316 + 317

CUSTOMER ENERGY EFFICIENCY PROGRAM
DSM POLICY AND EVALUATION

IMPACT EVALUATION OF 1994 COMMERCIAL AND INDUSTRIAL ENERGY MANAGEMENT SERVICES (EMS) PROGRAM

Report Number CEQ-96-HBO1
(CEC Number 316 and 317)
February 1996

DSM Policy and Evaluation
Pacific Gas and Electric Company
San Francisco, California

All inquiries should be directed to:

Susan M. Buller
Pacific Gas and Electric Company
Customer Energy Management, H28A
123 Mission Street
P.O. Box 770000
San Francisco, CA 94177

316/317 Complete

Impact Evaluation of the
1994 Commercial and Industrial Energy Management Services (EMS) Program

Purpose of Study:

This study evaluated the gross and net energy and demand impacts resulting from commercial and industrial customers who recieved an on-site energy audit through PG&E's EMS Program. In order to avoid double counting savings, this evaluation only considered the savings associated with measures installed outside PG&E's incentive programs.

The impacts were derived from a billing data analysis using a time-series/cross-sectional model of monthly data. Engineering models were used to determing impacts of capital measures for the industrial EMS program.

Findings:

A evaluation findings are presented below:

COMMERCIAL EMS PROGRAM	kW	kWh
Gross Evaluation Results	*5,390*	*29,837,000*
Net-to-Gross Ratio	*0.91*	*0.91*
Net Impact Results	*4,910*	*27,187,000*

C00-001

INDUSTRIAL EMS PROGRAM	kW	kWh
Gross Evaluation Results	*1,660*	*9,211,000*
Net-to-Gross Ratio	*0.84*	*0.84*
Net Impact Results	*1,390*	*7,694,000*

I00-001

316 +
317

IMPACT EVALUATION OF PG&E'S 1994 COMMERCIAL-INDUSTRIAL ENERGY MANAGEMENT SERVICES PROGRAMS

Final Report

Prepared for:

Pacific Gas & Electric
Attention: Lisa Reid
123 Mission Street
Room 2354-H28A
San Francisco, CA 94105
(415) 973-4747

Prepared by:

Hagler Bailly Consulting, Inc.
P.O. Drawer O
Boulder, CO 80306-1906
(303) 449-5515

ADM Associates, Inc.
3239 Ramos Circle
Sacramento, CA
(916) 363-8383

February 26, 1996

CONTENTS

EXECUTIVE SUMMARY

This report documents the methods used and the results of the impact evaluation of Pacific Gas and Electric's (PG&E's) 1994 Commercial Industrial (C-I) Energy Management Services (EMS) Programs.

S.1 PROJECT OVERVIEW

This evaluation project was undertaken to quantify the energy and demand impacts associated with PG&E's Commercial Industrial Energy Management Services Programs for calendar year 1994. The EMS programs offer information and recommendations to commercial and industrial customers regarding energy-efficient technologies and practices. The load impacts analyzed in this project were divided into two categories: impacts from low-cost/no-cost measures and impacts from the installation of auditor recommended capital intensive measures. In order to avoid double counting savings, this evaluation only considered the savings associated with measures installed outside PG&E's incentive programs. This evaluation was conducted in such a way as to satisfy all requirements listed in the Joint Protocols for Measurement and Evaluation developed for the California Public Utilities Commission (CPUC). Appendix A presents the required Protocol summary table.

S.2 LOAD IMPACT ESTIMATES

The total estimated gross and net load impacts (both energy and demand) associated with the EMS program are presented in Exhibit S-1. This exhibit also presents the 80% and 90% confidence intervals for each estimate.

S.2.1 Gross Impact Estimates

The gross impact estimates presented in Exhibit S-1 were based on a billing data analysis using a pooled time-series/cross-sectional regression model and an engineering analysis using information obtained from the on-site surveys. The regression model used as inputs billing data for participants and nonparticipants, program tracking data, and telephone survey results. This model controlled for the level of consumption across customers, weather, and other nonprogram changes.

Exhibit S-1
PG&E's 1994 Commercial-Industrial Energy Management Services Program
Estimated Impacts

Measure Types	Annual Impacts	Confidence Interval 80% Low	80% High	90% Low	90% High
Total Gross Energy Impacts (MWh)					
Low-cost/no-cost measures:					
— Commercial walk-through audit	20,415	8,242	32,588	4,843	35,987
— Commercial/Industrial detailed audit	5,087	1,011	9,163	-127	10,301
Recommended measures:					
Commercial					
— Lighting	3,560	-515	7,635	-1,653	8,773
— HVAC	4,409	2,376	6,442	1,808	7,010
— Other	1,453	-1,171	4,077	-1,903	4,809
Industrial					
— Lighting	1,822	1,368	2,276	1,241	2,403
— Other	2,302	1,498	3,106	1,273	3,331
Total Gross Energy Impacts	39,048	26,533	51,563	23,038	55,058
Total Net Energy Impacts (MWh)					
Low-cost/no-cost measures:					
— Commercial walk-through audit	20,415	8,242	32,588	4,843	35,987
— Commercial/Industrial detailed audit	5,087	1,011	9,163	-127	10,301
Recommended measures:					
Commercial					
— Lighting	2,581	-373	5,535	-1,198	6,360
— HVAC	3,395	1,829	4,961	1,392	5,398
— Other	796	-641	2,234	-1,043	2,635
Industrial					
— Lighting	1,295	972	1,619	882	1,709
— Other	1,312	854	1,770	726	1,898
Total Net Energy Impacts	34,882	22,529	47,235	19,079	50,685
Total Net Demand Impacts (MW)					
Low-cost/no-cost measures:					
— Commercial walk through audit	3.69	1.49	5.90	0.88	6.51
— Commercial/Industrial detailed audit	0.92	0.18	1.66	-0.02	1.86
Recommended measures:					
Commercial					
— Lighting	0.47	-0.07	1.00	-0.22	1.15
— HVAC	0.61	0.33	0.90	0.25	0.98
— Other	0.14	-0.12	0.40	-0.19	0.48
Industrial					
— Lighting	0.23	0.18	0.29	0.16	0.31
— Other	0.24	0.15	0.32	0.13	0.34
Total Demand Impacts	6.31	4.08	8.55	3.45	9.17

S.2.2 Net Impact Estimates

The net energy impacts (net of free ridership) were estimated by multiplying the gross impacts found by the billing data analysis by the net-to-gross ratio. This net-to-gross ratio represents the percentage of savings due to participants who are not free riders and as such it equals one minus the percentage of savings by free riders in the program. The net-to-gross ratio associated with the EMS programs were computed by different methods depending upon the measures involved. For the low-cost/no-cost measures, the nature of these measures is such that had participants been aware of these measures/practices before the audit, they would have implemented them. Therefore, it is assumed that there is no free ridership for these measures, thus the net-to-gross ratio is 1.

For the capital intensive measures, the estimate of the level of free ridership by measure was obtained from analyzing the responses from the participant survey. These responses were in turn weighted by the appropriate gross impacts. Based on this approach, the percentage of savings that is due to free ridership for the commercial sector was determined to be 27.5% for lighting, 23.0% for HVAC, and 45.2% for other measures. For the industrial sector, the percentage of savings associated with free riders where 28.9% for lighting and 43.0% for other measures.

S.2.3 Net Demand Impact Estimates

The net demand (kW) impacts were found by applying PG&E's H-factors (which allocate energy savings to costing periods — these factors are presented in Appendix D) to the net energy (kWh) savings. This produced the summer kWh savings. These were then divided by the number of hours in the summer on-peak period to give the net kW reductions.

S.3 COMPARISON TO EXISTING PG&E ESTIMATES

Exhibit S-2 summarizes the estimates developed in this project and compares them to PG&E's existing estimates of impacts. In comparing the estimates found in this analysis with PG&E's prior estimates, it is apparent that the impacts found in this study are slightly below PG&E's estimates, with overall realization rates of 91% for net energy savings and 85% for net demand savings (the number by low-cost versus capital intensive measures are not directly comparable). The possible reasons for the difference in estimates include:

- PG&E estimates are based on different analysis techniques than the estimates presented in this report. Specifically, the prior estimates of the impacts of the low-cost/no-cost measures were based on a billing data analysis, while the impacts of the capital intensive measures were based on engineering analysis. Thus, the prior

Exhibit S-2
PG&E C-I Energy Management Services Net Impacts

	Prior PG&E Estimate		Impact Evaluation		Realization Rate	
	MW	MWh	MW	MWh	MW	MWh
Total Net Savings[1]	7.46	38,164	6.31	34,882	85%	91%
Low-Cost Measures[2]	3.49	18,165	4.61	25,502	132%	140%
Capital Intensive Measures:[2]						
Commercial	2.90	14,266	1.23	6,772	42%	47%
Industrial	0.07	539	0.49	2,607	700%	484%

1. Obtained from "PG&E Annual Summary of DSM Programs — April 1995" for the 1994 EMS Program.
2. Obtained from "Impact Evaluation of 1990-1992 Nonresidential Energy Management Services Programs." These numbers relate to the 1992 EMS program and so are not directly comparable to the results of this analysis of the 1994 program.

estimates may not have accounted for any behavioral responses associated with the capital intensive measures.

- There may be a difference over time in the types of measures (both low-cost/no-cost and capital intensive) implemented by participants so that the measures installed (and hence the savings) by participants in previous periods are not necessarily indicative of the measures installed in later periods. Thus, predictions of overall program impacts based upon past impacts may not be accurate.

- In order to avoid double-counting, EMS participants who were also rebate program participants were eliminated from the study. Since many of the largest EMS program participants went on to implement rebated measures, most of the large EMS program participants were eliminated from the study. This has the effect of underestimating the average savings per participant in the EMS program.

CHAPTER 1
INTRODUCTION

This report documents the methods used and the results of the impact evaluation of Pacific Gas and Electric's (PG&E's) 1994 Commercial Industrial (C-I) Energy Management Services (EMS) Programs. This chapter introduces the project, outlines the methodology, and describes the structure of this report.

1.1 PROGRAM BACKGROUND AND PROJECT OBJECTIVES

This evaluation project was undertaken to quantify the load impacts of PG&E's C-I EMS Programs for calendar year 1994. The EMS programs offer information and recommendations to commercial and industrial customers regarding energy-efficient technologies and practices. These services range from walk-through energy surveys for smaller customers to comprehensive energy audits that provide detailed written analyses and recommendations on major energy consuming systems for larger customers. Technology experts are often enlisted to analyze complex industrial end use issues. The end uses addressed in the commercial and industrial audits primarily include: lighting, HVAC, refrigeration, and hot water heating. Other end uses include: process, process boiler, nonprocess boiler, and miscellaneous.

While customers receiving audits are subsequently encouraged to apply for incentives in implementing audit recommendations, the purpose of this analysis is to determine the energy savings of those measures for which participants *did not receive an incentive*. The specific objectives of this project include:

- Estimation of gross load impacts associated directly with the EMS program. This includes an investigation by type of audit (walk-through versus detailed) and by end use.
- Determination of the net-to-gross ratio using survey responses.
- Comparison of the estimated gross and net load impacts to PG&E's existing estimates, with an explanation of the differences, if any.

This evaluation was conducted in such a way as to satisfy all requirements listed in the Joint Protocols for Measurement and Evaluation developed for the California Public Utilities Commission (CPUC). For example, the end uses considered in this analysis are lighting,

HVAC, and other for the commercial sector, and lighting and other for the industrial sector (there were no motor measures).

1.2 STRUCTURE OF THE REPORT

This report is organized in the following manner. Chapter 2 discusses and reviews the results of this analysis. Chapter 3 addresses the data collection effort and the survey methodology. Chapter 4 presents the statistical methods used to determine the load impacts associated with the program, develops the net-to-gross ratio estimates, and presents the engineering analysis. This report also includes four appendices:

- Appendix A presents the CPUC's M&E Protocols Summary Report Table (Table 6 of the Protocols).
- Appendix B contains the participant and nonparticipant telephone survey instruments.
- Appendix C contains the participant on-site survey instrument.
- Appendix D presents PG&E's H-Factors.

CHAPTER 2
RESULTS

This chapter provides an overview of the key findings of this analysis in terms of kWh and kW impacts. This discussion provides a review of findings and a comparison of these findings to PG&E's prior estimates. The details of how these estimates were developed are presented in later chapters.

2.1 ENERGY IMPACTS

The development of the gross energy impacts relied on an analysis of participant and nonparticipant billing data using a pooled time-series/cross-sectional regression model which controls for weather and other nonprogram effects and an engineering analysis of on-site data (the details of these analyses are presented in Chapter 4). The estimated gross energy impacts are presented in Exhibit 2-1.

The net energy impacts (net of free riders) were estimated by multiplying the gross impacts by the net-to-gross ratio. This net-to-gross ratio represents the percentage of savings due to participants who are not free riders. The net-to-gross ratio associated with the EMS programs were computed by different methods depending upon the type of measures involved. For the low-cost/no-cost measures, the nature of these measures is such that had participants been aware of these measures/practices before the audit, they would have implemented them. Therefore, the audit was instrumental in the adoption of these measures, and we assume that there is no free ridership for these measures.

For the capital intensive measures, the net energy impacts were found by multiplying the gross energy savings estimates by the net-to-gross ratio, which equals one minus the percentage of savings due to free riders in the program. The estimates of the level of savings by free riders for these measures were obtained from analyzing the responses from the participant survey. These responses were in turn weighted by the appropriate gross impacts. Based on this approach, the level of free ridership was determined to be 27.5% for lighting, 23.0% for HVAC, and 45.2% for other measures in the commercial sector, and 28.9% for lighting and 43.0% for other measures in the industrial sector. This approach is presented in detail in Chapter 4. The resulting net energy impacts are presented in Exhibit 2-2.

Exhibit 2-1
PG&E Commercial-Industrial Energy Management Services Program
Gross Energy Impacts

Measure Types	Annual Impacts	Confidence Interval			
		80%		90%	
		Low	High	Low	High
Per Participant Gross Impacts (kWh)					
Low-cost/no-cost measures:					
— Commercial walk through audit	1,779	718	2,840	422	3,136
— Commercial/industrial detailed audit	87,700	17,430	157,970	-2,192	177,593
Recommended measures:					
Commercial					
— Lighting	1,345	-195	2,885	-624	3,314
— HVAC	4,748	2,558	6,938	1,947	7,549
— Other	1,059	-853	2,971	-1,387	3,505
Industrial					
— Lighting	3,343	2,509	4,177	2,276	4,410
— Other	4,224	2,748	5,700	2,336	6,112
Total Program Gross Impacts (MWh)					
Low-cost/no-cost measures:					
— Commercial walk through audit	20,415	8,242	32,588	4,843	35,987
— Commercial/industrial detailed audit	5,087	1,011	9,163	-127	10,301
Recommended measures:					
Commercial					
— Lighting	3,560	-515	7,635	-1,653	8,773
— HVAC	4,409	2,376	6,442	1,808	7,010
— Other	1,453	-1,171	4,077	-1,903	4,809
Industrial					
— Lighting	1,822	1,368	2,276	1,241	2,403
— Other	2,302	1,498	3,106	1,273	3,331
Total Gross Energy Impacts	39,048	26,533	51,563	23,038	55,058

Exhibit 2-2
PG&E Commercial-Industrial Energy Management Services Program
Net Energy Impacts

Measure Types	Annual Impacts	Confidence Interval			
		80%		90%	
		Low	High	Low	High
Per Participant Net Impacts (kWh)					
Low-cost/no-cost measures:					
— Commercial walk through audit	1,779	718	2,840	422	3,136
— Commercial/industrial detailed audit	87,700	17,430	157,970	-2,192	177,593
Recommended measures:					
Commercial					
— Lighting	975	-141	2,091	-453	2,403
— HVAC	3,656	1,976	5,336	1,507	5,805
— Other	580	-468	1,628	-760	1,921
Industrial					
— Lighting	2,377	1,784	2,970	1,618	3,135
— Other	2,408	1,567	3,249	1,332	3,484
Total Program Net Impacts (MWh)					
Low-cost/no-cost measures:					
— Commercial walk through audit	20,415	8,242	32,588	4,843	35,987
— Commercial/industrial detailed audit	5,087	1,011	9,163	-127	10,301
Recommended measures:					
Commercial					
— Lighting	2,581	-373	5,535	-1,198	6,360
— HVAC	3,395	1,829	4,961	1,392	5,398
— Other	796	-641	2,234	-1,043	2,635
Industrial					
— Lighting	1,295	972	1,619	882	1,709
— Other	1,312	854	1,770	726	1,898
Total Net Energy Impacts	34,882	22,529	47,235	19,079	50,685

2.2 NET DEMAND IMPACTS

This section reviews the net demand (kW) impacts associated with the EMS programs. The kW impacts were found by applying PG&E's H-Factors (which allocate energy savings to costing periods — these factors are presented in Appendix D) to the net kWh savings. This produced the summer kWh savings. These were then divided by the number of hours in the summer on-peak period to give the net kW reductions. These results were also verified against the results of the on-site surveys and the engineering analysis. Exhibit 2-3 presents the estimated net demand impacts.

Exhibit 2-4 summarizes the kW and kWh savings by costing period, based on PG&E's H-Factors per costing period.

2.3 COMPARISON WITH EXISTING PG&E ESTIMATES OF TOTAL SAVINGS

Exhibit 2-5 summarizes the above impact estimates and includes PG&E's existing estimates of impacts. In comparing the estimates found in this analysis with PG&E's prior estimates, it is apparent that the impacts found in this study are slightly below PG&E's estimates, with overall realization rates of 91% for net energy savings and 85% for net demand savings (the number by low-cost versus capital intensive measures are not directly comparable). The possible reasons for the difference in estimates include:

- PG&E estimates are based on different analysis techniques than the estimates presented in this report. Specifically, the prior estimates of the impacts of the low-cost/no-cost measures were based on a billing data analysis, while the impacts of the capital intensive measures were based on engineering analysis. Thus, the prior estimates may not have accounted for any behavioral responses associated with the capital intensive measures.

- There may be a difference over time in the types of measures (both low-cost/no-cost and capital intensive) implemented by participants so that the measures installed (and hence the savings) by participants in previous periods are not necessarily indicative of the measures installed in later periods. Thus, predictions of overall program impacts based upon past impacts may not be accurate.

- In order to avoid double-counting, EMS participants who were also rebate program participants were eliminated from the study. Since many of the largest EMS program participants went on to implement rebated measures, most of the large EMS program participants were eliminated from the study. This has the effect of underestimating the average savings per participant in the EMS program.

Exhibit 2-3
PG&E Commercial-Industrial Energy Management Services Program
Net Demand Impacts

Measure Types	Annual Impacts	Confidence Interval			
		80%		90%	
		Low	High	Low	High
Per Participant Net Demand Impacts (kW)					
Low-cost/no-cost measures:					
— Commercial walk through audit	0.32	0.13	0.51	0.08	0.57
— Commercial/industrial detailed audit	15.87	3.15	28.59	-0.40	32.14
Recommended measures: Commercial					
— Lighting	0.18	-0.03	0.38	-0.08	0.43
— HVAC	0.66	0.36	0.97	0.27	1.05
— Other	0.11	-0.08	0.29	-0.14	0.35
Industrial					
— Lighting	0.43	0.32	0.54	0.29	0.57
— Other	0.44	0.28	0.59	0.24	0.63
Total Program Net Demand Impacts (MW)					
Low-cost/no-cost measures:					
— Commercial walk through audit	3.69	1.49	5.90	0.88	6.51
— Commercial/Industrial Detailed audit	0.92	0.18	1.66	-0.02	1.86
Recommended measures: Commercial					
— Lighting	0.47	-0.07	1.00	-0.22	1.15
— HVAC	0.61	0.33	0.90	0.25	0.99
— Other	0.14	-0.12	0.40	-0.19	0.48
Industrial					
— Lighting	0.23	0.18	0.29	0.16	0.31
— Other	0.24	0.15	0.32	0.13	0.34
Total Net Demand Impacts	6.31	4.08	8.55	3.45	9.17

Exhibit 2-4
Net kW and kWh Impacts by Costing Period

Costing Period	kW Impacts	kWh Impacts
Summer On Peak	6.31	4,849
Summer Partial Peak	5.18	4,639
Summer Off Peak	3.23	8,895
Winter Partial Peak	3.51	8,267
Winter Off Peak	4.13	8,232

Exhibit 2-5
PG&E C-I Energy Management Services Net Impacts

	Prior PG&E Estimate		Impact Evaluation		Realization Rate	
	MW	MWh	MW	MWh	MW	MWh
Total Net Savings[1]	7.46	38,164	6.31	34,882	85%	91%
Low-Cost Measures[2]	3.49	18,165	4.61	25,502	132%	140%
Capital Intensive Measures:[2]						
Commercial	2.90	14,266	1.23	6,772	42%	47%
Industrial	0.07	539	0.49	2,607	700%	484%

1. Obtained from "PG&E Annual Summary of DSM Programs — April 1995" for the 1994 EMS Program.
2. Obtained from "Impact Evaluation of 1990-1992 Nonresidential Energy Management Services Programs." These numbers relate to the 1992 EMS program and so are not directly comparable to the results of this analysis of the 1994 program.

CHAPTER 3
DATA COLLECTION AND ANALYSIS

This chapter presents an overview of the data collection effort undertaken for this project and summarizes the results of the survey data collection tasks.

3.1 DATA SOURCES

Data were collected from various sources including utility program records, customer telephone and on-site surveys, and monthly billing records. The data from these sources, as well as the processing of the data, are presented below.

3.1.1 Program Tracking Data (MDSS)

The primary source for information on participants and recommended measures for this analysis was the Marketing Decision Support Service (MDSS) database. From this database, we obtained:

- a list of the 1994 participating customers
- the date of the audit
- the type of audit conducted (walk-through or detailed)
- the measures recommended and their expected kW and kWh savings
- PG&E premise code and division code.

Since the focus of this analysis was to estimate the load impacts associated with the audit program and not PG&E's incentive programs, the MDSS database was used to remove from the sample frame all participants who had also participated in PG&E's incentive programs.

3.1.2 Billing and Weather Data

Billing data were extracted from PG&E's billing system for both participant and nonparticipant accounts for the years 1993, 1994, and 1995 (to the extent available). These data were screened for tenancy changes (assumed if the customer name changed during the period 1993-1995), as well as for missing or zero reads. The cleaning and processing of the billing data was conducted before the telephone and site surveys in order to ensure that all surveyed customers had usable data.

To the extent possible, the size distribution (as measured by kWh consumption) for participants was matched by the nonparticipant sample. Exhibit 3-1 presents the average consumption per day (kWh/day) between surveyed nonparticipants and participants for the years 1993 (pre-installation), 1994 (installation) and 1995 (post-installation). Participants are larger on average than nonparticipants because of the different response rate between the two groups. This difference does not, however, affect the billing data analysis, as the model used in this analysis effectively controls for any differences in the level of consumption across customers (this is explained in detail in Chapter 4).

Exhibit 3-1
Average Consumption per Day
(in kWh/day) (surveyed customers only)

Year	Nonparticipants (n = 451)	Participants (n = 905)
1993	419.3	558.3
1994	418.7	560.0
1995	425.7	563.0
Total	420.8	560.3

Weather data (daily high and low temperatures) were received from PG&E for a number of weather stations in the utility service territory. The weather data were matched to the billing data by means of the division/office code specific to each customer and associated with a particular weather station. The weather data were used to compute heating degree days and cooling degree days for each month between 1993 and 1995. The weather and billing files were merged with the survey files and MDSS data by means of the premise number and control ID to produce the evaluation dataset.

3.1.3 Telephone Survey

The first step in the development of the telephone survey was the development of the participant sample. This involved the elimination of those EMS participants who received an audit and also participated in PG&E's incentive program. Based on an analysis of the MDSS database, there were 5,963 customers who received an audit in 1994 as part of the EMS program who did not also receive a rebate and who have complete and usable billing data (after cleaning the billing data). In addition, customers classified as agricultural (31 customers) were also excluded from this total, as were customers that PG&E viewed as sensitive or that have been surveyed for other projects. There are two distinct populations of participants — industrial and commercial customers. The sample plan for each of these populations is discussed below.

Industrial Participant Sample. Of the 5,963 customers who received an audit but not a rebate, 31 are classified as industrial customers. All 31 customers were included in the sample.

Commercial Participant Sample. The commercial participant sampling frame consists of 5,932 customers who received an audit in 1994 but not a rebate. Based on the Protocol requirements, three end-uses are of interest for this population: lighting, HVAC, and other measures. Since over 99 percent of the customers received a recommendation concerning lighting, the population was classified into one of two groups prior to sampling. Those who received a recommendation for "other" measures were classified into one group (these customers may also have received a recommendation for lighting or HVAC measures). Customers who received a recommendation for lighting and/or HVAC, but not an "other" measure were classified into the second group.

Within each of the two groups, the sampling frame was further stratified by the magnitude of the expected savings attributable to the recommended measure(s). Approximately 40 percent of the sample points were allocated to those customers who had an estimated savings in the top 20 percent of customers in that group. This sample plan minimized the amount of required stratification and weighting while still achieving the requirements of the Protocols (i.e., 450 observations by end use).

Exhibit 3-2 summarizes the sample plan for the telephone survey as well as the number of completed surveys. The telephone survey instrument is presented in Appendix B.

Exhibit 3-2
Telephone Survey Disposition

	Participant	Nonparticipant
Beginning sample	1,594	700
Out of sample (moved/out of business, deceased)	48	36
Adjusted sample	1,546	664
No recollection of audit	196	—
Language barrier	20	10
Phone problems	77	98
Refusals	151	74
No contact/called at least six time	197	31
Completed surveys	905	451

3.1.4 On-Site Data Collection

The sample of EMS customers for the on-site data collection effort was selected as a subsample of the customers who were first contacted through a telephone survey. Respondents to the telephone survey were asked whether they had implemented any of the capital-intensive energy efficiency measures that PG&E's EMS representatives had

recommended to them. The sample of customers for the on-site visits was selected from among those telephone survey respondents who indicated that they had implemented one or more from a list of fourteen possible recommended measures. These measures included the following:

- T-8 fluorescent lamps with electronic ballasts
- compact fluorescent fixtures
- halogen lamp conversion
- motion detectors
- other lighting modifications
- setback thermostat
- clean condenser coils on HVAC equipment
- HVAC maintenance
- other HVAC measures
- nonprocess boiler measures
- clean condenser coils on refrigeration equipment
- other refrigeration measures
- process measures
- agricultural-related measures.

Customers who had implemented any of these measures were the focus for the on-site visits because a primary purpose of the on-site data collection was to obtain data with which to estimate more accurately the savings realized from implementing recommended measures. Only customers who had implemented a measure could provide the information needed for this estimation.

The survey instrument used for collecting the on-site data is provided in Appendix C. This instrument was used to collect data pertaining not only to implementation of recommended measures but also to characteristics of the premise, its equipment, and its operating schedules. The characteristics data were used in engineering analysis to calculate the energy savings associated with energy efficiency measures implemented by the customers. Savings were calculated as kW or kWh, whichever was appropriate for the implemented measure.

On-site data collection was conducted for 137 commercial and industrial customers. These customers had received recommendations from PG&E for 255 capital intensive energy efficiency measures and had implemented 125 of these measures. Exhibit 3-3 shows how the customers visited on-site were distributed across building types. It also shows the distribution of PG&E's recommended measures across building types and the distribution of those reporting that they had implemented one or more of the recommended measures. Note that in some cases the customer reported that a measure was installed, yet this could not be verified during the on-site.

Exhibit 3-3
Distribution of On-Site Surveys, Recommended Measures, and Implemented Measures by Building Type

Building Type	Number of Sites Visited	Number of Recommended Measures at Visited Sites	Number of Implemented Measures at Visited Sites
Offices	17	29	15
Restaurants	21	44	20
Food Stores	16	24	11
Retail Stores	28	58	29
Warehouses	3	4	3
Health Care	7	13	6
Education	3	4	2
Lodging	2	3	2
Public Assembly	5	11	5
Services	14	23	9
Other	13	26	16
Industrial	8	16	7
Total	137	255	125

3.2 TELEPHONE SURVEY FINDINGS

This section presents findings from the participant and nonparticipant telephone surveys as they relate to:

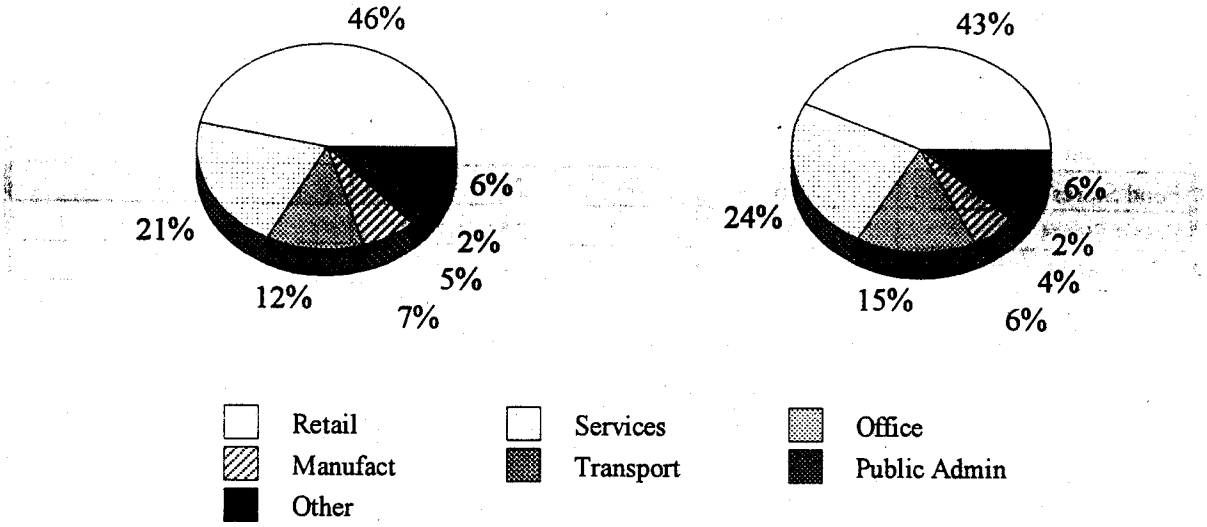
- facility characteristics
- measure installation and awareness of PG&E rebates
- program audit staffing and performance
- dollar value of audit and willingness to pay.

3.2.1 Facility Characteristics

- **A majority of surveyed customers were from retail trade and services.**

As shown in Exhibit 3-4, telephone surveys for this evaluation were conducted primarily with companies which are classified under *Retail Trade* and *Services* according to the Standard Industrial Classification (SIC). Notice that the distribution by business sector for nonparticipants closely matches the distribution for participants.

Exhibit 3-4
Business Sector
Participants (N = 905) and Nonparticipants (N = 451)

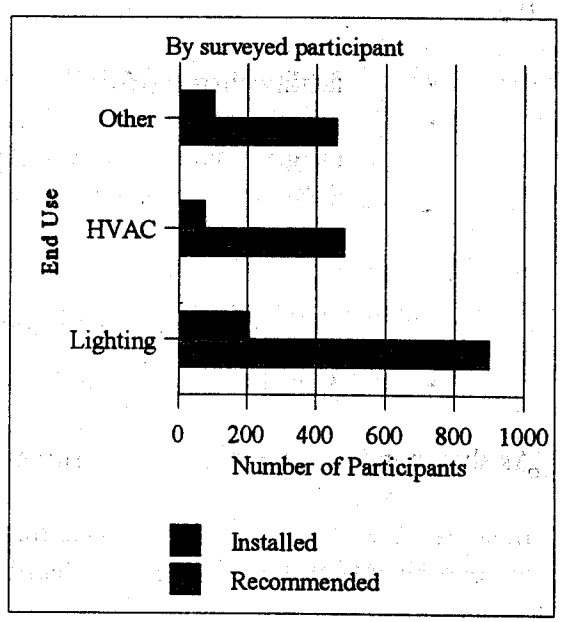


3.2.2 Measure Installation and Awareness of PG&E Rebates

- **More than half the participants did not install, or do not recall installing, measure(s) recommended by the PG&E representative.**

Participants in the 1994 Program were asked whether or not they had installed the measure(s) recommended to them during the energy audit. Only about 38 percent (or, 345 of 905) of the participants in the EMS Program indicated that they have installed any of the recommended measure(s). The breakdown of measure installation by end-use is presented in Exhibit 3-5. Based on these results, there is a 23% installation rate for lighting, 16% installation rate for HVAC, and a 23% rate for other.

Exhibit 3-5
Recommended Measure Installation



- **About two-thirds of the participants knew about PG&E's rebates for their installed measure(s).**

During the telephone survey, participants were also asked whether they were aware of PG&E's rebate programs for customers who were installing the measures recommended through the audit Program. Most of the participants who installed one or more measures (62%, or 214 of 345) indicated that they were aware of PG&E's rebate payments for these measure(s) but did not apply for the rebate. There was not one single primary reason for this lack of obtaining a rebate, rather the reasons mentioned included:

- filling out the rebate applications was too much trouble
- they applied for a rebate, but never received it
- they applied for a rebate, but did not qualify
- applied for rebate, but was told that there were not rebates for measure.

Those participants who did not install the recommended measures were asked for the reason behind that action for each measure. The reasons were:

- initial cost was too high (43%)
- was not aware of recommendation (10%)
- energy saving estimates were not as great as expected (8%)
- installation was too difficult (2%)
- maintenance costs were too high (1%).

Fifty percent of the respondents who did *not* install the measure knew about PG&E's rebates for these measures. Reasons for not taking advantage of these rebate opportunities were:

- rebate amount was not enough (33%)
- filling out the rebate applications (9%)
- not enough time/too busy
- in process of applying for rebate
- plan to close/out of business
- want to try out the existing equipment/not worth changing right now.

CHAPTER 4
ANALYSIS METHODOLOGY

This chapter addresses the analysis used in the estimation of the load impacts associated with PG&E's 1994 Commercial-Industrial Energy Management Services Programs (EMS). Section 4.1 of this chapter reviews the billing data analysis. Section 4.2 presents the net-to-gross analysis, and Section 4.3 concludes the chapter with a discussion of the engineering analysis.

4.1 STATISTICAL BILLING ANALYSIS

This section discusses the characteristics of the regression model used to estimate the load impacts of the installation of low-cost/no-cost measures and the installation of recommended measures under EMS in the commercial sector. The approach involved the estimation of a monthly panel model, i.e., a model that used both cross-sectional observations (data across customers) and time-series observations (data over time for each customer). The details of this specification are discussed below. Because the number of industrial participants in the telephone survey sample who installed recommended measures was relatively small (12 customers), a meaningful statistical analysis of these customers was not possible. Therefore, the analysis of the load impacts associated with the capital intensive measures in the industrial sector was based upon the engineering analysis of the on-site data.

4.1.1 Model Specification

There are two widespread problems encountered in evaluations of C-I programs such as this one. The first is that there is such a diverse population in these sectors that it is difficult to (1) obtain comparable nonparticipant buildings, and (2) develop a meaningful model which "pools" across customers. The second issue is that the regression results may be significantly affected by outliers, i.e., firms whose consumption is so different from the others in the sample that they overwhelm the results of the model. These problems can produce impact estimates which are statistically insignificant or unreasonable.

One approach to resolving these problems is to run separate regressions for each facility. In addition to being prohibitively expensive, this approach is also inefficient since it ignores any information common across sites. Therefore, this study used **monthly panel models** to resolve these problems.

The monthly models used in this analysis, termed "fixed-effects panel models," have as the dependent variable the monthly consumption for a firm less its average consumption over the time period. The independent variables are similarly defined. In this manner, each firm is essentially given a unique constant term which controls for differences between firms in terms of constant characteristics. These include characteristics such as size, facility type, and even the unexplained portion of energy use. Therefore, a fixed-effects monthly panel model investigates only the factors that change energy use over time (which is the essence of an impact evaluation), rather than trying to explain the more complicated issue of factors that affect total energy use.

Monthly panel models have the further advantage of **not** requiring detailed information about the facilities, since many of these variables either drop out of the model (the fixed effects model controls for any explanatory variables that do not change over time), or are statistically insignificant. In addition, these models do not require the development of a single pre- and post-installation window. Rather, each individual has a unique pre- and post-installation time period (which could be thought of as a "rolling" participation window), and in a sense, each participant serves as their own control group.

An additional benefit of this type of model is that it implicitly controls for self-selection bias by modeling the factors which affect the change in consumption over time, rather than the level of consumption. To understand this result, consider that self-selection bias arises because program participants select themselves into the program, while nonparticipants select themselves out of the program. This volunteerism implies that there may be a systematic (and unobserved) difference between the energy use of participants and nonparticipants, so that any comparison of the two will give an inaccurate estimate of the program impact. For example, suppose that participants decide to participate because they are more "energy conscious" relative to nonparticipants, and we cannot measure directly a customer's level of energy consciousness. What this implies is that, all other things being equal, participants will be more likely to have a lower level of energy consumption than nonparticipants even without an energy efficiency program. The bias occurs if the researcher does not control for this difference in attitudes, and so attributes this difference in consumption to the energy efficiency program.

In the monthly panel model specification used for this analysis, each customer's energy use is modeled as the deviation from their average energy use. Thus, any differences in the *level* of energy use due to unmeasurable attitudes and opinions (such as energy consciousness), will be eliminated, and therefore so will self-selection bias. It may be, however, that there are some unmeasured factors which also effect the change in consumption over time. While this type of self-selection bias will not be corrected for by the monthly panel model, it will also not be corrected by the standard techniques used to correct for self-selection bias. A technical discussion of these issues can be found in *Longitudinal Labor Market Studies: Theory, Methods, and Empirical Results*, edited by J. Heckman and B. Singer, Academic Press, 1982.

In general, there are four possible specifications which can be used for monthly panel models.[1] The first specification is known as the *fixed effects* model, where the differences across customers are captured in differences in the constant term. That is, each firm in the model has a unique constant term which is constant over time. Letting i and t denote subscripts for facility i and month t respectively, the general form of the fixed effects model may be written as:

$$y_{it} = \alpha_i + \beta' X_{it} + \epsilon_{it} \ , \qquad (4\text{-}1)$$

where:

y	=	energy consumption
α	=	constant term
ß	=	vector of coefficients
x	=	vector of variables that determine energy consumption
ϵ	=	error term.

As shown by the equation, in contrast to a pre/post model, the unit of observation in a panel model is *a given period of time (e.g., a month) for a given facility*. This has the beneficial effect of increasing the number of data points available for analysis. For example, in the context of the EMS regression models, implementation of a panel data model approach is associated with a number of observations on the order of 38,000.

In the fixed effects specification shown above, the differences across units are captured by individual-specific constant terms (the α_i terms). In the context of the EMS models, differences across facilities that determine energy consumption, such as facility size and facility type, are thus captured in the firm-specific intercept term. In practice, rather than estimating several thousand unique intercept terms, an equivalent approach is employed which expresses both the dependent and independent variables in terms of deviations from their time-series means for each firm. The resulting estimated coefficients from this "deviation from the mean" approach are equal to the coefficients found using customer-specific intercept terms.

The fixed effects model can be expanded to include time effects (that is effects which are constant across customers but vary over time):

$$y_{it} = \alpha_i + \gamma_t + \beta' x_{it} + \epsilon_{it} \ . \qquad (4\text{-}2)$$

1. There are other models, not discussed here, which allow the slope coefficients to vary over both time and individuals (in either a fixed or random fashion). These models are significantly more complicated, and there is little justification for these models over the ones discussed above.

In this specification, the γ_t terms are month-specific indicator variables. In previous evaluations conducted in the commercial and industrial sectors, we have found that this approach seems to produce more precise results than a model with only individual firm effects. Therefore, we generally prefer the individual and time effects approach (Equation 4-2) over the individual effects only approach (Equation 4-1).

A significantly different approach is to assume that the differences across firms are random variables (rather than fixed constants as is done in Equation 4-1). In other words, the constant terms are randomly distributed across firms — there is no systematic difference across firms. This is termed the ***random effects*** model:

$$y_{it} = \alpha + \beta' x_{it} + \mu_i + \epsilon_{it} \quad . \tag{4-3}$$

In a sense, this model implies that the firms in the model are a random sample of a much larger population, an assumption not required for the fixed effects model. One of the (slight) benefits of the random effects model is that it allows the inclusion of level variables (i.e., variables that do not change over time) in the X matrix contrasted with the fixed-effects model which requires that the independent variables change over time.

The random effects model with random time effects (called the *variance components* model) is:

$$y_{it} = \alpha + \beta' x_{it} + \mu_i + \nu_t + \epsilon_{it} \quad . \tag{4-4}$$

Based on our past experience in the commercial and industrial sectors, there is strong evidence to concentrate on models with both individual effects and time effects. Therefore, we have concentrated our analyses on Equations 4-2 and 4-4.

The question then becomes how to choose between the fixed effects and the random effects models. Historically, the fixed effects model was not used by most researchers because it is costly in terms of degrees of freedom lost. This is clearly not an issue given our huge datasets. Therefore, there is good reason to estimate a fixed effects model. In addition, the random effects model has the considerable drawback that it assumes that the individual effects (the μ_i and ν_t in Equation 4-4) are **uncorrelated with the other regressors**. If this is not the case, then the random effects model may suffer from bias. If the random effects is the correct specification, then the fixed effects model, while consistent, is inefficient relative to the random effects model. The bottom line however, is that the potential bias of the random effects seems to be a large price to pay for efficiency and the ability to include level variables in the model. Therefore, we generally prefer the fixed effects model to the random effects model.

Fortunately, we are able to make use of the test developed by Hausman (see "Specification Tests in Econometrics," *Econometrica*, 46:1251-1272, 1978) to determine on a case-by-case basis whether or not the random effects model is the proper specification. Basically, this test involves computing the variance of the difference between the parameter estimates obtained from the fixed effect and the random effects models. If this difference is "small," then the random effects model is the correct specification. If this difference is large, then the random effects may be correlated with the other regressors, and the fixed effects specification should be used.

Application of the Hausman test to the EMS random effects and fixed effects models has indicated that we can reject the hypothesis that random effects is the correct specification. We thus have focused the remainder of the panel data regression analyses on the fixed effects with time effects specification.

The next section presents the results of the fixed effects models.

4.1.2 Estimation Results

The regression model was estimated over a sample of participant and nonparticipant facilities. Inclusion of nonparticipant facilities helps to control for the effects on energy use of a number of changes that occur over time (e.g., changes in population, business activity, energy prices, expectations regarding future business conditions) that influence the demand and supply of goods and services produced in the commercial and industrial sectors and hence the derived demand for energy in these sectors.

Consumption data were gathered and processed for the period of January 1993 through September 1995. The dependent variable in the model was the natural log of the average daily kWh consumption by month and facility, for each month available between January 1993 and September 1995. In order to give participants time to install measures (as well as to account for the timing of the audit), we eliminated for each participant the month that the audit took place. This log specification is useful since the parameters on the participation and measure installation indicator variables show the *percentage savings* associated with the program (rather than a level savings produced by a linear specification).

The independent variables were:

- Average daily heating degree days for the month, interacted with a 1-0 variable indicating whether the facility uses electricity for space heating.
- Average daily cooling degree days for the month, interacted with a 1-0 variable indicating whether the facility uses electricity for space cooling.

- A 1-0 variable indicating participation in the EMS audit, intended to capture any *pure audit effect apart from the installation of recommended measures.* For facilities that received an audit, this variable takes on a value of zero for all months preceding the audit and a value of one for months thereafter. The variable takes on a zero value for all months for audit nonparticipants.

- An additional 1-0 variable indicating that the facility received an detailed audit under EMS. This was done to capture *the additional savings associated with a detailed audit.*

- 1-0 indicator variables for commercial customers who installed recommended lighting, HVAC, and other measures. These variables takes on a value of zero for all months for nonparticipants, as well as for audit participants who did not indicate, via their responses to the survey questions, that they had installed any recommended measures. For participants who reported that they did install certain recommended measures, the appropriate variable takes on a value of zero up until the month of installation, at which point it takes on the value one.

- A variable denoting the number of employees at the facility in the specific month.

- A 1-0 indicator variable for those firms which stated that they remodeled during the time period of the model. For facilities that underwent this change, the variable takes on a value of zero for all months preceding the time of the change and is equal to one for all months after the change.

- A 1-0 indicator variable for those firms which stated that they added electrical equipment during the time period of the model. For facilities that underwent this change, the variable takes on a value of zero for all months preceding the time of the change and is equal to one for all months after the change.

In order to maximize the number of observations in the model, any missing survey data was treated as a negative response. For example, if a customer did not answer the question on whether or not they added electrical equipment during the time period of the model, we assumed that they did not add any. This has the effect of introducing random error in the model, it does not cause any bias.

The model was initially estimated over the entire sample of participants and nonparticipants, and the presence of outliers and influential data points where investigated using studentized residuals (where the residuals for each observations are scaled to have the students distribution) and DFFITS (which measures how much each observation influences the estimated coefficients). For a discussion of these tests, see Ozog et. al "Model Specification and Treatment of Outliers in the Evaluation of a Commercial Lighting Program," *Energy*

Services Journal, Vol. 1, No.1, September 1995. Based on these tests and an investigation of the data, we found eight firms which were outliers. Since these observations had extreme, unexplainable, fluctuations in monthly consumption (as high as a 5,000% change in consumption over the time period of the model) we elected to eliminated these observations from the model.

The results of the final monthly panel model are presented in Exhibit 4-1. All of the estimated coefficients have the expected signs and are statistically significant at reasonable levels of confidence (since most of the t-values are greater than 1). For the no-cost/low-cost measures (i.e., the coefficient on the participation indicator variables), the coefficient on the overall audit variable (-0.0096) indicates that all EMS participants reduced their usage by 0.96% by installing low-cost/no-cost measures. Additionally, the participation variable for the detailed audit (-0.0351) indicates that participants who received the detailed audit reduced their consumption by *an additional* 3.51%. Both of these results are statistically significant at the 90% level of confidence.

Exhibit 4-1
Results of Fixed Effects Panel Model

Dependent variable: Natural log of the average daily kWh consumption by month and facility: January 1993 to September 1995	
Independent Variable	**Coefficient (t-value)**
Heating degree days	0.0003 (0.70)
Cooling degree days	0.0218 (48.41)
1-0 variable indicating participation in the EMS program	-0.0096 (-2.15)
1-0 variable indicating the customer received a detailed audit	-0.0351 (-1.60)
1-0 variable indicating installation of lighting recommended measures for commercial customers	-0.0082 (-1.12)
1-0 variable indicating installation of HVAC recommended measures for commercial customers	-0.0301 (-2.79)
1-0 variable indicating installation of other recommended measures for commercial customers	-0.0068 (-0.71)
Number of employees	0.0009 (3.15)
Remodeled facility	0.0384 (4.18)
Added electrical equipment	0.0570 (5.26)
Full R-squared Partial R-squared	98% 3%
Number of observations	37,612

For the capital intensive measures in the commercial sector, the results in Exhibit 4-1 show that participants who stated that they installed the recommended lighting, HVAC, or other measures saved 0.82%, 3.01%, and 0.68% of their consumption, respectively. These savings figures are *in addition* to the savings associated with having the audit.

In order to compute the kWh impacts from the results presented in Exhibit 4-1, the coefficients (representing percentage savings) must be multiplied by the appropriate average consumption to produce the level of savings. The required inputs and results of this process are presented in Exhibit 4-2.

Exhibit 4-2
Computation of Gross kWh Impacts

	Comm. Walk-through Audit	Detailed Audit	Commercial		
			Lighting	HVAC	Other
% Savings	0.96%	4.48%	0.82%	3.01%	0.68%
Average consumption (annual kWh)	184,690	1,958,152	163,082	157,573	156,202
kWh savings per participant	1,779	87,700	1,345	4,748	1,059
# of participants	11,476	58	2,647	929	1,372
Program MWh savings	20,415	5,087	3,560	4,409	1,453

We investigated the presence of autocorrelation and heteroskedasticity in the model, where autocorrelation is when the error terms in the model are correlated over time, and heteroskedasticity is where the error terms across observations (i.e., customers) are correlated. In both cases, the estimated coefficients are unbiased, but they are inefficient (high variance) and thus the t-values may be misleading. For this study, we found that correcting for these did not substantially change the results. This was expected, because the large sample size in the model tends to minimize the effects of autocorrelation and heteroskedasticity since the inefficiency of the estimates are reduced in large samples. Collinearity is also not an issue in this model, as was verified by eliminating variables and observing that the remaining coefficients did not change (this crude test is only useful if the coefficients do not change — changing coefficients need not imply the presence of collinearity).

Estimation of the load impacts of both the low-cost/no-cost and capital intensive measures were attempted on a facility level basis. However, due to the small number of individuals who installed the recommended capital measures, we were unable to produce meaningful estimates by facility type.

4.2 NET-TO-GROSS ANALYSIS

The billing analysis presented above produced estimates of the gross program impacts. In order to produce net load impacts, the results of the billing analysis must be modified by the net-to-gross ratio (see Ozog and Waldman, "Reply to 'Using Discrete Choice Models to Determine Free-Ridership,'" *Evaluation Exchange*, Vol. 3, No. 1, March/April 1993 for a discussion of this issue).

For the low-cost/no-cost measures, we assume that the reason participants did not install the measures prior to the audit is that they were unaware of these measures (since the measures are essentially costless to implement). Therefore, it is reasonable to assume that participants would not be aware of these measures without the audit, and the free ridership rate is therefore 0%, implying a net-to-gross ratio of 1.

For the capital intensive measures, the estimate of free ridership was completed based on participants' self-reported survey responses. Specifically, participating customers were asked during the telephone survey to indicate their likelihood of installing the measures they received through the program *without the audit recommendations*. Those customers who indicated that they would have been likely to install the measures without the audit recommendations were then asked about the time frame within which they would have installed the measures (i.e., at same time of participation or at a later date).

The free ridership rate shown in Exhibit 4-3 has been estimated for each measure based on participant responses to the two survey questions discussed above, using the following weights:

- "very likely to install at the same time," weight = 100%
- "very likely to install at a later date," weight = 75%
- "somewhat likely to install at the same time," weight = 75%
- "somewhat likely to install at a later date," weight = 50%
- "not very likely to install without recommendation," weight = 0%.[2]

These responses were then weighted by the gross savings estimates by end-use to get the net-to-gross ratio by end-use presented in Exhibit 4-3.

As shown in Exhibit 4-3, the free ridership rate by end use in the commercial sector is 27% for lighting, 23% for HVAC, and 45% for other. In the industrial sector, the rates are 28.9% for lighting and 43% for other (including HVAC).

2. Includes "don't know" and "refuse/no response" cases.

Exhibit 4-3
Results of the Free Ridership Analysis

Measure Type	Commercial			Industrial		
	Measures Installed	Free-Ridership Rate	Weighted Free-Ridership Rate	Measures Installed	Free-Ridership Rate	Weighted Free-Ridership Rate
2 T_8 Lamps w/ Elect. Ballast	136	2.4%	9.0%	8	28.1%	16.3%
Compact Fluor. Fixtures	82	33.5%	3.1%	1	100.0%	3.0%
Halogen Lamp Conversion	20	33.8%	5.2%	2	0.0%	0.0%
Motion Detectors	8	12.5%	0.4%	—	—	—
Lighting — Other	73	28.1%	9.8%	10	25.0%	9.6%
Lighting Measures	***319***	***31.0%***	***27.5%***	***21***	***27.4%***	***28.9%***
Setback Thermostat	46	37.0%	6.6%	—	—	—
Cl. Cndsr Coils on HVAC	43	3.5%	0.2%	6	45.8%	2.3%
HVAC M&O	6	29.2%	4.8%	—	—	—
HVAC — Other	21	19.1%	11.5%	2	50.0%	4.3%
HVAC Measures	***116***	***36.4%***	***23.0%***			
Non-Process Boiler	1	50.0%	0.0%	—	—	—
Cl. Cndsr Coils on Refr.	80	51.6%	12.5%	5	35.0%	0.4%
Refrigeration — Other	39	29.5%	6.5%	2	0.0%	0.0%
Process	20	48.8%	26.1%	2	50.0%	42.6%
Other Measures	***140***	***45.0%***	***45.2%***	***17***	***38.2%***	***43.0%***

4.3 ENGINEERING ANALYSIS

Of the 255 measures recommended by PG&E to the customers in the on-site sample, 125 measures were verified as being implemented. The data collected on-site for these measures were used in engineering analyses to calculate the achieved savings associated with a measure. Savings were calculated both as kW reductions and kWh savings, as appropriate for the implemented measure.

Information pertaining to the estimates of savings for implemented measures is reported in Exhibit 4-4 for the commercial sector and Exhibit 4-5 for the industrial sector.

Based on the figures for the commercial sector, the kWh impacts from this engineering analysis are slightly lower than PG&E's estimate in the MDSS database, with an overall realization rate of 78%. These are also slightly lower than the results found in the billing

Exhibit 4-4
kW and kWh Savings for Recommended Measures that Were Implemented in the Commercial Sector

Action Code	Action Description	Number of Measures Recommended by PG&E	Number of Recommended Measures Implemented by Customers	Average kW Reductions for Implemented Measures	Average Annual kWh Savings for Implemented Measures
101	Change to 12w compact fluorescent lamps	1	1	0.99	4,371
102	Compact fluorescent fixtures	27	15	0.92	5,895
123	Change to HPS or LPS outdoors	1	1	—	—
144	T8 (original) but f72t12cwalso proposed.	1	0	—	—
146	Replace T12s with T8s & change to electronic ballast.	11	6	3.41	9,869
150	Other lighting changes	2	1	0.59	2,124
156	Halogen lamp conversion	6	5	1.18	2,216
166	Motion detectors for outside security lights.	4	1	0.48	1,401
171	2-F32T8 with electronic ballast and reflector	11	6	4.14	18,473
176	T8 (F32t8 w/ elec ballast)	32	12	4.51	13,282
182	Halogen lamp conversion	1	0	—	—
199	Lighting, other	10	7	5.39	14,352
205	Setback thermostat	19	9	2.61	4,101
250	HVAC maintenance	2	1	1.77	3,787
257	Clean HVAC condenser coil	14	7	2.15	4,569
299	Other HVAC changes	8	2	3.01	3,787
329	Nonprocess, boiler	1	0	—	—
339	Nonprocess, boiler	1	0	—	—
472	Clean condenser coils of refrigeration equipment	34	23	0.12	369
489	Refrigeration, other	18	5	2.11	6,181
519	Food process equipment	1	0	—	—
598	Process (office equipment)	2	0	—	—
599	Process other	6	0	—	—
	Totals	213	102		

Exhibit 4-5
kW and kWh Savings for Recommended Measures that Were Implemented in the Industrial Sector

Action Code	Action Description	Number of Measures Recommended by PG&E	Number of Recommended Measures Implemented by Customers	Average kW Reductions for Implemented Measures	Average Annual kWh Savings for Implemented Measures
144	T8 (original) but f72t12 cw also proposed.	1	0	—	—
146	Replace T12s with T8s & change to electronic ballast.	1	1	7.78	30,747
149	Change fluorescent fixtures to electronic ballast	1	1	0.91	2,064
156	Halogen lamp conversion	2	1	8.11	20,655
176	T8 (F32t8 w/elec ballast)	1	0	—	—
199	Lighting, other	3	3	4.21	9,487
205	Set back thermostat	1	0	—	—
257	Clean HVAC condenser coil	3	1	0.61	865
472	Clean condenser coils of refrigeration equipment	1	0	—	—
599	Process other	2	0	—	—
	Totals	16	7		

analysis. Since these realization rates are based on a small number of on-site visits for the various measures relative to the billing analysis, we believe that these results may be anecdotal and are not statistically significant.

For the industrial sector, these results indicate that the estimated kWh impacts from this analysis are 66.8% and 76.7% of the MDSS estimates for light and other measures, respectively. Since, as stated previously, the sample size of industrial customers who installed capital intensive measures was too small for a meaningful statistical analysis (most of the industrial customers received a rebate for installing measures), we used these realization rates based on the engineering analysis to estimate these load impacts of these measures. Exhibit 4-6 presents the procedure used to extrapolate these results to the population of industrial program participants. Based on this analysis, the total end-use impacts in the industrial sector are 1,822 MWh for lighting and 2,302 MWh for other measures.

Exhibit 4-6
Industrial kWh Impacts of Capital Intensive Measures

	Lighting	Other
Average kWh savings from recommended measures (MDSS)	25,650	32,509
Average installation rate of recommendations	19.5%	16.9%
Realization rate from analysis of on-site data	66.8%	76.9%
Average savings per participant (kWh)	3,343	4,224
Total Savings (MWh)	1,822	2,302

APPENDIX A

EVALUATION SUMMARY TABLE (CPUC PROTOCOL TABLE 6)

Exhibit A-1: PG&E Commercial EMS Program

CPUC Protocol Table 6 - Study No. CEQ-96-HB01

	Average	Confidence Interval			
		80%		90%	
		Low	High	Low	High
Item 2a: Overall Gross End-Use Load Impacts (MWh)					
Walk Through Audit	20,415	8,242	32,588	4,843	35,987
Lighting	3,560	(515)	7,635	(1,653)	8,773
HVAC	4,409	2,376	6,442	1,808	7,010
Other	1,453	(1,171)	4,077	(1,903)	4,809
Item 2a: Overall Net End-Use Load Impacts (MWh)					
Walk Through Audit	20,415	8,242	32,588	4,843	35,987
Lighting	2,581	(373)	5,535	(1,198)	6,360
HVAC	3,395	1,829	4,961	1,392	5,398
Other	796	(641)	2,234	(1,043)	2,635
Item 2a: Overall Gross End-Use Load Impacts (MW)					
Walk Through Audit	3.69	1.49	5.90	0.88	6.51
Lighting	0.65	(0.10)	1.38	(0.30)	1.59
HVAC	0.79	0.43	1.17	0.32	1.29
Other	0.26	(0.22)	0.73	(0.35)	0.88
Item 2a: Overall Net End-Use Load Impacts (MW)					
Walk Through Audit	3.69	1.49	5.90	0.88	6.51
Lighting	0.47	(0.07)	1.00	(0.22)	1.15
HVAC	0.61	0.33	0.90	0.25	0.99
Other	0.14	(0.12)	0.40	(0.19)	0.48
Item 2b: Average Per Participant Gross End-Use Load Impacts (kWh)					
Walk Through Audit	1,779	718	2,840	422	3,136
Lighting	1,345	(195)	2,885	(624)	3,314
HVAC	4,748	2,558	6,938	1,947	7,549
Other	1,059	(853)	2,971	(1,387)	3,505
Item 2b: Average Per Participant Net End-Use Load Impacts (kWh)					
Walk Through Audit	1,779	718	2,840	422	3,136
Lighting	975	(141)	2,091	(453)	2,403
HVAC	3,662	1,976	5,336	1,507	5,805
Other	580	(467)	1,628	(760)	1,921
Item 2b: Average Per Participant Gross End-Use Load Impacts (kW)					
Walk Through Audit	0.32	0.13	0.51	0.08	0.57
Lighting	0.24	(0.04)	0.52	(0.11)	0.60
HVAC	0.85	0.47	1.26	0.35	1.36
Other	0.20	(0.15)	0.53	(0.25)	0.64
Item 2b: Average Per Participant Net End-Use Load Impacts (kW)					
Walk Through Audit	0.32	0.13	0.51	0.08	0.57
Lighting	0.18	(0.03)	0.38	(0.08)	0.43
HVAC	0.66	0.36	0.97	0.27	1.05
Other	0.11	(0.08)	0.29	(0.14)	0.35
Item 2d: Average Net Energy Impacts Realization Rate					
Overall	91%	-	-	-	-
Low-Cost/No-Cost Measures	140%	-	-	-	-
Capital Intensive Measures	47%	-	-	-	-
Item 2d: Average Net Demand Impacts Realization Rate					
Overall	85%	-	-	-	-
Low-Cost/No-Cost Measures	132%	-	-	-	-
Capital Intensive Measures	42%	-	-	-	-

Notes:
- Items 1A, 1B, 2D,and 3C are not included because the model used did not provide appropriate UECs.
- Savings by end-use are not available from the utility's first year earnings claim, so realization rates by end use are not possible
- Realization rate by measure type are based on the evaluation of the 1992 EMS program
- There is no confidence level about the realization rate because there is no formula for determining the variance of the ratio of two numbers who each have a variance

Exhibit A-1: PG&E Commercial EMS Program
CPUC Protocol Table 6 - Study No. CEQ-96-HB01

	Average	Confidence Interval			
		80%		90%	
		Low	High	Low	High
Item 3: Net-To-Gross Ratios					
Walk Through Audit	100.0%	100.0%	100.0%	100.0%	100.0%
Lighting	27.5%	-9.95%	64.95%	-20.48%	75.48%
HVAC	23.0%	-4.26%	50.26%	-11.93%	57.93%
Other	45.2%	5.30%	85.10%	-5.92%	96.32%
Item 4a: Designated Unit Intermediate Data - Pre-Installation					
Square Footage					
Participants	11,943	6,050	17,836	4,393	19,493
Comparison Group	17,576	11,672	23,479	10,012	25,139
Employees					
Participants	23.2	11.3	35.1	7.9	38.5
Comparison Group	30.2	15.2	45.2	11.0	49.4
Business Hours per week					
Participants	77.1	66.5	87.7	63.5	90.7
Comparison Group	75.5	64.9	86.1	61.9	89.1
Item 4b: Designated Unit Intermediate Data - Pre-Installation					
Square Footage					
Participants	11,949	6,057	17,842	4,399	19,499
Comparison Group	17,579	11,676	23,482	10,015	25,143
Employees					
Participants	24.1	12.2	36.0	8.8	39.4
Comparison Group	30.6	15.6	45.6	11.4	49.8
Business Hours per week					
Participants	76.6	66.0	87.2	63.0	90.2
Comparison Group	75.6	65.0	86.2	62.0	89.2

Notes: - Item 3b, NGR by unit of measurement, is the same as Item 3a.

Exhibit A-1: PG&E Commercial EMS Program

CPUC Protocol Table 6 - Study No. CEQ-96-HB01

	Participants	Comparison Group
Item 6a,c: Measure Count Data - Sample (number of customers installing measures)		
146 2 T_8 Lamps w/ Elect. Ballast	136	60
102 Compact Fluor. Fixtures	82	50
156 Halogen Lamp Conversion	20	12
166 Motion Detectors	8	2
150 Lighting -- Other	73	--
205 Setback Thermostat	46	35
257 Clean Cndsr Coils on HVAC	43	--
250 HVAC Maintenance	6	--
299 HVAC -- Other	21	--
329 Non-Process Boiler	1	--
472 Clean Cndsr Coils on Refr.	80	62
489 Refrigeration -- Other	39	--
599 Process	20	--
Item 6b: Measure Count Data - All Program Participants (number of customers installing		
146 2 T_8 Lamps w/ Elect. Ballast	1839	
102 Compact Fluor. Fixtures	1109	
156 Halogen Lamp Conversion	270	
166 Motion Detectors	108	
150 Lighting -- Other	987	
205 Setback Thermostat	622	
257 Clean Cndsr Coils on HVAC	581	
250 HVAC Maintenance	81	
299 HVAC -- Other	284	
329 Non-Process Boiler	14	
472 Clean Cndsr Coils on Refr.	1082	
489 Refrigeration -- Other	527	
599 Process	270	

Notes: - Due to the nature of the program, measures were modeled/surveyed by type, rather than number
Thus, the only practical division is the type of measure installed by participant, not measure count.

Exhibit A-1: PG&E Commercial EMS Program

CPUC Protocol Table 6 - Study No. CEQ-96-HB01

Item 7: Distribution by 3 digit SIC

3-Digit SIC	requenc	Percent
0	1273	11.5%
1	2	0.0%
2	14	0.1%
3	9	0.1%
11	1	0.0%
13	1	0.0%
16	3	0.0%
17	18	0.2%
18	19	0.2%
19	11	0.1%
21	1	0.0%
24	22	0.2%
25	11	0.1%
27	4	0.0%
29	3	0.0%
72	26	0.2%
74	37	0.3%
75	16	0.1%
78	8	0.1%
108	1	0.0%
138	2	0.0%
144	2	0.0%
149	1	0.0%
152	7	0.1%
153	11	0.1%
154	20	0.2%
160	1	0.0%
161	5	0.0%
162	3	0.0%
171	21	0.2%
172	4	0.0%
173	10	0.1%
174	6	0.1%
175	4	0.0%
176	6	0.1%
177	2	0.0%
178	2	0.0%
179	11	0.1%
401	1	0.0%
411	6	0.1%
412	1	0.0%
413	2	0.0%
415	5	0.0%
417	2	0.0%
421	35	0.3%
422	178	1.6%
423	1	0.0%
431	38	0.3%
441	1	0.0%
448	1	0.0%
449	16	0.1%
451	4	0.0%
458	5	0.0%

Exhibit A-1: PG&E Commercial EMS Program

CPUC Protocol Table 6 - Study No. CEQ-96-HB01

Item 7: Distribution by 3 digit SIC

3-Digit SIC	requenc	Percent
472	51	0.5%
473	16	0.1%
478	1	0.0%
481	12	0.1%
483	5	0.0%
489	1	0.0%
490	1	0.0%
493	2	0.0%
494	13	0.1%
495	17	0.2%
497	2	0.0%
498	1	0.0%
501	7	0.1%
502	7	0.1%
503	18	0.2%
504	35	0.3%
505	2	0.0%
506	33	0.3%
507	25	0.2%
508	57	0.5%
509	26	0.2%
510	1	0.0%
511	16	0.1%
512	3	0.0%
513	3	0.0%
514	47	0.4%
516	5	0.0%
517	4	0.0%
518	5	0.0%
519	35	0.3%
521	35	0.3%
523	35	0.3%
525	55	0.5%
526	13	0.1%
531	34	0.3%
533	99	0.9%
539	14	0.1%
540	3	0.0%
541	669	6.1%
542	23	0.2%
543	16	0.1%
544	18	0.2%
545	6	0.1%
546	126	1.1%
549	80	0.7%
551	73	0.7%
552	22	0.2%
553	136	1.2%
554	132	1.2%
555	3	0.0%
556	6	0.1%
557	12	0.1%
560	28	0.3%
561	36	0.3%

Exhibit A-1: PG&E Commercial EMS Program

CPUC Protocol Table 6 - Study No. CEQ-96-HB01

Item 7: Distribution by 3 digit SIC

3-Digit SIC	requenc	Percent
562	151	1.4%
563	20	0.2%
564	23	0.2%
565	41	0.4%
566	124	1.1%
569	49	0.4%
571	204	1.8%
572	29	0.3%
573	132	1.2%
581	1241	11.2%
591	52	0.5%
592	139	1.3%
593	81	0.7%
594	476	4.3%
596	9	0.1%
598	2	0.0%
599	258	2.3%
602	55	0.5%
603	57	0.5%
606	15	0.1%
609	11	0.1%
611	1	0.0%
614	12	0.1%
615	2	0.0%
616	14	0.1%
621	2	0.0%
628	5	0.0%
631	4	0.0%
632	1	0.0%
633	67	0.6%
636	21	0.2%
637	1	0.0%
641	30	0.3%
650	89	0.8%
651	18	0.2%
652	269	2.4%
653	106	1.0%
655	8	0.1%
656	40	0.4%
662	2	0.0%
672	3	0.0%
673	1	0.0%
679	2	0.0%
701	181	1.6%
702	4	0.0%
703	14	0.1%
704	8	0.1%
721	177	1.6%
722	18	0.2%
723	247	2.2%
724	36	0.3%
725	14	0.1%
726	7	0.1%
729	39	0.4%

Exhibit A-1: PG&E Commercial EMS Program

CPUC Protocol Table 6 - Study No. CEQ-96-HB01

Item 7: Distribution by 3 digit SIC

3-Digit SIC	requenc	Percent
731	5	0.0%
732	6	0.1%
733	67	0.6%
734	16	0.1%
735	29	0.3%
736	19	0.2%
737	32	0.3%
738	112	1.0%
750	1	0.0%
751	13	0.1%
752	8	0.1%
753	262	2.4%
754	41	0.4%
762	22	0.2%
763	1	0.0%
764	12	0.1%
769	63	0.6%
781	6	0.1%
783	19	0.2%
784	108	1.0%
791	4	0.0%
792	6	0.1%
793	14	0.1%
799	200	1.8%
801	96	0.9%
802	121	1.1%
804	96	0.9%
805	22	0.2%
806	10	0.1%
807	11	0.1%
808	1	0.0%
809	14	0.1%
811	42	0.4%
821	159	1.4%
822	11	0.1%
823	7	0.1%
824	7	0.1%
829	8	0.1%
830	1	0.0%
832	61	0.6%
833	8	0.1%
835	26	0.2%
836	33	0.3%
839	18	0.2%
841	5	0.0%
861	9	0.1%
862	2	0.0%
863	9	0.1%
864	46	0.4%
866	239	2.2%
869	7	0.1%

Exhibit A-1: PG&E Commercial EMS Program

CPUC Protocol Table 6 - Study No. CEQ-96-HB01

Item 7: Distribution by 3 digit SIC

3-Digit SIC	requenc	Percent
871	29	0.3%
872	45	0.4%
873	26	0.2%
874	19	0.2%
899	9	0.1%
913	7	0.1%
919	19	0.2%
921	1	0.0%
922	52	0.5%
931	1	0.0%
941	1	0.0%
943	3	0.0%
944	5	0.0%
951	1	0.0%
953	1	0.0%
962	5	0.0%
963	1	0.0%
964	3	0.0%
971	6	0.1%
999	42	0.4%

Exhibit A-1: PG&E Industrial EMS Program

CPUC Protocol Table 6 - Study No. CEQ-96-HB01

	Average	Confidence Interval			
		80%		90%	
		Low	High	Low	High
Item 2a: Gross End-Use Load Impacts (MWh)					
Detailed Audit	5,087	1,011	9,163	(127)	10,301
Lighting	1,822	1,368	2,276	1,241	2,403
Other	2,302	1,498	3,106	1,273	3,331
Item 2a: Net End-Use Load Impacts (MWh)					
Detailed Audit	5,087	1,011	9,163	(127)	10,301
Lighting	1,295	972	1,619	882	1,709
Other	1,312	854	1,770	726	1,898
Item 2a: Gross End-Use Load Impacts (MW)					
Detailed Audit	0.92	0.18	1.66	(0.02)	1.86
Lighting	0.32	0.25	0.41	0.23	0.44
Other	0.42	0.26	0.56	0.23	0.60
Item 2a: Net End-Use Load Impacts (MW)					
Detailed Audit	0.92	0.18	1.66	(0.02)	1.86
Lighting	0.23	0.18	0.29	0.16	0.31
Other	0.24	0.15	0.32	0.13	0.34
Item 2b: Average Per Participant Gross End-Use Load Impacts (kWh)					
Detailed Audit	87,700	17,430	157,970	(2,192)	177,593
Lighting	3,343	2,509	4,177	2,276	4,410
Other	4,224	2,748	5,700	2,336	6,112
Item 2b: Average Per Participant Net End-Use Load Impacts (kWh)					
Detailed Audit	87,700	17,430	157,970	(2,192)	177,593
Lighting	2,377	1,784	2,970	1,618	3,135
Other	2,408	1,567	3,249	1,332	3,484
Item 2b: Average Per Participant Gross End-Use Load Impacts (kW)					
Detailed Audit	15.87	3.15	28.59	(0.40)	32.14
Lighting	0.60	0.45	0.76	0.41	0.80
Other	0.77	0.48	1.03	0.42	1.11
Item 2b: Average Per Participant Net End-Use Load Impacts (kW)					
Detailed Audit	15.87	3.15	28.59	(0.40)	32.14
Lighting	0.43	0.32	0.54	0.29	0.57
Other	0.44	0.28	0.59	0.24	0.63
Item 2d: Average Net Energy Impacts Realization Rate					
Overall	91%	-	-	-	-
Low-Cost/No-Cost Measur	140%	-	-	-	-
Capital Intensive Measures Industrial	484%	-	-	-	-
Item 2d: Average Net Demand Impacts Realization Rate					
Overall	85%	-	-	-	-
Low-Cost/No-Cost Measur	132%	-	-	-	-
Capital Intensive Measures Industrial	700%	-	-	-	-

Notes:
- Items 1A, 1B, 2D,and 3C are not included because the model used did not provide appropriate UECs.
- Savings by end-use are not available from the utility's first year earnings claim, so realization rates by end use are not possible
- Realization rate by measure type are based on the evaluation of the 1992 EMS program
- There is no confidence level about the realization rate because there is no formula for determining the variance of the ratio of two numbers who each have a variance

Exhibit A-1: PG&E Industrial EMS Program

CPUC Protocol Table 6 - Study No. CEQ-96-HB01

	Average	Confidence Interval			
		80%		90%	
		Low	High	Low	High
Item 3a,b: Net-To-Gross Ratios					
Detailed Audit	100.0%	100.0%	100.0%	100.0%	100.0%
Lighting	28.9%	-35.2%	93.0%	-53.2%	100.0%
Other	43.0%	-19.5%	100.0%	-37.1%	100.0%
Item 4a:Designated Unit Intermediate Data - Pre-Installation					
Square Footage					
Participants	44,598	38,705	50,491	37,048	52,148
Comparison Group	24,096	18,193	29,999	16,532	31,660
Employees					
Participants	58.5	46.6	70.4	43.2	73.8
Comparison Group	45.4	30.4	60.4	26.2	64.6
Business Hours per week					
Participants	69.6	59.0	80.2	56.0	83.2
Comparison Group	66.9	56.3	77.5	53.3	80.5
Item 4b:Designated Unit Intermediate Data - Post-Installation					
Square Footage					
Participants	45,213	39,320	51,106	37,663	52,763
Comparison Group	24,096	18,193	29,999	16,532	31,660
Employees					
Participants	58.2	46.3	70.1	42.9	73.5
Comparison Group	46.0	31.0	61.0	26.8	65.2
Business Hours per week					
Participants	70.8	60.2	81.4	57.2	84.4
Comparison Group	66.8	56.2	77.4	53.2	80.4

Notes: - Item 3b, NGR by unit of measurement, is the same as Item 3a.

Exhibit A-1: PG&E Industrial EMS Program

CPUC Protocol Table 6 - Study No. CEQ-96-HB01

	Participants	Comparison Group
Item 6a,c: Measure Count Data (number of customers installing measures)		
146 2 T_8 Lamps w/ Elect. Ballast	8	6
102 Compact Fluor. Fixtures	1	3
156 Halogen Lamp Conversion	2	1
166 Motion Detectors	-	-
150 Lighting -- Other	10	--
205 Setback Thermostat	-	1
257 Clean Cndsr Coils on HVAC	6	--
250 HVAC Maintenance	-	--
299 HVAC -- Other	2	--
329 Non-Process Boiler	-	--
472 Clean Cndsr Coils on Refr.	5	4
489 Refrigeration -- Other	2	--
599 Process	2	--
Item 6b: Measure Count Data - All Program Participants (number of customers installing measu		
146 2 T_8 Lamps w/ Elect. Ballast	57	
102 Compact Fluor. Fixtures	7	
156 Halogen Lamp Conversion	14	
166 Motion Detectors	0	
150 Lighting -- Other	71	
205 Setback Thermostat	0	
257 Clean Cndsr Coils on HVAC	42	
250 HVAC Maintenance	0	
299 HVAC -- Other	14	
329 Non-Process Boiler	0	
472 Clean Cndsr Coils on Refr.	35	
489 Refrigeration -- Other	14	
599 Process	14	

Notes: - Due to the nature of the program, measures were modeled/surveyed by type, rather than number
Thus, the only practical division is the type of measure installed by participant, not measure count.

Exhibit A-1: PG&E Industrial EMS Program

CPUC Protocol Table 6 - Study No. CEQ-96-HB01

Item 7: Distribution by 3 digit SIC

3-Digit SIC	Frequency	Percent
201	10	1.8%
202	3	0.6%
203	9	1.7%
204	4	0.7%
205	6	1.1%
206	3	0.6%
207	1	0.2%
208	34	6.2%
209	13	2.4%
221	1	0.2%
226	1	0.2%
227	3	0.6%
233	1	0.2%
234	7	1.3%
238	1	0.2%
239	3	0.6%
241	1	0.2%
242	5	0.9%
243	23	4.2%
244	2	0.4%
245	2	0.4%
249	9	1.7%
250	1	0.2%
251	3	0.6%
252	2	0.4%
254	2	0.4%
259	1	0.2%
262	2	0.4%
265	5	0.9%
267	3	0.6%
270	2	0.4%
271	8	1.5%
272	1	0.2%
273	4	0.7%
274	1	0.2%
275	82	15.0%
277	1	0.2%
278	4	0.7%
279	4	0.7%
281	3	0.6%
282	2	0.4%
283	3	0.6%
284	1	0.2%
285	1	0.2%
289	3	0.6%
291	1	0.2%
299	1	0.2%
306	2	0.4%
308	19	3.5%
317	1	0.2%

Exhibit A-1: PG&E Industrial EMS Program

CPUC Protocol Table 6 - Study No. CEQ-96-HB01

Item 7: Distribution by 3 digit SIC

3-Digit SIC	Frequency	Percent
319	1	0.2%
320	1	0.2%
321	2	0.4%
322	1	0.2%
323	2	0.4%
325	3	0.6%
326	2	0.4%
327	8	1.5%
328	3	0.6%
329	2	0.4%
330	1	0.2%
331	2	0.4%
332	1	0.2%
334	1	0.2%
335	4	0.7%
336	1	0.2%
342	2	0.4%
343	1	0.2%
344	25	4.6%
347	10	1.8%
349	9	1.7%
351	1	0.2%
352	5	0.9%
353	5	0.9%
354	7	1.3%
355	2	0.4%
356	4	0.7%
357	10	1.8%
358	2	0.4%
359	47	8.6%
361	3	0.6%
364	2	0.4%
365	2	0.4%
366	7	1.3%
367	19	3.5%
369	1	0.2%
371	7	1.3%
372	2	0.4%
373	6	1.1%
375	1	0.2%
382	10	1.8%
384	3	0.6%
391	2	0.4%
393	1	0.2%
394	1	0.2%
399	8	1.5%

Exhibit A-2: PG&E Commercial EMS Program

CPUC Protocol Table 7 - Study CEQ-96-HB01

A Overview Information

1 Study Title:	Impact Evaluation of PG&E's 1994 Commercial Energy Management Services Program
Study ID:	CEQ-96-HB01
2 Program Description	Commercial Energy Management Program - 1994 program year
3 End-Uses Covered	Lighting, HVAC, and Other
4 Methods Used	Billing data analysis using a time-series/cross-sectional model of monthly data
5 Participant Definition	Any participant in PG&E's 1994 commercial EMS program who did not later participate in PG&E's Incentive Programs
Comparison Group	Any PG&E commercial customer who did not participate in either the EMS program or the Incentive Programs during 1994.
6 Analysis Sample Size	Commercial: 828 participants and 422 nonparticipants 191 installed lighting measures, 67 HVAC, and 99 other - Details in Exhibit A-1 For both groups, 33 months of billing data were used (Jan. '93 through Sept. '95)

B Database Management

1 Data Flow	Four data elements were used: Billing Data, Survey Data, Weather Data and Participant Data
2 Specific Data Sources	Consumption history was obtained from PG&E billing data Participation date, recommended measures, and audit type were obtained from PG&E's MDSS Weather Data was obtained directly from PG&E Information on installed measures, background variables (changes) obtained from telephone survey Information for engineering analysis obtained from the on-site surveys

3 Data Attrition*

C-I Sample Attrition:	Participants	Nonparticipants
Customers with Billing Data	12066	23651
After screening for Tenent Change, Missing Reads, Zero reads	9551	13052
After screen for large consumption changes	8789	11595
Non-rebate customers	5995	-
Match to Participants (consumption, facility)	-	
Final Sample	905	449

4 Quality Checks	Billing and Participation records were merged on the basis of premise number and control IDs. Weather data was merged with billing records on the basis of division/office codes
5 Unused Data	There was no data collected that was not used for the analysis

C Sampling

1 Sampling Procedures	The sampling frame for participants was all 1994 Commercial EMS Participants who did not receive an incentive from PG&E to install the recommended measures For non-participants, the sample frame was all Commercial customers The sampling frame strategy was stratified random sampling using facility type and and consumption as the stratify variables The sampling basis is the control number. The sample size was based on 450 by end-use in the commercial sector For the on-site survey, all participating customers who installed measures and who agreed to the on-site survey received an on-site survey
2 Survey Information	The survey instrument for both the telephone and on-site surveys are in Appendix B and C, resp. The response rates and refusals are presented in Exhibit 3-2 There were no efforts to test or account for non-response bias

3 Statistical Descriptions — The Descriptive statistics for the key variables are:

	Participant		Comparison Group	
	Mean	St.Dev.	Mean	St. Dev.
kWh/day	5.052	1.433	4.891	1.479
Installed Lighting	0.1852	0.3885	0	0
Installed HVAC	0.069	0.2534	0	0
Installed Other	0.0917	0.2886	0	0
HDD	1.9464	4.303	2.1938	4.574
CDD	1.9978	4.142	1.787	3.8635
Remodel	0.074	0.2617	0.04	0.195
Number of Employees	24.86	54.78	28.105	88.71
Added Electric Equipment	0.0441	0.2054	0.0167	0.1281

Exhibit A-2: PG&E Commercial EMS Program

CPUC Protocol Table 7 - Study CEQ-96-HB01

D Data Screening	
1 Outliers, Missing Data Weatherization	-Outliers were found using studentized residuals -Missing Data: missing consumption reads were left as missing, otherwise see item D.11 below -Weatherization was done through the inclusion of CDD and HDD in the model
2 Background Variables	A comparison group was used to control for non-program effects that were not measured.
3 Screening Customers	Beyond the elimination of 8 firms who were outliers, the only screening was that shown in B.3
4 Regression Statistics	These are provided in Exhibit 4-1
5 Specification	This discussion is found in Section 4.1.1
6 Errors in Variables	The study utilized data collection methods which give the highest quality data with the lowest errors in measurement. For example, use of telephone surveys rather than mail surveys to gain consistency in survey results. Telephone and on-site surveyors were given special training.
7 Autocorrelation	There were no autocorrelation problems in the model
8 Heteroskedasticiy	We corrected for heteroskedasticity by dividing by each observations estimated variance this did not significant change the results, so the model was left untreated
9 Collinearity	We investigated collinearity by observation bi-variate correlations and found not significant collinearity.
10 Influential Data points	We used DFFITS to identify influential data points. If there observations were not outliers they remained in the model as there is otherwise no reason to eliminate these observations
11 Missing Data	Missing consumption data was kept missing, and missing survey responses was coded as "no" for that change. This does not introduce bias, only increases the random error.
12 Precision	The standard error for key parameters for net and gross impacts were derived from the regression equation. For net-to-gross ratios, the precision is based on the variance of survey responses.
E Data Interpretation and Application	
1 Net Impacts	The total net impacts presented in the report were calculated by average participant impacts times the number of units times the net-to-gross ratio
2 Rationale	This method was used as it is the most appropriate given the result of a regression analysis which produces neither net nor gross impacts. Thus, we may be underestimating net impacts

Exhibit A-2: PG&E Industrial EMS Program

CPUC Protocol Table 7 - Study CEQ-96-HB01

D	*Data Screening*		
	1	*Outliers, Missing Data Weatherization*	-Outliers were found using studentized residuals, then eliminated on the basis of whether -Missing Data: missing consumption reads were left as missing, otherwise see item D.11 below -Weatherization was done through the inclusion of CDD and HDD in the model
	2	*Background Variables*	A comparison group was used to control for non-program effects that were not measured.
	3	*Screening Customers*	Beyond the elimination of 8 firms who were outliers, the only screening was that shown in B.3
	4	*Regression Statistics*	These are provided in Exhibit 4-1
	5	*Specification*	This discussion is found in Section 4.1.1
	6	*Errors in Variables*	The study utilized data collection methods which give the highest quality data with the lowest errors in measurement. For example, use of telephone surveys rather than mail surveys to gain consistency in survey results. Telephone and on-site surveyors were given special training.
	7	*Autocorrelation*	There were no autocorrelation problems in the model
	8	*Heteroskedasticiy*	We corrected for heteroskedasticity by dividing by each observations estimated variance this did not significant change the results, so the model was left untreated
	9	*Collinearity*	We investigated collinearity by observation bi-variate correlations and found not significant collinearity.
	10	*Influential Data points*	We used DFFITS to identify influential data points. If there observations were not outliers they remained in the model as there is otherwise no reason to eliminate these observations
	11	*Missing Data*	Missing consumption data was kept missing, and missing survey responses was coded as "no" for that change. This does not introduce bias, only increases the random error.
	12	*Precision*	The standard error for key parameters for net and gross impacts were derived from the regression equation. For net-to-gross ratios, the precision is based on the variance of survey responses.
E	*Data Interpretation and Application*		
	1	*Net Impacts*	The total net impacts presented in the report were calculated by average participant impacts times the number of units times the net-to-gross ratio
	2	*Rationale*	This method was used as it is the most appropriate given the result of a regression analysis which produces neither net nor gross impacts. Thus, we may be underestimating net impacts