Interior HID 36-70 Watts	Fixtures	112	$70.00	$70.00	-	-
L8	Incandescent to T8 Conversion	Fixtures	235.8	-$67.00	$70.00	-	-
L80	Interior HID 71-100 Watts	Fixtures	155	$80.00	$80.00	-	-
L81	Interior HID 251-400 Watts	Fixtures	620	$230.00	$230.00	-	-
L83	Ceiling Mounted Occupancy Sensors	Sensors	NA	$80.00	$80.00	824	0.00

3.2.3 HVAC End-Use Models

The HVAC engineering analysis consisted of simplified models, based largely upon PG&E's Advice Filings, that were applied to each customer self-reported adoption and other data taken from the individual hard copy survey on a customer by customer basis.

Selected Per-Unit HVAC End-Use Results

A summary of per-unit impact and cost results are presented in Exhibit 3-12 for selected Measures/Practices that were adopted by CEMS participants. Per-Unit estimates were used to determine individual customer kW, kWh and therm impacts for participants that reported Measure/Practice adoption. The incremental and total installation cost figures were taken from PG&E Advice Filing records.

Exhibit 3-12
Per-Unit Impacts and Costs for the HVAC End-Use

PG&E S-Code	Measure/Practice Description	Units	Per-Unit Annual Energy Impact (kWh)	Per-Unit Annual Therm Impact (therms)	Per-Unit Coincident Demand Impact (kW)	Per-Unit Incremental Cost ($)	Total Per-Unit Cost ($)	Source of Per-Unit Estimates
S22	Adjustable Speed Drive	hp	753	0	0.0000	$202.0	$202.0	1996 Advice Filing
S96	Cooling Tower Replacement	sqft x 1000	433	0	0.1600	$130.0	$130.0	1997 Advice Filing
S14	Evaporative Condenser	ton delta EER	82	0	0.0510	$40.0	$40.0	1996 Advice Filing
S21	Evaporative Cooler	tons cooling	2,911	0	1.6600	$127.0	$127.0	1996 Advice Filing
NA	HVAC M&O	AC unit	2,071	0	0.3000	$0.0	$0.0	Xenergy 1992 MEC Savings Calculations
S17	HVAC Timeclock	timeclocks	4,171	1,866	0.0000	$113.0	$267.5	1996 Advice Filing
S18	Programmable Thermostat	thermostats	4,093	1,095	0.0000	$205.0	$300.0	1996 Advice Filing
S6	PTAC	ton delta EER	162	0	0.1180	$65.0	NA	1996 Advice Filing
S160	Air-Source AC Replacement	ton delta EER	122	0	0.0750	$50.0	NA	1996 Advice Filing
S20	Window Film	sqft film	14	0	0.0064	$1.8	$1.8	1996 Advice Filing

3.2.4 Other End-Use Models

The Other end-use engineering analysis consisted of simplified engineering models, based largely upon PG&E's Advice Filings, that were applied to each customer based on their self-reported adoption and other data taken from the individual hard copy survey.

Selected Per-Unit Other End-Use Results

A summary of per-unit impact and cost results are presented in Exhibit 3-13 for selected Measures/Practices that were adopted by CEMS participants. Per-Unit estimates were used to determine individual customer kW, kWh and therm impacts for participants that reported Measure/Practice adoption. The incremental and total installation cost figures were taken from PG&E Advice Filing records.

Exhibit 3-13
Per-Unit Impacts and Costs for Other End Uses

PG&E Code	Measure/Practice Description	Units	Per-Unit Annual Energy Impact (kWh)	Per-Unit Annual Therm Impact (therms)	Per-Unit Coincident Demand Impact (kW)	Per-Unit Incremental Cost ($)	Per-Unit Total Cost ($)	Source of Per-Unit Estimates
NA	Replace Electric Hot Water with Gas	water heaters	9,400	-159	1.0731	$400.0	$400.0	EMS Survey
M20	Motor Retrofit	hp	150	0	0.0234	$6.0	$139.0	1996 Advice Filing
R50	Refrigeration Door Gaskets	2 linear ft of door	2,091	0	0.2390	$80.0	$80.0	1995 EEI Evaluation, and 1996 Advice Filing
NA	Refrigeration M&O	6 ft med temp display	69	0	0.0100	NA	NA	Xenergy 1992 MEC Savings Calculations
R5	Refrigeration Case Doors	linear ft display	403	0	0.0460	$100.0	$100.0	1996 Advice Filing
NA	Repair Leaky Faucet	faucets repaired	0	23	0.0000	NA	NA	Business Edge Report
R15	Replaced Condenser	ton	1,185	0	0.1550	$105.0	NA	1996 Advice Filing
NA	Replace Refrigerator	refrigerators	126	0	0.0000	$25.0	NA	1996 Advice Filing (Residential)
R2	Strip Curtains for Walk-in	sqft	386	0	0.0441	$3.1	NA	1995 EEI Evaluation, and 1996 Advice Filing
NA	Water Heater Blanket - Gas	blankets	0	30	0.0000	$20.0	$20.0	EMS Survey
NA	Water Heater Blanket - Electric	blankets	2,011	0	0.2296	$20.0	$20.0	EMS Survey
NA	Water heater timer	timers	1,830	0	0.0000	NA	NA	EMS Survey

3.3 STATISTICAL ANALYSIS

Multivariate time-series, cross sectional SAE regression models were applied to meet the requirements of a Load Impact Regression Model (LIRM), as defined in the Protocols, consistent with best industry practice.

3.3.1 Overview

The key objective of the billing analysis is to determine the first-year program energy impacts. A statistical analysis is employed to model the differences of customers' energy usage between pre- and post-installation periods using actual customer billing data. The model is specified using the billing data and independent variables gathered in the telephone survey that explain changes in customers' energy usage, including the engineering estimates of energy impact due to program participation. This statistically adjusted engineering (SAE) analysis is consistent with the requirements of the LIRM defined in the CPUC's Protocols.

The results of the billing regression analysis are estimated as ratios, termed "SAE coefficients," of realized impacts to the engineering impact estimates. These realized impacts represent the fraction of engineering estimates actually "observed" or "detected" in the statistical analysis of the billing data. The SAE coefficients estimated in the billing analysis are relative to the results of the evaluation-based engineering estimates, not the PG&E Program ex ante estimates. This distinction is important, as the SAE coefficients are then used to estimate gross ex post program impacts, which in turn are used to calculate realization rates relative to the ex ante estimates.

The remainder of this section presents the analysis findings for CEMS gross billing analysis.

3.3.2 Data Sources for Billing Regression Analysis

The billing regression analysis for the 1996 CEMS Evaluation uses data from five primary data sources: PG&E's Marketing Decision Support System (MDSS) tracking database, the billing database, the telephone survey data, the engineering estimates of changes in usage between the pre- and post-installation periods, and weather data from PG&E's load research weather sites. A summary of the data elements used in the regression analysis are presented below.

Program Participant Tracking System

The participant tracking system for the On-Site, Telephone, and Business Edge Programs are maintained as part of the MDSS. It contains customer contact information, program survey codes which link the MDSS record to a paper application form, and technical information about recommended measures and/or practices. There is, unfortunately, no specific information regarding the recommended quantities to install, or quantifiable estimates of energy, demand, and therm savings. This data had to be collected during the telephone survey of the CEMS participant. The MDSS database is linked to the billing database and other program databases through PG&E's customer specific control number.

PG&E Billing Data

The PG&E billing data used in this year's evaluation study were obtained from two different data requests to PG&E's Load Data Services department. The original nonresidential billing dataset contained prorated monthly energy usage for all nonresidential accounts in PG&E's service territory, and was used in the sample design described in *Section 3.1*. The billing histories contained in this database run from January 1995 through April 1997.

A second billing dataset was later obtained from PG&E Load Data Services for use in the SAE analysis. This billing dataset contains bill readings that run from January 1993 through December 1994, and then from January 1997 to September 1997. The resulting combined dataset represents the billing series of PG&E pro-rated monthly usage data for each calendar month from January 1993 to September 1997.

Weather Data

The hourly dry bulb temperature collected for 25 PG&E load research weather sites was used in the billing regression analysis to calculate total monthly cooling degree days for each month in the analysis period. For each customer in the analysis dataset, the appropriate weather site was

linked to that customer by using the PG&E-defined weather site to PG&E local office mapping (embedded in the account code for each customer).

Telephone Survey Data

All available telephone surveys (except for the participants that did not adopt any recommended measures) collected as part of the evaluation for the CEMS Program were used as inputs to the billing regression analysis. Two telephone survey samples totaling 816 sample points (354 participant adopters and 462 nonparticipants) were utilized for the CEMS Evaluation. The data collected in the telephone survey supplies information on energy-related changes at each site for the billing period covered by the billing regression analysis. For a detailed discussion of the telephone survey and the final sample disposition, see *Survey Appendices*. A discussion of the sample design can be found in *Section 3.1.*

Engineering Estimates

Engineering estimates of savings were estimated for each of the 354 participant adopters. Separate estimates of energy savings were calculated for every measure and practice adopted. The Engineering Analysis (*Section 3.2*) discusses the calculation of the savings estimates used in the billing analysis in greater detail.

3.3.3 Data Aggregation and Analysis Dataset Development

Because many measures and practices adopted under the CEMS Program affected multiple customer accounts within a unique site, the billing analysis had to be performed at the site level. Therefore, all account level data (including billing usage) had to be aggregated up to the QC defined site identifier. In PG&E's billing data, an array of variables are defined to track a customer. These include the following:

- Control number, which is the finest level of aggregation, and is usually unique to a customer's meter.

- Premise number, which is used to define a unique site, but can sometimes contain multiple buildings. The premise number may map to many control numbers, but a control number will always map to a unique premise number.

- Corporation number, which is used to define a unique corporation, which can map to many premise numbers. A premise number maps to a unique corporation number.

Of the three, the premise number serves as the best indicator of a unique site. However, there are some premise numbers that contain multiple sites. To address this issue, the customer's service address was also used to help identify a unique site. If there was more than one service address for a premise number, it was broken out into multiple sites. Therefore, a unique site was defined as all of the control numbers within a unique combination of service address,[5]

[5] Because of potential data entry errors in the billing system, or inconsistencies in tracking service addresses in the billing system, only the first eight characters of the service address were used. Generally, this would contain the

premise number, and corporation number. A unique Site ID was created based on this combination of address, premise, and corporation to serve as the key variable for linking data.

The telephone surveys were sampled at the Site ID level, and all questions were phrased to ask about all of the control numbers associated with the Site ID. The engineering estimates of change were also aggregated to the Site ID level.

As discussed above, a total of 354 participant adopters and 462 nonparticipants comprised the billing analysis database. The measures and practices installed among the 354 adopters were segmented by major end use: lighting, HVAC, and other. There were 193 sites that adopted lighting measures and/or practices, 124 that adopted HVAC, and 49 that adopted other.

3.3.4 Analysis Periods

When the billing regression analysis is used to model the change of consumption attributable to the program measures, the first step is to isolate the pre- and post-installation periods for each customer in the analysis database so that the impact of these measures can be verified.

Billing data were available from January 1993 through September 1997. To maximize the number of post installation months in the regression model, a post period of October 1996 through September 1997 was used. Because surveyed participants and nonparticipants were asked about changes that have occurred at their facility since January 1995, a pre-period of October 1993 through September 1994 was used.

3.3.5 Data Censoring

Three types of data censoring was applied to the billing analysis sample frame to remove customers with invalid data.

- The most common removal was customers with invalid billing data. Each customer must "pass" two criteria to be included in the billing analysis sample frame, as discussed below.

- Extremely large customers were removed from the sample frame *a priori*. There are several important factors that have influenced this decision, as discussed below.

- In instances where the engineering analysis indicated that the measure or practice adopted had no associated savings, or where the adopted measure or practice caused an increase in usage, the customer was removed from the sample frame.

Invalid Usage

For customers to be included in the final billing analysis, customers had to have billing data that met two criteria. The first was that the pre- and post-installation annual bills had to have been comprised of at least six non-zero monthly bills. If there were seven or more monthly bills

numeric portion of the address and the first few characters of the street name. For the large majority of records in the billing system, premise number and service address were unique.

with zero energy, the customer was removed from the analysis. If there were between one and six monthly bills with zero energy, the remaining months were prorated to an annual estimate.

The second criteria held that the pre-installation annual bill could not be more than twice or less than one half the post-installation bill. If this occurred, the customer was removed from the SAE analysis.

Exhibit 3-14 presents the number of participants and nonparticipants that were deleted for each of the above criteria. Only 27 participants and 20 nonparticipants were deleted. Of the 47 customers deleted, 39 were deleted due to the zero bill criteria.

Exhibit 3-14
Distribution of Customers Removed From Billing Analysis
By Data Censoring Criteria
Customers with Invalid Billing Data

Participant or Nonparticipant	Zero Monthly Bills > 6	Usage Tripled	Number Removed From Analysis
NP	No	Yes	5
NP	Yes	No	7
NP	Yes	Yes	8
TOTAL			20
P	No	Yes	3
P	Yes	No	2
P	Yes	Yes	22
TOTAL			27

Large Customers

Customers whose annual pre-installation energy consumption exceeded three million kWh were excluded from the billing analysis. A total of 8 participants and 10 nonparticipants were dropped for this reason. This decision was made *a priori* to collecting the survey data, as is documented in the Evaluation Research Plan; and is based upon the results of the previous two CEEI Lighting Evaluations, both of which were unsuccessful in obtaining reliable results when including customers with usage above this level. This is also consistent with the recommendations made by the Verification Report of PG&E's 1995 Commercial Lighting Evaluation, which states "program effects can be difficult to detect for large customers," and recommended censoring large customers for the final billing analyses.

No Savings

The engineering analysis indicated that some measures and practices adopted had no associated savings. Customers with measure/practices that had no associated savings were not included in the final billing model. However, customers with multiple adoptions were

included as long as at least one adoption had a savings estimate. A total of 65 customers were removed for this reason alone. In addition, one other customer was identified as having an adopted measure or practice that caused an increase in usage, which was not included in the analysis.

Exhibit 3-15 below summarizes all of the data censoring discussed above. Overall, a total of 30 nonparticipants and 110 participants were removed from the billing analysis, resulting in a sample of 234 participants and 432 nonparticipants. Of the remaining 234 participant sites, 138 had lighting adoptions, 102 had HVAC adoptions, and 43 had other adoptions.

Exhibit 3-15
Distribution of Customers Removed from Billing Analysis
By Data Censoring Criteria

Participant or Nonparticipant	Zero Monthly Bills > 6	Usage Tripled or Cut in Third?	Large Customer?	Measure Increases Usage	No Impact Estimated	Number of Sites Removed
NP	No	No	Yes	No	No	10
NP	No	Yes	No	No	No	5
NP	Yes	No	No	No	No	7
NP	Yes	Yes	No	No	No	8
TOTAL						30
P	No	No	No	No	Yes	65
P	No	No	No	Yes	No	1
P	No	No	Yes	No	No	7
P	No	No	Yes	No	Yes	1
P	No	Yes	No	No	No	3
P	No	Yes	No	No	Yes	1
P	Yes	No	No	No	No	2
P	Yes	No	No	No	Yes	3
P	Yes	Yes	No	No	No	22
P	Yes	Yes	No	No	Yes	5
TOTAL						110

3.3.6 Model Specification

The billing regression analysis for the CEMS Evaluation used two different multivariate regression models under an integrated framework of providing unbiased and robust model estimates in the commercial sector. The key feature of the approach is that it employs a simultaneous equation approach to account for both the year-to-year and cross-sectional variation in a manner that consistently and efficiently isolates program impacts.

A baseline model is initially estimated using only the comparison (nonparticipant) group sample. This model estimates a relationship that is then used to forecast what the post-installation-year energy consumption for participants (as a function of pre-installation year usage) would have been in the absence of the program. In this way, baseline energy usage is

forecasted for participants by assuming that their usage will change, on average, in the same way that usage did for the comparison group.

The resulting SAE coefficients from the first baseline model are used to adjust the engineering estimates of expected annual energy impacts for the entire participant population. These impacts are presented in *Section 4* and are used to compute program realization rates.

Baseline Model

The baseline model explains post-installation energy usage as a function of the pre-installation energy usage, weather changes, and customer self-reports of factors that could affect energy usage. In order to isolate the program impact from the energy usage changes, only the comparison group is used to fit this model. The baseline model has the following functional form:

$$kWh_{post,i} = \sum_j (\beta_j kWh_{pre,i}) + \gamma(\Delta CDD_i) * kWh_{pre,i} + \sum_k \eta_k Chg_{i,k} + \varepsilon$$

Where,

$kWh_{post,i}$ and $kWh_{pre,i}$ are customer i's annualized energy usage for the post- and pre-installation periods, respectively;

ΔCDD_i are the annual change of cooling degree days (base 62°F) between the post-installation year and pre-installation year;

$Chg_{i,k}$ are the customer self-reported change variables from the survey data, including adding, replacing, or removing equipment associated with major end uses, and changes in square footage and number of employees;

β, γ and η are the estimated slopes on their respective independent variables. Separate slopes on pre-usage are estimated by business type; and,

ε is the random error term of the model.

For each customer in the analysis dataset, a post-installation predicted usage value is calculated using the parameters of the baseline models estimated for the 1994 to 1997 analysis period. They both take the same functional form with different segment-level intercept series and slopes (β and γ):

$$\hat{kWh}_{post,i} = F_{pre}(kWh_{pre}, \Delta CDD) = \sum_j (\beta_j kWh_{pre,i}) + \gamma(\Delta CDD_i) * kWh_{pre,i}$$

Exhibit 3-16 summarizes the final baseline model results that were estimated using 432 nonparticipant customers, as discussed in the *Data Censoring* section. Exhibit 3-16 summarizes the independent variables used in the baseline model, together with the t-statistics and the sample sizes available for each parameter estimate used to predict the post-period usage. The final functional relation is estimated as follows:

Baseline Model (1994 to 1997):

$$\begin{aligned}\hat{kWh}_{97,i} = {} & 1.06 * SM\_OFF4 + 1.16 * OTH\_OFF4 + 1.10 * SM\_RET4 + 1.00 * OTH\_RET4 \\ & + 1.26 * SCHOOL4 + 1.13 * SM\_GRC4 + 1.18 * OTH\_GRC4 + 0.97 * RESTRNT4 \\ & + 1.15 * HOSP4 + 1.10 * HOTMOT4 + 1.26 * WHRSE4 + 1.28 * PERSVC4 \\ & + 1.09 * SM\_COM4 + 1.15 * OTH\_COM4 + 1.35 * MISC4 \\ & - 0.000137 * CDD2_{97-94,i} * kWh_{94,i} + 0.000046872 * CDD3_{97-94,i} * kWh_{94,i} \\ & - 0.000337 * CDD4_{97-94,i} * kWh_{94,i} - 0.000339 * CDD11_{97-94,i} * kWh_{94,i} \\ & - 0.000105 * CDD12_{97-94,i} * kWh_{94,i} + 0.000393 * CDD13_{97-94,i} * kWh_{94,i} \\ & - 0.000661 * CDD16_{97-94,i} * kWh_{94,i}\end{aligned}$$

Participant SAE Model

Using the predicted post-installation usage values estimated in the baseline model, a simultaneous equation model is specified to estimate the SAE coefficients on energy impact. The SAE simultaneous system can be described as follows:

$$kWh_{97,i} - \hat{kWh}_{97,i} = kWh_{97,i} - F_{94}(kWh_{94}, \Delta CDD) = \sum_m \beta_m' Eng_m + \sum_k \eta_k' Chg_{i,k} + \mu_i$$

The difference between predicted and actual usage in 1997 was used as the dependent variable in a SAE model. As discussed above, the predicted usage is estimated using only the comparison group to forecast the 1997 usage as a function of 1994 usage and change of cooling degree days from 1994 to 1997. This usage prediction presents what would have happened in the absence of *any* changes made at the facility.

Exhibit 3-16
Billing Regression Analysis Final Baseline Model Outputs

Parameter Descriptions	Analysis Variable Name	Units	Parameter Estimate	t-Statistic	Sample Size
Pre-Usage					
Small Office	SM_OFF4	kWh	1.058357	3.594	50
Large Office	OTH_OFF4	kWh	1.150235	36.939	57
Small Retail	SM_RET4	kWh	1.105076	2.544	41
Large Retail	OTH_RET4	kWh	1.005338	20.482	27
Schools	SCHOOL4	kWh	1.257642	17.725	31
Small Grocery	SM_GRC4	kWh	1.133993	2.997	6
Large Grocery	OTH_GRC4	kWh	1.177617	34.488	15
Restaurant	RESTRNT4	kWh	0.973474	11.342	26
Hospital	HOSP4	kWh	1.151166	41.495	23
Hotel/Motel	HOTMOT4	kWh	1.103302	13.468	15
Warehouse	WHRSE4	kWh	1.255673	24.654	34
Personal Service	PERSVC4	kWh	1.284108	22.688	25
Small Comm. Service	SM_COM4	kWh	1.090614	2.503	35
Large Comm. Servcie	OTH_COM4	kWh	1.150272	24.811	20
Miscellaneous	MISC4	kWh	1.347934	57.229	30
Weather Changes					
Change in CDD CliZone 2	CDD2_74	CDD*kWh	-0.000137	-2.195	51
Change in CDD CliZone 3	CDD3_74	CDD*kWh	0.000046872	0.484	114
Change in CDD CliZone 4	CDD4_74	CDD*kWh	-0.000337	-5.518	38
Change in CDD CliZone 11	CDD11_74	CDD*kWh	-0.000339	-0.732	53
Change in CDD CliZone 12	CDD12_74	CDD*kWh	-0.000105	-1.132	75
Change in CDD CliZone 13	CDD13_74	CDD*kWh	0.000393	1.498	57
Change in CDD CliZone 16	CDD16_74	CDD*kWh	-0.000661	-0.121	4
Other Site Changes					
Lighting Changes	LGTCHG4	kWh	0.125067	3.858	41
HVAC Changes	HVCCHG4	kWh	-0.206500	-9.168	53
Other Equipment Changes	OTHCHG4	kWh	0.106509	1.104	19
Square Foot Changes	SQFT_CHG	sqft	-0.833931	-1.396	25
EMS Change	EMS_CHG4	kWh	-0.104606	-3.816	34
Employee Changes	EMP_CHG	# Emp*kWh	186.071444	1.741	70

3.3.7 Billing Regression Analysis Results

The coefficients of the engineering impact, termed the SAE coefficients, are then used to calculate the ex post gross energy impacts. Exhibit 3-17 summarizes the final SAE model results that were estimated using 234 participants, as discussed in the *Data Censoring* section. The exhibit illustrates the independent variables used in the SAE model, together with the t-statistics and the sample sizes available for each parameter estimate.

Exhibit 3-17
Gross Billing Regression Analysis Final Model Outputs

Parameter Descriptions	Analysis Variable Name	Units	Parameter Estimate	t-Statistic	Sample Size
SAE Coefficients					
Lighting End Use	LGTPKWH	kWh	-1.153987	-6.649	138
HVAC End Use	HVPKWH	kWh	-0.808047	-3.603	102
Other End Uses	OTHPKWH	kWh	-1.311986	-1.326	43
Change Variables					
Lighting Changes	LGTCHG4	kWh	-0.075893	-1.614	16
HVAC Changes	HVCCHG4	kWh	-0.071726	-3.376	16
Other Equipment Changes	OTHCHG4	kWh	-0.152398	-2.427	22
Square Foot Changes	SQFT_CHG	sqft	2.397112	1.501	18
EMS Change	EMS_CHG4	kWh	0.141698	2.723	24
Employee Changes	EMP_CHG	# Emp*kWh	3259.598436	4.472	50

The dependent variable is the difference between the actual and predicted 1997 usage using the 1994 baseline model.

SAE coefficients are calculated for 3 different end uses (Lighting, HVAC, and Other). Measures and practices were combined into a single regression variable because a number of sites adopted both measures and practices (i.e. there was a high degree of correlation). Primarily those end uses that have broad participation and relatively high expected impacts were supported by separate SAE coefficients.

Both the lighting and HVAC SAE coefficients are significant at the 99 percent confidence level. The other end use SAE coefficient is significant at the 80 percent confidence level. The overall SAE coefficient, weighted by the unadjusted engineering estimate is 1.00.

Of the remaining parameter estimates, the lighting change, HVAC change and other change variable are all significant at the 90 percent confidence level, and indicate a substantial energy savings of seven to fifteen percent of pre usage. The employee change variable is significant at the 99 percent confidence level and indicates an increase in energy of 3,260 kWh per additional person. The square footage change variable is significant at the 85 percent confidence level and indicates an increase in energy of 2.4 kWh per additional square foot. Finally, the CEMS change variable is significant at the 99% confidence interval, but indicates an unexpected increase in energy usage of 14 percent of pre usage. This is explained by the high correlation with other changes (56 %).

Relative Precision Calculation

Relative precision at 90 percent and 80 percent confidence levels for the adjusted gross energy impact estimates are calculated for each of the SAE analysis segments. As mentioned above, there are a total of three end-use segments that were explicitly modeled, and the relative precision estimates based upon the model output are presented in Exhibit 3-18 below. In order

to calculate the total program level adjusted gross impact and relative precision, the segment-level results were weighted by their unadjusted engineering energy impact estimates in the following equations.

$$\text{Total Adjusted Energy Impact} = \sum_i \beta_i Eng_i$$

Where β_i and Eng_i are the SAE coefficients and unadjusted engineering impact estimates for segment i, respectively. The program level standard error can be estimated as:[6]

$$\text{StdErr} = \sqrt{\sum_i (CV_i * \beta_i * Eng_i)^2}$$

Where,

$CV_i = \frac{std(\beta_i)}{\beta_i}$ is the coefficient of variation in segment i, estimated in the billing regression model.

Finally, the relative precision at 90 percent and 80 percent confidence levels were calculated as:

$$RP = \frac{t * StdErr}{\text{Total Adj. Energy Impact}}$$

Where,

t equals 1.645 and 1.282 for the 90 percent and 80 percent confidence levels, respectively.

Exhibit 3-18 presents the relative precision calculations.

[6] This procedure assumes that the samples in different segments are independent and can be treated as strata in a stratified sampling.

Exhibit 3-18
Relative Precision Calculation

SAE Analysis Level	SAE Coefficient	t-Statistic	Relative Precision at 80%	Relative Precision at 90%
Lighting End Use	-1.15	6.65	-22%	-29%
HVAC End Use	-0.81	3.60	-29%	-37%
Other End Use	-1.31	1.32	-127%	-164%
TOTAL	1.00	7.23	18%	23%

3.4 NET-TO-GROSS ANALYSIS

The goal of the net-to-gross analysis is to quantify the CEMS Programs' net effect on the energy and demand savings estimates. The net-to-gross analysis was conducted using a self-report analysis, which asks customers directly regarding their equipment choices and purchase decisions.

In addition, there was no spillover analysis for the CEMS Evaluation. The nonparticipant sample used for this study was the same group of nonparticipants surveyed for the CEEI evaluation. All nonparticipant spillover effects have already been attributed to the CEEI programs.

The self report methodology described next was applied to indoor lighting and HVAC end use participants. "Other" adoptions were not assessed during the telephone survey. Instead, if either HVAC or lighting was categorized as a free rider response, then Other adoptions were also categorized as free riders. While this is not a precise estimate (albeit conservative), it should be noted that the Other end use comprises only 3 percent of total gross impact.

3.4.1 Self Report Method

Self Report Method for Scoring Free Ridership

The following discussion explains the methods employed to calculate "self-report" estimates of free-ridership amongst CEMS Program participants. Definitions used for free-ridership and net participation among the participant population are presented. The specific scoring algorithm and questions used to identify free-riders in the participant survey, as well as the survey itself, are also discussed.

Overview of the Methodology

Participants involved in an CEMS Program can be classified into three basic categories depending on the actions they would have taken in the absence of the CEMS Programs:

In the absence of the CEMS Program, the participant would not have installed any new equipment, or modified the manner in which they operate that equipment.

In the absence of the CEMS Program, the participant would have installed new equipment, or modified the manner in which they operate that equipment, but not as soon (more than one year later).

In the absence of the CEMS Program, the participant would have installed new equipment, or modified the manner in which they operate that equipment at the same time (within the year).

Customers who fall into the first two categories can be considered net program participants, because the program either accelerated their adoption of energy efficient technologies, or directly caused the event to occur. Customers who fall into the third category should be considered free-riders, as they would have implemented the changes regardless of the program. The self report estimates of free-ridership were based on these three categories. Data used to calculate the self-report free-ridership estimates was collected as part of the telephone survey of CEMS Program participants. The survey collected information on the participants' likely HVAC and Lighting retrofit behavior, with regards to the CEMS Program. Responses consistent with categories one through two were counted towards net participation.

The questions used to classify responses directly reflect the definitions of net participation and free ridership presented above. Respondents were asked what they would have done in the absence of the recommendations they received. They were asked whether or not they would have installed that equipment, or modified their behavior, and when. Generally, the answers to both of these questions allow the responses to be classified into one of the three categories described above. Specific scoring algorithms and the exact text of the corresponding questions are presented next.

Raw results from the self-report free-ridership estimates were weighted by the estimated impact associated with a given respondent. Results of the weighted self-report free-ridership estimates were then calculated for each survey group. Results are presented at the survey group and impact (kW, kWh, and therms) level, allowing differences in free-ridership rates by survey type to be examined.

Scoring Method and Scoring Algorithms

Responses will initially be scored based on the following set of questions for lighting and HVAC adopters:

Q138/Q145	*Before you received the PG&E recommendations, which of the following statements best describes your company's plans to carry-out these lighting/HVAC actions? (READ RESPONSES).* 1 = You hadn't considered it. 2 = You were considering it. 3 = You were going to do it. 8 = (Refused) 9 = (Don't Know)
Q138A/ Q145A	*How soon?* 1 = Probably not within the year. 2 = Within the year. 8 = (Refused) 9 = (Don't Know)

A response will count toward **net participation** if either of the two criteria are met:

Q138 or Q148 = 1 or 2

Q138 or Q148 = 3 AND Q138A or Q145A = 1

Under the first condition, the respondent indicated that, before they knew about the recommendations, they hadn't even considered taking any action, or were considering the recommendation but probably were not going to take any action. Under the second condition, the respondent was likely to carry out the action, but probably not within the year.

A response will count toward **free-ridership** if:

Q138 or Q148 = 3 AND Q138A or Q145A = 2

Under this condition, the respondent indicated that, before he knew about the program, he had already decided to take action within the year.

If the participant answers "don't know" or refuses to give a response to question Q135 or Q142, their responses will be reclassified according to a second question:

Q135/Q142	*If you had not received the PG&E recommendations, how many years would you have waited to carry-out these lighting/HVAC actions...* 1 = We would NOT have replaced 2 = We would have replaced within 1 year 3 = We would have waited more than 1 year 8 = (Refused) 9 = (Don't Know)

A response will count towards **net participation** (consistent with categories 1 and 2) if:

Q135 or Q142 = 1 or 3

Under this condition, the respondent indicated that, in the absence of the program, he would have made no equipment changes, or would have waited more than one year to make the recommended changes.

A response will count towards **free-ridership** if:

Q135 or Q142 = 2

Under this condition the respondent indicated that, in the absence of the program, they would have performed the recommended action within the year.

The scoring routine described above classifies responses in accordance with the three categories described at the beginning of this section. Respondents who indicate that, in the absence of the program, they 1) would not have modified their actions or; 2) would have modified their actions and/or equipment, but at a later time; are counted as net participants. Customers who fit the third classification; those who, in the absence of the program, would have taken action at the same time, will be counted as free-riders.

If the initial questions (Q135/Q145), cannot classify a response because of a "don't know" or a "refusal" response, then the responses to the additional question will be used. The Q135/Q142 questions make almost the same distinction as the initial set of questions. The only difference is that the respondent is asked what they would have done "in the absence of the program," as opposed to what they intended to do "before they knew about the program."

Data Sources

Data used in deriving the self-report estimates of free ridership included responses from 903 completed telephone surveys of CEMS Program participants. The responses included 354 CEMS adopters. The surveys were conducted between October and November of 1997 as part of a comprehensive telephone survey of CEMS Program participants.

Results

Self-reported estimates of free ridership are presented below by survey group and impact segment (kW, kWh, therm). The survey group with the lowest rate of free ridership was the Medium/Small On-Site segment. The free ridership energy rate for this group was estimated to be 13%. The highest rate of free ridership was observed in the Large On-Site segment, where 89% of the energy impact would have been implemented regardless of the program. These free ridership rates were developed within each segment by weighting each site's estimated impact associated with the adopted Measure/Practices. Separate estimates for demand (kW), energy (kWh), and Therms (therm) were calculated.

Exhibit 3-19
Weighted Self-report Estimates of Free Ridership
for Survey Groups in the 1996 Commercial EMS Programs

	1-FR		
	kW	kWh	Therms
Large On-Site	0.22	0.21	0.04
Med/Sm On-Site	0.86	0.87	0.82
Telephone	0.79	0.69	0.71
Business Edge	0.56	0.60	-1.63
CustomNet	0.50	0.50	0.50
	0.70	0.68	0.28

At first glance it would appear odd to have a highly negative estimate of one minus free ridership within the Business Edge therms segment. The net estimate of therms (within the Business Edge survey group) is comprised of participants who either adopted HVAC or lighting technologies. The HVAC adopters have a positive therm impact, while the lighting adopters have a negative impact (due to the HVAC interactive effect). When summing the impacts to the survey group level, the gross impacts tend to "cancel" each other out – the gross therm estimate for this group is 3,426 therms. The majority of the HVAC adopters were free riders, which removes their contribution to net impact from the sample population. The resulting sum of net therm impacts for this survey group is –5,599 therms, comprised mostly of Lighting adopters. Dividing the net estimate by gross yields the value in Exhibit 3-19. A similar justification explains the low observed value of (1-FR) in the Large On-Site/therm segment.

The CustomNet estimate of (1-FR) is discussed in *Section 3.6, CustomNet Analysis.*

Final NTG

Because no spillover estimates were calculated as part of the CEMS Evaluation, the final NTG ratios applied to the gross ex post impacts are the self-reported estimates of 1-FR. The overall program net-to-gross ratios are then 0.70 for demand, 0.68 for energy, and 0.28 for therms. *Section 4* discusses the resulting estimates of net ex post demand, energy, and therms.

3.5 Integrated Analysis

While the engineering, billing, and net-to-gross analyses were conducted at the end use segment level, the integrated analysis was performed by survey group. To assess per unit impacts by survey group, the following strategy was devised:

Gross Analysis

First, unadjusted engineering estimates of energy savings were calculated for every participant adopter. These estimates were calculated using the methods described in *Section 3.1*. A customer (or site) could have adopted multiple recommendations, in which case the analysis was performed at the recommendation level (i.e. estimates were calculated for each adopted recommendation).

The engineering energy estimates served as inputs to the gross billing regression analysis described in *Section 3.2*. Unadjusted gross estimates of energy were aggregated to the site level, and regressed in the billing model. The resulting SAE coefficients (by end use), were then applied to each of the engineering estimates. This step produces the ex post gross estimate of energy for each adopted recommendation. Ex post demand and therm estimates were taken directly from the engineering estimates.

To determine the total ex post gross impact associated with a particular survey group, the following equation was used:

$$ExPost_{SG} = \frac{\sum_{SG} ExPost_{jk}}{Pop_{SG,n}} * Pop_{SG,N}$$

Where,

$ExPost_{SG}$ = The program ex post gross impact for survey group SG;

$ExPost_{jk}$ = The ex post gross impact for customer j, adopted recommendation k;

$Pop_{SG,n}$ = The total sample population (n) for survey group SG; and,

$Pop_{SG,N}$ = The total 1996 CEMS Program accomplishments (N) for survey group SG.

The term $\frac{\sum_{SG} ExPost_{j}}{Pop_{SG,n}}$ is just the ex post gross per unit impact for each survey group. This estimate is derived by summing all of the ex post gross estimates for that survey group, and dividing by the number of unique customers in the sample population who participated in that CEMS Program (both adopters and nonadopters). This per unit estimate is then leveraged to the entire participant population by multiplying by the number of completed surveys in 1996 (the program accomplishments).

Exhibit 3-20 summarizes the integrated analysis steps used to derive gross impact.

Exhibit 3-20
Integrated Analysis Gross Impact Development

	Total Sample Impact			# of Surveyed	Impact Per Survey			# of Surveys	Total Gross Impact		
Survey Group	kW	kWh	Therm	Sites	kW	kWh	Therm	in Population	kW	kWh	Therm
Large On-Site	929	5,632,021	-1,307,499	39	23.83	144,411	-33,526	116	2,764	16,751,653	-3,888,972
Med/Sm On-Site	663	4,073,344	-109,649	463	1.43	8,798	-237	5,658	8,099	49,777,495	-1,339,945
Telephone	88	322,905	-29,745	138	0.64	2,340	-216	933	594	2,183,115	-201,104
Business Edge	37	277,414	4,446	263	0.14	1,055	17	3,406	482	3,592,664	57,581
TOTAL	1,717	10,305,683	-1,442,447	903	26.04	156,603	-33,961	10,113	11,939	72,304,927	-5,372,440

Net Analysis

Each participant was classified as a free rider (with an indicator of 1 or 0), based on the scoring algorithm described in *Section 3.3*. This indicator variable was merged to the engineering database, and the net impact calculated for each adopted measure. The net impact would either be 0 if the participant was a free rider, or the ex post gross estimate if they were a net participant. To calculate total program net effects (by survey group), the net estimates were summed to the survey group level and divided by the number of unique sites that contributed to the net number. The equation is of the same functional form as that presented in the Gross Analysis.

Participants that did not have a valid estimate of free ridership (based on a "don't know" or "refused" response), were not included in the net analysis.

Once total net program impacts were calculated for each survey group, final NTG ratios were calculated by dividing total ex post gross energy, demand, and therms by total ex post net energy, demand, and therms, respectively. In essence, the NTG ratios were "backed out" of total program (both gross and net) accomplishments for each survey group. Refer to *Section 3.3* for a summary of the NTG ratios calculated for each survey group and impact element.

3.6 CUSTOMNET ANALYSIS

This section provides the stand-alone integrated analysis and results from the CustomNet Pilot Program. As mentioned previously, the CustomNet Program had just one participant in 1996, a large retail department store chain. This section begins with an overview of the customers' actions following participation in the CustomNet Program (*Section 3.6.1*), followed by a description of the billing analysis conducted (*Section 3.6.2*), and culminating with a discussion surrounding the influence of the CustomNet Program (*Section 3.6.3*).

3.6.1 Overview

The evaluation of the 1996 CustomNet Program participant began with a review of the January 1, 1996 CustomNet Benchmarking Analysis that was prepared by PG&E. Two subsequent CEMS on-site surveys/reports were also reviewed prior to conducting the evaluation

interviews. Interviews were conducted with three of the store's corporate energy management personnel.

During these interviews a detailed explanation was provided of this chain's energy conservation efforts during the period between late winter 1996 and summer 1996. Energy saving measures were implemented nationally at all 276 stores. Just 57 of those stores are located within PG&E's service territory, and 125 are located within California. Exhibit 3-21 lists the measures that were described by each of two respondents and identifies whether or not these activities were rebated. If rebated, these activities fell under the evaluation umbrella of PG&E's CEEI Programs, not the CEMS Programs. Also provided are estimates by each respondent of the percent of total store savings achieved by each of these measures.

Exhibit 3-21
CustomNet Energy Conservation Measures and Practices Implemented

Measure Description	Rebated Measure?	All Stores?	Estimated Percent Bill Reduction	
			Respondent 1	Respondent 2
Install Occupancy Sensors	Yes	No	2.00%	1.50%
T8 Lighting Retrofits	Yes	No	0.50%	$17,000/store*
Reduced Safety Light Use	No	Yes	0.50%	1.0%
Whole Building Equipment Check	No	Yes	2.00%	2.0%
Centralized Store Control	No	Yes	7.50%	6.25%

* Respondent indicated that not all stores were retrofit, though most stores in PG&E service territory were, due to the availability of rebates under PG&E's EEI programs.

Respondent 1 indicated that the savings nation-wide were $4,800,000 (or $17,391 per store annually), with the CustomNet Program savings representing more than 80 percent of the total. This represents roughly a 13 percent reduction in annual bills for the CEEI and CEMS Program accomplishments combined. The evaluation billing analysis results indicate that the average per-store savings are 12.4 percent for both CEEI and CustomNet Programs, while 10.6 percent are attributed to the CEMS Program alone.

The most significant savings achieved, according to responses made during the interviews, was due to the implementation of a centralized EMS control system, where all store activities were constrained to occur during the period of 6:00 AM to 10:30 PM. Respondent 2 estimated that the store control alone represents over 50 percent of the total cross-program energy conservation savings.

3.6.2 CustomNet Billing Analysis

A billing comparison analysis was conducted for the CustomNet Program to estimate energy savings associated with the practices adopted by one national retail chain. The analysis consisted of the following steps: (1) identifying all of the chain stores in PG&E's service

territory, (2) identifying a control group of similar chain stores, (3) selecting a sample of stores from the participant and nonparticipant group that had valid billing data, (4) comparing the pre- and post-period billing data for each group, and (5) estimating the resulting energy savings associated with the adopted practices.

Identification of Participating Sites

The CustomNet Program consisted of a single national retail chain. The CIS was used to identify all control numbers in PG&E's service territory that were associated with this chain. This was done by searching for all CIS customer billnames that contained the retail chain's business name. All associated Corporate IDs were selected from this group and a second search was done on the CIS to identify all control numbers associated with that set of Corporate ID numbers. Only the retail stores (as opposed to warehouses and offices) were affected by participation in the CustomNet Program. Therefore, only the control numbers with the appropriate SIC code (5311) were selected. Finally, only the remaining control numbers with valid electric rate schedules were selected. This resulted in a total of 63 unique control numbers representing the participant stores.

Because some stores have multiple control numbers, usage was aggregated to the site level. Among the 63 control numbers, there were 57 unique sites (as defined by a unique Corporate ID, Premise ID and service address). Usage was aggregated for the 63 controls, up to the 57 unique sites.

Identification of Control Group

The control group for the CustomNet participant was selected primarily using two criteria. First, the control group had to consist of the same SIC code, 5311. Secondly, only retail chains with at least 20 stores within PG&E's service territory were selected. Five retail chains were identified based on this criteria, and all but one were used for the control group. The one retail chain that was not selected was removed because the chain had filed for bankruptcy, purchased two other major retail business, and was consolidating its stores over the past few years.

The process of identifying these stores was similar to that done for the CustomNet participant. The CIS was used to identify all control numbers in PG&E's service territory that were of the 5311 SIC code. Then, the set of Corporation IDs was selected that were associated with the set of bill names that occurred at least 20 times. All control numbers associated with these Corporation IDs were selected. Only the controls with SIC code 5311 and valid electric rate schedules were selected. Finally, all controls associated with the one removed retail chain were deleted. This resulted in a total of 162 nonparticipant unique control numbers.

Because some stores have multiple control numbers, usage was aggregated to the site level. Among the 162 control numbers, there were 149 unique sites (as defined by a unique Corporate ID, Premise ID and service address). Usage was aggregated for the 162 controls, up to the 149 unique sites.

Selecting Sites with Valid Billing Data

Sites were only selected for the billing comparison that met the following three criteria:

- The site's annual usage must have consisted of at least 8 non-missing monthly bills.
- The site's pre- and post-usage could not have differed by more than 50%.
- Total annual usage had to fall within an expected range of 100,000 to 5,000,000 kWh.

Of the 57 participant sites, 43 met all three criteria. Of the 14 removed, seven had missing billing data, three had large changes in usage, and four had usage outside of the expected range.

Of the 149 control group sites, 93 met all three criteria. Of the 56 removed, 25 had missing billing data, 18 had large changes in usage, and 13 had usage outside of the expected range.

Bill Comparison

The billing comparison was conducted on the 43 participant and 93 control group sites. Because the practices that were adopted occurred during 1996, the pre- and post-periods selected for the bill comparison were October 1994 – September 1995 and October 1996 – September 1997, respectively. The mean annual pre-period usage for the 43 participant sites was 1,252,615 kWh, compared to 1,505,679 kWh for the control group. The mean annual post-period usage for the 43 participant sites was 1,096,859 kWh, compared to 1,573,502 kWh for the control group.

Because the CustomNet participant also participated in a CEEI Program, the post-period usage was adjusted to reflect what the usage would have been in the absence of the program. It was found that over the period of 1994-1996, the 43 CustomNet sites installed rebated CEEI measures that had an average per-site ex ante energy savings of 23,131 kWh. Therefore, in the absence of the program, it is expected that the 43 CustomNet sites would have used, on average, 23,131 kWh more energy. Adding this value to their actual post-period usage provides an expected post-period usage of 1,119,990 kWh.

Overall, the 43 participant sites experienced a decrease in energy usage of 10.6 percent, after adjusting for participation in the CEEI Program. The 93 control group sites, however, experienced an increase in energy usage of 4.5 percent. Exhibit 3-22 summarizes the results of the billing comparison.

Exhibit 3-22
Results of Billing Comparison

	CustomNet Participant	***Control Group***
Number of Sites	43	93
1995 Pre-Usage	1,252,615	1,505,679
1997 Post-Usage	1,096,859	1,573,502
EEI Impact	23,131	-
Adjusted 1997 Post Usage	1,119,990	1,573,502
Percentage Change in Usage	**-10.59%**	**4.50%**

Calculation of Impacts

Energy savings was estimated as a percentage of pre-period usage based on the billing comparison discussed above. To estimate total energy savings associated with the CustomNet Program, an average per site savings was first estimated for the 43 sites used in the billing comparison. This average per site energy savings was then multiplied by the 57 unique sites found in PG&E's CIS.

To first estimate the energy savings as a percentage of pre-period usage, one of two methods were considered. The first was to take the difference in the percentage change in pre-to-post usage for the participant and control groups used in the billing comparison. Using this method, the energy savings would be estimated as 15.1 percent of pre-period usage (which equals 4.5 percent minus negative 10.6 percent, from Exhibit 3-22 above).

A more conservative approach would be to only take the percentage savings realized by the CustomNet participant sites in the billing comparison. This method uses the control group as a verification step to indicate that usage would not have decreased in the absence of the CustomNet Program. Therefore, any reduction in energy use in excess of the contribution made by the CEEI Program can be attributed to the CustomNet Program. Using this approach, the energy savings are estimated as 10.6 percent of pre-period (from Exhibit 3-22 above).

To be conservative, the second approach was selected, providing an estimate of energy savings equivalent to 10.6 percent of pre-period usage. Based on the 43 sites used in the billing comparison, the average per site energy savings is estimated at 132,625 kWh per year (10.6 percent multiplied by the average 1995 pre-usage of 1,252,615 kWh). Multiplying the per–site energy savings by the 57 sites in PG&E's service territory provides a total CustomNet Program energy savings estimate of 7,559,623, as presented in Exhibit 3-23.

Exhibit 3-23
Calculation of Total Energy Savings

	CustomNet Participant
Energy Savings (% of Pre-Usage)	10.59%
Average 1995 Pre-Usage	1,252,615
Per Site Energy Savings	132,625
Number of Total Sites	57
Total Energy Savings	**7,559,623**

The relative precision of the per site energy savings estimate can be estimated as the difference between means. Exhibit 3-24 below provides the mean, standard error, and relative precision calculations for the pre-usage, post-usage, and CEEI impact, based on the 43 sites used in the billing comparison. The overall relative precision of the mean per site energy savings, measured at the 90 percent confidence interval, is 13 percent.

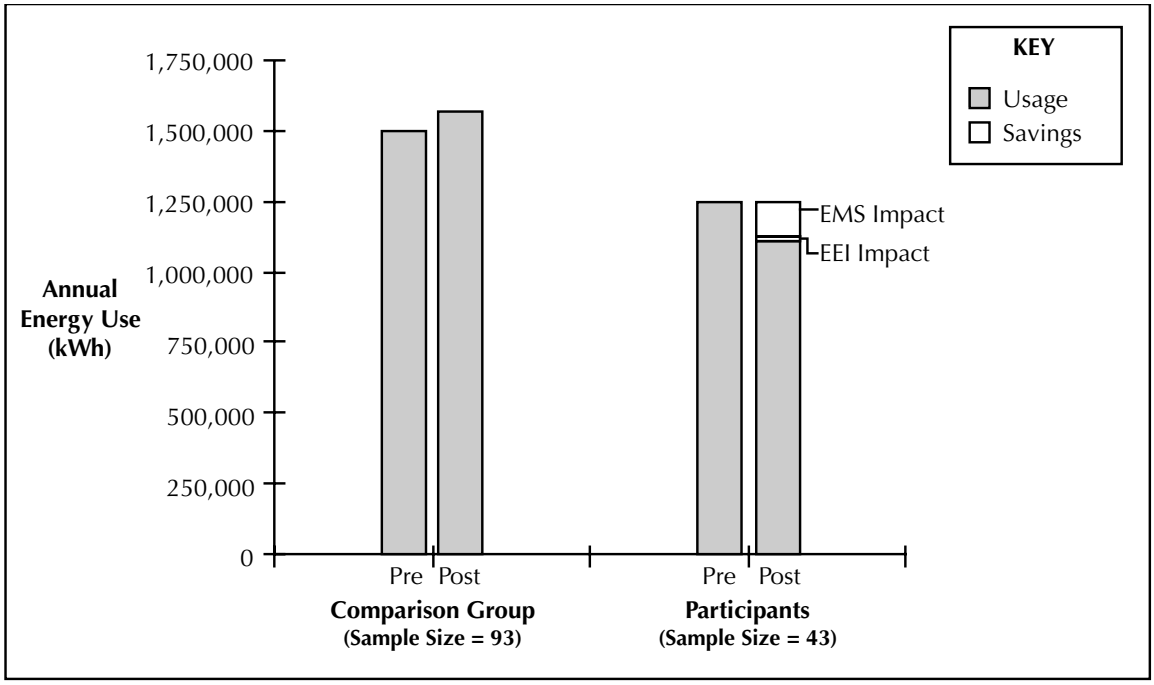
Exhibit 3-24
Relative Precision Calculation

	Mean	Standard Error	Relative Precision at 80%	Relative Precision at 90%
1995 Pre-Usage	1,252,615	45,839	2%	3%
1997 Post-Usage	1,096,859	36,325	2%	3%
EEI Impact	23,131	8,144	22%	29%
Per Site Energy Savings	132,625	10,115	10%	13%

Presentation of Evaluation Impacts

The observed participant reduction in energy usage (less any CEEI impacts) were attributed to CustomNet effects. Observed nonparticipant billing records (or the control group) exhibited a 4.5 percent increase in usage across the pre- and post-retrofit analysis periods, for the sample of 93 similar department stores. A conservative approach was employed in estimating the CustomNet impacts, since the expected post-period bills were not adjusted upwards based on an expected increase in usage (in the absence of intervention). Estimates were instead based upon the difference observed in the energy use of the participant group, and an adjustment downward in savings due to CEEI participation. The observed bill savings are presented in Exhibit 3-25.

Exhibit 3-25
Billing Analysis Results for a Typical Participant and Nonparticipant Store



3.6.3 CustomNet Influence

The interviews conducted with the three corporate energy management contacts included an assessment of the CustomNet Program's influence on their company's energy conservation Practices. Respondent 1 indicated that the CustomNet report prepared by PG&E was distributed amongst personnel at the corporate offices, and also to each of the stores. Overall satisfaction with the CustomNet report, and the professionalism and technical knowledge of the PG&E representative(s), was identified as a 4 on a scale from 1 to 5, with 1 being dissatisfied and 5 being very satisfied.

A number of questions were asked in an attempt to quantify influence. Questions and responses are provided in Exhibit 3-26.

Exhibit 3-26
Influence Questions and Responses

Question	Choices	Individual Responses	
		Respondent 1	Respondent 3
On a scale of 1-5, with 1 being NOT influential and 5 being VERY influential, how much did CustomNet influence your decisions to carry out energy efficiency improvements?	NA	3.5	2.5
On the same scale, Please rate your satisfaction with the USEFULNESS of the CustomNet analysis in helping you to make energy management decisions.	NA	-	2.5
On a scale of 1-5, where 1 is NOT AT ALL IMPORTANT and 5 is VERY IMPORTANT, how important was the CustomNet analysis in helping your company make its energy management decisions.	NA	-	2.5
If you had not receive the CustomNet report, how many years would you have waited to carry-out the energy management actions?	NA	-	Immediately
Before you received the PG&E recommendations, which of the following statements best describes your company's plans to carry-out these energy management actions?	1. Hadn't considered it 2. You were considering it 3. You were going to do it	-	3
How soon?	1. Probably not within the year 2. Within the year	-	2*

* The respondent indicated that PG&E helped their stores to identify solutions more rapidly, and thereby influenced the speed with which these stores were able to implement changes in store energy management policy. He stated that the project would not have been completed as quickly without the input from PG&E.

Based on the above responses, a net to gross factor of 0.5 was attributed to this one pilot program participant. The mean response from each of two corporate contacts was 3.0 on a scale of 1 to 5, indicating that the CustomNet Program had influenced their decision to carry out energy efficiency improvements. PG&E's participation in their corporate planning process ensured that the implementation of these new energy management policies was significantly

accelerated. The respondents also indicated that PG&E assisted their stores by identifying solutions in support of energy use reduction.

The influences were also felt outside of PG&E's service territory, although savings are not being claimed for the savings attributed to these additional 219 stores. In closing, the evaluation yielded gross energy savings of 7,559,623 kWh across the 57 stores in PG&E's service territory, and a net savings of 3,779,811 kWh. No demand or therm savings were achieved.

4. EVALUATION RESULTS

This section contains the results of the Commercial EMS (CEMS) Evaluation, beginning with ex ante net impacts. The ex post gross impacts are then presented, followed by the net-to-gross (NTG) adjustments, and concluding with the program realization rates (ratio of ex post findings to the ex ante estimates), for net impacts. There is no discussion of gross realization rates, because the ex ante estimates are only presented at a net level. Explanations for the differences between the net ex ante and net ex post estimates are discussed in the presentation of the realization rates.

Where segment analysis could be supported, results are presented at the survey group and impact level. All results are aggregated to the total commercial sector.

4.1 EX ANTE NET IMPACT RESULTS

Ex ante net energy, demand, and therm estimates are presented in Exhibit 4-1. These estimates are based on filed per unit impacts[7] and the Profitability Analysis Model (PAM) runs, which provided 1996 program accomplishments by survey group.

Exhibit 4-1
Ex Ante Net Impacts
by Survey Group
For Commercial EMS Programs

	Impacts / Unit			# of	1996 Net Program Impacts		
Survey Group	kW	kWh	Therms	Surveys	kW	kWh	Therms
Large On-Site	0.65	3,316	63	116	75	384,656	7,308
Med/Sm On-Site	0.65	3,316	63	5,658	3,678	18,761,928	356,454
Telephone	0.33	1,658	32	933	308	1,546,914	29,856
Business Edge	0.33	1,658	32	3406	1,124	5,647,148	108,992
CustomNet	-	-	-	1	-	0	-
			TOTALS	10,114	5,185	26,340,646	502,610

The Medium/Small On-site survey group accounted for over half of the EMS Programs energy impact, with over 18.7 MWh of energy savings. The Phone/Mail surveys per unit impacts were estimated at half of the On-Site per unit impacts, due to lack of previous measurement and evaluation results. The Large On-Site impacts were set equal to the Medium/Small On-Site per unit impacts for the same reason.

[7] Pacific Gas and Electric Company 1996 Customer Energy Efficiency Programs, Advice Letter No. 1921-G/1540-E, Attachments.

4.2 EX POST GROSS IMPACT RESULTS

Ex post gross energy, demand, and therm impacts are presented in Exhibit 4-2. The 1996 program accomplishments are based on the PAM inputs, and not on the contents of the MDSS received as part of the Commercial EMS Evaluation. This is due to the fact that additional 1996 accomplishments were entered in the MDSS after the PAM impacts had been calculated. In order to create a comparison base, the same number of completed surveys by survey group from the ex ante exhibit are used. Any resulting variances in the ex post and ex ante values can then be attributed to the per unit estimates, and the NTG ratio applied.

Exhibit 4-2
Ex Post Gross Impacts
by Survey Group
For Commercial EMS Programs

	Impacts / Unit			# of	Gross Ex Post Program Impacts		
Survey Group	kW	kWh	Therms	Surveys	kW	kWh	Therms
Large On-Site	23.83	144,411	-33,526	116	2,764	16,751,653	(3,888,972)
Med/Sm On-Site	1.43	8,798	-237	5,658	8,099	49,777,495	(1,339,945)
Telephone	0.64	2,340	-216	933	594	2,183,115	(201,104)
Business Edge	0.14	1,055	17	3406	482	3,592,664	57,581
CustomNet	-	7,559,623	-	1	-	7,559,623	-
			TOTALS	10,114	11,939	79,864,550	(5,372,440)

Gross ex post savings are significantly higher for on-site surveys than their respective net ex ante estimates. The evaluation team is confident that these impact estimates are valid. The SAE coefficients from the LIRM model were statistically significant, and the overall SAE coefficient was 1.00. This suggests that the unadjusted engineering impacts are correct. Adoption rates were much higher than anticipated, also accounting for the increase in per unit impacts. Specific comments on the per unit impacts for specific survey groups follows:

Telephone Surveys Energy Savings were found to be 41 percent greater than the net ex ante estimates. Recall that both the Telephone/Mail estimates were estimated at half the On-Site per unit impacts. The higher telephone per unit impact is not unexpected, as the Advice Filings specifically states "Per unit impacts for these alternative survey tools are anticipated to be greater than half of the current On-Site impact estimates."

Business Edge (Mail) Savings were found to be 36 percent **less** than the net ex ante estimates. This result is the opposite of expectations, but not surprising when adoption rates are examined. This survey group experienced the lowest recollection of the survey having taken place, and most respondents that did recall the survey indicated that they did not adopt the recommendations.

CustomNet Savings: As discussed in more detail in *Section 3.6*, CustomNet stores that participated in the program exhibited a ten percent decrease in energy usage from 1995 to 1997. The comparison group's usage actually **rose** 4.5 percent in the same time period – thus, a

conservative 10.6 percent energy savings was attributed to this program. There were no ex ante estimates for comparison.

4.3 NET-TO-GROSS ADJUSTMENTS

The NTG results are designed to account for all of the market effects attributed to free ridership, by survey group and impact estimate. Exhibit 4-3 presents the NTG values by survey group and impact. Also shown are the overall program level NTG results, weighted across survey group by the ex-post gross energy, demand, and therm savings. For this CEMS Evaluation, the results from the self-report analysis were used. Refer to *Section 3.4, Net-to-Gross Analysis* for additional information surrounding the decision-making process.

Exhibit 4-3
Net-to-Gross Adjustment
by Survey Group
For Commercial EMS Programs

	1-FR		
	kW	kWh	Therms
Large On-Site	0.22	0.21	0.04
Med/Sm On-Site	0.86	0.87	0.82
Telephone	0.79	0.69	0.71
Business Edge	0.56	0.60	-1.63
CustomNet	0.50	0.50	0.50
	0.70	0.68	0.28

The survey group with the lowest observed free ridership was in the Medium/Small On-Site group. For energy, only 13 percent of the population were free riders. The survey group with the highest rate of reported free ridership is the Large On-Site group. Just under 80 percent of the respondents indicated they would have installed/adopted the energy saving recommendations made during the on-site survey. This is not altogether surprising, given that these customers typically have personnel whose sole responsibility is to direct the energy consumption of their facilities. Overall program NTG adjustments were 0.70 for demand, 0.68 for energy, and 0.28 for therms.

4.4 EX POST NET IMPACT RESULTS

Exhibit 4-4 presents the ex post net energy, demand, and therm impacts for each of the survey groups evaluated.

These exhibits show reductions of 68 percent in ex post energy impacts (overall) and 70 percent in ex post demand impacts (when compared to Exhibit 4-2), as a result of the application of the NTG ratios presented in Exhibit 4-3.

On a net basis, the Large On-Site survey group experienced the largest reduction, with almost 80 percent of its energy impact removed. The Medium/Small On-Site survey group remained the dominant contributor to total program impacts, accounting for 79.8 percent of the total net energy savings.

Exhibit 4-4
Ex Post Net Impacts
by Survey Group
For Commercial EMS Programs

	Net-to-Gross			Net Ex Post Program Impacts		
Survey Group	kW	kWh	Therms	kW	kWh	Therms
Large On-Site	0.22	0.21	0.04	622	3,435,877	(156,343)
Med/Sm On-Site	0.86	0.87	0.82	6,984	43,142,735	(1,102,409)
Telephone	0.79	0.69	0.71	471	1,510,834	(143,713)
Business Edge	0.56	0.60	-1.63	272	2,148,645	(94,084)
CustomNet	0.50	0.50	0.50	-	3,779,812	-
	0.70	0.68	0.28	8,349	54,017,903	(1,496,549)

4.5 NET REALIZATION RATES

Exhibit 4-5 presents the net realization rates for energy, demand, and therm impacts for the CEMS Programs. These values represent, by survey, the ratio of the ex post net impact evaluation findings to the net ex ante estimates. These realization rates illustrate how well the ex ante estimates predicted energy savings, after taking into account customer's actions within the CEMS Programs.

Recall that the ex ante estimates in the Advice Filings are for net estimates only. Therefore, no gross realization rates could be calculated.

Exhibit 4-5
Net Realization Rates
by Survey Group
For Commercial EMS Programs

	Net Realization Rates		
Survey Group	kW	kWh	Therms
Large On-Site	8.25	8.93	-21.39
Med/Sm On-Site	1.90	2.30	-3.09
Telephone	1.53	0.98	-4.81
Business Edge	0.24	0.38	-0.86
CustomNet	-	-	-
	1.61	2.05	-2.98

To the extent that they build upon the previous evaluation results, many of the results presented above can be explained using information from the review of the net ex ante estimates and the evaluation engineering and billing analyses. Specific comments and justifications for each of the survey groups follows:

Large On-Site Surveys saw the most dramatic increase in net ex post savings. This is the direct result of a higher per unit ex post value being applied. Even with the low net participation level in this segment (roughly 20%), the net ex post estimates are more than 8 times greater than the ex ante values for energy and demand. The highly negative therm realization rate is directly attributed to the application of an HVAC interactive effect for lighting technologies. While all of the estimates for Large participants are higher than ex ante, this should not be that surprising. It is an unlikely assumption that the per unit impact of a Large customer On-Site would be the same as their Medium/Small counterparts, as suggested in the ex ante estimates. Typically these larger customer's energy usage is on an order of magnitude larger than the Medium/Small customers. If these customers experience a similar percent reduction in overall usage, then the savings estimate should also be an order of magnitude larger. This is well exhibited in the realization rates shown above.

Medium/Small On-Site Surveys also saw an increase in net ex post savings. This is the result of several factors. First, the higher-than-expected adoption rate within this segment increased each survey's per unit impact. This is coupled with the fact that the retrofits made outside of the rebate program were more sophisticated than expected, ultimately providing a larger demand and energy impact.

Telephone Surveys net energy realization rate was 0.98 – confirming ex ante estimates. The demand impacts rose by fifty percent due to a higher CDF factor being applied to Lighting end use technologies. Therm impacts are much larger (and negative) because of the HVAC interactive effects also being applied to the lighting technologies.

Business Edge Mail Surveys impacts were significantly reduced. This is a function of several different factors: first, a number of participants could not recall having received the mail survey, considerably lowering the adoption rate of this survey group. Those individuals who did adopt a Measure/Practice were typically smaller customers – thus the retrofit had a smaller impact. Finally, many of the Practices adopted had limited impact. The negative realization rate in therm impact is the direct result of an HVAC interactive effect being applied to Lighting end use adoptions.

4.6 OVERVIEW OF IMPACTS

The ex post net impacts demonstrate a very conservative ex ante estimate for both Large and Medium/Small On-Site surveys. The net ex post telephone survey savings are relatively consistent with the ex ante estimates, varying by only a few percent of energy. The Business Edge programs estimates should be reduced, as the effectiveness of this survey tool is somewhat limited in scope. Exhibit 4-6 summarizes all of the gross and net energy, demand, and therm impacts discussed in this section. Results are also presented for the net-to-gross adjustments and the net realization rates.

Exhibit 4-6
Commercial EMS Programs Impact Summary
by Survey Group

Survey Group	Gross Program Impact kWh	kW	Therm	NTG Adjustment (1-FR)*	Net Program Impact kWh	kW	Therm
Ex Ante							
Large On-Site	-	-	-	1.00	384,656	75	7,308
Med/Sm On-Site	-	-	-	1.00	18,761,928	3,678	356,454
Telephone	-	-	-	1.00	1,546,914	308	29,856
Business Edge (Mail)	-	-	-	1.00	5,647,148	1,124	108,992
CustomNet	-	-	-	-	-	-	-
TOTAL	-	-	-	1.00	26,340,646	5,185	502,610
Ex Post							
Large On-Site	16,751,653	2,764	-3,888,972	0.21	3,435,877	622	-156,343
Med/Sm On-Site	49,777,495	8,099	-1,339,945	0.87	43,142,735	6,984	-1,102,409
Telephone	2,183,115	594	-201,104	0.69	1,510,834	471	-143,713
Business Edge (Mail)	3,592,664	482	57,581	0.60	2,148,645	272	-94,084
CustomNet	7,559,623	0	0	0.50	3,779,812	0	0
TOTAL	79,864,550	11,939	-5,372,440	0.68	54,017,903	8,349	-1,496,549
Realization Rates							
Large On-Site	-	-	-	-	8.93	8.25	-21.39
Med/Sm On-Site	-	-	-	-	2.30	1.90	-3.09
Telephone	-	-	-	-	0.98	1.53	-4.81
Business Edge (Mail)	-	-	-	-	0.38	0.24	-0.86
CustomNet	-	-	-	-	-	-	-
TOTAL	-	-	-	-	2.05	1.61	-2.98

* Weighted by energy