PRE-1998 INDUSTRIAL ENERGY EFFICIENCY INCENTIVE PROGRAM 1998 CARRY OVER IMPACT EVALUATION

Process End Use, PG&E Study ID number: 403a
Process Boiler End Use, PG&E Study ID number: 403b
Space Conditioning Use, PG&E Study ID number: 403c

March 1, 2000

Measurement and Evaluation
Customer Energy Efficiency Policy & Evaluation Section
Pacific Gas and Electric Company
San Francisco, California

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As part of its Customer Energy Efficiency Programs, Pacific Gas and Electric Company (PG&E) has engaged consultants to conduct a series of studies designed to increase the certainty of and confidence in the energy savings delivered by the programs. This report describes one of those studies. It represents the findings and views of the consultant employed to conduct the study and not of PG&E itself.

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PRE-1998 INDUSTRIAL ENERGY EFFICIENCY INCENTIVE PROGRAM 1998 CARRY OVER IMPACT EVALUATION

PG&E Study ID numbers: 403a, 403b, and 403c

Purpose of Study

This study was conducted in compliance with the requirements specified in "Protocols and Procedures for the Verification of Costs, Benefits, and Shareholders Earnings from Demand-Side Management Programs", as adopted by California Public Utilities Commission Decision 93-05-063, revised June, 1999, pursuant to Decisions 94-05-063, 94-10-059, 94-12-021, 95-12-054, 96-12-079, 98-03-069, and 99-06-052.

This study evaluated the ex post gross and net kW, kWh, and therm savings from the installation of energy efficiency measures in the process, process boiler, and space conditioning end uses for which rebates were paid in 1998 by the following Pacific Gas & Electric Pre-1998 Company Industrial Energy Efficiency Incentive Programs that were offered from 1994 to 1997: Advanced Performance Options (APO), Retrofit Express (RE), Retrofit Efficiency Options (REO), and Customer Efficiency Options (CEO).

Methodology

The impact evaluation utilized calibrated engineering analysis to determine gross impacts. Net impacts were derived using the gross impact estimates and net-to-gross ratios estimated using a customer self-report method. This approach is consistent with methods outlined in Table C-5 of the M&E Protocols.

Project-specific analyses were developed for projects that comprised at least 70% of the kWh, kW, and therm savings for each of the process, process boiler, and space conditioning end uses. Analyses were supported by on-site data collection for each project. A project-specific report was developed for each of the 30 analysis projects (18 process, three process boiler, and nine space conditioning). The project-specific analyses also quantified spillover impacts where identified. An additional 47 verification-only surveys were conducted from the remaining projects such that a census of projects was attempted for the evaluation.

A standardized net-to-gross (NTG) survey was administered for all projects, provided the customer was willing to cooperate with the survey and a customer representative who was reasonably familiar with the project decision was available. A total of 70 projects were included in the standardized NTG analysis (29 process, five process boiler, and 36 space conditioning projects). A scoring algorithm was applied to this survey to develop NTG ratios for each project.

In addition, nine of the largest projects received a customized NTG analysis. The customized analysis built upon the standardized NTG approach and included information from project files, additional customer interviews, vendor interviews, and PG&E Representative interviews. The goal of the customized NTG analysis was to provide the best possible NTG ratio for each large project by incorporating data from multiple sources, resolving inconsistencies among sources, and providing a narrative documenting the assigned project NTG ratio.

The project-specific evaluation results were expanded to program totals using appropriate techniques. Gross savings were expanded by end use using ratio estimators. NTG ratios were calculated for each end use as a savings-weighted average of project-specific NTG ratios.

Study Results

The results of the industrial sector evaluation in the Process and Indoor Lighting end uses are summarized below:

PG&E Pre-1998 Industrial Energy Efficiency Incentives Program Carry-Over
Summary of Evaluation Gross and Net Load Impacts
Process, Process Boiler, and Space Conditioning End Uses

Process Study 403a	Gross Savings	Gros Realization Rate	Net-To-Gross 1-FR	Net-To-Gross SO	Net Savings	Net Realization Rate
EX ANTE						
kW	1,947		0.75	-	1,460	
kWh	21,433,846		0.75	-	16,075,385	
Therms	3,107,34		0.75	-	2,330,51	
EX POST						
kW	2,259	1.160	0.88	0.0064	1,994	1.366
kWh	22,123,180	1.032	0.83	0.0057	18,374,098	1.143
Therms	5,148,49	1.657	0.82	0.0000	4,228,51	1.814

Process Boilers Study 403b	Gross Savings	Gros Realization Rate	Net-To-Gross 1-FR	Net-To-Gross SO	Net Savings	Net Realization Rate
EX ANTE						
kW	0		-	-	0	
kWh	0		-	-	0	
Therms	2,738,34		0.75	-	2,053,76	
EX POST						
kW	0	-	-	-	0	-
kWh	0	-	-	-	0	-
Therms	3,810,80	1.392	0.90	0.0000	3,425,26	1.668

Space Conditioning Study 403c	Gross Savings	Gros Realization Rate	Net-To-Gross 1-FR	Net-To-Gross SO	Net Savings	Net Realization Rate
EX ANTE						
kW	3,159		0.76	-	2,404	
kWh	13,354,280		0.76	-	10,116,586	
Therms	0		-	-	0	
EX POST						
kW	1,686	0.534	0.53	0.0000	896	0.373
kWh	10,720,243	0.803	0.65	0.0000	6,998,92	0.692
Therms	0	-	-	-	0	-

* FR: free-ridership rate; SO: spillover rat

Regulatory Waivers and Filing Variances

No regulatory waivers were filed.

There were no E-Table variances.

PRE-1998 INDUSTRIAL ENERGY EFFICIENCY INCENTIVE PROGRAM 1998 CARRY-OVER IMPACT EVALUATION

Process End Use: PG&E Study ID #403a
Process Boiler End Use: PG&E Study ID #403b
Space Conditioning End Use: PG&E Study ID #403c

FINAL REPORT

Prepared for

Pacific Gas and Electric Company
San Francisco, California

Prepared by

XENERGY Inc.
Oakland, California

March 1, 2000

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E EXECUTIVE SUMMARY

This report presents results of the impact evaluation of process, process boiler, and space conditioning measures covered in Pacific Gas and Electric Company's (PG&E's) Pre-1998 Industrial Energy Efficiency Incentives Program Carry-Over. The Programs include the Retrofit Express (RE) Program, the Retrofit Efficiency Options (REO) Program, the Advanced Performance Options (APO) Program, and the Customer Efficiency Options (CEO) Program.

Both gross and net Program impacts were developed for electric consumption (kWh), electric demand (kW), and natural gas consumption (therms). The evaluation approach was designed to meet the requirements of the Measurement and Evaluation (M&E) Protocols[1]. Site-specific engineering estimates of energy impacts for a sample of Program participants were utilized to determine gross impacts. Where applicable, short-term metering and monitoring were used to support the analyses. As required by the M&E Protocols, the analysis sample addressed over 70% of end-use kWh, kW, and therm impacts. Net-to-gross ratios (NTGRs) were developed from customer self-report data and were applied to gross impacts to determine net Program impacts.

E.1 BACKGROUND

Through its Programs, PG&E offers rebates to industrial customers who adopt energy efficiency measures to reduce energy consumption and demand in existing industrial facilities. In 1998, a total of 136 customers were paid rebates for energy efficiency projects through the RE, REO, APO, and CEO Programs. The process, process boiler, and space conditioning end uses covered by this evaluation account for 80 of the projects and 92% of the industrial ex ante net avoided cost impacts. Figure E-1 shows a breakdown of Program impacts by end use. Since the Protocols require that end uses accounting for at least 85% of Program savings be evaluated, the current evaluation is restricted to these key end uses. The goal of the evaluation was to determine the load impacts associated with the process, process boiler, and space conditioning end-use components of the Industrial Programs.

E.2 METHODOLOGY

The impact evaluation utilized calibrated engineering analysis to determine gross impacts. Net impacts were derived using the gross impact estimates and NTGRs estimated using a customer self-report method. This approach is consistent with methods outlined in Table C-5 of the M&E Protocols.

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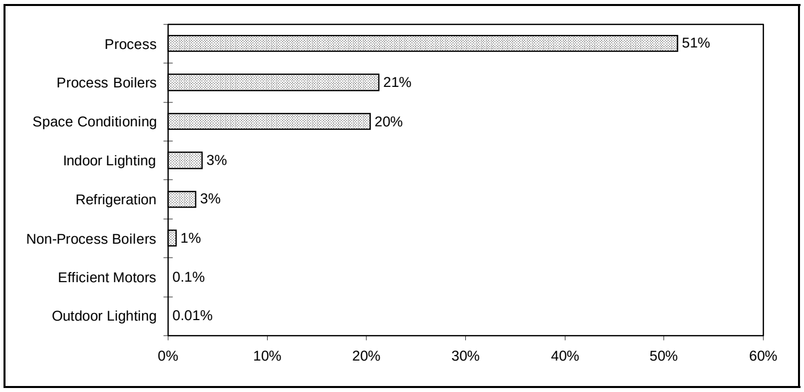
[1] Protocols and Procedures for the Verification of Costs, Benefits, and Shareholder Earnings for Demand-Side Management Programs, as adopted by California Public Utilities Commission Decision 93-05-063, revised June 1999.

Figure E-1
Percent of Ex Ante Net Avoided Cost Impacts by End Use



Project-specific analyses were developed for a sample of projects that comprised at least 70% of the kWh, kW, and therm savings for each of the process, process boiler, and space conditioning end uses. Analyses were supported by on-site data collection for each project. A project-specific report was developed for each analysis project. The project-specific analyses also quantified spillover impacts where identified. Additional verification-only surveys were conducted for all projects that didn't receive a project-specific evaluation, such that a census of process projects was attempted for the evaluation survey activities. A summary of the sample disposition is provided in Table E-1.

Table E-1
Sample Disposition Summary

End Use	Process	Process Boiler	Space Conditioning
Total 1997 Projects	34	5	41
Analysis Sample	18	3	9
% of Total kW	81%	-	90%
% of Total kWh	82%	-	85%
% of Total Therms	96%	89%	-
Verification Sample	14	2	31

A standardized net-to-gross (NTG) survey was administered for all projects included in the sample, provided the customer was willing to cooperate with the survey and a customer staff memeber who was reasonably familiar with the project decision was available. A total of 29 process projects, five process boiler projects, and 36 space conditioning projects were included in the standardized NTG analysis. A scoring algorithm was applied to this survey to develop NTGRs for each project.

In addition, large analysis projects (12 process, two process boiler, and two space conditioning) were targeted to receive a customized NTG analysis. Due to customer refusals, nine customized analyses were completed. The customized analysis built upon the standardized NTG approach and included information from project files, additional customer interviews, vendor interviews, and PG&E Representative interviews. The goal of the customized NTG analysis was to provide the best possible NTGR for each large project by incorporating data from multiple sources, resolving inconsistencies among sources, and providing a narrative documenting the assigned project NTGR.

The project-specific evaluation results were expanded to Program totals using appropriate techniques. Gross savings were expanded by end use using ratio estimators. NTGRs were calculated for each end use as a savings-weighted average of project-specific NTGRs.

E.3 KEY FINDINGS

Evaluation ex post estimates of Program impacts, relative to ex ante estimates, are summarized in Table E-2. Overall, net Program savings are estimated to be 2,888 kW, 25,366,031 kWh, and 7,653,747 therms on an annual basis. Approximately 75% of PG&E's ex ante net kW savings, 97% of the ex ante net kWh savings, and 175% of the ex ante net therm savings are being realized. Ninety percent confidence intervals are ±10% for net kW impacts, ±21% for net kWh impacts, and ±23% for net therm impacts.

Table E-2
PG&E 1997 Industrial Energy Efficiency Incentives Programs
Summary of Evaluation Gross and Net Load Impacts
Process, Process Boiler, and Space Conditioning End Uses

	Gross Savings	Gross Realization Rate	Net-To-Gross 1-FR*	Net-To-Gross SO*	Net Savings	Net Realization Rate
EX ANTE						
kW	5,106		0.76	-	3,865	
kWh	34,788,126		0.75	-	26,191,971	
Therms	5,845,693		0.75	-	4,384,270	
EX POST						
kW	3,945	0.773	0.73	0.0037	2,888	0.747
kWh	32,843,423	0.944	0.77	0.0039	25,366,031	0.968
Therms	8,959,295	1.533	0.85	0.0000	7,653,747	1.746

* FR: free-ridership rate; SO: spillover rate

E.3.1 Process End Use

Process ex post impacts are presented and compared to ex ante estimates in Table E-3. Ex post net impacts are 137% of the ex ante estimates for kW, 114% for kWh, and 181% for therms. The high net realization rates are a combination of gross realization rates that are greater than one and NTGRs that are greater than PG&E's assumed NTGR of 0.75.

Table E-3
PG&E 1997 Industrial Energy Efficiency Incentives Programs
Summary of Evaluation Gross and Net Load Impacts
Process End Use

	Gross Savings	Gross Realization Rate	Net-To-Gross 1-FR*	Net-To-Gross SO*	Net Savings	Net Realization Rate
EX ANTE						
kW	1,947		0.75	-	1,460	
kWh	21,433,846		0.75	-	16,075,385	
Therms	3,107,346		0.75	-	2,330,510	
EX POST						
kW	2,259	1.160	0.88	0.0064	1,994	1.366
kWh	22,123,180	1.032	0.83	0.0057	18,374,098	1.143
Therms	5,148,495	1.657	0.82	0.0000	4,228,511	1.814

* FR: free-ridership rate; SO: spillover rate

Table E-4 summarizes gross realization rates for the 18 process projects that received site-specific analysis. About half of the projects have realization rates in the 0.70 to 1.30 range, indicating that ex post results are in general agreement with ex ante estimates. Several of the larger projects have high realization rates, driving overall gross realization rates above one.

Table E-4
Distribution of Process Gross Realization Rates

Gross Realization Rate	Number of Projects kW	% Projects	kWh	% Projects	Therms	% Projects
> 1.30	2	20%	4	29%	1	20%
0.70 - 1.30	4	40%	7	50%	2	40%
< 0.70	4	40%	3	21%	2	40%
Totals	10	100%	14	100%	5	100%

Key reasons for gross impact discrepancies include:

- Measures not in place: One site had gone out of business and impacts were set to zero.
- Equipment/system performance that was different from projections: The largest performance discrepancies involved several refinery furnace projects where equipment efficiencies exceeded expectations, and a glass furnace project where impacts were negative.
- Different operating conditions: Equipment is often operated in a manner different from ex ante predictions. Production hours and output are constantly changing. For a number of compressor projects, air flows had changed for production reasons since the system retrofit.
- Secondary impacts not addressed: Occasionally the ex ante analysis fails to consider total project impacts. For example, one heat recovery project added two fans to recirculate exhaust heat, thereby saving natural gas but resulting in negative electric impacts.

- Methodology differences: There were a number of projects for which the ex ante kW calculation method reflected a comparison of connected load impacts, whereas the ex post approach was based on determining expected kW impacts at the time of the PG&E system peak.

Table E-5 presents the distribution of NTGRs for process projects. A majority of the NTGRs came in at 0.70 or higher, explaining the average NTGRs of 0.82 to 0.88 shown in Table E-3.

Table E-5
Distribution of Process Net-to-Gross Ratios

NTGR Range	# Projects	% Projects
1.00	4	14%
0.70-0.99	15	52%
0.30-0.69	7	24%
0.01-0.29	1	3%
0.00	2	7%
	29	100%

One process project was associated with spillover impacts. This customer downsized five wastewater aerator motors as part of a PG&E-sponsored project. Wastewater treatment performance was better than expected, and the customer downsized another motor without Program assistance.

E.3.2 Process Boiler End Use

Process boiler ex post impacts are presented and compared to ex ante estimates in Table E-6. Ex post net impacts are 167% of the ex ante estimates for therms.

Table E-6
PG&E 1997 Industrial Energy Efficiency Incentives Programs
Summary of Evaluation Gross and Net Load Impacts
Process Boiler End Use

	Gross Savings	Gross Realization Rate	Net-To-Gross 1-FR*	Net-To-Gross SO*	Net Savings	Net Realization Rate
EX ANTE						
kW	0		-	-	0	
kWh	0		-	-	0	
Therms	2,738,347		0.75	-	2,053,760	
EX POST						
kW	0	-	-	-	0	-
kWh	0	-	-	-	0	-
Therms	3,810,800	1.392	0.90	0.0000	3,425,261	1.668

* FR: free-ridership rate; SO: spillover rate

Of the three process boiler projects that were analyzed, the largest project (accounting for 84% of ex ante therm savings) had a realization rate of 1.92. This project involved furnace-stack controls that serve to reduce excess combustion in a refinery furnace. The equipment performance is more efficient than expected, and operating hours are greater than expected.

Table E-7 shows the distribution of process boiler NTGRs. The largest process boiler project had a NTGR of 0.85.

Table E-7
Distribution of Process Boiler Net-to-Gross Ratios

NTGR Range	# Projects	% Projects
1.00	2	40%
0.70-0.99	2	40%
0.30-0.69	1	20%
0.01-0.29	0	0%
0.00	0	0%
	5	100

E.3.3 Space Conditioning End Use

Space conditioning ex post impacts are presented and compared to ex ante estimates in Table E-8. Ex post net impacts are 37% of the ex ante estimates for kW and 69% for kWh. Both ex post gross impacts and NTGRs fell below the ex ante estimates.

Table E-8
PG&E 1997 Industrial Energy Efficiency Incentives Programs
Summary of Evaluation Gross and Net Load Impacts
Space Conditioning End Use

	Gross Savings	Gross Realization Rate	Net-To-Gross 1-FR*	Net-To-Gross SO*	Net Savings	Net Realization Rate
EX ANTE						
kW	3,159		0.76	-	2,404	
kWh	13,354,280		0.76	-	10,116,586	
Therms	0		-	-	0	
EX POST						
kW	1,686	0.534	0.53	0.0000	896	0.373
kWh	10,720,243	0.803	0.65	0.0000	6,998,925	0.692
Therms	0	-	-	-	0	-

* FR: free-ridership rate; SO: spillover rate

Table E-9 summarizes gross realization rates for the nine space conditioning projects that were analyzed. As the table shows, the majority of kW realization rates are in the 0.70 to 1.30 range, reflecting general agreement between ex ante estimates and ex post results. The kWh realization rates are more dispersed.

Table E-9
Distribution of Space Conditioning Gross Realization Rates

Gross Realization Rate	Number of Projects			
	kW	% Projects	kWh	% Projects
>1.30	0	0%	3	30%
0.70-1.30	6	75%	3	30%
<0.70	2	25%	4	40%
Totals	8	100%	10	100%

Key reasons for gross impact discrepancies include:

- A number of projects were assigned prescriptive ex ante impact estimates that didn't reflect actual operating conditions at the site; this included effects at one of the two largest projects where cooling loads were much lower than predicted; and
- For one of the two largest space conditioning projects involving HVAC controls, a couple of the control strategies were not implemented as expected.

Table E-10 shows the distribution of space conditioning NTGRs. NTGRs for the largest space conditioning projects were in the 0.50 to 0.70 range, driving the overall end use NTGRs.

Table E-10
Distribution of Space Conditioning Net-to-Gross Ratios

NTGR Range	# Projects	% Projects
1.00	3	8%
0.70-0.99	4	11%
0.30-0.69	26	72%
0.01-0.29	1	3%
0.00	2	6%
	36	100%

1 INTRODUCTION

In past years, PG&E has offered rebates to qualifying industrial customers who adopt energy efficiency measures through its Programs to reduce energy consumption and demand in existing industrial facilities. In 1998, a total of 136 industrial customer projects were paid rebates through RE, REO, APO, and CEO Programs. The process, process boiler, and space conditioning end uses covered by this evaluation accounted for 80 of the projects and 92% of the industrial ex ante net avoided cost impacts. Since the M&E Protocols require that end uses accounting for at least 85% of Program savings be evaluated, the current evaluation is restricted to these key end uses. The research documented in this report was undertaken to determine the ex post gross and net energy and demand impacts associated with PG&E's investment in these Programs. This report presents the methodology and results of the Program evaluation.

1.1 REBATE PROGRAM DESCRIPTIONS

Each of the rebate Programs covered by this evaluation is summarized below.

1.1.1 Retrofit Express (RE)

The RE Program offered fixed rebates to PG&E's customers that installed specific gas and electric energy efficient equipment in their facilities. For 1996 and 1997, the customer could also opt to receive assistance with equipment selection, the bidding process, economic analysis, and other services in exchange for a reduced rebate. The Program covered the most common energy-savings measures: lighting, air conditioning, refrigeration/food service, and motors. The maximum total rebate amount was $300,000 per account. This included participation in any combination of the lighting, air conditioning, refrigeration/food service, and motor Program options.

1.1.2 Retrofit Efficiency Options (REO)

The REO Program offered rebates for selected measures previously addressed by the Express and Customized Programs. The REO Program targeted commercial, industrial, and agricultural market segments most likely to benefit from these selected measures. Marketing efforts were coordinated among PG&E Divisions, emphasizing local planning areas with high marginal electric costs, to maximize Program benefits. The minimum and maximum incentive amounts were $250 and $100,000 per project, respectively.

1.1.3 Advanced Performance Options (APO)

The APO Program offered financial incentives of $125/kW, $0.06/kWh and $0.20/therm of first-year energy savings to customers undertaking large or complex projects not covered under other PG&E Programs. These customers worked with their PG&E Customer Representative to identify potentially viable projects. PG&E was then responsible for calculating energy savings for the project. Maximum total incentive amount for the APO Program was $300,000 per account. The minimum qualifying incentive amount was $5,000 per project.

1.1.4 Customer Efficiency Options (CEO)

The CEO Program offered technical, financial, and follow-up services to complement or create individual customer energy, environmental, and productivity improvement plans. The Program was selectively marketed. Field Marketing Representatives screened customers using an objective and subjective screen that limited customer participation to those willing to act on high impact, cost effective recommendations. All Program components were tailored to the customer, based on identified needs.

1.2 PROJECT OVERVIEW

1.2.1 Evaluation Objectives

The primary objectives of the impact evaluation are to:

- Determine estimates of the gross and net impacts (kW, kWh, and therms) resulting from industrial process, process boiler, and space conditioning measures installed through PG&E's incentive Programs and rebated during 1998;
- Identify any discrepancies between estimated and measured impacts at the measure level and the end-use level;
- Suggest reasons for such discrepancies, such as differences between planning assumptions and what is found on site for factors such as number of measures installed, connected load, and hours of operation;
- Conduct all analyses in a manner consistent with the M&E Protocols; and
- Provide complete project documentation and databases required for regulatory replication of the study.

1.2.2 Evaluation Approach

The evaluation approach was designed to meet the requirements of the M&E Protocols. Site-specific engineering estimates of energy impacts for a sample of Program participants were utilized to determine gross impacts. Where applicable, short-term metering and monitoring were used to support the analyses. As required by the Protocols, the analysis sample addressed over 70% of end-use kWh, kW, and therm impacts.

NTGRs were developed from customer self-report data and were applied to gross impacts to determine net Program impacts. All customer project contacts were targeted for a standard NTG survey. A scoring algorithm was used to establish NTGRs for each project based on the survey results. For the largest projects, a follow-up customized survey and analysis was implemented to refine the initial NTGRs.

1.3 REPORT ORGANIZATION

The remainder of this report is organized as follows:

- Section 2 discusses the evaluation methodology. The study design, analysis methods, and data collection procedures are described.
- Section 3 presents evaluation results. Gross and net impacts for each analyzed end use – process, process boilers, and space conditioning – are presented and discussed.
- Appendices include
  - ◊ A: Site-specific evaluation results;
  - ◊ B: Sample data collection forms;
  - ◊ C: Site plan and report templates;
  - ◊ D: M&E Protocols Tables 6 and 7; and
  - ◊ E: A description of the evaluation database.

2 METHODOLOGY

2.1 OVERVIEW

This section describes the methodology used for this study. First, the study design, including the sample design, is presented. Second, gross impact analysis methods are discussed. Third, net impact calculation methods are described. Finally, the project data collection approach is presented.

2.2 STUDY DESIGN

The impact evaluation focused on the process, process boiler, and space conditioning end-use components of PG&E's Pre-1998 Industrial Program Carry-Over. Together, these end uses comprise 92% of ex ante Program net avoided cost savings. Project-specific analyses were utilized to estimate gross and net impacts for a sample of projects, with a concentration on the largest projects. Appropriate statistical techniques were used to expand sample results to the Program population.

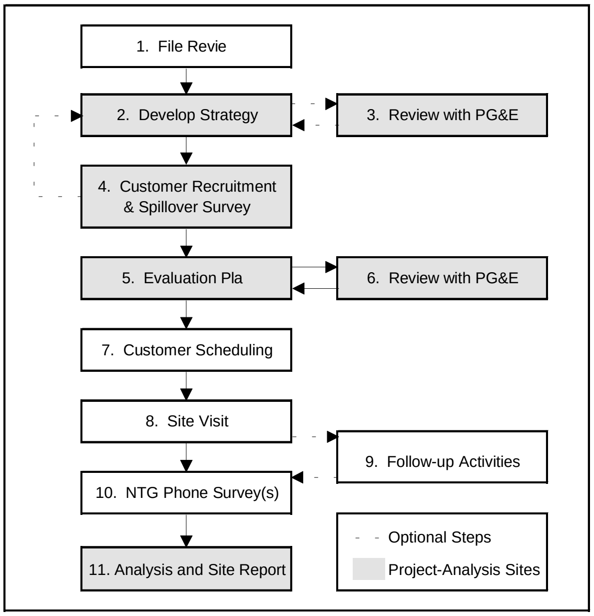
To develop gross savings estimates, a project-specific engineering analysis was conducted for most of the largest projects and a sample of smaller projects in each end use. The analyses were supported by on-site data collection activities. Verification-only on-site surveys were conducted for additional smaller projects in order to comply with the requirements of the M&E Protocols.

Net impacts were estimated for each sampled project by combining gross savings results with NTGRs. The NTGRs were developed on a project-specific basis. A standard net-to-gross (NTG) survey was administered to customers for most sampled projects. (Projects for which a decision maker was unwilling to participate or was no longer with the company and an informed associate was not available did not receive NTG surveys.) A scoring algorithm was applied to this survey to develop NTGRs for each project. In addition, a customized NTG analysis was conducted for the largest projects in each end use. The customized analysis built upon the standardized NTG approach included information from project files and additional interviews with customers, vendors, and PG&E Customer Representatives.

2.2.1 Project Analysis Process

The focus of this impact evaluation was on the project analysis. Each project designated for analysis was approached in a similar fashion. Figure 2-1 presents a schematic of the analysis process. The verification-only studies utilized some of the same steps as the larger analysis studies, as indicated by the unshaded boxes in Figure 2-1. Paths indicated with dotted lines in the figure show optional steps or steps that were not required for all projects.

Figure 2-1
Project Analysis Process



As diagrammed above, the project analysis process consisted of the following steps:

1. File Review. Project technical files and support documentation provided useful information on the measure scope, equipment efficiency assumptions, operation conditions, and base case assumptions. This information was usually sufficient to develop an initial measurement plan without a customer site visit. Key technical data and free-ridership information were extracted from the files.

2. Develop Strategy. The strategy included an overall analytical approach, data collection activities and instruments, and, where necessary, a proposed monitoring plan. The goal of the strategy was to leverage the initial analysis conducted for Program approval by identifying and verifying key assumptions through surveys, modeling, and monitoring.

3. Review with PG&E. PG&E Customer Representative were contacted, if necessary, to clarify issues of project scope and for background information. Based on discussions with the Representative, the site strategy may have been revised.

4. Customer Recruitment and Spillover Survey. Contact the customer to recruit participation, identify potential spillover, develop a preliminary understanding of data availability, and access for monitoring, as well as tentatively schedule site activities. Request that logs or other operating information be retained for use in the evaluation.

5. Evaluation Plan. Prepare a site-specific evaluation plan based on strategy and level of resources available. Plans included lists of specific site information required and proposed monitoring instrumentation to be installed. Generic site-survey instruments were modified to apply to the specific site. Customer limitations with respect to on-site personnel support, staff time, and scheduling were taken into account.

6. Review with PG&E. Submit plan to PG&E Project Manager for approval and modify, as necessary, per PG&E comments.
7. Customer Scheduling. Schedule the site visit. Request that documentation be provided. Follow up with written confirmation/request as necessary.
8. Site Visit. Implement data collection activities. Conduct on-site surveys, perform measurements, and install monitoring equipment as needed.
9. Follow-up Activities. If necessary, return to the site to remove monitoring equipment. Conduct other follow-up activities, as necessary. (If measures were not in place, PG&E representatives were contacted to investigate further.)
10. NTG Phone Surveys. Conduct necessary NTG telephone interviews of the appropriate decision makers. Interviewees may have included additional customer staff, vendors, and/or PG&E Representatives.
11. Analysis and Site Report. Carry out analyses and prepare a site report. A discrepancy analysis with tracking system estimates and assumptions is included in the site report.

A concise site report was prepared documenting the evaluation analysis, summarizing and documenting the gross savings results, explaining any discrepancies and discussing the NTG findings. The report includes a table that summarizes the key annual and time-of-use impact results for each rebated measure. Spillover projects were evaluated separately. Individual site results typically include both a text document and supporting data and analysis, usually in the form of an Excel spreadsheet. The raw and reduced site data, the analytical model input and output, and the analysis results are provided as attachments to the final site evaluation report in both hard copy and electronic formats. Site-specific evaluation report templates are provided in Appendix C.

2.2.2 Site Evaluation Plans and Reports

The site evaluation plans were used to summarize the approaches to be utilized in the site analyses. A number of important factors were included as part of the plan, including (where applicable and available):

- Customer identification, including contacts
- Measure tabulation from PG&E records
- Description of business, products, and processes
- Pre-installation equipment and operations
- Technical discussion of the project
    - ◊ Measure-specific technical detail
- PG&E ex ante energy savings methodology
- Available site data
- Baseline identification
- Proposed ex post evaluation methodology

  - ◊ Seasonality
  - ◊ Activity-level variable to be used for annualization
  - ◊ Interaction effects
  - ◊ Changes in production/operating levels
- Data requirements (site and secondary)
  - ◊ Data collection plan
  - ◊ Metering/Monitoring to be conducted
- Spillover identification and proposed analysis
- NTG considerations
  - ◊ Project economics (costs, required paybacks)
  - ◊ Discussion of project alternatives
  - ◊ Non-energy-savings benefits, if any

The site reports were developed as an extension of the site plans, with the inclusion of collected data, applied methodologies, and results. Attributes of the site reports include:

- Summary of evaluation results versus PG&E estimates
- Categorical explanation of discrepancies
- Full documentation of the analysis approach and calculations
- Findings of the NTG analysis
- Appendices containing relevant data collected during the study

2.2.3 Measurement and Evaluation Protocols

For industrial evaluations, the M&E Protocols (Table C-5) require that project-specific engineering analyses must be applied to projects representing a least 70% of the total kW, kWh, and therm savings for the targeted end-use element. Verification of installation must be conducted for all projects in the evaluation sample (a minimum of 150 projects for each end use or a census of projects if the end-use population is less than 150). The process, process boiler, and space conditioning sample designs (discussed next) were constructed to comply with the M&E Protocols.

2.2.4 Process Sample Design

The process end use is the largest component of the 1998 Programs. It accounts for 51% of expected avoided cost savings, 43% of gross kWh savings (21,433,846 kWh), 30% of gross kW savings (1,947 kW), and 53% of gross therm savings (3,107,346 therms).

2.2.5 Process Measures

Based on a review of the process project files, projects were allocated into seven different measure-technology groups. A savings breakdown by these measure groups is presented graphically in Figure 2-2 and is also shown in Table 2-1. As the figure and the table show, thermal process modifications, process heating, and controls account for all of the therm savings. Air compressors and variable frequency drive installations account for about 74% of the kWh savings and 64% of the kW savings. Oil well pump-off controllers, typically a large process measure group, only account for about 2% of this year's kWh and kW savings.

Figure 2-2
Ex Ante Process Savings by Measure Group

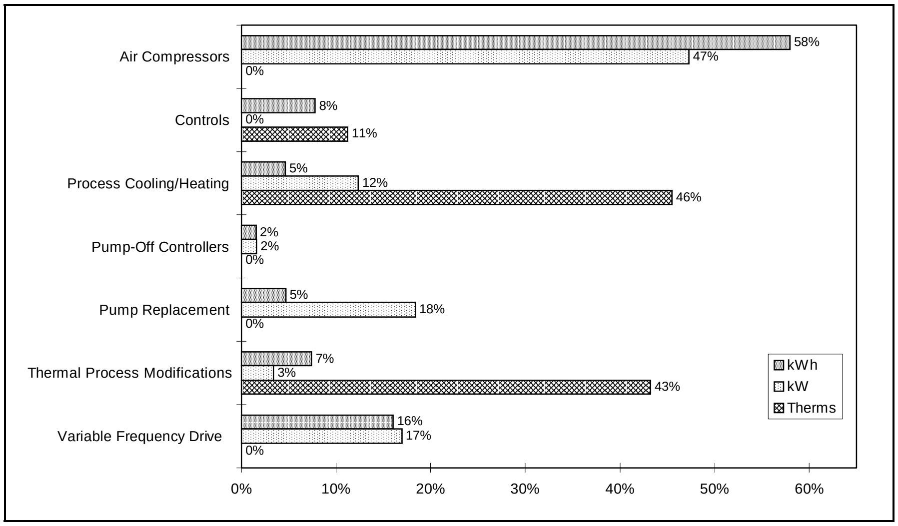


Table 2-1
Process Savings by Measure Group

Measure Type	# Projects	kWh	%	kW	%	Therms	%
Air Compressors	11	12,422,565	58%	921	47%	0	0%
Controls	4	1,669,881	8%	0	0%	349,347	11%
Process Cooling/Heating	5	989,503	5%	240	12%	1,414,907	46%
Pump-Off Controllers	2	330,344	2%	32	2%	0	0%
Pump Replacement	2	1,001,562	5%	358	18%	0	0%
Thermal Process Modifications	4	1,588,046	7%	66	3%	1,343,092	43%
Variable Frequency Drives	6	3,431,945	16%	330	17%	0	0%
Totals	34	21,433,846	100%	1,947	100%	3,107,346	100%

2.2.6 Process Projects

A total of 34 industrial process projects were rebated in 1998. Figure 2-3 shows the distribution of electric savings for the 28 projects associated with electric savings. As the figure shows, the top 10 projects account for over 77% of the kWh savings and over 71% of the kW savings; the top 20 projects account for over 90% of the kWh and kW savings. Seven process projects were associated with therm savings. As shown in Figure 2-4, the largest two projects accounted for 80% of these savings.

Figure 2-3
Cumulative Distribution of Electric Savings for the Process Projects

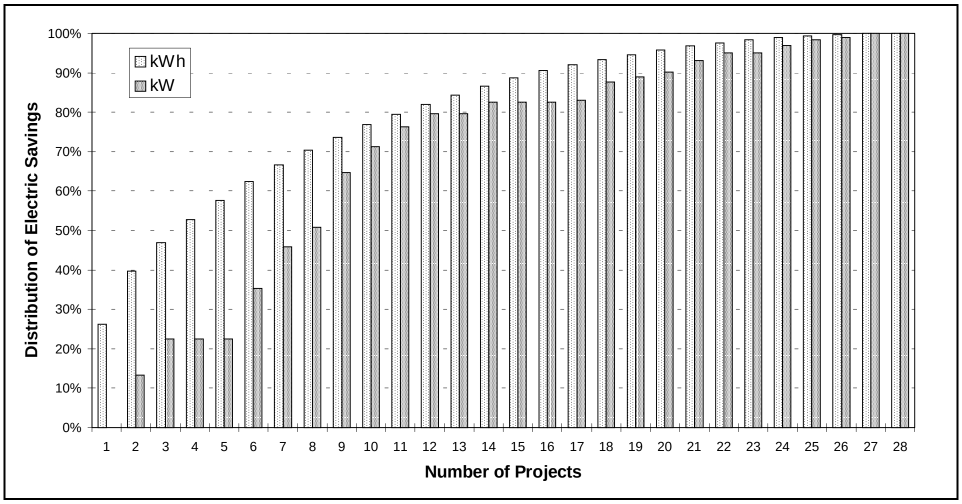
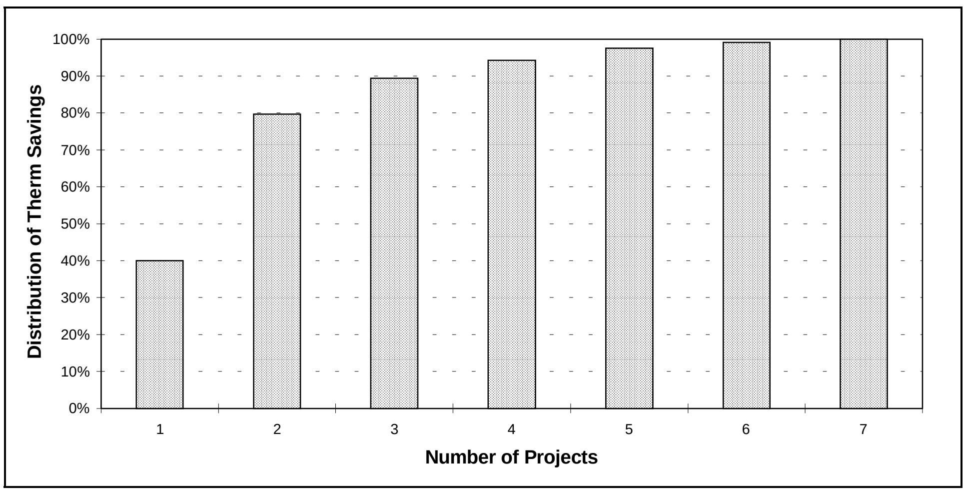


Figure 2-4
Cumulative Distribution of Therm Savings for the Process Projects



Sample Design

A census of all process projects was attempted for the study. These projects received varying levels of analysis. For the 34 process projects, three strata were identified as follows:

1. Large: The 12 largest projects that account for at least 70% of the ex ante kW, kWh, and therms and received a full engineering analysis and a customized NTG analysis.
2. Medium: The next largest 10 projects (with ex ante avoided cost greater than $200,000). Four of these projects received a full engineering analysis and a standard NTG analysis. The remaining six projects were targeted for verification surveys and standard NTG analyses.

3. Small: The 12 remaining smaller projects. Two of these projects received a full engineering analysis and a standard NTG analysis. The remaining 10 projects were targeted for verification surveys and standard NTG analyses.

Table 2-2 presents the process sample design. There were 12 "Large" projects, accounting for 77% of the kWh impacts, 71% of the kW impacts, and 80% of the therm impacts. Two sites in this group account for all the therm impacts. Ten "Medium" projects account for an additional 14% of kWh impacts, 19% of kW impacts, and 18% of the therm impacts. The remaining 12 "Small" projects account for 10% or less of the kWh, kW, and therm impacts.

Table 2-2
Industrial Process Sample Design

Strata	# Projects	kWh	% kWh	kW	% kW	Therms	% Therms	Analysis Sample Size
Large	12	16,471,335	76.8%	1,388	71.3%	2,478,000	79.7%	12
Medium	10	3,076,088	14.4%	364	18.7%	551,136	17.7%	4
Small	12	1,886,423	8.8%	195	10.0%	78,210	2.5%	2
Total	34	21,433,846	100.0%	1,947	100.0%	3,107,346	100.0%	18

Projects Included in the Evaluation

Table 2-3 summarizes the process projects included in the evaluation. Overall, 32 sites were verified or analyzed. These projects account for well over 70% of the ex ante gross impacts. Of these 32 projects, 29 were included in the NTG analysis.

Table 2-3
Process Projects Included in the Evaluation

Strata	Total Projects	Verification Projects	Analysis Projects	Percent of Ex Ante Gross Impacts Analyzed			Sites in Net-to-Gross Analysis
				kWh	kW	Therms	
Large	12	0	12	100%	100%	100%	12
Medium	10	6	4	36%	45%	82%	9
Small	12	8	2	3%	11%	65%	8
Total	34	14	18	82%	81%	96%	29

2.2.7 Process Boiler Sample Design

Process boiler measures were responsible for the second largest level of end-use savings in 1998, accounting for 21% of expected avoided cost and 47% of therm savings (2,738,347 therms).

2.2.8 Process Boiler Measures

Table 2-4 shows the percent of process boiler therm savings by primary measure group, based on tracking system data. Two large thermal process projects account for 84% of the savings.

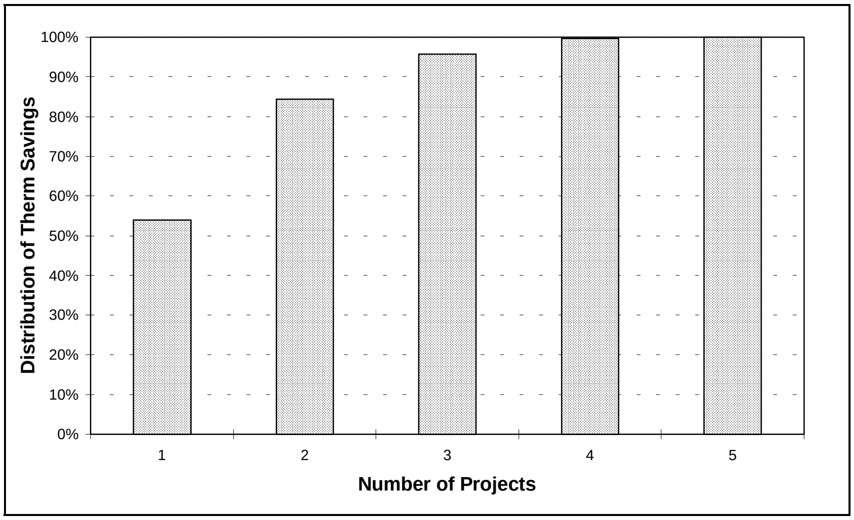
Table 2-4
Process Boiler Savings by Measure Group

Measure Type	# Projects	Therms	%
Thermal Process Modifications	2	2,311,694	84%
Stack Economizer	2	314,013	11%
Tankless Water Heater	1	112,640	4%
Totals	5	2,738,347	100%

2.2.9 Process Boiler Projects

A total of five industrial process boiler projects were rebated in 1998. Figure 2-5 shows the distribution of savings for the projects. As the figure shows, the top three projects account for nearly all of the savings (96%).

Figure 2-5
Cumulative Distribution of Therm Savings for the Process Boiler Projects



Sample Design

A census of the five process boiler projects was attempted for the study. Three projects received an engineering analysis and two projects were targeted for verification surveys. Two strata were developed as follows:

1. Large: The largest two projects that received site-specific engineering analyses and customized NTG analyses. These projects account for 84% of the end-use therm savings (no kWh or kW savings were claimed).
2. Small: The remaining projects that account for the remaining 16% of therm savings. One of these projects received a site-specific engineering analysis and a standard NTG analysis. The remaining two projects received verification surveys and standard NTG analyses.

Table 2-5 summarizes the process boiler sample design.

Table 2-5
Industrial Process Boiler Sample Design

Strata	# Projects	Therms	% Therms	Analysis Sample Size
Large	2	2,311,694	84.4%	2
Small	3	426,653	15.6%	1
Total	5	2,738,347	100.0%	3

Projects Included in the Evaluation

Table 2-6 summarizes the process boiler projects included in the evaluation. Overall five sites were verified or analyzed. These projects account for 100% of the ex ante gross impacts. All five of these projects were included in the NTG analysis.

Table 2-6
Process Boiler Projects Included in the Evaluation

Strata	Total Projects	Projects Verified	Projects Analyzed	Percent of Ex Ante Gross Therms Impacts Analyzed	Sites in Net-to-Gross Analysis
Large	2	0	2	100%	2
Small	3	2	1	26%	3
Total	5	2	3	89%	5

2.2.10 Space Conditioning Sample Design

Space conditioning measures comprised the third largest end-use savings in 1998, accounting for 20% of expected avoided cost, 27% of gross kWh savings (13,354,280 kWh), and 49% of gross kW savings (3,159 kW).

2.2.11 Space Conditioning Measures

Based on space conditioning measure descriptions, projects were allocated into six different measure groups. A savings breakdown by these measure groups is presented graphically in Figure 2-6 and is also shown in Table 2-7. As the figure and the table show, chiller replacements account for the bulk of end-use savings. Almost all of these savings are associated with two large projects. While there were a large number of central air conditioning (either packaged or split system) replacements, these projects were all small and account for less than 2% of end-use impacts.

Figure 2-6
Space Conditioning Savings by Measure Group

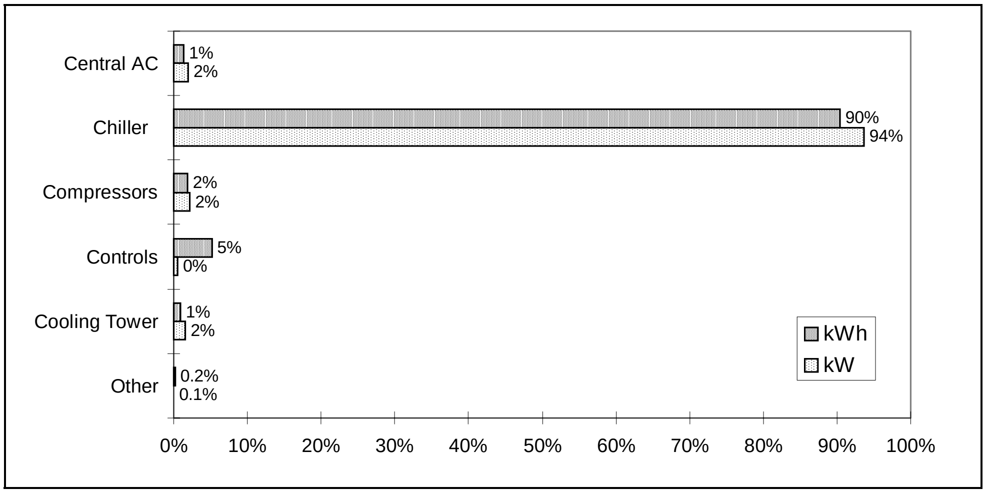


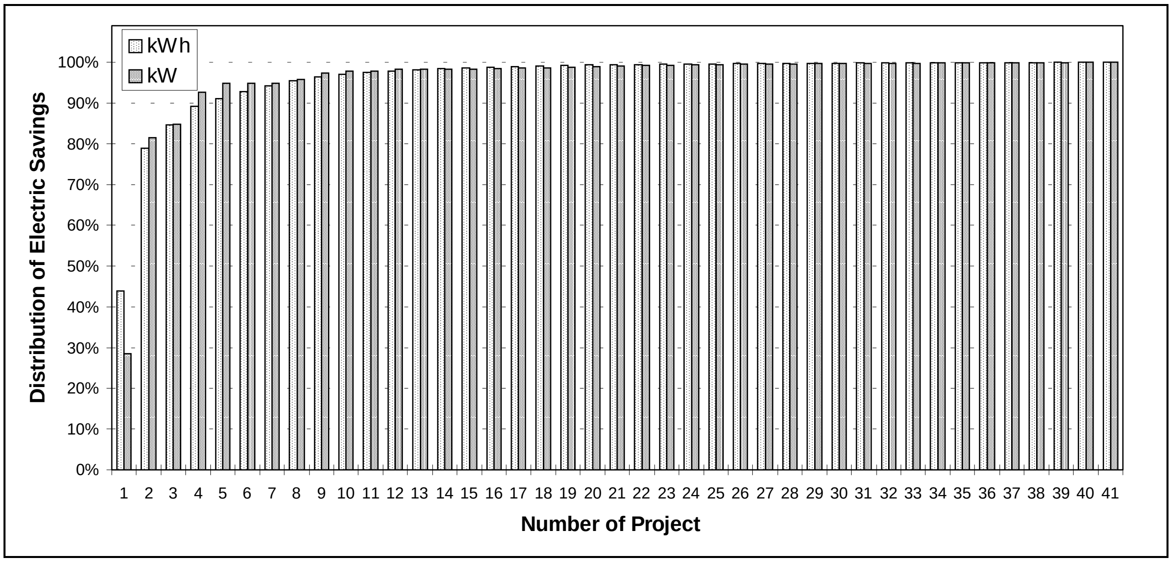
Table 2-7
Space Conditioning Savings by Measure Group

Measure Type	# Projects	kWh	%	kW	%
Central AC	24	182,690	1%	63	2%
Chillers	5	12,073,266	90%	2,957	94%
Compressors	1	250,458	2%	70	2%
Controls	8	695,396	5%	15	0%
Cooling Tower	1	129,899	1%	51	2%
Other	2	22,571	0%	3	0%
Totals	41	13,354,280	100%	3,159	100%

2.2.12 Space Conditioning Projects

Rebates were paid on a total of 41 industrial space conditioning projects in 1998. Figure 2-7 shows the distribution of electric savings for these projects (there were no claimed therm savings). As the figure shows, the top two projects account for about 80% of the kWh and kW savings; the top 10 projects account for over 97% of the savings. Of the smallest 26 projects that account for less than 1% of end-use savings, all but three are central air conditioner replacement projects.

Figure 2-7
Cumulative Distribution of Electric Savings for the Space Conditioning Projects



Sample Design

A census of all space conditioning projects was attempted for the study. These projects received varying levels of analysis. For the 41 space conditioning projects, three strata were identified as follows:

1. Large: The two largest projects that account for at least 70% of the ex ante kW, kWh, and therms and received a full engineering analysis and a customized NTG analysis.
2. Medium: The next largest 17 projects (with ex ante avoided cost greater than $7,000). Three of these projects were targeted for a full engineering analysis and a standard NTG analysis. The remaining 14 projects were targeted for verification surveys and standard NTG analyses.
3. Small: The 22 remaining smaller projects. Three of these projects received an engineering analysis and a standard NTG analysis. The remaining 19 projects received verification surveys and standard NTG analyses.

Table 2-8 presents the space conditioning sample design. There are two “Large” projects, accounting for 79% of the kWh impacts and 82% of the kW impacts. Eighteen “Medium” projects account for an additional 21% of kWh impacts and 18% of kW impacts. The remaining 21 “Small” projects account for less than 1% of the kWh and kW impacts.

Table 2-8
Industrial Space Conditioning Sample Design

Strata	# Projects	kWh	% kWh	kW	% kW	Analysis Sample Size
Large	2	10,537,766	78.9%	2,574	81.5%	2
Medium	17	2,709,734	20.3%	554	17.5%	3
Small	22	106,780	0.8%	31	1.0%	3
Total	41	13,354,280	100.0%	3,159	100.0%	8

Projects Included in the Evaluation

Table 2-9 summarizes the space conditioning projects included in the evaluation. Overall 40 sites were verified or analyzed. These projects account for about 80% of the ex ante gross impacts. Of these 40 projects, 36 were included in the NTG analysis.

Table 2-9
Space Conditioning Projects Included in the Evaluation

Strata	Total Projects	Projects Verified	Projects Analyzed	Percent of Ex Ante Gross Impacts Analyzed		Sites in Net-to-Gross Analysis
				kWh	kW	
Large	2	0	2	100%	100%	2
Medium	17	12	4	31%	50%	12
Small	22	19	3	9%	11%	22
Total	41	31	9	85%	90%	36

2.2.13 Impact Evaluation Summary

Figure 2-8 presents a summary of the impact evaluation activities. Primary data collection, analysis, and site reporting assignments are shown, and sample sizes are indicated.

Figure 2-8
Summary of Impact Evaluation Activities

End Use	Study Group	Data Collection	Analysi	Reporting	Sample	Complete
Process	Large	Detailed Surveys / Custom NTG	Engineering/Custom NTG Analysis	Project-specific	12	12
	Medium Analysis	Detailed Surveys / Custom NTG	Engineering/Custom NTG Analysis	Project-specific	4	4
	Medium Verification	Verficiation Surveys / Standard NTG	Verification/Standard NTG Analysis	Verification Memo	6	5
	Small Analysis	Detailed Surveys / Custom NTG	Engineering/Custom NTG Analysis	Project-specific	2	2
	Small Verification	Verficiation Surveys / Standard NTG	Verification/Standard NTG Analysis	Verification Memo	10	9
Process Boilers	Large	Detailed Surveys / Custom NTG	Engineering/Custom NTG Analysis	Project-specific	2	2
	Small Analysis	Detailed Surveys / Custom NTG	Engineering/Custom NTG Analysis	Project-specific	1	1
	Small Verification	Verficiation Surveys / Standard NTG	Verification/Standard NTG Analysis	Verification Memo	2	2
Space Conditioning	Large	Detailed Surveys / Custom NTG	Engineering/Custom NTG Analysis	Project-specific	2	2
	Medium Analysis	Detailed Surveys / Custom NTG	Engineering/Custom NTG Analysis	Project-specific	3	4
	Medium Verification	Verficiation Surveys / Standard NTG	Verification/Standard NTG Analysis	Verification Memo	14	12
	Small Analysis	Detailed Surveys / Custom NTG	Engineering/Custom NTG Analysis	Project-specific	3	3
	Small Verification	Verficiation Surveys / Standard NTG	Verification/Standard NTG Analysis	Verification Memo	19	19

2.3 GROSS MEASURE SAVINGS METHODOLOGY

Gross measure savings were developed on a project-specific (and measure-specific) basis for each site in the analysis sample. Verification surveys were performed at additional smaller sites, and verified measures are included in the analysis of Program savings. All sampled sites were expanded to Program totals using statistical techniques.

2.3.1 Process and Process Boiler Analyses

The process projects are, by definition, specialized and unique so the engineering approach for calculating gross impacts varied for each project and site. Data requirements and sources of data varied depending on the technology, complexity of the process, the nature of the site, and the degree of support and cooperation of the customer.

Principles

While engineering approaches and data collection requirements varied from site to site, there were certain common principles that were applied to evaluate these sites in assessing gross savings. These principles included the following:

Technical Validity: Evaluation analysis was based on strict adherence to engineering principles and the underlying laws of electricity and physics. All methods used accepted engineering techniques. Sources of the methods used and documentation supporting their validity were provided as part of the site reports. Any models used were based on accepted, equipment-specific or system-specific engineering calculation methods (i.e., ASHRAE, AIEEE, ASME, ARI) using algorithms that are accepted by industry, utility groups, and regulatory bodies.

The PG&E project files included an engineering analysis which was reviewed during the site planning process. When possible, the same methodology was utilized in the evaluation, while verifying key engineering model inputs during the on-site surveys. Alternate methods were used when the PG&E analysis method was deemed not appropriate or when availability of site data supported a more accurate methodology. Use of a consistent method helped to facilitate the explanation of discrepancies between the PG&E project impact estimates and the evaluation results.

Base Case Identification: The base case selection is usually crucial to the evaluation result. Many times, the base case selected can have a greater influence on the evaluation result than the performance of the systems that are modified. The base case for each measure was thoroughly documented and clearly presented in each site report. For most process sites in the project-specific analysis sample for this evaluation, the base case consisted of the pre-project equipment or system performance, operating under verified post-project operating conditions and service levels. The basic principles of base case specification included the following:

1. Title 20/24 does not apply to any of the process measures being evaluated. A hypothetical “Code” base case was not an issue.
2. When the process measure consisted of a process modification that changed the system completely, the pre-project system configuration was used as the base case. Information regarding the other benefits and motivations for the project were noted in the project review file for the customized free-ridership analysis.
3. When a direct replacement occurred, the evaluation attempted to make a determination of the age and state of repair of the equipment that was replaced. Customer interviews regarding the remaining useful life of the retrofitted equipment were incorporated into this determination. If the equipment that was replaced was at the end of its effective service life, then the base case was defined as a “standard” system that represents the “typical current industry practice.” Where the PG&E project file provides an incremental cost, the standard system used as the base case was defined as the equipment or system which could have been purchased for the incremental amount below the total project identified in the project file.
4. An attempt was made to adjust impacts for level of service or production output for all process measures. This analysis was carried out with reference to the principles expressed in the “Quality Assurance Guidelines and Self-Report Methods for Estimating DSM Program Impacts” (California DSM Measurement Advisory Committee (CADMAC) Study 2001M, April 1998). Customers were asked to provide information indicating the level of production before and after the measure implementation. When such information was available, an attempt was made to adjust results to reflect production changes on impact in accordance with the principles of Section 3.4 of CADMAC 2001M. Customer interviews were used to assess whether or not the rebate was directly responsible for changes in production. If the rebate was responsible for production changes, then pre-retrofit production levels were used in the impact assessment. Otherwise, post-retrofit production levels were utilized.

5. Adjustments for level of service were based on *actual* production output rather than *rated* equipment output.

Power Measurements: On-site monitoring and measurements were carried out in accord with procedures recommended in PG&E/CADMAC Document "Development of Statewide Metering/Monitoring Protocols: Monitoring Protocols" (May 1994) and with reference to the "NAESCO Standard for Measurement of Energy Savings for Electric Utility Demand-Side Management Projects" (November 1993).

Most site-specific evaluations required measurement of key equipment operating and performance parameters to support analysis—unless suitable data were available from the customer monitoring or operating logs. Direct measure of true RMS power was used whenever possible, consistent with the project budget and the availability of equipment. When equipment was not available, amperage was measured as a surrogate and power calculated from the amperage measurements. When amperage was monitored, spot readings of voltage and power factor were taken within the range of amperage readings to ensure that power factor was properly considered in the power calculation.

Load Measurements: Data necessary to calculate output loads were measured to allow assessment of equipment performance when individual equipment efficiency or performance was a key aspect of the evaluation strategy. Where possible and practical within the analysis budget, loads were calculated from measured parameters rather than using manufacturer's performance curves. If load data could not be measured with reasonable accuracy, manufacturer's performance curves were used to develop the evaluation output load profile for the equipment.

Annualization of Results: The M&E Protocols call for evaluations to identify first-year project savings. Results for all measures were annualized to a representative annual period. All results and impacts were normalized to a "typical" operating year. An annualization methodology was identified in each site-specific evaluation report. The methodology identified the method and algorithms used to extrapolate the monitoring period results to annual results. Daily, weekly, monthly, and seasonal variances in production, weather, and operating schedule were considered in developing the annualization strategy. Whenever possible, hourly data were used to calculate the first year savings. When hourly data were not available, an annualization strategy was developed and described in the evaluation report. The strategy attempted to use actual hours of system operation for each seasonal period if such data were available. When hours were not available, customer interviews indicating relative intensity of operations over the annual period were used. Where possible, secondary data such as shift hours, production units, and man hours, were used to indicate seasonal variations in operations (and hence energy impacts).

Program measures at several analysis sites involved technology applications that are affected by ambient weather conditions. For these measures, pre-project and post-project energy use were related to ambient conditions. The results were then extrapolated to an annual period by relating the impacts to the appropriate "typical meteorological year" (TMY) weather data for the weather station deemed most representative for the customer location.

Time Period Aggregation of Impacts: The annual results were aggregated into PG&E's five time-of-use periods. Generally, impacts were calculated for 8760 annual hours using a weather or loading/performance file for each operating hour of the year. The time-of-use period impacts were then aggregated by summation of hourly impacts into the appropriate PG&E time-of-use periods. If daily and weekly or seasonal operating patterns could not be clearly distinguished, a rational means based on customer estimates of relative operating intensity was developed. The method is described in the specific evaluation report for each site.

General Analytical Technique

This section describes the general analytical approach used for process and process boiler analysis sites. In general, the procedure identified an hourly load profile and system performance for the monitoring period. The performance for the monitoring period was related to an independent variable by which the monitoring period impacts could be annualized. If annual data were available from customer records or logs, these data were used as the basis for the annual impact results. Once the hourly results were determined, they were summarized and aggregated into the PG&E time-of-use periods. The major steps of this approach are described in further detail below.

1. Measure Energy Input Profile for Evaluation Period: The actual system energy use (or power) each hour comprises the unadjusted post-project power and energy use. An equipment submeter which records actual kW or parameters from which input power may be calculated, such as percent full load or amps, was used as documentation of the post-project energy use. For items where measurement of the rate of energy or fuel input was not appropriate or was impractical, measurements of parameters that provide a secondary indication of power and energy input were used. For instance, where a process line involving a large number of motors comprises the project, a representative group of motors was monitored as an indication of overall process use. The measurements are described in the site-specific evaluation report.

2. Measure System Load Profile for Evaluation Period: The equipment or system loading or output for the period was calculated using measured operating factors whenever possible. Loading might be expressed as chiller tons, compressed air flow (at a given pressure), air flow rate (fan output), or other similar variables. (Note: Loading was calculated directly from measured operating parameters or "backed into" using known manufacturer's operating performance from equipment submittals.) For example, chiller tonnage may be calculated using the supply and return chilled water temperature and the flow rate if these factors are known. If these variables are not known, the system output for the monitoring period may be developed from the manufacturer's performance curves for the equipment. In the absence of data, the customer was asked to estimate the relative output of the system at various power input levels, or an engineering estimate based on typical performance for the type and configuration of equipment was made by the evaluation engineer.

3. Identify System Performance Profile for Evaluation Period: The operating efficacy was calculated by dividing the input energy developed in Step 1 by the output identified in Step 2.

(For example, for a chiller, the input power and supply and return chilled water temperatures would be measured at hourly intervals. Chiller tonnage would be calculated by multiplying the difference between the measured supply and return chilled water temperature and the flow rate by appropriate conversion factors. The power measured in Step 1, in turn, would be divided by the calculated tons to determine the kW per ton at various loading levels.)

4. Identify Profile of Key Operating Variable(s): Key variables that affect system load and performance and which are known or can be estimated with reasonable confidence were identified. Functional relationships of the system loading and performance to the key variables were then identified. For the projects in the sample group, these variables are described below:

a. Compressors: Air demand profile and operating schedule, air flow rates and pressure at various demand levels

b. Conveyors and Process Drive Systems: Mass flow rates for solids and process fluids, speed and torque profile for rotating machinery

c. Variable Speed Drives on Fans/Pumps: Ambient temperature, process cooling requirements, and fluid flow rates and pressures, operating schedule

d. Thermal Process Projects: Mass flow rates, specific heat or other thermodynamic properties of primary and secondary fluids, and secondary process stream impacts (operating schedule is constant)

5. Extrapolation to Annual Period: The extrapolation to the annual period which is representative of the "first-year savings" was performed by extrapolating the base case and post-installation energy use measured during the monitoring period using the functional relationships defined in the previous step. Attempts were made to assess the degree of relationship and confidence level of the relationship through standard statistical techniques. Relationships with a low confidence level were not used or suitable justification for their use was provided in the site reports. If no relationship was identified between system performance/load and annualizing variable, then a simple load-duration profile (i.e., direct time at various levels of load), average loads, or a production output relationship defined in consultation with the customer was used. Project impacts that were determined to be significantly related to weather were extrapolated to an annual period using TMY data for the nearest or most representative weather station.

Site-Specific Analyses

Site-specific analysis approaches for the process and process boiler analysis projects are outlined in Appendix A.

2.3.2 Space Conditioning Analyses

Many of the evaluation components outlined above in the process analysis section were also applied to the space conditioning analyses. Additional information on analysis approach for the space conditioning projects is discussed next.

For the space conditioning measure sites, the evaluation planning process identified the technology and key performance attributes of the project that affected savings. Generally, the evaluation of industrial space conditioning measures involves defining four key variables for each operating period: equipment performance (efficiency), loading profile, operating conditions (e.g., temperature or pressure set points), and weather.

Two types of analysis were utilized for the space conditioning analysis sites: An hourly simulation methodology for seven of the analysis sites and a spreadsheet-based adjustment model for one site where an extensive analysis, that included pre-retrofit and post-retrofit measurements, had been carried out as part of the initial ex ante project documentation.

The VisualDoe model was used to perform the hourly simulation analyses. For four of the larger projects, "plant-only" model runs were developed. For these models, information on loading profile and operating conditions was developed from data extracted from the customers' energy management system and from measurements taken during the site survey. The models were then run to simulate space conditioning system performance and energy use for the post case equipment and the base case (less efficient) system. For three smaller projects that involved installation of high efficiency packaged air conditioning, full VisualDoe models were developed. In all cases, models were developed using site-specific inputs, and the models are sufficiently detailed to reasonably reflect the impact of a specific measure at a specific site. All impact results are annualized in the simulation analysis using "typical year" weather data.

Since all analyzed projects exhibited some degree of weather dependence, the calculation of peak kW impacts varied somewhat from the approach taken for the process and process boiler projects. For the process and process boiler projects, the summer on-peak kW estimate was based on an average of expected kW impacts for a typical summer weekday between 3pm and 4pm. This estimate usually reflected an average of peak hour impacts across all 3-4pm hours during the summer costing period. To address the fact that space conditioning impacts tend to correlate with PG&E's system peak which is associated with the hottest days of the year, the summer on-peak kW impact estimate is calculated as the average of peak hour (3-4pm) impacts for the five hottest weekdays of the year. This approach is consistent with the method PG&E has used to determine commercial space conditioning peak impacts.

2.3.3 Verification

For the smaller projects that didn't receive a site analysis, verification reviews were conducted. On-site surveyors were provided a list of installed measures and measure descriptions from the Program tracking system, supplemented with extracts for more detailed measure descriptions from the hard copy project files. The surveyors then went on site to verify the quantity of measure items which were installed and operable. Where reported measure quantities differed from observed measures, discrepancies were noted and reasons for differences were explored and tabulated.

2.3.4 Program-Level Impacts

The estimate of gross measure impacts for each end use were developed using the results of the site studies and verification visits. A method known as ratio estimation was used to extrapolate the sample results and derive the overall Program impacts.

In ratio estimation, the tracking system estimates of savings are used to leverage the results from the various site studies and surveys. A separate ratio, or realization rate, will be developed for each sampling stratum. The equation below demonstrates how the total Program impacts were derived.

$$IMPACT = \sum_{i \in P} T_i \times \frac{\sum_{j \in S} I_j}{\sum_{j \in S} T_j}$$

where:

IMPACT = The total gross impact for a given stratum (in kWh, kW, and/or therms);
T_i = The tracking system estimate for site *i*;
I_j = The estimated impacts from the site study for site *j*; and
P and *S* = The collection of sites in the given strata of the population and site study sample, respectively.

Standard statistical formulas for the variance of ratio estimators are utilized to develop estimates of precision and associated confidence intervals for each end use.

In order to incorporate the verification analysis into the study results the ratio analysis was modified, and the following approach was taken for each end use and stratum:

- Analysis sites: Impacts were determined by summing all site-specific impacts.
- Verification sites: Impacts for all *verified* projects were calculated by applying the realization rate for all the verified analysis projects to the tracking system estimates for the projects. Savings are zero for projects that are not verified.
- Not-studied sites: The overall realization rate for the analysis and verification sites was applied to the tracking system estimates for these sites.
- Total impacts: Analysis, verification, and not-studied impacts were summed to reach total impacts for each end use and stratum.

Equations used to calculate Program impacts for each end use and stratum are:

Analysis sites: $I_A = \sum_{j \in A} I_j$

Verification sites: $I_V = \sum_{i \in V} (T_i \times BV_i) \times RR_1$

Not-studied sites: $I_N = \sum_{i \in N} T_i \times RR_2$

Total Impact: $IMPACT = I_A + I_V + I_N$

where:

$$RR_1 = \frac{\sum_{j \in A|V} I_j}{\sum_{j \in A|V} T_j}$$ (the average realization rate for the verified analysis sites)

$$RR_2 = \frac{I_A + I_V}{\sum_{j \in (A \cup V)} T_j}$$ (the average realization rate for all the analysis and verification sites)

and:

I	= Gross impacts as determined by the evaluation
T	= Gross tracking system impacts
BV	= Binary verification variable, = 1 if project is verified, and = 0 otherwise
A	= Subscript indicating analysis sites
V	= Subscript indicating verification sites
N	= Subscript indicating not-studied sites
i, j	= Site-specific indicator subscripts

2.4 NET PROGRAM SAVINGS METHODOLOGY

Net Program savings were developed by applying NTGRs to gross Program impacts. The net savings were developed at the project level and then expanded to the Program population using appropriate statistical techniques. Two levels of analysis were used to assign project-level NTGRs: First, a standard NTG analysis, using survey data collected at the time of the site visit, was applied to all projects; second, a customized NTG analysis, utilizing information from a follow-up telephone survey, built upon the standard NTG analysis to better characterize project decision making. Program spillover was calculated and included as a final adjustment to Program net impacts.

2.4.1 Project Analyses

Standard NTG Analysis

In the standard project-specific NTG analysis, customer surveys were used to develop NTG probabilities. Multiple choice survey questions were used to divide into distinct categories customers' stated intentions regarding measure installation. For each category, a probability that the Program caused the action is assigned. For example, a probability of 0.8 would indicate there is an 80% probability that the Program was responsible for the customer's action. In addition, the Program could be given credit for accelerating energy efficiency purchases and promoting higher efficiency measures for customers who indicate they would have installed some measures anyway. The probabilities are interpreted as the project-specific NTGRs.

Initial Ratios

The "stated intentions" question (Question C7 of the standard NTG survey included in Appendix B) was used to derive initial NTGRs for each surveyed facility and technology, based on what respondents state they would have done in the absence of the PG&E Program. Table 2-10 shows how the initial ratios were calculated. NTGR #1 is a simple zero/one determination depending on whether or not the customer was likely to install measures without the PG&E incentive. NTGR #2 allows for a variation in the NTG score depending upon how certain the customer was about their decision to install measures. NTGR #2 was used for the final calculations, and NTGR #1 was calculated as a cross-check on how the intermediate values in NTGR #2 affect the score.

Table 2-10
Net-to-Gross Ratio Assignments Based on Participants' Stated Intentions

Install measures without Program? (Question C7)	NTGR #1	NTGR #2
Definitely would not install without Program	1.0	1.0
Probably would not install without Program	1.0	0.7
Probably would install without Program	0.0	0.3
Definitely would install without Program	0.0	0.0

For customers who indicated that they would "probably install" or "probably not install" the same measures without the Program, an additional question (C7a) was asked to assess the likelihood, on a zero to ten scale, that they would have installed the same measures without the Program. This question provided additional information to modify NTGR #2 in cases where the customer is not certain about what their actions would have been without the Program.

Consistency Checks

Next, consistency checks were used to limit the NTG probabilities when respondents' answers appeared to be inconsistent. Table 2-11 outlines the consistency checks used to adjust NTG probabilities. These checks were based on customers' responses to questions relating to sources of energy efficiency information, steps in the decision process, and significance of the PG&E Program in influencing customer decisions.

Table 2-11
Consistency Checks

Check	Survey Question	Consistency Check	Assigned Probability Limit
1	C2	If customer first heard of efficient technologies from PG&E	Minimum of 0.5
2	C5	If customer had already been planning to purchase the measures before hearing about the Program	Maximum of 0.5
3	C6	If the Program was rated extremely significant in customer's decision to install energy efficiency measures	Minimum of 0.85
4	C6	If the Program was rated very significant in customer's decision to install energy efficiency measures	Minimum of 0.7
5	C6	If the Program was rated somewhat significant in customer's decision to install DSM measures	Minimum of 0.5
6	C6	If the Program was rated insignificant in customer's decision to install DSM measures	Maximum of 0.3

Check #1 provides some NTG credit to PG&E for informing the customer about the energy efficiency measure. There is at least some doubt about whether or not the measures would have been installed if the customer had not learned about them from PG&E. Check #2 limits the NTGR to a maximum of 0.5 if customer first heard about the PG&E Program after planning to purchase specific measures. The limit is not set to zero in this case because purchase plans are not always implemented.

Checks #3 through #6 limit the NTGRs based on the significance of the Program on the customer's decision to install measures (as determined in Question C6 of the standard survey). If the Program was "extremely significant," the NTGR *minimum* is set at 0.85, which is halfway between the "definitely would not install" and "probably would not install" probabilities shown in Table 2-10. A "very significant" rating equates to a *minimum* "probably would not install" NTGR of 0.7 in Table 2-10. A "somewhat significant" rating is equated to a *minimum* NTG probability of 0.5 which gives the PG&E Program partial credit for the measure installation. Finally, an "insignificant" rating limits the NTG probability to a *maximum* of 0.3, consistent with a "probably would install anyway" assignment in Table 2-10.

Assessing Partial Free-ridership

Partial free-ridership occurs when, in the absence of the Program, the customer would have installed equipment that is more efficient than was assumed for the baseline efficiency but not as efficient as the equipment that was actually installed as a result of the Program. To address partial free-ridership in the standard NTG analysis, an additional benefit or penalty was added to the initial NTGRs based on what the customer said they would have installed without the Program.

Customers who were likely to have installed measures anyway without the Program are asked if the nonprogram equipment would have been as energy efficient as the equipment that was actually installed under the Program (Question C8 of the standard NTG survey). If the customer indicated the equipment would not have been as efficient, the initial NTGR was incremented by 0.2 to give the Program some credit for increasing the customer's energy efficiency.

Customers who were not likely to have installed measures without the Program are asked if the equipment they otherwise would have installed would have been of standard efficiency or some intermediate level of efficiency (Question C9 of the survey). If the customer indicated the equipment would have been of intermediate efficiency, the initial NTGR was decreased by 0.2 to account for the fact that the gross savings estimate, which is based on standard efficiencies, overstates impacts that would have occurred without the Program. Table 2-12 summarizes the adjusted NTGR assignments after accounting for partial free-ridership.

Table 2-12
Adjusted NTGRs Based on Efficiency of Nonprogram Equipment That Would Have Been Installed Without the Program

Install measures without Program? (Question C7)	NTGR #2 from Table 2-10	Efficiency of nonprogram equipment that would have been installed (Qs C8 & C9)	Adjusted NTGR
Definitely would not install without Program	1.0	Standard efficiency	1.0
		Above-standard efficiency	0.8
Probably would not install without Program	0.7	Standard efficiency	0.7
		Above-standard efficiency	0.5
Probably would install without Program	0.3	Not as efficient as Program equipment	0.5
		As efficient as Program equipment	0.3
Definitely would install without Program	0.0	Not as efficient as Program equipment	0.2
		As efficient as Program equipment	0.0

The choice of an increment/decrement of ±0.2 to address partial free-ridership was made for the following reasons:

- The adjustment provides for a fairly smooth progression in the adjusted NTGR based on a combination of the customer's initial stated intentions and the type of equipment they may have installed without the Program;
- The adjustment gives more weight to the "would not/would have installed" question (Question C7 of the survey) versus the "not as/as efficient" questions (Questions C8 and C9); this is preferable because, under the hypothetical situation the survey respondent is being put in, the "would not/would have installed" question is one level less abstract that the "not as/as efficient" questions; and
- For the largest Program projects that received custom NTG analyses, the issue of partial free-ridership was explicitly addressed by trying to determine the actual equipment that would have been installed without the Program.

Accounting for Deferred Free-ridership

Deferred free-riders are those customers who would have installed equipment in the absence of the Program but would have installed it at a later date. Therefore, the Program is responsible for accelerating the installation of the energy efficient equipment.

For customers who indicated that they probably or definitely would have installed the same equipment without the Program (question C7 equaling three or four and question C8 equaling two), the possibility that the Program may have accelerated their project was factored into the analysis. If the customer indicated that they would have, in the absence of the incentive, installed the equipment over a year later (question C10), a NTGR from the following forecast conversion table[1] was developed.

Table 2-13
Forecast Conversion

Forecast Installation of Same Equipment	Implied NTGR
Less than 1 year	0.00
1 to 2 years	0.25
2 to 3 years	0.50
3 to 4 years	0.75
4 or more years	1.00
Never	1.00

For the affected customers, the implied NTGR was averaged with the NTGR developed from the motivation questioning sequence to provide the standard NTGR.

Additional Survey Questions

A number of additional questions that are not directly factored into the NTGR calculations were included in the Standard NTG survey. The questions mainly involved customer satisfaction with the measures and the Program, sources of customer knowledge about the Program, and factors affecting the decision and timing of the measure installation. These questions were included to get the customer thinking about the decisions surrounding the measure installation and to serve as a warm up for the customer prior to asking them the questions that directly affect the NTGRs.

Non-Responses and "Don't Know's"

Some customers who agreed to be included in the gross impact analyses did not want to respond to the NTG survey. Alternately, the customer decision maker for some projects was no longer available, and it was not possible to field the NTG survey. The general approach for these sites was to drop them from the NTG analysis and to calculate the end-use and Program NTGRs using savings-weighted averages of customers who do complete the surveys (see the subsection below on calculating Program NTGRs).

Each site that was dropped from the NTG analysis due to non-response was reviewed to determine if the site should receive special treatment such as the assignment of a NTGR based on other sources such as discussions with customer operations staff, discussions with vendors,

[1] Spanner, G., and Riewer, S., "The Energy Savings Plan: Incentives for Efficiency Improvements in the Industrial Sector." Proceedings of the ACEEE Summer Study. Washington D.C., 1990 pp. 7.251-7.260.

and/or reviews of project economics as contained in the hard copy project files (for process projects).

A number of NTG surveys were completed but contained "Don't Know" responses to analysis questions. In general, NTGRs were calculated for each survey where there was a legitimate response to either the "Program significance" question (Question C6 of the standard NTG survey) or the "what would have happened without the Program" question (Question C7). Other survey questions were more auxiliary in nature and were not as central to the determination of free-ridership. In cases where either Question C6 or Question C7 is missing, all survey responses were reviewed to determine if the survey was legitimate. In cases where both C6 and C7 were missing, the survey was dropped from the NTG analysis. For Custom NTG projects, additional discussions with the customer, possibly with a different contact person, were used in an attempt to eliminate the "Don't Know's."

Custom NTG Analysis

The goals of the custom NTG analysis were to establish accurate project NTGRs, minimize uncertainty in the assigned NTGRs, and develop narratives documenting the justification for the assigned NTGR.

The custom NTG analysis was designed to build upon the information obtained in the standard NTG analysis. In preparation for custom NTG interviews with customers and vendors, data elements were carefully reviewed to identify key issues that could affect the NTG ratio. Sources of data included:

- The standard NTG surveys
- Project files
- Relevant material from the gross impact analysis

The custom NTG interviews were open ended. Trained XENERGY analysts worked with the customer to establish an understanding of the project decision making process and the role of the PG&E Program in that process. Issues that were considered in conducting the custom NTG interviews and analyses included:

- Where the customer got information on the technology (PG&E, vendor, other)
- Primary motivation for installation of the equipment (energy savings, production quality, retooling)
- Motivation for selection of the high-efficiency versus base equipment
- Perspectives of different players (engineer, CFO, plant manager)
- Influence from outside parties (ESCOs, contractors)
- Alternatives considered, past practices of the customer, project economics, non-energy benefits, project timing, project planning process, and project approval process

Vendor surveys were triggered in instances where the customer decision maker (or in some cases the PG&E customer representative) indicated that a vendor was the primary proponent for the installation of more efficient equipment. Vendors were asked about the significance of the PG&E Program in their recommendation to install rebated measures and whether or not the rebated measures would have been installed in the absence of the Program.

Inconsistencies identified during the standard NTG survey analysis (i.e., where the consistency checks are activated) and in various other data components (discussions with PG&E staff and vendors, project files, information obtained during the gross impact analysis) were isolated and explored. For example, during the standard NTG survey, some customers may have said the Program was significant in their decision to install measures but also have said they would have installed measures without the Program. During the follow-up NTG interview, the customer would be asked to clarify or revise these statements.

In conducting the custom NTG analysis, the starting point was the result of the standard NTG analysis. If the information behind the standard NTGR was not contradicted or improved upon during the custom NTG analysis, the standard NTGR was used for a particular project. In cases where additional or different information was developed during the custom NTG analysis process, the standard NTG ratio was adjusted and the factors contributing to this adjustment were explained as part of the site report. In cases where the custom process simply provided better data for elements of the standard NTG survey, the standard NTG analysis was updated using the better data.

2.4.2 Program Impacts

For each end use and stratum, net impacts were developed by applying site-specific NTGRs to site-specific impacts as follows:

Analysis sites: $$NI_A = \sum_{j \in A} I_j \times NTGR_j$$

Verification sites: $$NI_V = \sum_{i \in V} (T_i \times BV_i) \times RR_1 \times NTGR_i$$

Not-studied sites: $$NI_N = \sum_{i \in N} T_i \times RR_2 \times \overline{NTGR_{A,V}}$$

Total Net Impact: $$NET\ \ IMPACT = NI_A + NI_V + NI_N$$

where:

$$\overline{NTGR_{A,V}} = \frac{I_A + I_V}{NI_A + NI_V}$$

NI = Net impacts

and other variables are as defined above in the section describing calculation of Program gross impacts.

NTGRs for any stratum or end use (combinations of stratum and end use) can be calculated by dividing net impacts by gross impacts.

2.4.3 Spillover Adjustment

As part of the project-specific analyses, screening surveys were conducted to assess the effects of Program spillover—installations of energy efficient equipment installed outside the Program but induced by the Program. If the customer indicated that they had installed energy efficiency measures outside of the Program as a result of their involvement with the PG&E Program, and they did not intend to seek a rebate for the measures, then an engineering analysis was conducted to quantify spillover impacts.

To incorporate spillover effects into Program net impacts: Spillover rates were calculated as the total spillover impact (across all projects) divided by total gross impacts; NTGRs were then augmented by the spillover rates; and the adjusted NTGRs were applied to gross savings.

2.5 DATA COLLECTION

2.5.1 The Data Collection Process

The data collection process began with extraction of data from the Program tracking system and PG&E billing system. Pertinent data for each site and project was isolated and reported in a consistent fashion for each study site. Key variables included site location, key contacts, measure descriptions and counts, ex ante savings estimates, project costs, rebate amounts, and key dates. For this exercise, data were loaded into a Microsoft Excel spreadsheet and linked electronically to site forms in Microsoft Word using "mail merge" techniques. (Some of the key data are contained on page one of the site reports shown in Appendix C.)

Next, a hard copy project file review was conducted. This review built upon information developed from the tracking data extraction. For example, if multiple project contacts were available, they were added to the one contact that was extracted electronically. The file review was most important for the process analysis sites where customized savings methodologies were presented.

After the file review was complete and a general understanding of each project was developed, PG&E Customer Representatives and other key PG&E staff were contacted as necessary to discuss the project and to develop a strategy for contacting the customer. Customer recruitment and administration of the spillover survey provided additional information.

Next, after completion of project-specific evaluation planning, the key data collection element of the gross impact portion of the study, the on-site survey, was conducted. Observation of equipment, necessary measurements, collection of customer-provided data, and interviews with the customer took place during the survey. All site data outlined in the evaluation plan were collected, if feasible, or alternative approaches for the evaluation were developed, based on facility logistics.

To complete the gross impact analysis for projects, it was sometimes necessary to contact vendors, equipment manufacturers, or other secondary sources. These telephone requests for information depended on project-specific circumstances.

Finally, the NTG follow-up interviews took place, as necessary. For smaller sites, it was usually possible to implement the standard NTG surveys during the on-site process. For larger sites customized NTG surveys necessitated at least one telephone call to a customer decision maker.

2.5.2 Data Collection Requirements

Some of the key data collection requirements and associated issues are discussed next.

Project-Specific Analysis Sites

General Data Requirements:

The specific parameters that the PG&E estimates and evaluation savings are based on varied for each different type of equipment and technology. In general, the factors addressed in the evaluation included:

- Operating schedule (daily, weekly, monthly, and seasonal);
- Input power versus output service level (full and part load);
- System efficiency (full and part load);
- Control setpoints and control strategy;
- Operating conditions (e.g., temperatures, pressures);
- Output rates and total output (e.g., gallons per minute and gallons, cubic feet per minute and total cubic feet at a given pressure, Btu's per hour and total Btu's of cooling);
- External loading factors (e.g., service level, weather); and
- Equipment annual load profile.

On-Site Monitoring and Measurement

On-site monitoring and measurement of key operating parameters were used where the methodology included site measurements as the most reliable, accurate and cost-effective means of identifying the true impacts, and where the customer agreed to allow it. The following instrumentation was used where appropriate. All of the listed devices have computer interfaces which allow downloading of data into an Excel spreadsheet or other useful format for graphic presentation or statistical analysis, and for permanent documentation:

- Motor time-of-use loggers: Pacific Science & Technology;
- Power monitoring/logging: Pacific Science & Technology "Elite"; Fluke; Summit PowerSight Energy Analyzer, PS3000, Power Logger;
- Current/temperature loggers: ACR "Trend Reader"; and
- Temperature logging: HOBO "Stow Away"

Data obtained by logging equipment were retained in Excel readable format. It is summarized or presented in truncated form in the site-specific analysis reports for the sample sites.

Data Sources and Data Collection Strategies

The evaluation focused on making maximum use of available resources and using as much easily and readily available customer information as possible at the site visits. Data sources that were used include:

- Focused interviews with customer operating management and line operating staff;
- Customer measurements;
- Customer data from SCADA or EMS systems;
- Customer data from hand-written operating logs;
- Plans, specifications, balancing or commissioning reports obtained from the customer or vendor;
- Previous consultant studies and measurements;
- Customer submetering or observations of submeters;
- Spot measurements during site visit; and
- Short-term monitoring of input amps or power and key load parameters

A portion of the initial customer contact included a discussion of data available from the customer. The data requirements and the source of each data item are provided in the site-specific analysis plan for sampled sites.

Net-to-Gross Surveys

The NTG or Decision Analysis data collection script consisted of a series of questions designed to isolate the motivation for, and the timing of, equipment installations. To increase the probability that unbiased and accurate decision-related data were collected, the questions were designed to:

- Help the customer separate their current thoughts about the project from their decision process at the time of Program participation;
- Prevent the customer from giving defensive or manipulated answers;
- Identify and justify apparent inconsistencies in respondents' answers;
- Ensure responses are obtained from a financial decision maker or that such a person's opinion is at least taken into account; and
- Provide additional insight about the project decision making, current satisfaction, and possible spillover effects.

Experience indicates that biased answers are likely to be obtained if surveyors simply ask participants if they would have undertaken similar equipment installations in the Program's absence. One reason for this bias is that respondents tend to answer as if the question were "if you had it to do over again, would you do the same project, even if you couldn't get financing or had not received information?" Customers who are happy with their projects will tend to reply in the affirmative. Another reason is that if this is the only question asked, respondents may recognize the purpose of the question, and give the answer they think will have the desired effect on the Program. An additional concern was that while the main contact might have wanted to pursue the project even without PG&E incentives, the investment might not actually have been approved by the ultimate decision maker without the rebate. Thus, a part of the interview focused on identifying the key decision-maker who should address the NTG issues.

2.5.3 Summary of Data Collection Instruments

Project data collection forms are contained in Appendix B. Following is a brief description of each form.

Recruitment and Spillover Survey

The recruitment form and spillover survey was utilized during the early customer contact process. The recruitment form was utilized to log initial attempts to contact the customer and provided an explanation if a customer did not wish to participate in the study.

The spillover survey was utilized to determine if participants had installed additional measures during the study period that: 1) are not included in PG&E rebate Programs, and 2) can be shown to have been installed as a result (or partial result) of the PG&E Program.

Process Equipment Surveys

Because of the diversity of projects in the process end use, a generic survey instrument would only capture some of the information required for the process analyses. The basic instrument was used to record verification/retention data and related factors. General plant scheduling and metering equipment identification was also collected on the standard form.

For process-specific data collection needs, a customized equipment-specific survey instrument was utilized, as appropriate. An example set of survey instruments, indicating the data that would be required for some of the equipment expected at the sample sites is included in Appendix B. These forms were modified to meet the specific site circumstances.

Net-to-Gross Surveys

The NTG survey instruments (standard and custom) were designed to collect key elements necessary to assess the impact of the PG&E Program on customers' decisions to install energy efficiency measures, including:

- Identification of the primary decision maker(s);
- Source of the customer's knowledge about the installed measures;
- Timing of the measure installation decision process relative to learning about the rebate Program;
- Significance of the Program in the decision to install efficient equipment;

- Whether the measures would have been installed without the Program; and
- Whether the Program affected the timing or the level of the measure installations.

The standard and custom NTG survey instruments were designed to collect similar information. The standard instrument is a multiple-choice instrument while the custom instrument is open ended. The custom instrument also contains questions that address project economics.

3 RESULTS

3.1 OVERVIEW

This section presents results of the impact evaluation of PG&E's Pre-1998 Industrial Energy Efficiency Incentives Program Carry-Over. Overall net electric energy impacts for the process, process boiler, and space conditioning end uses covered by this evaluation are estimated to be 18.4 GWh; net summer on-peak demand savings are estimated to be 2.0 MW; and net natural gas savings are estimated to be 4.2 million therms per year.

3.2 GROSS PROGRAM SAVINGS

Gross savings estimates were based on detailed site-specific engineering analyses for a sample of Program sites. Results from these studies were generalized to the Program level using a ratio approach.

3.2.1 Program-Level Results

Table 3-1 presents aggregate energy and demand impacts and realization rates. As these numbers indicate, process end-use projects are realizing about 116% of ex ante kW savings, 103% of ex ante kWh savings, and 166% of ex ante therm savings. Process boiler projects are realizing about 139% of ex ante therm savings. Space conditioning projects are realizing about 53% of ex ante kW savings and 80% of ex ante kWh savings. Combined process, process boiler, and space conditioning savings are about 77% of ex ante estimates for kW, 94% for kWh, and 153% for therms.

For the process projects, ex post kW results include large impacts for one project for which the ex ante estimates were zero. The kWh impacts for two process projects were found to be negative, offsetting the effects of several large projects where the ex post result exceeded the ex ante estimate. The higher process therm impacts result largely from one very large project for which equipment performance greatly exceeded expectations.

Process boiler impacts are dominated by one large project where equipment efficiency is better than expected, and operating hours are greater that predicted.

Two large projects account for most of the space conditioning impacts. For one chiller project, building loads are not as high as anticipated. For a second HVAC control project, two of the control strategies were not implemented as planned.

Table 3-1
Summary of Gross Impact Results

End Use	Ex Ante Estimates	Ex Post Results	Realization Rate	90% Conf. Interval
Process				
Summer On-peak kW	1,947	2,259	1.16	±0.049
Annual kWh	21,433,846	22,123,180	1.03	±0.030
Annual Therms	3,107,346	5,148,495	1.66	±0.247
Process Boilers				
Summer On-peak kW	-	0	-	-
Annual kWh	-	0	-	-
Annual Therms	2,738,347	3,810,800	1.39	±0.159
Space Conditioning				
Summer On-peak kW	3,159	1,686	0.53	±0.042
Annual kWh	13,354,280	10,720,243	0.80	±0.186
Annual Therms	-	0	-	-
Total				
Summer On-peak kW	5,106	3,945	0.77	±0.064
Annual kWh	34,788,126	32,843,423	0.94	±0.188
Annual Therms	5,845,693	8,959,295	1.53	±0.293

3.2.2 Detailed Results for Studied Projects

This subsection focuses on results for projects that received site-specific analyses. Overall, 18 process projects, 3 process boiler projects, and 9 space conditioning projects were included in the analysis study. A more detailed review of evaluation findings for these projects provides additional insight as to why ex post results differed from ex ante predictions. Note that these results reflect un-weighted impacts for the projects included in the evaluation. In this way, they differ from the summary results presented above. Process and process boiler projects are discussed first, followed by space conditioning projects. Factors contributing to discrepancies between ex ante estimates and ex post results are summarized at the end of this subsection.

Process and Process Boiler Projects

The evaluated process and process boiler projects can be separated into seven technology categories. Evaluation results by category are shown in Table 3-2. The air compressor projects and the variable frequency drive projects tended to perform better than ex ante predictions. The process cooling/heating measures and the thermal process modification measures show negative kW and kWh savings resulting from two large projects (one in each category). One process heating project involved installation of a heat recovery unit that saved a considerable amount of natural gas. However, two fan motors that were required by the post-retrofit system were overlooked in the ex ante analysis. One glass furnace project showed negative savings, based on a comparison of metering data. It appears that the pre-retrofit furnace was more efficient than it was initially thought to be. Post-retrofit operation of the furnace also appears to be less than optimal.

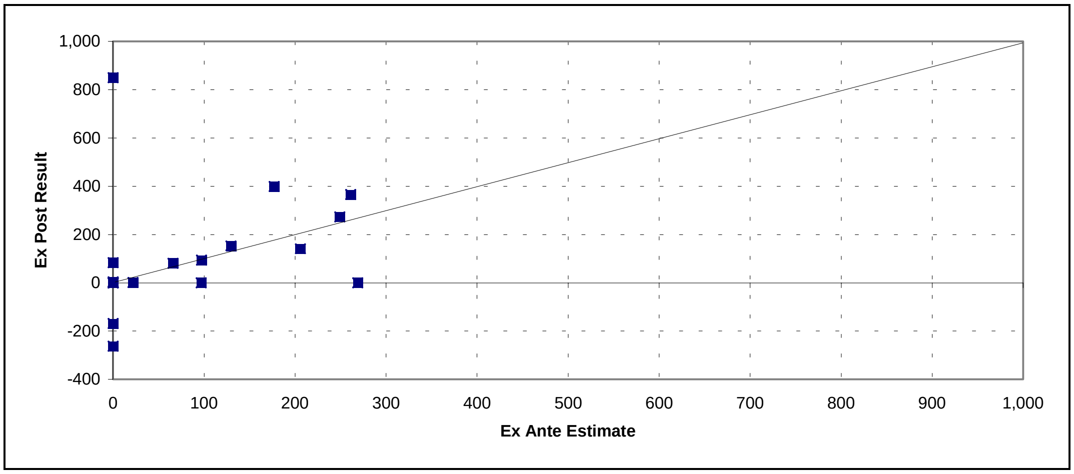
Table 3-2
Summary of Evaluated Process and Process Boiler Project Results by Measure Group

Measure Categor	Total Projects	Evaluated Projects	kW Ex Ante	kW Ex Post	kW RR	kWh Ex Ante	kWh Ex Post	kWh RR	Therms Ex Ante	Therms Ex Post	Therms RR
Process Boilers	5	3	0	0	-	0	0	-	2,424,334	3,421,484	1.41
Air Compressors	11	6	11,067,204	13,603,829	1.23	758	1,644	2.17	0	0	-
Controls	6	3	1,265,131	832,826	0.66	0	87	-	349,347	102,936	0.29
Process Cooling/Heating	5	3	893,538	-649,749	-0.73	206	-28	-0.14	1,387,330	3,772,977	2.72
Pump Replacement	2	1	712,396	747,192	1.05	269	0	0.00	0	0	-
Thermal Process Modifications	4	3	1,588,046	-663,728	-0.42	66	-182	-2.77	1,244,000	1,204,458	0.97
Variable Frequency Drives	6	2	2,108,348	4,063,574	1.93	274	492	1.80	0	0	-
Totals	39	21	17,634,663	17,933,944	1.02	1,573	2,013	1.28	5,405,011	8,501,855	1.57

RR = Realization Rate

Figures 3-1 through 3-3 compare ex post evaluation results to ex ante savings estimates for kW, kWh, and therms. The diagonal lines represent points at which ex post results and ex ante estimates are equal (realization rates equal to 1.0).

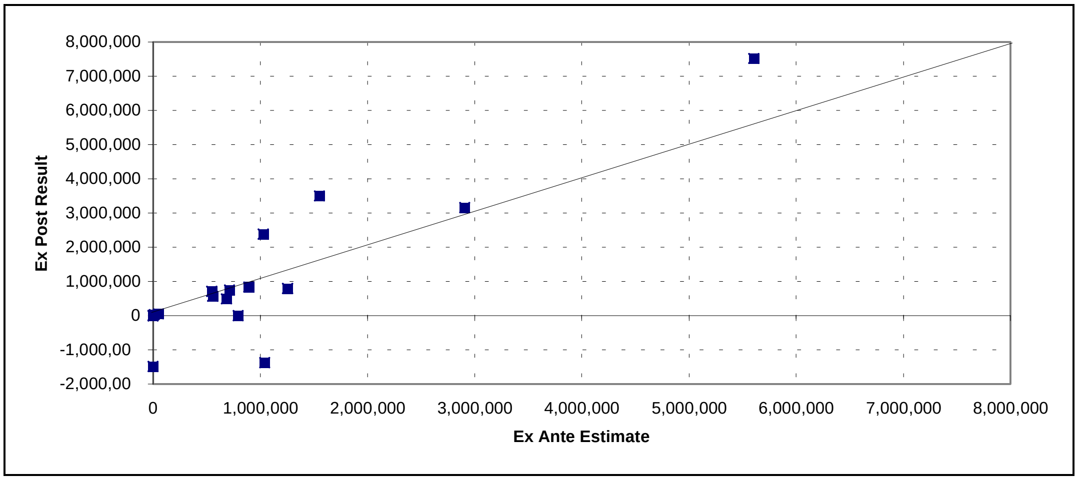
Figure 3-1
Process and Process Boiler Summer On-Peak kW Savings - Ex Ante vs. Ex Post



As Figure 3-1 shows, a number of projects performed better than ex ante projections (points above the diagonal line). One large compressor control project with zero ex ante impacts was found to have savings of over 800 kW. The ex ante analysis conservatively set peak kW savings to zero because there was no change in connected load, while the ex post evaluation determined that considerable savings could be expected on summer afternoons. The positive effects of this project are partially offset by the two negative-impact projects discussed above. Also, a project with one of the largest ex ante kW impacts was determined by the evaluation to have zero impacts, because the retrofitted equipment did not operate during the system peak hour.

The comparison of kWh impacts in Figure 3-2 shows that most of the larger projects performed better that expected. The largest project, involving a compressor control system, is saving 30% more energy than predicted. The efficiencies of the affected compressors are lower than those utilized in the ex ante analysis, and the control system allows these compressors to run less often. Another large project, involving the downsizing of aerator motors at a wastewater treatment pond, is realizing over twice as many kWh impacts as predicted. Post-retrofit performance for this project was better than expected, allowing the customer to shut down additional aerators.

Figure 3-2
Process and Process Boiler Annual kWh Savings - Ex Ante vs. Ex Post



As shown in Figure 3-3, evaluation gas impact results are dominated by two large projects where equipment performance greatly exceeded expectations. One project involved installation of furnace controls, while the other is a furnace exhaust heat recovery project.

Figure 3-3
Process and Process Boiler Annual Therm Savings - Ex Ante vs. Ex Post

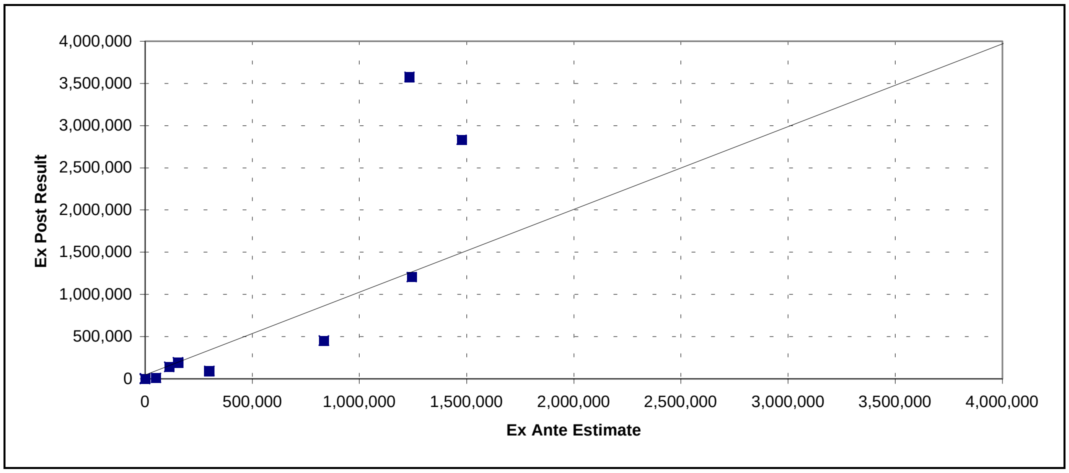


Table 3-3 presents the distribution of realization rates for process and process boiler projects. This table summarizes some of the relationships displayed graphically above.

Table 3-3
Distribution of Process and Process Boiler Realization Rates

Gross Realization Rate	Number of Projects: kW	% Projects	kWh	% Projects	Therms	% Projects
> 1.30	2	20%	4	29%	3	38%
0.70 - 1.30	4	40%	7	50%	3	38%
< 0.70	4	40%	3	21%	2	25%
Totals	10	100%	14	100%	8	100%

Space Conditioning Projects

The evaluated space conditioning projects can be separated into four technology categories, central air conditioning, chillers, controls, and other measures. Evaluation results by category are shown in Table 3-4. For kWh projects, chiller measures provided the highest realization rates. Control measures performed the best, relative to the ex ante kW estimates. The small air conditioning projects saved less that expected because building cooling loads were found to be lower than those incorporated into the prescriptive ex ante impact calculations.

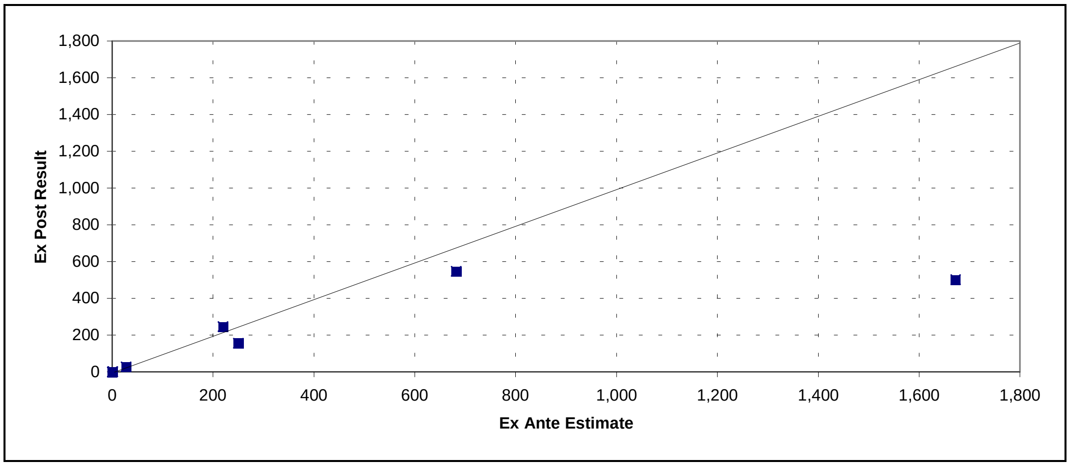
Table 3-4
Summary of Evaluated Space Conditioning Project Results by Measure Group

Measure Category	Total Projects	Evaluated Projects	kW Ex Ante	kW Ex Post	kW RR	kWh Ex Ante	kWh Ex Post	kWh RR	Therms Ex Ante	Therms Ex Post	Therms RR
Central Air Conditioning	24	3	9,911	4,746	0.48	4	3	0.77	0	0	-
Chillers	5	4	6,998,76	5,141,82	0.73	2,632	1,232	0.47	0	0	-
Controls	9	3	4,390,34	2,854,78	0.65	22	24	1.12	0	0	-
Other[1]	4	0	0	0	-	0	0	-	0	0	-
Totals	42	10	11,399,027	8,001,35	0.70	2,856	1,481	0.52	0	0	-

RR = Realization Rate
[1] The "Other" category accounts for less than 4% of ex ante kWh and kW impacts.

Figures 3-4 and 3-5 compare space conditioning ex post evaluation results to ex ante savings estimates for kW, and kWh. The diagonal lines represent points at which ex post results and ex ante estimates are equal.

Figure 3-4
Space Conditioning Summer On-Peak kW Savings - Ex Ante vs. Ex Post



Peak kW impacts compared in Figure 3-4 are dominated by one large project. This is a water-cooled chiller project where peak chilled water demand is only about half of the design capacity which is used in the prescriptive ex ante impact calculations. In addition, secondary impacts associated with cooling tower and recirculation pumps are not taken into account in the ex ante analysis.

The large chiller project also contributes to lower-than-expected kWh impacts, as shown in Figure 3-5. In addition, a large HVAC controls project was determined to have lower ex post savings because two of the six control strategies were not implemented as predicted.

Figure 3-5
Space Conditioning Annual kWh Savings - Ex Ante vs. Ex Post

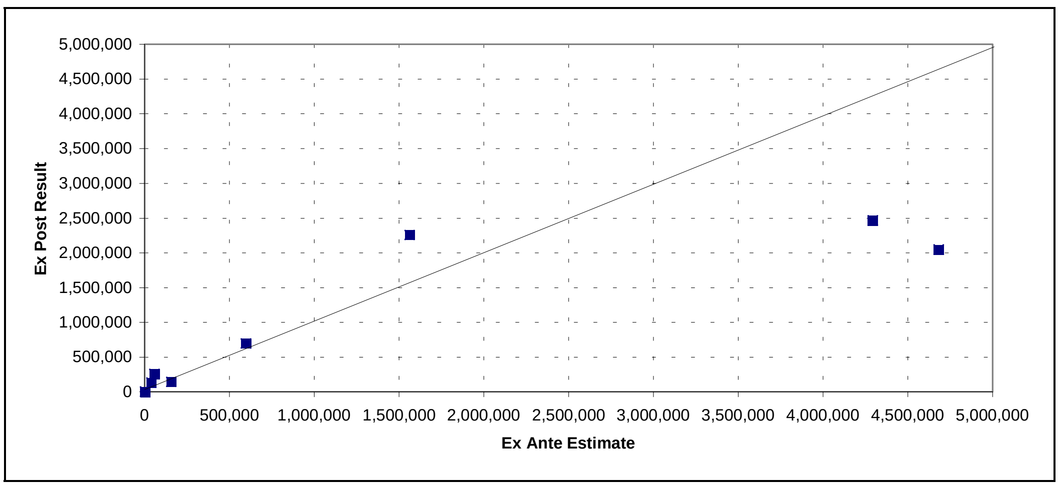


Table 3-5 presents the distribution of realization rates for space conditioning projects. This table summarizes some of the relationships displayed graphically above.

Table 3-5
Distribution of Space Conditioning Realization Rates

Gross Realization Rate	Number of Projects			
	kW	% Projects	kWh	% Projects
>1.30	0	0%	3	30%
0.70-1.30	6	75%	3	30%
<0.70	2	25%	4	40%
Totals	8	100%	10	100%

Discussion of Discrepancies

As part of the project-specific analyses, key factors leading to discrepancies between evaluation results and PG&E's estimated impacts were identified. Table 3-6 lists key factors causing discrepancies and the number of sites associated with each discrepancy. The approximate magnitude of each discrepancy is also indicated and is broken out for cases where the discrepancy led to higher impacts (where the ex post result was higher than the ex ante prediction) and lower impacts (where the ex post result was lower than the ex ante prediction). Following is a brief discussion of each discrepancy factor.

Table 3-6
Summary of Discrepancies

Discrepancy Factor	Number of Projects	Energy Units	Magnitude of Discrepancies		
			Where Ex post > Ex Ante	Where Ex post < Ex Ante	Net
Measures not in place	2	kW	0	-97	-97
	2	kWh	0	-2,435,179	-2,435,179
	0	Therms	0	0	0
Equipment/system performance different from projections	9	kW	1,124	-287	837
	10	kWh	4,330,063	-1,770,848	2,559,215
	8	Therms	2,904,647	-665,207	2,239,441
Different operating conditions	10	kW	72	-898	-827
	13	kWh	1,719,038	-2,810,195	-1,091,157
	3	Therms	676,957	-14,661	662,296
Base case differences	1	kW	0	-8	-8
	0	kWh	0	0	0
	3	Therms	176,789	0	176,789
Methodology differences	15	kW	366	-918	-611
	10	kWh	740,473	-1,263,576	-646,103
	1	Therms	8,142	0	8,142
Secondary impacts not addressed	3	kW	0.0	-284.1	-225.5
	3	kWh	0	-1,608,164	-1,485,164
	1	Therms	10,178	0	10,178

<u>Measures Not in Place</u>: This discrepancy is associated with one process site for which the owner went out of business, and the space conditioning control project for which two of the control measures were not implemented.

<u>Equipment/System Performance Different From Projections</u>: The ex ante energy savings estimates are assumptions based on how installed equipment will perform at specified operating conditions. Performance factors include such items as operating kW at certain load conditions

(motors or pumps/fans), rated efficiency at certain loads (chillers and furnaces), and control system behavior in unloaded or at specified part-load conditions (compressors and furnaces). At some sites, the evaluation was able to collect data on actual post-retrofit performance via metering/monitoring and review of customer data. The evaluation was able to improve on the initial estimates by using actual versus predicted performance in savings calculations/models. The largest performance discrepancies involved several refinery furnace projects for which post-retrofit efficiencies exceeded expectations and a glass furnace project where impacts were negative.

Different Operating Conditions: Different operating conditions reflect the fact that equipment is being operated in a manner that is different from the ex ante predictions. This may include total production quantities, production rates, operating schedules/hours, or other factors that affect equipment performance such as operating temperature and pressures.

In some cases, equipment is installed as part of a system and the relationship of the equipment within the system is changed, either as a result of the retrofit project or because of operating changes made following the retrofit project (such as the new compressor becoming the "lead" compressor when replacing an older "lag" compressor, due to its age). In many cases, the desired output from the equipment does not change (i.e., the air flow and pressure in the case of a compressor), but the operating conditions or equipment operating strategy used to produce that outcome does change.

At some sites, operating hours or schedules were different than initially predicted. At some space conditioning sites cooling loads were less than predicted in the prescriptive ex ante analysis. At a number of sites, the evaluation revealed that equipment cycled or experienced a diversity factor that was not considered in the ex ante calculations. Changes in operating conditions contributed to both over- and under-predictions of Program savings.

Base Case Differences: As part of the evaluation, an assessment was made of the appropriateness of the ex ante base case. The ex ante base case was accepted for most projects. In several cases, minor adjustments were made to the base case efficiencies to reflect findings made on site.

Methodology Differences: This category includes projects that used an ex ante savings estimation methodology that was so different from the evaluation methodology that the reasons for impact differences were difficult to discern. Additionally, there were projects where the ex ante kW calculation method reflected a comparison of connected load impacts, whereas the ex post approach was based on determining expected kW impacts at the time of the PG&E system peak.

Secondary Impacts Not Addressed: Projects where the ex ante estimate didn't consider all the impacts fall into this category. Examples of these projects include the heat recovery project that added two fans, resulting in negative electric saving, and the chiller project that added cooling tower and recirculation pumps.

3.2.3 Verification Activities at Non-Analysis Sites

In addition to the 30 analysis sites, a total of 47 additional projects received verification surveys. All measures were found to be in place for the verification surveys, while installation of measures was not verified at one analysis site for which the company was out of business. Table 3-7 summarizes the verification results.

Table 3-7
Measure Verification Results

Strata	Study Type	Process		Process Boilers		Space Conditioning		Total	
		Total	Verified	Total	Verified	Total	Verified	Total	Verified
1	Analysis	12	11	2	2	2	2	16	15
2	Analysis	4	4	1	1	4	4	9	9
	Verification	5	5	2	2	12	12	19	19
3	Analysis	2	2	0	0	3	3	5	5
	Verification	9	9	0	0	19	19	28	28
Total		32	31	5	5	40	40	77	76

3.2.4 Calculation of Program-Level Gross Impacts

As discussed in Section 2, site-level impacts were expanded to Program-level impacts by end use and stratum. Realization rates were calculated for each sample cell, based on site analysis results, then the realization rates were applied to tracking system saving impacts for the non-analyzed sites to determine Program-level savings. Results are summarized in Table 3-8.

Table 3-8
Calculation of Program-Level Gross Impacts

End Use	Strata		Analysis Projects Ex Ante (A)	Analysis Projects Ex Post (B)	Analysis Projects RR (C=B/A)	Population Ex Ante (D)	Population Ex Post (E=C×D)
Process	1	kW	1,388	1,834	1.32	1,388	1,834
		kWh	16,471,335	16,576,067	1.01	16,471,335	16,576,067
		Therms	2,478,000	4,783,395	1.93	2,478,000	4,783,395
	2	kW	163	177	1.09	375	408
		kWh	1,113,857	1,308,549	1.17	3,370,901	3,960,104
		Therms	452,044	287,682	0.64	551,136	350,744
	3	kW	22	2	0.09	184	17
		kWh	49,471	49,328	1.00	1,591,610	1,587,009
		Therms	50,633	9,294	0.18	78,210	14,356
Process Boilers	1	kW	0	0	-	0	0
		kWh	0	0	-	0	0
		Therms	2,311,694	3,281,832	1.42	2,311,694	3,281,832
	2	kW	0	0	-	0	0
		kWh	0	0	-	0	0
		Therms	112,640	139,652	1.24	426,653	528,968
Space Conditioning	1	kW	2,574	1,295	0.50	2,574	1,295
		kWh	10,537,766	6,772,304	0.64	10,537,766	6,772,304
		Therms	0	0	-	0	0
	2	kW	278	184	0.66	554	367
		kWh	851,350	1,224,307	1.44	2,709,734	3,896,807
		Therms	0	0	-	0	0
	3	kW	4	3	0.77	31	24
		kWh	9,911	4,746	0.48	106,780	51,133
		Therms	0	0	-	0	0

RR = Realization Rate

3.2.5 Gross Impacts by PG&E Costing Period

As part of the gross impact analysis, Program savings were allocated to PG&E time-of-use periods. Results are presented in Table 3-9. The process boiler end use is not shown in the table because there were no electric impacts for this end use.

Table 3-9
Gross Impacts by PG&E Costing Period

Costing Period	Avg kW Savings	Avg kW Savings Coincident with System Maximum	kW Adjustment Factor	kWh Savings	kWh Adjustment Factor	Annual kWh Savings	Connected Load kW Savings
Process							
Summer On Peak	2,609	2,259	1.000	2,003,600	0.091	22,123,180	238
Summer Part Peak	2,620	2,234	0.989	2,347,152	0.106	22,123,180	238
Summer Off Peak	2,320	2,148	0.951	6,383,430	0.289	22,123,180	238
Winter Part Peak	2,756	2,374	1.051	4,515,086	0.204	22,123,180	238
Winter Off Peak	2,540	2,706	1.198	6,873,909	0.311	22,123,180	238
Space Conditioning							
Summer On Peak	1,637	1,686	1.000	1,257,481	0.117	10,720,243	0
Summer Part Peak	1,488	1,487	0.882	1,333,194	0.124	10,720,243	0
Summer Off Peak	1,302	1,310	0.777	3,584,048	0.334	10,720,243	0
Winter Part Peak	1,205	1,030	0.611	1,974,141	0.184	10,720,243	0
Winter Off Peak	950	1,060	0.629	2,571,375	0.240	10,720,243	0
Total Process and Space Conditioning							
Summer On Peak	4,246	3,945	1.000	3,261,080	0.099	32,843,423	238
Summer Part Peak	4,108	3,722	0.943	3,680,346	0.112	32,843,423	238
Summer Off Peak	3,622	3,459	0.877	9,967,478	0.303	32,843,423	238
Winter Part Peak	3,962	3,404	0.863	6,489,227	0.198	32,843,423	238
Winter Off Peak	3,490	3,766	0.955	9,445,283	0.288	32,843,423	238

Summer On Peak: May 1 to Oct. 31 Noon-6 p.m. Weekdays; Coincident Hour 3 p.m.
Summer Part Peak: May 1 to Oct. 31 8:30 a.m. - Noon & 6-9:30 p.m. Weekdays; Coincident Hour 6 p.m.
Summer Off Peak: May 1 to Oct. 31 9:30 p.m.-8:30 a.m. Weekdays & All Saturday/Sunday; Coincident Hour 10 p.m.
Winter Part Peak: Nov. 1 to Apr. 30 8:30 a.m. - 9:30 p.m.; Coincident Hour 6 p.m.
Winter Off Peak: Nov. 1 to Apr. 30 9:30 p.m.-8:30 a.m. Weekdays & All Saturday/Sunday; Coincident Hour 8 a.m.

3.3 NET PROGRAM SAVINGS

3.3.1 Net-to-Gross Analysis

The objective of the net-to-gross analysis is to determine what equipment purchase decisions would have occurred without the PG&E Pre-1998 Industrial Programs. As discussed in Section 2 of this report, both free-ridership and spillover are taken into account, with a primary emphasis on free-ridership.

Standard Net-to-Gross Survey

All available evaluation projects received a standard NTG survey. Program participants were asked a series of survey questions to probe their decision process with respect to the installation of energy efficient measures. The results of these questions were then used to construct NTGRs. Key survey results which are presented below address:

- How participants first heard about the energy efficiency equipment they installed;
- The timing of the Program intervention in participants' project decision process;
- The reported significance of the Program on participants' decision to install measures;
- The likelihood customers would have installed measures if the PG&E incentive was not available; and
- The type of equipment that would have been installed without the PG&E rebate.

An important aspect of many energy efficiency programs are their ability to inform customers of the availability of efficient technologies. To understand the information impact of the PG&E Program, the participants were asked how they first learned about the energy efficient technologies installed through the Program. Table 3-10 presents the results. About 10% of the surveyed participants first learned about relevant technologies from PG&E. Contractors were much more of a factor in introducing customers to small packaged air conditioning units that make up a large portion of the space conditioning projects.

Table 3-10
How Participants First Heard About Efficient Technologies

	Percentage of Respondents	
	Process/ Process Boiler	Space Conditioning
From a contractor	12%	79%
From an architect/engineer	6%	5%
From a vendor	18%	2%
From PG&E	9%	10%
From a previous installation	18%	0%
From other sources	36%	5%
Total	100%	100%

The further along a customer is in the decision-making process before hearing about the rebate Program, the less likely it is that the Program affected his/her purchase decision. Participants were queried about how far along they were in the decision process to purchase energy efficient equipment when they first learned of the Program. The key questions were:

- *When did you first learn about the PG&E Program? Was it **BEFORE** or was it **AFTER** you first began to think about installing **Energy Efficient Equipment**?* and
- *Did you learn about the PG&E Program **BEFORE** or **AFTER** you decided to purchase the **specific Energy Efficient Equipment** that was eventually installed?*

Results are presented below in Table 3-11. Only 3% of the process/process boiler participants stated they had learned about the Program after deciding on their specific energy efficiency purchases. While 19% of the space conditioning participants claimed they learned about the Program after deciding on their specific equipment, these were mainly purchasers of small packaged air conditioning units and programmable thermostats.

Table 3-11
When Participants Learned About PG&E Rebate Program

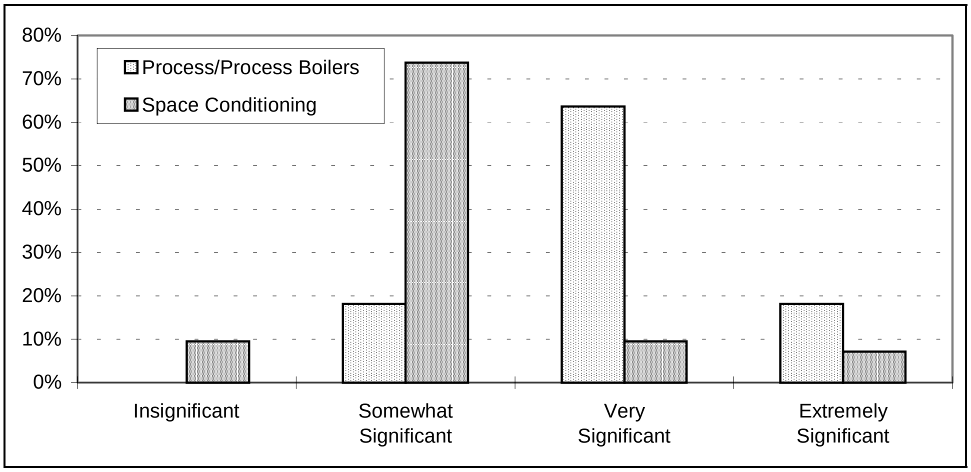
	When Participants Learned About Program			
	Before		After	
Decision Process	% of Process/ Process Boiler Respondents	% of Space Conditioning Respondents	% of Process/ Process Boiler Respondents	% of Space Conditioning Respondents
Thinking about installing energy efficient equipment	76%	45%	24%	55%
Decided to purchase specific equipment	97%	81%	3%	19%

To test Program importance, the question was:

- *How significant was the PG&E Program in influencing your decision to install the energy- efficient equipment?*

Responses are shown in Figure 3-6. About 80% of the process and process boiler respondents indicated the Program was very significant or extremely significant in influencing the energy efficiency installations. A much larger share of the space conditioning respondents rated the Program as less significant. Again, these are dominated by the small package air conditioner purchasers.

Figure 3-6
Significance of Program on Decision to Install Measures

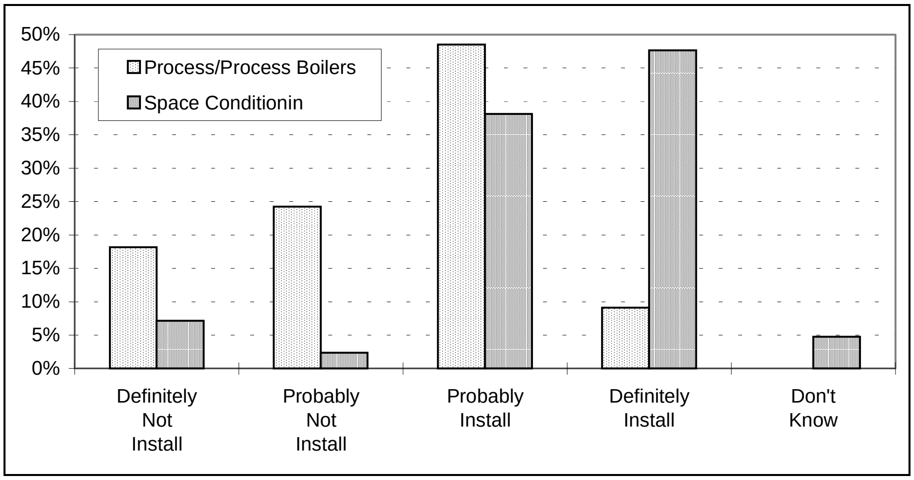


The stated intentions question was the key question used to construct the standard self-report NTGRs. The primary stated intentions question was:

- *If the PG&E incentive had not been available, how likely is it that you would have installed the energy efficient equipment?*

Responses are shown in Figure 3-7. About 40% of the process and process boiler respondents and 10% of the space conditioning respondents indicated they definitely or probably would not have installed the measures without the rebate. While a large number of participants indicated that they *probably* would have installed the measures without the rebate, it is generally believed that some of these customers interpret the question as: "*If you could do the project over again, would you?*" Customers who are happy with their project (now that performance uncertainty is no longer a barrier) are likely to say they would do the project again. About 40% of the respondents who state they probably would have installed the measures anyway also indicate that the Program was very significant or extremely significant in their decision to install measures. Concerns about respondents' ability to accurately respond to the hypothetical "what if" question is a major reason consistency checks are used in the standard NTG calculations (see Section 2).

Figure 3-7
Likelihood Customer Would Have Installed Measure If Incentive Was Not Available



Customers who were likely to have installed measures without the rebate were asked if those measures would have been as efficient without the rebate. Alternatively, customers who would not have installed measures without the rebate were asked if they would have installed equipment with above-standard efficiency without the rebate. Results are tabulated in Table 3-12. This table indicates that many of the customers who first indicated that they would install measures without the rebate would probably have installed equipment of the same efficiency as they did under the Program. None of customers who would not have installed measures without the rebate were likely to have selected equipment of intermediate efficiency.

Table 3-12
Type of Equipment That Would Have Been Installed Without Rebate

	Percentage of Respondents	
	Process/ Process Boilers	Space Conditioning
Efficiency of equipment that would have been installed for customers who would have installed measures anyway		
Probably NOT as efficient	22%	6%
Probably as efficient	67%	69%
Don't Know	11%	25%
Type of equipment that would have been installed by customers who would not have installed measures with incentives		
Standard Efficiency Equipment	31%	50%
Intermediate Efficiency Equipment	0%	0%
Would not have installed anything	69%	50%

Standard Net-to-Gross Results

Using results of the standard NTG survey and the scoring method described in Section 2 of this report, standard NTGRs were calculated for each project. Table 3-13 shows the distribution of NTGRs for the process, process boiler, and space conditioning projects. Reflective of the NTG survey results presented above, NTGRs for the space conditioning end use are generally lower than for the process and process boiler end uses.

Table 3-13
Distribution of Standard Net-to-Gross Ratios

NTGR Range	# Projects	% Projects
Process		
1.00	4	14%
0.70-0.99	21	75%
0.30-0.69	3	11%
0.01-0.29	0	0%
0.00	0	0%
Process Boilers		
1.00	2	40%
0.70-0.99	2	40%
0.30-0.69	1	20%
0.01-0.29	0	0%
0.00	0	0%
Space Conditioning		
1.00	3	8%
0.70-0.99	4	11%
0.30-0.69	27	75%
0.01-0.29	0	0%
0.00	2	6%

Table 3-14 shows the average standard NTGRs calculated for kW, kWh, and therms. Process and process boiler NTGRs follow rather directly from the distributions shown in Table 3-13. NTGRs for space conditioning are somewhat higher than expected, based on Table 3-13 results, because several of the largest space conditioning projects had above-average standard NTGRs.

Table 3-14
Impact-Weighted Average Standard Net-to-Gross Ratios

	Process	Process Boilers	Space Conditioning
Summer On-peak kW	0.82	-	0.68
Annual kWh	0.81	-	0.75
Annual Therms	0.72	0.82	-

Custom Net-to-Gross Ratios for Large Projects

The custom NTGRs were designed to improve upon the standard NTGRs for the largest impact projects by incorporating additional information from project files, additional customer interviews, and other sources such as vendors and PG&E Customer Representatives. While the largest 16 projects were target for a custom NTG analysis, only nine projects actually received one. One customer who was responsible for six projects did not want to respond to follow-up NTG inquiries. Another project received zero gross impacts because the customer went out of business, so a NTG analysis was not completed. For the projects receiving a custom NTG analysis, Table 3-15 shows how the NTGRs varied between the standard and custom analyses. The primary effect of the custom analysis was to lower a number of NTGRs.

Table 3-15
Distribution of Standard and Custom Net-to-Gross Ratios for Large Impact Projects

End Use	Project	Standard NTGR	Custom NTGR	Difference
Process	1	0.70	0.73	0.03
	2	0.70	0.30	-0.40
	3	0.70	0.70	0.00
	4	0.70	0.70	0.00
	5	0.70	0.25	-0.45
	6	0.70	0.50	-0.20
	7	0.70	0.00	-0.70
Space Conditioning	8	1.00	1.00	0.00
	9	0.70	0.25	-0.45

Spillover

Spillover was identified at one site where the downsizing of five effluent pond aerator motors led to the downsizing of a sixth motor, without the customer requesting a PG&E rebate to install the measure. The spillover rates were calculated as the total spillover impact divided by total gross impacts. Table 3-16 presents the results.

Table 3-16
Spillover Results

End Use	Gross Impacts	Spillover	Spillover Rate
Process			
Summer On-peak kW	2,259	14.5	0.00642
Annual kWh	22,123,180	126,878	0.00574
Annual Therms	5,148,495	0	0
Process Boilers			
Summer On-peak kW	0	0	0
Annual kWh	0	0	0
Annual Therms	3,810,800	0	0
Space Conditioning			
Summer On-peak kW	1,686	0	0
Annual kWh	10,720,243	0	0
Annual Therms	0	0	0
Total			
Summer On-peak kW	3,945	14.5	0.00368
Annual kWh	32,843,423	126,878	0.00386
Annual Therms	8,959,295	0	0

Final Net-to-Gross Ratios

Final NTGRs were developed by incorporating results of the custom NTG analysis and the spillover analysis into the standard NTGRs reported in Table 3-14. Results are shown in Table 3-17.

Table 3-17
Final Impact-Weighted Net-to-Gross Ratios

End Use	Standard NTGR	NTGR After Custom Adjustment	Spillover Rate	Final NTGRs Including Spillover
Process				
Summer On-peak kW	0.82	0.877	0.0064	0.883
Annual kWh	0.81	0.826	0.0057	0.831
Annual Therms	0.72	0.821	0.0000	0.821
Process Boilers				
Summer On-peak kW	-	-	-	-
Annual kWh	-	-	-	-
Annual Therms	0.82	0.899	0.0000	0.899
Space Conditioning				
Summer On-peak kW	0.68	0.532	0.0000	0.532
Annual kWh	0.75	0.653	0.0000	0.653
Annual Therms	-	-	-	-
Total				
Summer On-peak kW	0.76	0.729	0.0037	0.732
Annual kWh	0.79	0.769	0.0039	0.772
Annual Therms	0.76	0.854	0.0000	0.854

3.3.2 Net Impacts

Net impacts were developed by applying the NTGRs as summarized in the previous table to ex post gross impacts. The NTGRs were applied at the project level, then net impacts were summed across projects to determine Program impacts. Aggregate NTGRs were developed by dividing net impacts by gross impacts.

The net impact results are summarized in Table 3-18. For process projects, the net kW, kWh, and therm realization rates are 1.37, 1.14, and 1.81, respectively. For process boilers, the net therm realization rate is 1.67. For space conditioning, respective kW and kWh realization rates are 0.37 and 0.69.

Table 3-18
Summary of Net Impact Results

End Use	Ex Ante Estimates		Ex Post Results			Net Realization Rate
	Net Impacts	Net-to-Gross Ratio	Net Impacts	Net-to-Gross Ratio	90% Confidence Interval	
Process						
Summer On-peak kW	1,460	0.75	1,994	0.883	±0.035	1.37
Annual kWh	16,075,385	0.75	18,374,098	0.831	±0.032	1.14
Annual Therms	2,330,510	0.75	4,228,511	0.821	±0.000	1.81
Process Boilers						
Summer On-peak kW	0	-	0	-	-	-
Annual kWh	0	-	0	-	-	-
Annual Therms	2,053,760	0.75	3,425,261	0.899	±0.000	1.67
Space Conditioning						
Summer On-peak kW	2,404	0.76	896	0.532	±0.019	0.37
Annual kWh	10,116,586	0.76	6,998,925	0.653	±0.025	0.69
Annual Therms	0	-	0	-	-	-
Total						
Summer On-peak kW	3,865	0.76	2,890	0.732	±0.022	0.75
Annual kWh	26,191,971	0.75	25,373,023	0.772	±0.023	0.97
Annual Therms	4,384,270	0.75	7,653,772	0.854	±0.000	1.75

Net Impacts by PG&E Costing Period

Net Program impacts are shown by PG&E costing period in Table 3-19.

Table 3-19
Net Impacts by PG&E Costing Period

Costing Period	Avg kW Savings	Avg kW Savings Coincident with System Maximum	kW Adjustment Factor	kWh Savings	kWh Adjustment Factor	Annual kWh Savings	Connected Load kW Savings
Process							
Summer On Peak	2,179	1,994	0.883	1,673,842	0.091	18,374,098	604
Summer Part Peak	#REF!	1,994	0.883	1,963,350	0.107	18,374,098	604
Summer Off Peak	0	1,974	0.874	5,647,542	0.307	18,374,098	604
Winter Part Peak	18,269,309	1,980	0.876	3,550,869	0.193	18,374,098	604
Winter Off Peak	1,981	2,087	0.924	5,538,494	0.301	18,374,098	604
Space Conditioning							
Costing Period	**Avg kW Savings**	**Avg kW Savings Coincident with System Maximum**	**kW Adjustment Factor**	**kWh Savings**	**kWh Adjustment Factor**	**Annual kWh Savings**	**Connected Load kW Savings**
Summer On Peak	1,109	896	0.532	851,891	0.122	6,998,968	479
Summer Part Peak	991	825	0.490	887,540	0.127	6,998,968	479
Summer Off Peak	879	1,021	0.605	2,418,012	0.345	6,998,968	479
Winter Part Peak	722	550	0.326	1,182,880	0.169	6,998,968	479
Winter Off Peak	613	510	0.302	1,658,642	0.237	6,998,968	479
Total Process and Space Conditioning							
Costing Period	**Avg kW Savings**	**Avg kW Savings Coincident with System Maximum**	**kW Adjustment Factor**	**kWh Savings**	**kWh Adjustment Factor**	**Annual kWh Savings**	**Connected Load kW Savings**
Summer On Peak	#DIV/0!	2,890	0.733	2,525,733	0.100	25,373,066	1,083
Summer Part Peak	#DIV/0!	2,819	0.715	2,850,890	0.112	25,373,066	1,083
Summer Off Peak	#DIV/0!	2,994	0.759	8,065,554	0.318	25,373,066	1,083
Winter Part Peak	#DIV/0!	2,530	0.641	4,733,749	0.187	25,373,066	1,083
Winter Off Peak	#DIV/0!	2,596	0.658	7,197,135	0.284	25,373,066	1,083

Summer On Peak: May 1 to Oct. 31 Noon-6 p.m. Weekdays; Coincident Hour 3 p.m.
Summer Part Peak: May 1 to Oct. 31 8:30 a.m. - Noon & 6-9:30 p.m. Weekdays; Coincident Hour 6 p.m.
Summer Off Peak: May 1 to Oct. 31 9:30 p.m.-8:30 a.m. Weekdays & All Saturday/Sunday; Coincident Hour 10 p.m.
Winter Part Peak: Nov. 1 to Apr. 30 8:30 a.m. - 9:30 p.m.; Coincident Hour 6 p.m.
Winter Off Peak: Nov. 1 to Apr. 30 9:30 p.m.-8:30 a.m. Weekdays & All Saturday/Sunday; Coincident Hour 8 a.m.

A PROJECT-SPECIFIC RESULTS

This appendix presents project-specific impact results for projects analyzed as part of the evaluation. First, project results are shown, followed by a summary of site methodologies and discrepancies between ex ante estimates and ex post results.

Table A-1
Site Analysis Project Results

					Ex Ante Gross			Ex Ante	Ex Ante Net			Ex Post Gross			Ex Post	Ex Post Net			Gross RR			Net RR		
End Use	Strata	Cntl #	App #	Meas	kWh	kW	Thm	NTGR	kWh	kW	Thm	kWh	kW	Thm	NTGR	kWh	kW	Thm	kWh	kW	Thm	kWh	kW	Thm
SPACE COND	1	3950021	CEOVP005C	201	4,293,039	220.0	0	0.75	3,219,779	165.0	0	2,468,385	246.5	0	1.00	2,468,385	246.5	0	0.57	1.12		0.77	1.49	
SPACE COND	1	3950021	CEOVP005C	232	1,562,567	682.0	0	0.75	1,171,925	511.5	0	2,256,877	546.9	0	0.25	564,219	136.7	0	1.44	0.80		0.48	0.27	
SPACE COND	1	6053635	DJN3335	S13	4,682,160	1,672.2	0	0.75	3,511,620	1,254.2	0	2,047,042	501.4	0	0.50	1,023,521	250.7	0	0.44	0.30		0.29	0.20	
SPACE COND	2	0990053	ANR7721	232	597,486	250.0	0	0.75	448,115	187.5	0	694,609	155.7	0	0.70	486,226	109.0	0	1.16	0.62		1.09	0.58	
SPACE COND	2	5236187	AHB7006	248	156,556	27.8	0	0.75	117,417	20.8	0	143,299	28.3	0	0.50	71,649	14.2	0	0.92	1.02		0.61	0.68	
SPACE COND	2	5853747	AVV0010	204	39,632	0.00	0	0.75	29,724	0.0	0	130,586	0.0	0	na	na	na	na	3.29			na	na	na
SPACE COND	2	5853748	AVV0010	204	57,676	0.0	0	0.75	43,257	0.0	0	255,813	0.1	0	na	na	na	na	4.44			na	na	na
SPACE COND	3	0980072	DVV3439	S160	3,812	1.4	0	0.77	2,935	1.1	0	1,336	1.0	0	0.50	668	0.5	0	0.35	0.74		0.23	0.48	
SPACE COND	3	1011135	DVV3454	S160	3,812	1.4	0	0.77	2,935	1.1	0	1,336	1.0	0	0.50	668	0.5	0	0.35	0.74		0.23	0.48	
SPACE COND	3	4895002	DVV3349	S160	2,287	0.8	0	0.77	1,761	0.6	0	2,074	0.7	0	0.50	1,037	0.3	0	0.91	0.82		0.59	0.53	
PROC BOIL	1	5851942	AJG0027	352	0	0.0	1,477,000	0.75	0	0.0	1,107,750	0	0.0	2,830,914	0.85	0	0.0	2,406,277			1.92			2.17
PROC BOIL	1	5851942	AJG0029	373	0	0.0	834,694	0.75	0	0.0	626,021	0	0.0	450,918	1.00	0	0.0	450,918			0.54			0.72
PROC BOIL	2	5846359	AVT1016	370	0	0.0	112,640	0.75	0	0.0	84,480	0	0.0	139,652	0.50	0	0.0	69,826			1.24			0.83
PROCESS	1	0659256	AHS6020	599	2,906,733	261.0	0	0.75	2,180,050	195.8	0	3,159,287	366.0	0	0.73	2,306,279	267.2	0	1.09	1.40		1.06	1.36	
PROCESS	1	0676955	AJN1019	599	712,396	269.0	0	0.75	534,297	201.8	0	747,192	0.0	0	0.30	224,157	0.0	0	1.05	0.00		0.42	0.00	
PROCESS	1	1087436	AJN1023	589	792,990	96.9	0	0.75	594,743	72.6	0	0	0.0	0	0.00	0	0.0	0	0.00	0.00		0.00	0.00	
PROCESS	1	5251170	AJG0031	550	5,604,385	0.0	0	0.75	4,203,289	0.0	0	7,519,556	850.4	0	0.93	6,993,187	790.8	0	1.34			1.66		
PROCESS	1	5251170	AJG0036	550	1,552,053	177.0	0	0.75	1,164,040	132.8	0	3,500,904	399.6	0	1.00	3,500,904	399.6		2.26	2.26		3.01	3.01	
PROCESS	1	5575791	AFB1029	599	1,255,615	0.0	0	0.75	941,711	0.0	0	797,987	83.3	0	0.70	558,591	58.3	0	0.64			0.59		
PROCESS	1	5851941	AJG0026	560	0	0.0	1,244,000	0.75	0	0.0	933,000	0	0.0	1,204,458	0.70	0	0.0	843,121			0.97			0.90
PROCESS	1	5851942	AJG0032	560	0	0.0	1,234,000	0.75	0	0.0	925,500	-1,483,675	-169.4	3,578,937	0.85	-1,261,124	-144.0	3,042,097			2.90			3.29
PROCESS	1	6157771	ABJ1015	589	685,742	129.5	0	0.75	514,307	97.1	0	488,653	153.2	0	0.25	122,163	38.3	0	0.71	1.18		0.24	0.39	
PROCESS	1	6162370	ABT1028	599	1,027,883	249.0	0	0.75	770,912	186.8	0	2,387,005	272.5	0	0.58	1,384,463	158.0	0	2.32	1.09		1.80	0.85	
PROCESS	1	6172719	AXT0022	560	893,538	205.9	0	0.75	670,154	154.4	0	833,926	141.3	0	0.50	416,963	70.7	0	0.93	0.69		0.62	0.46	
PROCESS	1	6245705	AJQ0121	590	1,040,000	0.0	0	0.75	780,000	0.0	0	-1,374,768	-263.2	0	0.00	0	0.0	0	-1.32			0.00		
PROCESS	2	3827281	AFB1025	569	548,046	65.8	0	0.75	411,035	49.4	0	711,041	81.2	0	0.90	639,937	73.1	0	1.30	1.23		1.56	1.48	

Table A-1
Site Analysis Project Results

					Ex Ante Gross			Ex Ante	Ex Ante Net			Ex Post Gross			Ex Post	Ex Post Net			Gross RR			Net RR		
End Use	Strata	Cntl #	App #	Meas	kWh	kW	Thm	NTGR	kWh	kW	Thm	kWh	kW	Thm	NTGR	kWh	kW	Thm	kWh	kW	Thm	kWh	kW	Thm
PROCESS	2	4670922	AJN1022	578	556,295	97.0	0	0.75	417,221	72.8	0	569,876	93.5	0	0.85	569,876	93.5	0	1.02	0.96		1.37	1.29	
PROCESS	2	5851942	AJG0033	590	0	0.0	153,330	0.75	0	0.0	114,998	0	0.0	194,040	1.00	0	0.0	194,040			1.27			1.69
PROCESS	2	5851942	AJG0034	550	9,516	0.0	298,714	0.75	7,137	0.0	224,036	34,839	4.0	93,642	1.00	34,839	4.0	93,642	3.66		0.31	4.88		0.42
PROCESS	3	5851942	AJG0030	550	0	0.0	50,633	0.75	0	0.0	37,975	0	0.0	9,294	0.85	0	0.0	7,900			0.18			0.21
PROCESS	3	6401580	AXT0024	589	49,471	21.7	0	0.75	37,103	16.3	0	49,328	2.0	0	0.60	29,597	1.2	0	1.00	0.09		0.80	0.07	

Table A-2
Summary of Project Evaluation Approaches and Ex Ante Ex Post Discrepancies

End Use	Strata	Cntl #	App #	Meas	Measure	Evaluation Approach	Discrepancies
SPACE COND	1	3950021	CEOVP005C	201	Control system improvements and specification of new hardware, software and control algorithms	Spreadsheet-based model used to adjust the ex ante results based on ex post observations of system operations and performance.	Two pump control measures were not implemented as forecasted.
SPACE COND	1	3950021	CEOVP005C	232	Two 1500-ton chillers were replaced	Spreadsheet-based model used to adjust the ex ante results based on ex post observations of system operations and performance.	Chiller efficiencies and operating strategies were different that reflected in ex ante analysis (base case chiller sequencing was more energy intensive). Peak kW based on summer weekday 3-4pm vs. ex ante change is max loads.
SPACE COND	1	6053635	DJN3335	S13	Installed 3 880 ton water cooled chillers in place of 4 400 ton air cooled chillers.	VisualDOE plant-only modeling; uses chilled water profile developed from CoolTools software for a 3-shift process facility.	Full chiller capacity (2400 tons) used in the ex ante analysis, while actual peak chilled water demand is about half total design capacity; auxiliary pumps not considered ex ante.
SPACE COND	2	0990053	ANR7721	232	Installation of new 1500 ton high efficiency chiller. Removal from service of a 400 ton emergency chiller. Re-staging of remaining chillers.	VisualDOE plant-only modeling supported by data collected from customer's EMS.	Chillers spending more time at part load vs. ex ante analysis, and new chiller has better part load performance. Ex post kW based on expected demand impact at 3-4 pm while ex ante uses change in maximum kW.
SPACE COND	2	5236187	AHB7006	248	Installation of high efficiency 200 ton chiller; add VSD to existing chilled water pump.	Chiller: VisualDOE plant-only modeling supported by information for facilities staff and typical weather data. VSD: Performance curve based on spot measurements compared against constant speed motor.	Methodologies very different. Post-retrofit operations lower than predicted in the ex ante analysis. Ancillary savings not accounted for in the ex ante analysis.
SPACE COND	2	5853747	AVV0010	204	New controls added to the system to allow proper economizer operation. Base case outside air dampers are permanently closed (no outside air)	DOE-2 simulation model calibrated to billing data, comparing verified proper economizer operation to a no-economizer base case.	There were ex ante modeling errors, including modeling of post case with 100% outside air vs. proper economizer operation and understatement of floorspace by 40%.
SPACE COND	2	5853748	AVV0010	204	New controls added to the system to allow proper economizer operation. Base case outside air dampers are permanently closed (no outside air)	DOE-2 simulation model calibrated to billing data, comparing verified proper economizer operation to a no-economizer base case.	There were ex ante modeling errors, including modeling of post case with 100% outside air vs. proper economizer operation and understatement of floorspace by 40%.
SPACE COND	3	0980072	DVV3439	S160	Installed one five-ton packaged rooftop air conditioner (SEER of 13)	VisualDoe simulation model - AC serves mainly office/small laboratory space.	Ex ante full load operating hours (2100) are better suited to a full industrial space with high internal gains; ex post operating levels were lower.
SPACE COND	3	1011135	DVV3454	S160	Installed one five-ton packaged rooftop air conditioner (SEER of 13)	VisualDoe simulation model - AC serves mainly office/small laboratory space.	Ex ante full load operating hours (2100) are better suited to a full industrial space with high internal gains; ex post operating levels were lower.
SPACE COND	3	4895002	DVV3349	S160	Installed one three-ton packaged rooftop air conditioner (SEER of 13)	VisualDoe simulation model - AC serves mainly office space.	Calculations using ex ante method do not match tracking system; other differences are minor and probably due to operating differences.

Table A-2
Summary of Project Evaluation Approaches and Ex Ante Ex Post Discrepancies

End Use	Strata	Cntl #	App #	Meas	Measure	Evaluation Approach	Discrepancies
PROC BOIL	1	5851942	AJG0027	352	An oxygen analyzer and automated damper were installed on a furnace stack to reduce excess combustion air in the furnace.	Engineering approach similar to the ex ante analysis, utilizing a flow analysis of the combustion process (based on stoichiometric reactions) and an enthalpy analysis. Calculations utilize verified post-retrofit operating parameters.	Post-retrofit equipment performance is more efficient than predicted and operating hours are greater.
PROC BOIL	1	5851942	AJG0029	373	Steam traps and condensate collection piping were installed to recover hot steam condensate to minimize the use of cold makeup water for boiler feedwater.	Engineering calculations utilizing data from the customer's distributed control system of the pressures and temperatures of the steam system.	Recovery equipment is not as efficient as predicted, but this effect is partially offset by a lower steam boiler efficiency that indicates more natural gas is saved per unit of recovered condensate.
PROC BOIL	2	5846359	AVT1016	370	Remove boiler /heat-exchanger water heating system. Replace with "direct" water heater.	Calculations based on required temperature change, pre- and post-retrofit system efficiencies, and pre-retrofit losses.	Pre-retrofit system efficiency was determined to be lower than the efficiency used in the ex ante analysis.
PROCESS	1	0659256	AHS6020	599	Replace 4 compressors totaling 850 hp with 3-200 hp compressors + 1-40 hp compressor; modify compressed air controls and piping	Monitor compressor power; calculate air flow; Calculate base case power at flow using pre-retrofit measurements.	Much higher ex post air flows, offset somewhat by lower operating hours. Additional compressor and ancillary systems not in ex ante analysis. Ex post calculated expected kW impact, while ex ante used full load kW impact.
PROCESS	1	0676955	AJN1019	599	Replace two 600 hp water pumps with a capacity of 7300 gpm each@110 psi with 2-600 hp pumps capable of 8600 gpm @ 110 psi each. Increase manifold pipe size from 12" to 16".	Comparison of post-retrofit power monitoring with pre-retrofit monitoring and spot measurements.	No kW impacts because the affected portion of the pumping system did not operate after 3pm.
PROCESS	1	1087436	AJN1023	589	Air Compressor System Change/Modify	Not analyzed.	Site closed.
PROCESS	1	5251170	AJG0031	550	Install integrated control system for five air compressors.	Compressor performance (kW/scfm) established from monitoring applied to pre-retrofit and post-retrofit air flow rates obtained from customers DCS system.	Compressor kW/scfm higher ex post, based on measurements vs. ex ante use of rated kW and scfm; so scfm reduction saves more. Ex ante kW estimates were conservatively set to zero, while the evaluation found scfm reductions during peak hours.
PROCESS	1	5251170	AJG0036	550	Five motor driven 100 hp mechanical aerators were replaced with five 50 hp units.	Engineering calculation of hp reduction impacts supported by monitoring and spot measurements.	Post-retrofit system performance was better than expected, allowing the customer to shut down additional aerators.
PROCESS	1	5575791	AFB1029	599	A central automatic DO sensor and aerator control system was installed to operate the fewest aerators necessary to maintain the minimum dissolved oxygen levels.	Billing analysis normalized for the quantity of wastewater being treated by the system.	System performance different than predicted. Ex ante analysis based on short-term observations that may not have been representative. Ex post kW based on expected demand impact at 3-4 pm while ex ante uses change in maximum kW.
PROCESS	1	5851941	AJG0026	560	Installation of high efficiency gas burners and controls and additional furnace heat transfer	Engineering approach similar to the ex ante analysis, utilizing a flow analysis of the	Post-retrofit equipment performance is somewhat less efficient than predicted and

Table A-2
Summary of Project Evaluation Approaches and Ex Ante Ex Post Discrepancies

End Use	Strata	Cntl #	App #	Meas	Measure	Evaluation Approach	Discrepancies
					area	combustion process (based on stoichiometric reactions) and an enthalpy analysis. Calculations utilize verified post-retrofit operating parameters.	ambient temperatures are lower.
PROCESS	1	5851942	AJG0032	560	A combustion air pre-heater was installed on a furnace firebox to recover heat from the furnace exhaust into the combustion air.	Engineering approach similar to the ex ante analysis, utilizing a flow analysis of the combustion process (based on stoichiometric reactions) and an enthalpy analysis, and using post-retrofit operating parameters. Fan electric impacts also determined.	Reduced fuel flow rates to the furnace were observed to be much greater than expected. The annual capacity factor was also higher. Two fan motors required by the post-retrofit system were ignored in the ex ante analysis.
PROCESS	1	6157771	ABJ1015	589	Replace 3 screw compressors totaling 400 hp (nominal) with 1-400 hp screw compressor. Install one regenerative desiccant air dryer in place of 5-non-regenerative desiccant air dryers.	Monitor compressor power; calculate air flow; Calculate base case power at flow using pre-retrofit measurements. Also calculated impacts of dryer-reduced air demand using compressor performance data.	The actual air demand profile is different that that used in the ex ante calculations (which relied on a single average). In general, air demand was lower than predicted, but was higher that predicted on weekday afternoons.
PROCESS	1	6162370	ABT1028	599	Retrofit compressed air nitrogen membrane process with a pressure swing adsorption (PSA) system. This allows customer to increase nitrogen purity while reducing horsepower of the air compressor plant.	Compressor loaded and unloaded hours were used to determine average cfm demand for pre- and post-retrofit periods. Manufacturer's rated performance was used to calculate energy use for the cfm profiles.	Facility operating hours have more than doubled since the retrofit.
PROCESS	1	6172719	AXT0022	560	Install heat exchanger, piping, and controls to heat three process tanks in lieu of electric resistance heating.	Engineering calculation based on observed flow and temperature difference across the heat exchanger.	Base case resistance heating load was determined to be lower in ex post analysis; for peak kW, the ex ante analysis reflects full load conditions while the ex post reflects expected peak hour conditions.
PROCESS	1	6245705	AJQ0121	590	Replaced existing glass furnace with new one.	Comparison of pre- and post-retrofit metered loads, normalized for output.	Base case insulation from glass build-up not factored in to ex ante estimate; output glass temperature higher that expected; peak kW not taken into account in ex ante analysis.
PROCESS	2	3827281	AFB1025	569	Replaces two 130" electric fiberglass melters with new, more efficient 141" melters.	Plant production and electric demand logs used to compare base case and post case kW per unit, normalized to base case units.	Post-retrofit equipment is more efficient than predicted (power to production ratio is lower).
PROCESS	2	4670922	AJN1022	578	Install VFDs on 4-75 hp hydraulic pump motors on each of 2 injection molding machines.	Comparison of pre-retrofit and post-retrofit power measurements of identical retrofitted equipment over a range of operating speeds; applied to post case speed profile.	The ex post operating profile was somewhat different from the ex ante profile. In addition, motor loading was found to be lower in the ex post analysis.
PROCESS	2	5851942	AJG0033	590	Insulation of one outdoor heated asphalt storage tank	Application of standard heat transfer calculations, using key heat transfer parameters from ASHRAE and other sources.	Base case tank asphalt temperatures were higher ex post; reduction in asphalt transport heat-up not included in ex ante impacts

Table A-2
Summary of Project Evaluation Approaches and Ex Ante Ex Post Discrepancies

End Use	Strata	Cntl #	App #	Meas	Measure	Evaluation Approach	Discrepancies
PROCESS	2	5851942	AJG0034	550	Controls were installed to minimize the use of hot boiler feedwater by regulating the purge rate of the steam drum blowdown streams.	Engineering calculation reflecting the energy use required to heat less water in the post case; electric impacts of lower pumping requirements also addressed.	Blowdown rate was found to be smaller than predicted; application of an annual capacity factor also reduced savings. Verified electric motors were different from those assumed in the ex ante analysis.
PROCESS	3	5851942	AJG0030	550	An oxygen analyzer and automated damper were installed on a furnace stack to reduce excess combustion air in the furnace.	Engineering approach similar to the ex ante analysis, utilizing a flow analysis of the combustion process (based on stoichiometric reactions) and an enthalpy analysis. Calculations utilize verified post-retrofit operating parameters.	The furnace was found to be operating with both higher stack gas temperatures and excess oxygen levels than predicted.
PROCESS	3	6401580	AXT0024	589	Oversized 50 hp compressor was replaced with a 15 hp compressor and a 120 gallon receiver tank.	Monitor compressor power; calculate air flow; Calculate base case power at flow using pre-retrofit measurements.	The facility only operates occasionally during the summer peak hour.

B

DATA COLLECTION FORMS

This appendix presents survey forms used in the data collection process. Forms are shown in the following order:

- Telephone recruitment and spillover form
- On-site data collection forms
    - ◊ Equipment forms
    - ◊ Operations survey
- Net-to-gross forms
    - ◊ Standard net-to-gross questionnaire
    - ◊ Custom net-to-gross questionnaire

Telephone Recruitment and Spillover Form

B.1 INDUSTRIAL QUESTIONNAIRE

XENERGY / Pacific Gas and Electric
Industrial Retrofit Program Impact Evaluation
Recruitment Guidelines and Spillover Questionnaire

INTRODUCTION

INTRO Hello, my name is ________________ from _______________________, and I'm calling on behalf of Pacific Gas and Electric Company.

PS1 Ask to speak with **CONTACT** from recruitment form.

1 YES **[SKIPTO PS3]**
2 NO / NO LONGER WITH ORGANIZATION / NO CONTACT SHOWN
3 NO / NOT AVAILABLE NOW [SCHEDULE CALLBACK]
9 NO / IMMEDIATE REFUSAL **[SKIPTO THANK]**

PS2 If **CONTACT** is no longer available ask to speak with someone who is familiar with the operation of the facility particularly as it pertains to energy usage. Note NAME and PHONE NUMBER of the new contact.

New Contact:: ____

Phone Number: ____

PS3 PG&E is conducting a study to assess the effectiveness of the industrial energy efficiency programs they offer. PG&E records indicate that your organization received financial incentives to install energy saving measures in the facility at **(SERVICE ADDRESS)** during 1997. To help determine the impact of this program, we would like to ask your cooperation in this evaluation. Your responses will be held in the strictest of confidence.

[Indicate program measures from recruitment sheet if necessary.]

PS4a For **VERIFICATION** and **RETENTION** sites:
I would like to schedule a site visit to your facility to inspect the program measures and to ask you a few questions about their performance. This survey should take about **XXX** hour(s) and will involve an inventory of the installed measures to ensure that our records are accurate.

Scheduled visit: ____

End of Call

PS4b For **LIGHTING ANALYSIS** sites:
I would like to ask you a few questions related to your participation in the PG&E program and set a date for a site visit. This survey should take about **XXX** hour(s) and will involve an inventory of the installed measures and a review of key operating parameters.
[Explain site activities]

Scheduled visit: ____

PS4c For **PROCESS ANALYSIS** sites:

I would like to ask you a few questions related to your participation in the PG&E program and set a *tentative* date for a site visit. This survey should take about **XXX** hour(s) and will involve data collection activities to assess the impacts of the measures installed at your facility. [Explain site activities]

Tentative visit: ____

PS5 Summarize recruitment activities

1 Successful recruitment

2 Could not reach customer (minimum 3 attempts)

3 Customer refused to participate For analysis sites notify XENERGY project manager

4 Other, List: ____

IDENTIFICATION OF KEY CONTACT PERSONNEL

PS6 Determine who key contact personnel are:

Function	Name	Title	Phone
Site Contact			
Project Decision Maker			
Spillover Respondent			
Other staff ______________________			
Other staff ______________________			

ANALYSIS DISCUSSION

Review site analysis strategy with customer in order to prepare plan. If necessary schedule callback to appropriate contact person to get best input possible and test feasibility of approach and acceptance of potential monitoring equipment installations.

Conduct survey with identified spillover contact.

S1 In addition to the measures installed as part of the PG&E program, did you install or replace any equipment or take any actions to reduce you energy consumption during 1997?

1 YES
2 NO (End Survey)
9 DON'T KNOW / REFUSED (End Survey)

S2 Did PG&E influence your decision to install any of these measures?

1 No influence (End Survey)
2 Some influence
3 Significant influence
4 Extremely significant influence
9 DON'T KNOW / REFUSED (End Survey)

S3 How did PG&E influence your decision? (list multiple responses)

1 Provided information/project analysis
2 Past PG&E program participation
3 Recommended a vendor
4 Other, List: ____
9 DON'T KNOW / REFUSED

S4 Describe measures installed and influenced by PG&E?

Measure 1: ____

____

____

Measure 2: ____

____

____

Measure 3: ____

____

____

S4 Did you apply for a rebate for any of these measures?

1 YES
2 NO (End Survey)
9 DON'T KNOW / REFUSED (End Survey)

If rebate received or pending, eliminate measure from consideration

On-Site Data Collection Forms

PG&E INDUSTRIAL IMPACT STUDY

Control Number
PG&E Representative
Survey Types

Measure Description	Study	Prog Year	Applic Code	Meas Code	kWh	kW	Thm	No. Install	No. Oper.	No. Paid	Check No.
1.											
2.											
3.											
4.											
5.											
6.											
7.											
8.											
9.											
10.											
11.											
12.											

PG&E INDUSTRIAL IMPACT STUDY

Application Number	*Program Year*	*Control Number*	*Meter Rate*	*Strata*	*Check Number*
Check paid to			*Rebate*		*Check Date*
PG&E Representative					*SIC Code*
Contact Person					*Site Survey Type*
Complex					*Surveyor*
Site Address					*Survey Date*
City		*State*	*ZIP*		*Circle one:*

Site Visit Notes:

Review Notes:

1 2 3 4 5

Control Num	Application Num	Check Num	Check Date	Check paid to
Complex				

Measure Description:

Location: ______________________________

Paid Savings: ______________ kWh ______________ kW ______________ therms Rebate: $____________

Measure Attribute Measure Number →	
Measure Code	
Install Date	
Customer Equipment Name	
Manufacturer	
Model Number	
Serial Number	
Number Expected	*1*
Number Observed	
Rated Output Capacity / Size	
Rated Input Volts / RL Amps / therms	
Percent in Working Condition	
Normal Service ☐	*Standby/ Back up*
Discrepancy Code *see table below*	
Removal Code *see table below*	
Months Since Removal	

Schedule		Wkdy	Sat	Sun
Monthly Schedule	Jan			
	Feb			
	Mar			
	Apr			
	May			
	Jun			
	Jul			
	Aug			
	Sep			
	Oct			
	Nov			
	Dec			
OR...		Wkdy	Sat	Sun
Seasonal Schedule	Sum			
	Win			
OR...		Wkdy	Sat	Sun
Annual Schedule	All Yr			

Cooling	*Chilled Water* ☐	*Pkg Unit* ☐	*Evap* ☐	*HP* ☐	*None* ☐
Heating	*Gas Boiler* ☐	*Gas Burner* ☐	*Elect Resist* ☐	*HP* ☐	*None* ☐

Were power loggers installed? *Circle one:* Y / N

How many were installed? ____________

Please describe the locations sufficiently well in the space at right so that another surveyor can locate the loggers if needed.

Logger ID	**Location**

1 2 3 4 5

Discrepancy Codes

D		
	1	Removed, not replaced
	2	Removed, replaced with different (describe)
	4	Never installed
	5	Temporarily taken out of operation
	6	Could not locate
	7	Other (describe)

Removal Codes

R		
	1	Equipment failed, not replaced
	2	Remodeled / Equip Replaced
	3	Unable to locate equivalent replacement
	4	Change of use
	5	Other (describe)

B.2 OPERATIONS SURVEY

XENERGY / PG&E Industrial Retrofit Program Impact Evaluation

SURVEYOR NAME: ____________________________ **PG&E CONTROL NUMBER:** ______________

INTERVIEWEE NAME: __________________________ **CHECK NUMBER** ______________

ALTERNATIVE PROJECTS

A1. Were alternative, less efficient, projects considered?

1 YES
2 NO **[SKIP TO NEXT SECTION]**
9 DON'T KNOW **[SKIP TO NEXT SECTION]**

A2. Describe the alternatives

1 ____

____

2 ____

____

3 ____

____

A3. What role did the PG&E rebate have in the decision to install the current equipment versus the alternatives?

____

____

____

A4. (If applicable) What alternative would most likely have been installed without the PG&E rebate?

____

PRODUCTION INCREASES

P1. Was there a significant increase in production associated with the installation of the rebated measure?

1 YES
2 NO **[SKIP TO NEXT SECTION]**

P2. Were there plans to increase production regardless of the efficiency of the new equipment?

1 YES
2 NO
9 DON'T KNOW

P3. Would the production increase have occurred anyway, without the installation of the specific rebated equipment (possibly utilizing a less efficient technology)?

1 Definitely would have occurred anyway
2 Probably would have occurred anyway
3 Probably would **NOT** to have occurred anyway
4 Definitely would **NOT** to have occurred anyway
9 DON'T KNOW [GET NAME AND PHONE NUMBER OF PERSON WHO WOULD KNOW]

Name:______________________________________

Phone:______________________________________

EARLY REPLACEMENT

E1 Did the rebated equipment replace existing equipment?

1 YES
2 NO **[SKIP REMAINDER OF THIS SECTION]**

E2 What was the condition of the equipment that was replaced?

1 In good working condition
2 In working condition but no longer meeting our needs
3 Near the end of its useful life
9 DON'T KNOW

E3 Without the PG&E rebate, how long would you have operated on the older equipment?

1 Less than one more year
2 Over more than one more year Approximately how many more years ? _____________
9 DON'T KNOW

Net-to-Gross Forms

IDENTIFICATION OF DECISION MAKERS

Enter name of interviewee (person primarily responsible for decision to participate in PG&E program)

Name:____ Title:____

Phone:____ Date:____

A1. Who else at your company was involved in authorizing the decision to enter the PG&E program, and what were their roles in the decision making?

Name:____ Name:____

Role:____ Role:____

Phone:____ Phone:____

A2. Who was primarily responsible for the specification of the installed equipment?

Equipment type:________________________________ Equipment type:________________________________

Name:____ Name:____

Phone:____ Phone:____

Equipment type:________________________________ Equipment type:________________________________

Name:____ Name:____

Phone:____ Phone:____

MEASURE IDENTIFICATION

(Discuss with interviewee the measures you are going to ask questions about. Determine which measures they are familiar with and whether they or someone else is the more appropriate person to answer the questions. If necessary, conduct additional interviews with others to accurately answer the questions on the following pages.)

Interviewee Name (if different from interviewee on pg. 1): ____

Measures covered by this section.
Use additional sections as necessary for different interviewees or for breakout of answers by measure types.

Process Measures (describe)	Space Conditioning Measures (describe)
1.	1.
2.	2.
3.	3.

Section # ___________ **of #**__________ **sections** for this PG&E Control Number.

Remind the interviewee that the following questions pertain to the particular energy efficiency measures that were installed as part of the PG&E Program and are identified in the above tables.

MEASURE & PROGRAM PERFORMANCE SATISFACTION

(CIRCLE ANSWER NUMBERS)

S1 Were you satisfied with the overall performance of the ***Energy Efficiency Equipment*** that was installed?

1 Yes
2 No
3 Different for different measures,
[**Explain]**
____
9 DON'T KNOW / REFUSED

S2 What specific aspects of the ***Energy Efficiency Equipment*** performance (if any) were a source of dissatisfaction?

[OPEN END] ____

S3 Overall were you satisfied with the ***PG&E Energy Efficiency Program***?

1 Yes
2 No
9 DON'T KNOW / REFUSED

S4 What specific aspects of the ***Program*** (if any) were a source of dissatisfaction?

[OPEN END] ____

ENERGY EFFICIENCY DECISION MAKING SECTION

[Again, make sure interviewee is aware that you are talking about specific technologies that were installed through the PG&E Program and referred to in the Measure Identification Section above.]

C1 Which of the following statements best describes the situation that led you to install ***Program-Related Equipment***?

1 Needed to replace older equipment.
2 Needed to add equipment because of a remodel , build-out, or expansion.
3 Wanted to reduce our energy costs
4 Wanted more control over how the equipment was used.
5 NONE OF THE ABOVE
9 DON'T KNOW / REFUSED

C2 How did you first hear about the ***Energy Efficiency Equipment*** that was installed as part of the Program?

[SELECT SINGLE BEST RESPONSE]

1 Contractor
2 Architect / Engineer
3 Vendor
4 PG&E Information (Customer representative / literature / marketing materials)
5 Other non-PG&E literature
6 Friend / Business colleague / Professional association
7 Previous installation
8 OTHER **[SPECIFY]** ______________________________
9 DON'T KNOW / REFUSED

C3 How did you first learn of the PG&E Energy Efficiency Program?

[SELECT SINGLE BEST RESPONSE]

1 Contractor
2 Architect / Engineer
3 Vendor
4 *PG&E* representative
5 Friend / Business colleague / Professional association
6 PG&E marketing materials / advertising
7 OTHER **[SPECIFY]**
____
9 DON'T KNOW / REFUSED

C4 When did you first learn about the PG&E Program? Was it **BEFORE** or was it **AFTER** you first began to think about installing ***Energy Efficient Equipment***?

1 BEFORE

2 AFTER

9 DON'T KNOW / REFUSED

C5 Did you learn about the PG&E Program **BEFORE** or **AFTER** you decided to purchase the ***specific Energy Efficient Equipment*** that was eventually installed?

1 BEFORE

2 AFTER

9 DON'T KNOW / REFUSED

C6 How significant was the PG&E program in influencing your decision to install the ***Energy Efficient Equipment***? Would you say . . .

1 Insignificant

2 Somewhat Significant

3 Very Significant

4 Extremely Significant

9 DON'T KNOW / REFUSED

C7 If the PG&E incentive had not been available, how likely is it you would have installed the ***specific Energy Efficient Equipment***? Would you say . . .

1 Definitely would NOT HAVE installed **[SKIP TO C9]**

2 Probably would NOT HAVE installed **[SKIP TO C9]**

3 Probably would HAVE installed

4 Definitely would HAVE installed

9 DON'T KNOW / REFUSED

[IF C7 = 2 OR C7 = 3 THEN ASK C7a]

C7a How likely is it you would have installed the ***specific Energy Efficient Equipment*** without the PG&E incentive? This time using a scale from 0 to 10, with 0 meaning you definitely would NOT have installed the equipement and 10 meaning you definitely would have installed the equipment.

0 1 2 3 4 5 6 7 8 9 10

[IF C7 = 3 OR C7 = 4 THEN ASK C8]

C8 Without the incentive, how likely is it that the equipment you purchased would have been as energy efficient as the equipment you installed with the incentive? Would you say . . .

1 Probably NOT as efficient

2 Probably as efficient

9 DON'T KNOW / REFUSED

[IF C7 = 1 OR C7 = 2 THEN ASK C9]

C9 Without the incentive, what type of equipment would you have most likely installed? Would you say. . .

1 Standard efficiency equipment

2 Equipment with above-standard efficiency but with lower efficiency than the equipment that was actually installed

3 Would not have installed anything

9 DON'T KNOW / REFUSED

C10 If the PG&E incentive had not been available, would you have installed the ***Energy Efficient Equipment*** at about the same time or at a later date?

[IF AT A LATER DATE, PROBE: "Would that be less than 1 year later, or over 1 year later?", AND SELECT APPROPRIATE RESPONSE. If over 1 year later, probe for best estimate of how many years later.]

1 Same Time To Less Than 1 Year

2 Over 1 Year Later Approximately how many years later? _____________

9 DON'T KNOW / REFUSED

CONCLUSION

Thank you for your cooperation.

DECISION MAKER

Interviewee Name: ____

Title: ____ **Date:** ________/__________/_______

Measures covered by this section.

Use additional sections as necessary for different interviewees or for breakout of answers by measure types.

Process Measures (describe)	
1.	3.
2.	4.

A1. Who else was involved in authorizing the decisions to enter the PG&E program and to specify and purchase the installed equipment? ...what were their roles in the decision making? (If an equipment vendor was involved, get a name and phone.)

Name:____ Name:____

Dept:____ Dept:____

Role:____ Role:____

Phone:____ Phone:____

MEASURE & PROGRAM PERFORMANCE SATISFACTION

Note: if decision maker is the same person who completed a standard survey, do NOT ask each question from scratch; ask this person to confirm results of standard survey - and probe for inconsistencies, etc.

S1 Were you satisfied with the overall performance of the measures that were installed?

____

____

S2 What specific aspects of the measure performance (if any) were a source of dissatisfaction?

____

____

S3 Overall were you satisfied with the PG&E incentive program?

____

____

S4 What specific aspects of the program (if any) were a source of dissatisfaction?

____

____

ENERGY EFFICIENCY DECISION-MAKING SECTION

C1 What led you to consider installing the **energy-efficient equipment**? (If an eqpt vendor was involved, get a name and phone.) (If prompting needed, e.g. old eqpt worn out or didn't meet needs, remodeling/expanding and almost time for eqpt replacement anyhow, wanted to reduce energy costs.)

____

____

____

C2 What non-energy benefits did you expect from installing the **energy-efficient equipment**? (if prompting needed, e.g. better control of eqpt, brighter lighting of areas, reduced eqpt maintenance, reduced labor)

____

____

____

C3 Did you expect to lower your energy bill by installing the **energy-efficient equipment**? ...by how much did you expect to lower your bill per month?

____

____

____

C4 When did you first learn about the PG&E program? Was it **BEFORE** you first started to <u>think about installing</u> the **energy-efficient equipment**? (If an eqpt vendor was involved, get a name and phone.)

____

____

____

C5 How did you first hear about the **energy efficiency technologies** that were installed as part of the program? (If an equipment vendor was involved, get a name and phone.)

____

____

____

C6 Did you consider other equipment before selecting the **energy-efficient equipment**? ....what other equipment? (If alternate projects identified in the file or on-site, probe further)

____

____

____

C7 Had you been planning to purchase energy-efficient equipment before hearing about the PG&E program?

____

____

____

C8 How significant was the PG&E program in influencing your decision to install the energy efficient equipment?

C9 If the PG&E incentive had not been available, would you have specified equipment with the same efficiency? ...how efficient would it have been?

C10 ***[Only ask if State efficiency codes exist for installed Measure—list applicable Measures]*** Without the PG&E incentive, would you have specified equipment efficient enough to meet state efficiency codes? Would equipment been more efficient that for code?

C11 Without the PG&E incentive, would you have installed the energy-efficient equipment at the same time or at a later date? ....if later, how much later?

C12 Without the incentive, would you have installed the **same quantity** of energy-efficient equipment? ...how much less would you have installed?

Financial considerations: Review project economic data and probe where necessary (look at payback, size of rebate relative to project cost, etc.)

C13 Did your firm use any financial criteria to evaluate this energy-efficiency investment? (for example, payback, net present value, return on investment, break-even analysis, etc.) IF SO, indicate what criteria was used and what decision cut-off point was utilized:

Investment Criteria:

Decision cut-off point:

C14 What was the result of this calculation for this project, with and without the PG&E rebate?

With rebate:

Without rebate:

C15 How important were the financial calculations in you decision to install the measure(s)?
Not / Somewhat / Very / Extremely

___

___

___

C16 Where there any other financial considerations utilized in the decision? (examples include cash flow issues, tax considerations, etc.)

___

___

___

Potential Inconsistencies: Review data collected to date, identify potential inconsistencies in data, and explore - for example, where standard consistency check were activated or where different contacts provided different opinions about how important the Program was.

Inconsistency 1: ___

___

Response 1: ___

___

___

Inconsistency 2: ___

___

Response 2: ___

___

___

Inconsistency 3: ___

___

Response 3: ___

___

___

NOTES:

____

____

____

____

____

____

____

____

____

____

CONCLUSION

Thank you for your cooperation.

C

SITE REPORT TEMPLATES

This appendix contains templates used to develop the site plans and site reports. First the site plan template is shown, followed by the site report template. By design, the report template makes considerable use of the material developed during the site planning process.

Draft Site Specific Project Impact Evaluation Plan
Control #_______

Check Address *Site Address*

File Principal Contact:

File Secondary Contact:

PG&E Recommended Contact:

PG&E Div. Mktg. Rep:

Summary of Program Activity:

Projects Paid By 1997 Programs

Application Number	Program Year	Control Number	Account Number	End Use	PG&E Program	Project Type

Measures Within Each Project

Application Num	Meas ID	Measure Description	kWh	kW	Therms	Rebate	Project Type

Program and Evaluation Savings Estimate Summary

			Energy Savings						Net to	Realization Rate					
			Gross			Net			Gross	Gross			Net		
Applic. Num	Meas. ID	Source	kWh	kW	Therms	kWh	kW	Therms	Ratio	kWh	kW	Therms	kWh	kW	Therms
		Ex Ante	0	0.0	0	0	0.0	0	0.00						
		Ex Post	0	0.0	0	0	0.0	0	0.00	-	-	-	-	-	-

C.1 FACILITY DESCRIPTION

Describe the facility and the process that is impacted by the measure. Include: type of business, product, brief description of facility and how rebate project relates to overall facility and operation.

C.2 OVERVIEW OF FACILITY SCHEDULE

- *Provide general description of the facility's operating schedule*
    - *Daily, weekly, monthly, and seasonally*
- *If equipment operations differ from general schedule then provide additional information.*

C.3 MEASURE DESCRIPTION

- *Describe the installed measure as shown in the project file.*

C.3.1 Pre-Retrofit Conditions

- *Identify all pre-retrofit conditions pertaining to the measure that are available in the file and from the customer interview.*
- *Specifically identify equipment when information is available*
    - *Equipment manufacturer, model number, capacity, rated input power, efficiency and other key descriptive and performance data*
    - *Number of units*
    - *Power and energy consumption (measured of rated)*
    - *Operating schedule: daily, weekly seasonal for full year*
    - *Production output or activity metric*

C.3.2 Post-Retrofit Conditions

- *Identify all post-retrofit conditions pertaining to the measure that are available in the file and from the customer interview.*
- *Specifically identify equipment when information is available*
    - *Equipment manufacturer, model number, capacity, rated input power, efficiency and other key descriptive and performance data*
    - *Number of units*
    - *Power and energy consumption (measured of rated)*
    - *Operating schedule: daily, weekly seasonal for full year*
    - *Production output, activity or level of service metric*
    - *Technical and economic aspects of project: (maintenance costs, quality improvements, etc.)*

C.4 EX ANTE METHODOLOGY

C.4.1 Ex Ante Analysis Approach

Provide a general description of the ex ante analysis approach, based on the file review.

C.4.2 Ex Ante Algorithms

Present algorithms used in the ex ante analysis.

Re-create calculations in a spreadsheet, and include as a table.

C.4.3 Ex Ante Basecase

Summarize the basecase used in the ex ante analysis.

C.4.4 Ex Ante Operating Schedule

Present the operating schedule used for the ex ante analysis. This may differ from the facility schedule shown above.

C.4.5 Ex Ante Key Assumptions

- *List key assumptions that were made as part of the ex ante analysis.*

C.4.6 Ex Ante Data Sources

- *Identify all data sources used in the ex ante analysis.*

C.5 PROPOSED EX POST EVALUATION METHODOLOGY

C.5.1 Analysis Approach

- *Provide general overview of the proposed analysis approach.*
- *Identify alternative approaches if necessary.*

C.5.2 Algorithms

Present specific algorithms to be used

- *Preferred data, minimum data required to support calculations*

C.5.3 Basecase

Review ex ante basecase and determine if it seems appropriate.

- *Identify alternative basecase or intermediate basecase and discuss of rationale for choosing*

C.5.4 Operating Schedule

Determine if the operating schedule has changed from the ex ante schedule.

- *If so address how changes will affect impacts.*

Production Level Changes

Identify if production levels have changed.

- *If so, address whether or not the rebate caused the production changes.*

C.5.5 Annualization of Results

- *Explain how impact results will be annualized.*
    - *Direct extrapolation, weather extrapolation, production activity indexing, etc.)*
- *Address seasonality and how any seasonal operations will be taken into account.*

C.5.6 PG&E Costing Period Impact Calculations

Describe how each element of PG&E's costing period table will be calculated:

- *Gross kWh Impacts*
- *Annual Gross kWh Impact*
- *Average Gross kW Impacts*
- *Gross kW Impact Coincident with System Maximum (Hour)*
- *Connected Load Gross kW Impact*

C.6 DATA REQUIREMENTS

- *Identify each data item required for methodology and source:*
- *Customer documentation to be requested, expected sources*
    - *Control or operating system records*

C.6.1 Monitoring Requirements

Submetering to be performed (proposed items to be measured and duration, frequency, interval, equipment to be used)

- *Spot measurements to be taken*
- *Other data needs.*

C.7 SPILLOVER

- *The spillover survey will be applied at the time of initial customer contact. The questionnaire will identify:*

- *Preliminary (customer-reported) spillover measures*
- *Brief description of spillover measure*
  - *Pre-installation equipment or system*
  - *Spillover measure description*

- *Criteria for acceptance of spillover impacts as program impact*
- *Description of proposed means of estimating savings including algorithms to be used*
- *Description of data requirements for spillover impact estimate*

C.8 FREE RIDERSHIP ISSUES

C.8.1 Customer Cost/Benefit Analysis

Summarize cost/benefit analysis contained in the project file. Include payback with and without the incentive.

C.8.2 Non-Energy Costs and Benefits

Identify any non energy cost/benefits such as maintenance savings, reliability improvements, compatibility with other process equipment will be identified.

C.8.3 Equipment Alternatives/Alternative Baseline

Customer's basecase and alternatives considered. (Identify if different from the ex ante basecase and discuss reasons)

C.8.4 Motivation

- *Reasons for overall project implementation*
- *Reasons for selection of the specific equipment which was used (i.e. non-energy attributes that made the technology or efficient equipment the preferred option).*

C.8.5 Other Issues

Identify any other issues that may provide an indication of what the customer would have done if the incentive would not have been available.

Site Specific Project Impact Evaluation Report
Control #_______

Check Address *Site Address*

File Principal Contact:

File Secondary Contact:

PG&E Recommended Contact:

PG&E Div. Mktg. Rep:

Summary of Program Activity:

Projects Paid By 1998 Programs

Application Number	Program Year	Control Number	Account Number	End Use	PG&E Program	Project Type

Measures Within Each Project

Application Num	Meas ID	Measure Description	kWh	kW	Therms	Rebate	Project Type

Program and Evaluation Savings Estimate Summary

			Energy Savings						Net to	Realization Rate					
Applic.	Meas.		Gross			Net			Gross	Gross			Net		
Num	ID	Source	kWh	kW	Therms	kWh	kW	Therms	Ratio	kWh	kW	Therms	kWh	kW	Therms
		Ex Ante	0	0.0	0	0	0.0	0	0.00						
		Ex Post	0	0.0	0	0	0.0	0	0.00	-	-	-	-	-	-

C.9 SUMMARY OF FINDINGS

- *Summarize gross impact results.*
- *Compare to ex post results to ex ante; explain why there are differences.*
- *Address net impacts relative to gross impacts.*

C.10 FACILITY DESCRIPTION

Describe the facility and the process that is impacted by the measure. Include: type of business, product, brief description of facility and how rebate project relates to overall facility and operation.

C.11 OVERVIEW OF FACILITY SCHEDULE

- *Provide general description of the facility's operating schedule.*
    - *Daily, weekly, monthly, and seasonally*
- *If equipment operations differ from general schedule then provide additional information.*

C.12 MEASURE DESCRIPTION

- *Describe the installed measure as determined in the analysis.*
- *Explain if different from the ex ante description.*

For pre and post conditions - use what we know to be true; indicate using "[Note:]" format where initial information from the project file/plan is different.

C.12.1 Pre-Retrofit Conditions

- *Identify all pre-retrofit conditions pertaining to the measure.*
- *Specifically identify equipment when information is available:*
    - *Equipment manufacturer, model number, capacity, rated input power, efficiency and other key descriptive and performance data*
    - *Number of units*
    - *Power and energy consumption (measured of rated)*
    - *Operating schedule: daily, weekly seasonal for full year*
    - *Production output or activity metric*

C.12.2 Post-Retrofit Conditions

- *Identify all post-retrofit conditions pertaining to the measure.*
- *Specifically identify equipment when information is available:*

- *Equipment manufacturer, model number, capacity, rated input power, efficiency and other key descriptive and performance data*
- *Number of units*
- *Power and energy consumption (measured of rated)*
- *Operating schedule: daily, weekly seasonal for full year*
- *Production output, activity or level of service metric*
- *Technical and economic aspects of project: (maintenance costs, quality improvements, etc.)*

C.13 EX ANTE METHODOLOGY

C.13.1Ex Ante Analysis Approach

Provide a general description of the ex ante analysis approach, based on the file review.

C.13.2Ex Ante Algorithms

Present algorithms used in the ex ante analysis.

Re-create calculations in a spreadsheet, and include as a table.

C.13.3Ex Ante Base case

Summarize the base case used in the ex ante analysis.

C.13.4Ex Ante Operating Schedule

Present the operating schedule used for the ex ante analysis. This may differ from the facility schedule shown above.

C.13.5Ex Ante Key Assumptions

- *List key assumptions that were made as part of the ex ante analysis.*

C.13.6Ex Ante Data Sources

- *Identify all data sources used in the ex ante analysis.*

C.14 PROPOSED EX POST EVALUATION METHODOLOGY

C.14.1Ex Post Analysis Approach

- *Provide general overview of the proposed analysis approach.*
- *Identify alternative approaches if necessary.*

C.14.2Ex Post Base case

Explain if ex ante base case is deemed appropriate.

- *If not, describe alternative base case or intermediate base case and discuss rationale for choosing.*

C.14.3Ex Post Operating Schedule

Describe operating schedule used in the analysis. Identify differences from ex ante schedule.

Production Level Changes

Identify if production levels have changed.

- *If so, address whether or not the rebate caused the production changes and subsequent effect on the choice of base case and production level used in the analysis.*

C.14.4Collected Data Ex Post

- *Identify key data items required for methodology and sources.*

C.14.5Monitoring Requirements

If monitoring was utilized, describe. Present monitoring results - graphically.

C.14.6Ex Post Algorithms

Present specific algorithms used.
Provide table showing execution of the analysis approach.

C.14.7Annualization of Results

- *Explain how impact results were annualized.*
  - *Direct extrapolation, weather extrapolation, production activity indexing, etc.*
- *Address seasonality and how any seasonal operations were taken into account.*

C.14.8PG&E Costing Period Impact Calculations

Describe how each element of PG&E's costing period table was calculated:

- *Gross kWh Impacts*
- *Annual Gross kWh Impact*
- *Average Gross kW Impacts*
- *Gross kW Impact Coincident with System Maximum (Hour)*
- *Connected Load Gross kW Impact*

C.15 SUMMARY OF GROSS IMPACTS

- *Results and comparison of ex post vs. ex ante - mainly compare annual kWh/therms and summer peak.*
- *Discussion of discrepancies - why the ex ante was wrong.*
- *Provide results by costing period.*

C.15.1 Ex Ante - Ex Post Discrepancies

Ex Ante vs. Ex Post Discrepancies

	Percent of total difference		
Discrepancy Factor	kWh	kW	Therms
Measures not in place			
Equipment/system performance different from projections			
Different operating conditions			
Basecase differences			
Methodology differences			
Secondary impacts not addressed			

C.15.2 Results by Costing Period

Costing Period	Avg. kW Savings	Avg. kW Savings Coincident with System Maximum	kW Adjustment Factor	kWh Savings	kWh Adjustment Factor	Annual kWh Savings	Connected Load kW Savings
Summer On Peak	0.0	0.0	0.000	0	0.000	0	0.0
Summer Part Peak	0.0	0.0	0.000	0	0.000	0	0.0
Summer Off Peak	0.0	0.0	0.000	0	0.000	0	0.0
Winter Part Peak	0.0	0.0	0.000	0	0.000	0	0.0
Winter Off Peak	0.0	0.0	0.000	0	0.000	0	0.0

Summer On Peak: May 1 to Oct. 31 Noon-6 p.m. Weekdays (Coincid. Peak: 3-4 PM Weekdays)
Summer Part Peak: May 1 to Oct. 31 8:30 a.m. - Noon & 6-9:30 p.m. Weekdays (Coincid. Peak: 6-7 PM Weekdays)
Summer Off Peak: May 1 to Oct. 31 9:30 p.m.-8:30 a.m. Weekdays & All Saturday/Sunday (Coincid. Peak: 10-11 PM Weekdays)
Winter Part Peak: Nov. 1 to Apr. 30 8:30 a.m. - 9:30 p.m. (Coincid. Peak: 6-7 PM Weekdays)
Winter Off Peak: Nov. 1 to Apr. 30 9:30 p.m.-8:30 a.m. Weekdays & All Saturday/Sunday (Coincid. Peak: 8-9 AM Weekdays)

C.16 SPILLOVER

- *Identification of spillover measures*
- *Analysis of impacts*
- *Results*

C.17 NET-TO-GROSS RESULTS

Project net-to-gross ratio: ___

C.17.1 Standard Net-to-Gross Analysis

Discussion of survey results leading to the standard net-to-gross ratio.

C.17.2 Custom Net-to-Gross Analysis

Discussion of custom survey results and rationale for recommending a specific project net-to-gross ratio.

C.18 ATTACHMENTS

C.18.1 Included in This Report

Identify any tables, figures etc. that are included in the report.

C.18.2 Electronic

Spreadsheet containing detailed calculations and report tables: 0000000A.xls

D PROTOCOLS TABLES 6 AND 7

This appendix contains Tables 6 and 7 required to comply with the CPUC M&E Protocols. The tables are presented in the following order:

1. Table 6 - Process
2. Table 7 - Process
3. Table 6 - Process Boilers
4. Table 7 - Process Boilers
5. Table 6 - Space Conditioning
6. Table 7 - Space Conditioning

Table 6 - Process

ENDUSE: Process
Designated Unit of Measurement: Project

1. Average Participant Group and Average Comaprison Group		**Participant**	**Comparison**								
A. Pre-install usage:	Pre-install kW	na	na								
	Pre-install kW	na	na								
	Pre-install Therms	na	na								
	Base kW	na	na								
	Base kWh	na	na								
	Base Therms	na	na								
	Base kW/ designated unit of measurement	na	na								
	Base kWh/ designated unit of measurement	na	na								
	Base Therms/ designated unit of measurement	na	na								
B. Impact year usage:	Impact Yr kW	na	na								
	Impact Yr kWh	na	na								
	Impact Yr Therms	na	na								
	Impact Yr kW/designated unit	na	na								
	Impact Yr kWh/designated unit	na	na	**5. A. 90% CONFIDENCE LEVEL**				**5. B. 80% CONFIDENCE LEVEL**			
	Impact Yr Therms/designated unit	na	na	**LOW BND**	**UP BND**	**LOW BND**	**UP BND**	**LOW BND**	**UP BND**	**LOW BND**	**UP BND**
2. Average Net and Gross End Use Load Impacts		**AVG GROSS**	**AVG NET**	**AVG GROSS**	**AVG GROSS**	**AVG NET**	**AVG NET**	**AVG GROSS**	**AVG GROSS**	**AVG NET**	**AVG NET**
	A. i. Load Impacts - k	2,259	1,994	2,165	2,354	1,905	2,083	2,186	2,333	1,925	2,063
	A. ii. Load Impacts - kWh	22,123,180	18,374,098	21,474,420	22,771,940	17,782,344	18,965,852	21,617,581	22,628,779	17,912,925	18,835,270
	A. iii. Load Impacts - Therms	5,148,495	4,228,511	4,382,014	5,914,977	3,533,878	4,923,144	4,551,152	5,745,838	3,687,161	4,769,860
	B. i. Load Impacts/designated unit - k	66	59	64	69	56	61	64	69	57	61
	B. ii. Load Impacts/designated unit - kWh	650,682	540,415	631,601	669,763	523,010	557,819	635,811	665,552	526,851	553,979
	B. iii. Load Impacts/designated unit - Therms	151,426	124,368	128,883	173,970	103,938	144,798	133,857	168,995	108,446	140,290
	C. i. a. % change in usage - Part Grp - k	na	na	na	na	na	na	na	na	na	na
	C. i. b. % change in usage - Part Grp - kWh	na	na	na	na	na	na	na	na	na	na
	C. i. c. % change in usage - Part Grp - Therms	na	na	na	na	na	na	na	na	na	na
	C. ii. a. % change in usage - Comp Grp - k	na	na	na	na	na	na	na	na	na	na
	C. ii. b. % change in usage - Comp Grp - kWh	na	na	na	na	na	na	na	na	na	na
	C. ii. c. % change in usage - Comp Grp - Therms	na	na	na	na	na	na	na	na	na	na
D. Realization Rate:	D.A. i. Load Impacts - kW, realization rate	1.16	1.37	1.11	1.21	1.30	1.43	1.12	1.20	1.32	1.41
	D.A. ii. Load Impacts - kWh, realization rate	1.03	1.14	1.00	1.06	1.11	1.18	1.01	1.06	1.11	1.17
	D.A. iii. Load Impacts - Therms, realization rate	1.66	1.81	1.41	1.90	1.52	2.11	1.46	1.85	1.58	2.05
	D.B. i. Load Impacts/designated unit - kW, real rate	1.16	1.37	1.11	1.21	1.30	1.43	1.12	1.20	1.32	1.41
	D.B. ii. Load Impacts/designated unit - kWh, real rate	1.03	1.14	1.00	1.06	1.11	1.18	1.01	1.06	1.11	1.17
	D.B. iii. Load Impacts/designated unit - Therms, real rate	1.66	1.81	1.41	1.90	1.52	2.11	1.46	1.85	1.58	2.05
3. Net-to-Gross Ratios		**RATIO**		**RATIO**	**RATIO**			**RATIO**	**RATIO**		
	A. i. Average Load Impacts - k	0.88		0.85	0.92			0.86	0.91		
	A. ii. Average Load Impacts - kWh	0.83		0.80	0.86			0.81	0.86		
	A. iii. Average Load Impacts - Therms	0.82		0.82	0.82			0.82	0.82		
	B. i. Avg Load Impacts/designated unit of measurement - k	0.88		0.88	0.88			0.88	0.88		
	B. ii. Avg Load Impacts/designated unit of measurement - kWh	0.83		0.83	0.83			0.83	0.83		
	B. iii. Avg Load Impacts/designated unit of measurement - Therms	0.82		0.82	0.82			0.82	0.82		
	C. i. Avg Load Impacts based on % chg in usage in Impact year relative to Base usage in Impact year - k	na		na	na			na	na		
	C. ii. Avg Load Impacts based on % chg in usage in Impact year relative to Base usage in Impact year - kWh	na		na	na			na	na		
	C. iii. Avg Load Impacts based on % chg in usage in Impact year relative to Base usage in Impact year - Thms	na		na	na			na	na		
4. Designated Unit Intermediate Data		**PART GRP**	**NP GRP**					**PART GRP**	**PART GRP**		
	A. Pre-install average value	34	na					na	na		
	B. Post-install average value	34	na					na	na		
6. Measure Count Data		**NUMBER**									
	A. Number of measures installed by participants in Part Group	See next page									
	B. Number of measures installed by all program participants in the 12 months of the program year	See next page									
	C. Number of measures installed by Comp Group	na									
7. Market Segment Data											
	B. Distribution of participants by 3 digit SIC	See next page									

1 2 3 4 5

M&E PROTOCOLS TABLE 6 (CONTINUED)

6A/6B Measure Count Data

Measure Code	Measure Description	Participant Group	Population
550	PROCESS CONTROLS	5	7
560	PROCESS HEAT RECOVER	3	3
569	PROCESS CHANGE/ADD EQUIPMENT	1	2
574	PROCESS ENERGY EFFICIENT MOTOR		2
578	PROCESS ADJUSTABLE SPEED DRIVE	1	5
589	AIR COMPRESSER SYSTEM CHANGE/MODIF	4	8
590	PROCESS INSULATE	2	2
593	PROCESS NON-AG PUMP ADJUSTMENT		1
599	PROCESS OTHER	2	7
	Total	18	37

7B Distribution of 3 Digit SICs

SIC3	Percent
131	5.9%
144	5.9%
203	11.8%
208	5.9%
209	8.8%
242	2.9%
265	2.9%
291	20.6%
308	5.9%
322	2.9%
324	2.9%
327	2.9%
329	2.9%
331	2.9%
341	2.9%
344	2.9%
367	2.9%
371	2.9%
379	2.9%

Table 7 - Process

M&E PROTOCOLS TABLE 7
PROCESS END USE

The purpose of this section is to provide the documentation for data quality and processing as required in Table 7 of the M&E Protocols. Major topics are organized and presented in the same order as they are listed in Table 7 for ease of reference and review. When responses to the items are discussed in detail elsewhere in the report, only a brief summary will be given in this section to avoid redundancy.

D.1 OVERVIEW INFORMATION

D.1.1 Study Title and ID Number

Pre-1998 Industrial Energy Efficiency Incentive Program 1998 Carry-Over Impact Evaluation, ID # 403a

D.1.2 Program, Program Year, and Program Description

Program: PG&E's Pre-1998 Industrial Energy Efficiency Incentives Program Carry-Over

Program Year: Rebates paid in 1998

Program Description: The Programs provide incentives to industrial customers to install energy-efficiency measures. The Programs include the Retrofit Express Program (RE), the Retrofit Efficiency Options Program (REO), the Advanced Performance Options Program (APO), and the Customer Efficiency Options Program (CEO).

D.1.3 End Uses Covered

Industrial Process

D.1.4 Methods Used

Site-specific engineering approach

D.1.5 Participant and Comparison Group Definitions

Participants: Industrial customers who received rebate checks in 1998 for installing Process measures

Comparison Group: None

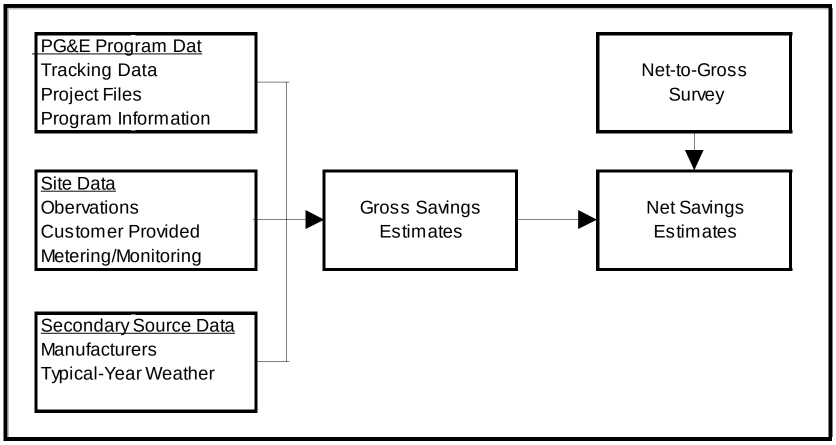
D.1.6 Analysis sample size

Fourteen customers, 18 installations, 18 measures installed, 18 observations (project installation level); these sites accounted for over 70% of the kW, kWh, and therm savings.

D.2 DATABASE MANAGEMENT

D.2.1 Data Flow Chart

Following is a flow chart describing the project data flow.



D.2.2 Data Sources

See flowchart provided above for Item B.1.

D.2.3 Sample Attrition

Eighteen projects were identified for possible site analyses; all 18 projects were analyzed.

The remaining 16 industrial process projects were targeted for verification surveys; 14 of these sites were verified. Of the two projects that were not surveyed were the result of customer refusals.

Of the 32 projects that were analyzed or verified, there were three projects where customers did not complete the net-to-gross surveys.

D.2.4 Quality Checks

Each site analysis was assigned to a senior engineer. This person was responsible for putting together a site analysis plan that made appropriate use of project data. The plan was reviewed by the lead evaluation engineer and the evaluation project manager. The site analysis was then conducted and a report was produced documenting all site-specific evaluation analyses and results. The site report was reviewed by an evaluation engineer, an evaluation technical reviewer, the evaluation project manager, and PG&E staff for completeness.

D.2.5 Data Not Used

N/A

D.3 SAMPLING

D.3.1 Sampling Procedures and Protocols

Population/sampling frame: 34 industrial process projects.

Sampling strategy: A census was attempted for the 12 largest projects; four of the 10 next largest projects were sampled; and two of the remaining 12 projects were sampled. Ultimately, 12 large projects, four medium projects, and two small projects were analyzed.

Sampling basis: A project was defined as a unique combination of end use, PG&E billing Control number, and Application number.

Stratification criteria: Energy savings.

D.3.2 Survey Information

Instruments - see Appendix B of this report for survey instruments;

Response rates - see Item B.3 above for response rates.

Non-response bias - no attempts were made to account for non-response bias.

D.3.3 Statistical Descriptions

N/A

D.4 DATA SCREENING AND ANALYSIS

1. *Outliers*: N/A
2. *Background Variables*: N/A
3. *Data Screening*: N/A, all visited sites were included.
4. *Regression Statistics*: N/A; analysis method was site-specific engineering calculation supported by metering/monitoring.
5. *Specification*: N/A; regression model was not used.
6. *Error in Measuring Variables*: Complex site studies made the best use of available data an the analysis approach was chosen to minimize measurement errors. Multiple levels of site analysis review were utilized to identify potential anomalies which were further researched.
7. *Autocorrelation*: N/A
8. *Heteroskedasticity*: N/A
9. *Collinerarity*: N/A

10. *Influential Data Points*: N/A

11. *Missing Data*: N/A

12. *Precision*: Gross savings - single ratio estimators were utilized; the standard approach for calculating the variance of a ratio estimator was utilized. Net-to-gross: the standard error of the mean net-to-gross ratio was utilized in the precision calculations.

13. *Engineering Analysis*: The engineering analyses used for this evaluation followed the general guidelines provided in Section 3 of Appendix J of the M&E Protocols. Several key aspects of the guidelines are addressed here:
    Data collection: On-site surveys conducted by senior engineering staff were used as the primary source of data collection. In most cases, the analysis was supported by metering/monitoring of post-retrofit equipment. Metering periods ranged from one week to four weeks. In addition, spot measurements or observation of customer's control-panel read-outs were used to ascertain equipment performance.
    Base case definition: For each analyzed project, the ex ante base case assumptions contained in PG&E project file were carefully reviewed for reasonableness. Discussions with customer staff were utilized to support the review. For all projects, pre-retrofit equipment/system specifications were available in the project file. In some necessary cases, pre-retrofit system measurements were also available. In most cases, the ex ante base case assumptions were deemed appropriate and used for the ex post analysis. Adjustments were made in some cases to base case equipment performance to reflect site findings.
    Interactive effects: Engineering calculations were based on simple, equipment-specific models and did not include interactive effects. The analyses did address impacts on the relevant process *systems* at each site and secondary effects were taken into account.
    Changes in production: Changes in production occurred at a number of analysis sites. In each case, the influence of the PG&E incentive on the production increase was assessed. For all but one project, it was determined (through customer interview or technical assessment of the measure, i.e. for control measures) that the production increases would have occurred anyway. In these cases, the post-retrofit production levels were used as the basis of the impact calculation. For one project, it was determined that the increase in production was a direct result of the PG&E incentive. In this case, the pre-retrofit production level was used as the basis for the impact calculation.

14. *Net-to-Gross Analysis*: As self-report method was utilized for this study. All projects received a standard net-to-gross survey, and the largest 12 projects were targeted for an additional custom survey and analysis. Key aspects of the net-to-gross analysis are discussed next:
    Identifying the correct respondent: The initial customer contact was asked to identify the appropriate net-to-gross respondent as part of the on-site survey.
    Set-up questions: Set-up questions regarding customer satisfaction with the measures and the Program and the customer's sources of measure and Program information were used to get the customer thinking about the measure installation decision.
    Use of multiple net-to-gross measures: Two primary questions were used to assess net-to-gross in the standard analysis. The questions addressed the significance of the Program in the

customer's decision to install measures and what the customer would have done in the absence of the incentive. The intended actions questions was the primary question is setting the net-to-gross ratio. The Program significance question was used as a consistency check to adjust the net-to-gross ratio when the intended actions question appeared inconsistent with other responses. In addition, the timing of the Program influence with respect to purchase decisions was used as an additional consistency check to identify free-riders. For the custom surveys, additional questions regarded financial assessment criteria and non-energy benefits were also factored into the net-to-gross analysis.

Use of multiple respondents: The custom net-to-gross analysis incorporated, when relevant, the input of multiple customer respondents. The most weight in the analysis was placed on the responses of the primary decision maker.

Partial and deferred free-ridership: Survey questions and analysis addressed both partial and deferred free-ridership.

Third party influence: For the custom net-to-gross analyses, if the customer respondent indicated a vendor was influential in the measure installation decision, an attempt was made to survey the vendor.

Non-responses and don't knows: customers who did not respond to the survey or did not respond to the 2 key survey questions (involving Program significance and intended actions) were dropped from the net-to-gross analysis. They essentially received the average net-to-gross ratio.

Weighting: Impact weighted-average net-to-gross ratios were calculated separately for kW, kWh, and therm impacts.

Spillover: Spillover was calculated for a project if: (1) the customer indicated they installed additional measures that were not included in the PG&E tracking records; (2) the measures were installed as a result of the PG&E Program; and (3) the customer did not plan to apply for a rebate for these additional measures.

D.5 DATA INTERPRETATION AND APPLICATION

2. E.1.c was used because the study did not require a comparison group.

Table 6 - Process Boilers

M&E PROTOCOLS TABLE 6 **Industrial Energy Efficiency Incentive Program**

ENDUSE: Process Boilers
Designated Unit of Measurement: Project

1. Average Participant Group and Average Comaprison Group		**Participant**	**Comparison**								
A. Pre-install usage:	Pre-install kW	na	na								
	Pre-install kWh	na	na								
	Pre-install Therms	na	na								
	Base kW	na	na								
	Base kWh	na	na								
	Base Therms	na	na								
	Base kW/ designated unit of measurement	na	na								
	Base kWh/ designated unit of measurement	na	na								
	Base Therms/ designated unit of measurement	na	na								
B. Impact year usage:	Impact Yr kW	na	na								
	Impact Yr kWh	na	na								
	Impact Yr Therms	na	na								
	Impact Yr kW/designated unit	na	na								
	Impact Yr kWh/designated unit	na	na	**5. A. 90% CONFIDENCE LEVEL**				**5. B. 80% CONFIDENCE LEVEL**			
	Impact Yr Therms/designated unit	na	na	**LOW BND**	**UP BND**	**LOW BND**	**UP BND**	**LOW BND**	**UP BND**	**LOW BND**	**UP BND**
2. Average Net and Gross End Use Load Impacts		**AVG GROSS**	**AVG NET**	**AVG GROSS**	**AVG GROSS**	**AVG NET**	**AVG NET**	**AVG GROSS**	**AVG GROSS**	**AVG NET**	**AVG NET**
	A. i. Load Impacts - k	0	0	0	0	0	0	0	0	0	0
	A. ii. Load Impacts - kWh	0	0	0	0	0	0	0	0	0	0
	A. iii. Load Impacts - Therms	3,810,800	3,425,261	3,375,725	4,245,875	3,012,752	3,837,771	3,471,732	4,149,867	3,103,780	3,746,743
	B. i. Load Impacts/designated unit - k	0	0	0	0	0	0	0	0	0	0
	B. ii. Load Impacts/designated unit - kWh	0	0	0	0	0	0	0	0	0	0
	B. iii. Load Impacts/designated unit - Therms	762,160	685,052	675,145	849,175	602,550	767,554	694,346	829,973	620,756	749,349
	C. i. a. % change in usage - Part Grp - kW	na	na	na	na	na	na	na	na	na	na
	C. i. b. % change in usage - Part Grp - kWh	na	na	na	na	na	na	na	na	na	na
	C. i. c. % change in usage - Part Grp - Therms	na	na	na	na	na	na	na	na	na	na
	C. ii. a. % change in usage - Comp Grp - kW	na	na	na	na	na	na	na	na	na	na
	C. ii. b. % change in usage - Comp Grp - kWh	na	na	na	na	na	na	na	na	na	na
	C. ii. c. % change in usage - Comp Grp - Therms	na	na	na	na	na	na	na	na	na	na
D. Realization Rate:	D.A. i. Load Impacts - kW, realization rate	na	na	na	na	na	na	na	na	na	na
	D.A. ii. Load Impacts - kWh, realization rate	na	na	na	na	na	na	na	na	na	na
	D.A. iii. Load Impacts - Therms, realization rate	1.39	1.67	1.23	1.55	1.47	1.87	1.27	1.52	1.51	1.82
	D.B. i. Load Impacts/designated unit - kW, real rate	na	na	na	na	na	na	na	na	na	na
	D.B. ii. Load Impacts/designated unit - kWh, real rate	na	na	na	na	na	na	na	na	na	na
	D.B. iii. Load Impacts/designated unit - Therms, real rate	1.39	1.67	1.23	1.55	1.47	1.87	1.27	1.52	1.51	1.82
3. Net-to-Gross Ratios		**RATIO**		**RATIO**	**RATIO**			**RATIO**	**RATIO**		
	A. i. Average Load Impacts - k	na		na	na			na	na		
	A. ii. Average Load Impacts - kWh	na		na	na			na	na		
	A. iii. Average Load Impacts - Therms	0.90		0.90	0.90			0.90	0.90		
	B. i. Avg Load Impacts/designated unit of measurement - k	na		na	na			na	na		
	B. ii. Avg Load Impacts/designated unit of measurement - kWh	na		na	na			na	na		
	B. iii. Avg Load Impacts/designated unit of measurement - Therms	0.90		0.90	0.90			0.90	0.90		
	C. i. Avg Load Impacts based on % chg in usage in Impact year relative to Base usage in Impact year - kW	na		na	na			na	na		
	C. ii. Avg Load Impacts based on % chg in usage in Impact year relative to Base usage in Impact year - kWh	na		na	na			na	na		
	C. iii. Avg Load Impacts based on % chg in usage in Impact year relative to Base usage in Impact year - Thms	na		na	na			na	na		
4. Designated Unit Intermediate Data		**PART GRP**	**NP GRP**					**PART GRP**	**PART GRP**		
	A. Pre-install average value	5	na					na	na		
	B. Post-install average value	5	na					na	na		
6. Measure Count Data		**NUMBER**									
	A. Number of measures installed by participants in Part Group	See next page									
	B. Number of measures installed by all program participants in the 12 months of the program year	See next page									
	C. Number of measures installed by Comp Group	na									
7. Market Segment Data											
	B. Distribution of participants by 3 digit SIC	See next page									

M&E PROTOCOLS TABLE 6 (CONTINUED)

6A/6B Measure Count Data

Measure Code	Measure Description	Participant Group	Population
352	PROCESS BOILER CONTROLS	1	1
370	PROCESS BOILER BURNERS	1	1
372	PROCESS BOILER ECONOMIZER		1
373	PROCESS BOILER HEAT RECOVER	1	1
389	PROCESS BOILER OTHER		1
	Totals	3	5

7B Distribution of 3 Digit SICs

SIC3	Percent
203	40.0%
291	40.0%
311	20.0%

Table 7 - Process Boilers

M&E PROTOCOLS TABLE 7
PROCESS BOILER END USE

The purpose of this section is to provide the documentation for data quality and processing as required in Table 7 of the M&E Protocols. Major topics are organized and presented in the same order as they are listed in Table 7 for ease of reference and review. When responses to the items are discussed in detail elsewhere in the report, only a brief summary will be given in this section to avoid redundancy.

D.6 OVERVIEW INFORMATION

D.6.1 Study Title and ID Number

Pre-1998 Industrial Energy Efficiency Incentive Program 1998 Carry-Over Impact Evaluation, ID # 403b

D.6.2 Program, Program Year, and Program Description

Program: PG&E's Pre-1998 Industrial Energy Efficiency Incentives Program Carry-Over

Program Year: Rebates paid in 1998

Program Description: The Programs provide incentives to industrial customers to install energy-efficiency measures. The Programs include the Retrofit Express Program (RE), the Retrofit Efficiency Options Program (REO), the Advanced Performance Options Program (APO), and the Customer Efficiency Options Program (CEO).

D.6.3 End Uses Covered

Industrial Process Boilers

D.6.4 Methods Used

Site-specific engineering approach

D.6.5 Participant and Comparison Group Definitions

Participants: Industrial customers who received rebate checks in 1998 for installing Process Boiler measures

Comparison Group: None

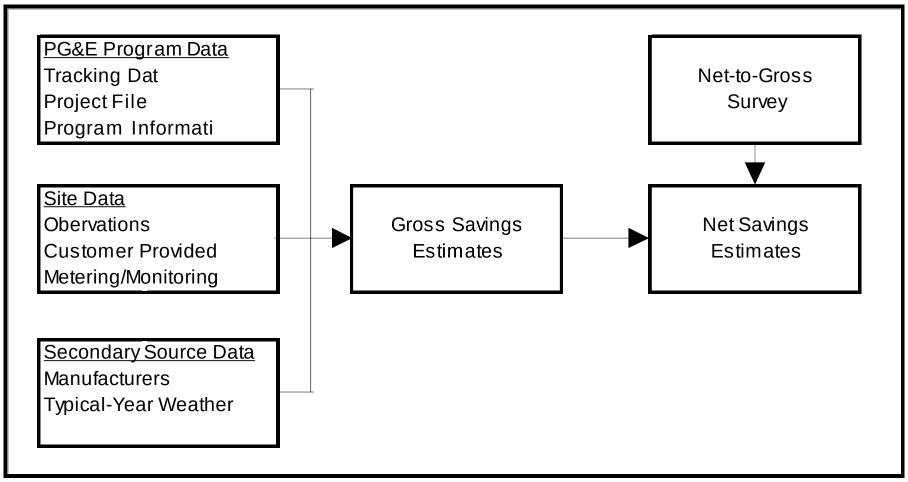
D.6.6 Analysis sample size

Two customers, three installations, three measures installed, three observations (project installation level); these sites accounted for over 70% of the kW, kWh, and therm savings.

D.7 DATABASE MANAGEMENT

D.7.1 Data Flow Chart

Following is a flow chart describing the project data flow.



D.7.2 Data Sources

See flowchart provided above for Item B.1.

D.7.3 Sample Attrition

Three projects were identified for possible site analyses; all three projects were analyzed.

The remaining 2 industrial process boiler projects were targeted for verification surveys; both of these sites were verified.

Net-to-gross surveys were completed for all five projects that were analyzed or verified.

D.7.4 Quality Checks

Each site analysis was assigned to a senior engineer. This person was responsible for putting together a site analysis plan that made appropriate use of project data. The plan was reviewed by the lead evaluation engineer and the evaluation project manager. The site analysis was then conducted and a report was produced documenting all site-specific evaluation analyses and results. The site report was reviewed by the an evaluation engineer, an evaluation technical reviewer, the evaluation project manager, and PG&E staff for completeness.

D.7.5 Data Not Used

N/A

D.8 SAMPLING

D.8.1 Sampling Procedures and Protocols

Population/sampling frame: five industrial process boiler projects.

Sampling strategy: A census was attempted for the two largest projects, and one of the three remaining projects were sampled. Ultimately, two large projects, and one small projects were analyzed.

Sampling basis: A project was defined as a unique combination of end use, PG&E billing Control number, and Application number.

Stratification criteria: Energy savings.

D.8.2 Survey Information

Instruments - see Appendix B of this report for survey instruments;

Response rates - see Item B.3 above for response rates.

Non-response bias - no attempts were made to account for non-response bias.

D.8.3 Statistical Descriptions

N/A

D.9 DATA SCREENING AND ANALYSIS

1. *Outliers*: N/A
2. *Background Variables*: N/A
3. *Data Screening*: N/A, all visited sites were included.
4. *Regression Statistics*: N/A; analysis method was site-specific engineering calculation supported by metering/monitoring.
5. *Specification*: N/A; regression model was not used.
6. *Error in Measuring Variables*: Complex site studies made the best use of available data an the analysis approach was chosen to minimize measurement errors. Multiple levels of site analysis review were utilized to identify potential anomalies which were further researched.
7. *Autocorrelation*: N/A
8. *Heteroskedasticity*: N/A
9. *Collinerarity*: N/A
10. *Influential Data Points*: N/A

11. *Missing Data*: N/A

12. *Precision*: Gross savings - single ratio estimators were utilized; the standard approach for calculating the variance of a ratio estimator was utilized. Net-to-gross: the standard error of the mean net-to-gross ratio was utilized in the precision calculations.

13. *Engineering Analysis*: The engineering analyses used for this evaluation followed the general guidelines provided in Section 3 of Appendix J of the M&E Protocols. Several key aspects of the guidelines are addressed here:
    <u>Data collection</u>: On-site surveys conducted by senior engineering staff were used as the primary source of data collection. In most cases, the analysis was supported by metering/monitoring of post-retrofit equipment. Metering periods ranged from one week to four weeks. In addition, spot measurements or observation of customer's control-panel read-outs were used to ascertain equipment performance.
    <u>Base case definition</u>: For each analyzed project, the ex ante base case assumptions contained in PG&E project file were carefully reviewed for reasonableness. Discussions with customer staff were utilized to support the review. For all projects, pre-retrofit equipment/system specifications were available in the project file. In some necessary cases, pre-retrofit system measurements were also available. In most cases, the ex ante base case assumptions were deemed appropriate and used for the ex post analysis. Adjustments were made in some cases to base case equipment performance to reflect site findings.
    <u>Interactive effects</u>: Engineering calculations were based on simple, equipment-specific models and did not include interactive effects. The analyses did address impacts on the relevant process *systems* at each site and secondary effects were taken into account.
    <u>Changes in production</u>: Changes in production occurred at a number of analysis sites. In each case, the influence of the PG&E incentive on the production increase was assessed. For all but one project, it was determined (through customer interview or technical assessment of the measure, i.e. for control measures) that the production increases would have occurred anyway. In these cases, the post-retrofit production levels were used as the basis of the impact calculation. For one project, it was determined that the increase in production was a direct result of the PG&E incentive. In this case, the pre-retrofit production level was used as the basis for the impact calculation.

14. *Net-to-Gross Analysis*: As self-report method was utilized for this study. All projects received a standard net-to-gross survey, and the largest 12 projects were targeted for an additional custom survey and analysis. Key aspects of the net-to-gross analysis are discussed next:
    <u>Identifying the correct respondent</u>: The initial customer contact was asked to identify the appropriate net-to-gross respondent as part of the on-site survey.
    <u>Set-up questions</u>: Set-up questions regarding customer satisfaction with the measures and the Program and the customer's sources of measure and Program information were used to get the customer thinking about the measure installation decision.
    <u>Use of multiple net-to-gross measures</u>: Two primary questions were used to assess net-to-gross in the standard analysis. The questions addressed the significance of the Program in the customer's decision to install measures and what the customer would have done in the absence of the incentive. The intended actions questions was the primary question is setting

the net-to-gross ratio. The Program significance question was used as a consistency check to adjust the net-to-gross ratio when the intended actions question appeared inconsistent with other responses. In addition, the timing of the Program influence with respect to purchase decisions was used as an additional consistency check to identify free-riders. For the custom surveys, additional questions regarded financial assessment criteria and non-energy benefits were also factored into the net-to-gross analysis.

Use of multiple respondents: The custom net-to-gross analysis incorporated, when relevant, the input of multiple customer respondents. The most weight in the analysis was placed on the responses of the primary decision maker.

Partial and deferred free-ridership: Survey questions and analysis addressed both partial and deferred free-ridership.

Third party influence: For the custom net-to-gross analyses, if the customer respondent indicated a vendor was influential in the measure installation decision, an attempt was made to survey the vendor.

Non-responses and don't knows: customers who did not respond to the survey or did not respond to the 2 key survey questions (involving Program significance and intended actions) were dropped from the net-to-gross analysis. They essentially received the average net-to-gross ratio.

Weighting: Impact weighted-average net-to-gross ratios were calculated separately for kW, kWh, and therm impacts.

Spillover: Spillover was calculated for a project if: (1) the customer indicated they installed additional measures that were not included in the PG&E tracking records; (2) the measures were installed as a result of the PG&E Program; and (3) the customer did not plan to apply for a rebate for these additional measures.

D.10 DATA INTERPRETATION AND APPLICATION

2. E.1.c was used because the study did not require a comparison group.

Table 6 - Space Conditioning

M&E PROTOCOLS TABLE 6 **Industrial Energy Efficiency Incentive Program**

ENDUSE: Space Conditioning
Designated Unit of Measurement: Project

1. Average Participant Group and Average Comaprison Group		**Participant**	**Comparison**								
A. Pre-install usage:	Pre-install kW	na	na								
	Pre-install kW	na	na								
	Pre-install Therms	na	na								
	Base kW	na	na								
	Base kWh	na	na								
	Base Therms	na	na								
	Base kW/ designated unit of measurement	na	na								
	Base kWh/ designated unit of measurement	na	na								
	Base Therms/ designated unit of measurement	na	na								
B. Impact year usage:	Impact Yr kW	na	na								
	Impact Yr kWh	na	na								
	Impact Yr Therms	na	na								
	Impact Yr kW/designated unit	na	na								
	Impact Yr kWh/designated unit	na	na	**5. A. 90% CONFIDENCE LEVEL**				**5. B. 80% CONFIDENCE LEVEL**			
	Impact Yr Therms/designated unit	na	na	**LOW BND**	**UP BND**	**LOW BND**	**UP BND**	**LOW BND**	**UP BND**	**LOW BND**	**UP BND**
2. Average Net and Gross End Use Load Impacts		**AVG GROSS**	**AVG NET**	**AVG GROS**	**AVG GROS**	**AVG NET**	**AVG NET**	**AVG GROS**	**AVG GROS**	**AVG NET**	**AVG NET**
	A. i. Load Impacts - k	1,686	896	1,552	1,819	799	993	1,581	1,790	820	972
	A. ii. Load Impacts - kWh	10,720,243	6,998,925	8,236,126	13,204,361	4,991,395	9,006,455	8,784,293	12,656,194	5,434,394	8,563,456
	A. iii. Load Impacts - Therms	0	0	0	0	0	0	0	0	0	0
	B. i. Load Impacts/designated unit - k	41	22	38	44	19	24	39	44	20	24
	B. ii. Load Impacts/designated unit - kWh	261,469	170,705	200,881	322,058	121,741	219,670	214,251	308,688	132,546	208,865
	B. iii. Load Impacts/designated unit - Therms	0	0	0	0	0	0	0	0	0	0
	C. i. a. % change in usage - Part Grp - k	na	na	na	na	na	na	na	na	na	na
	C. i. b. % change in usage - Part Grp - kWh	na	na	na	na	na	na	na	na	na	na
	C. i. c. % change in usage - Part Grp - Therms	na	na	na	na	na	na	na	na	na	na
	C. ii. a. % change in usage - Comp Grp - kW	na	na	na	na	na	na	na	na	na	na
	C. ii. b. % change in usage - Comp Grp - kWh	na	na	na	na	na	na	na	na	na	na
	C. ii. c. % change in usage - Comp Grp - Therms	na	na	na	na	na	na	na	na	na	na
D. Realization Rate:	D.A. i. Load Impacts - kW, realization rate	0.53	0.37	0.49	0.58	0.33	0.41	0.50	0.57	0.34	0.40
	D.A. ii. Load Impacts - kWh, realization rate	0.80	0.69	0.62	0.99	0.49	0.89	0.66	0.95	0.54	0.85
	D.A. iii. Load Impacts - Therms, realization rate	na	na	na	na	na	na	na	na	na	na
	D.B. i. Load Impacts/designated unit - kW, real rate	0.53	0.37	0.49	0.58	0.33	0.41	0.50	0.57	0.34	0.40
	D.B. ii. Load Impacts/designated unit - kWh, real rate	0.80	0.69	0.62	0.99	0.49	0.89	0.66	0.95	0.54	0.85
	D.B. iii. Load Impacts/designated unit - Therms, real rate	na	na	na	na	na	na	na	na	na	na
3. Net-to-Gross Ratios		**RATIO**		**RATIO**	**RATIO**			**RATIO**	**RATIO**		
	A. i. Average Load Impacts - k	0.53		0.50	0.57			0.50	0.56		
	A. ii. Average Load Impacts - kWh	0.65		0.62	0.68			0.63	0.68		
	A. iii. Average Load Impacts - Therms	na		na	na			na	na		
	B. i. Avg Load Impacts/designated unit of measurement - k	0.53		0.53	0.53			0.53	0.53		
	B. ii. Avg Load Impacts/designated unit of measurement - kWh	0.65		0.65	0.65			0.65	0.65		
	B. iii. Avg Load Impacts/designated unit of measurement - Therms	na		na	na			na	na		
	C. i. Avg Load Impacts based on % chg in usage in Impact year relative to Base usage in Impact year - k	na		na	na			na	na		
	C. ii. Avg Load Impacts based on % chg in usage in Impact year relative to Base usage in Impact year - kWh	na		na	na			na	na		
	C. iii. Avg Load Impacts based on % chg in usage in Impact year relative to Base usage in Impact year - Thms	na		na	na			na	na		
4. Designated Unit Intermediate Data		**PART GRP**	**NP GRP**					**PART GRP**	**PART GRP**		
	A. Pre-install average value	41	na					na	na		
	B. Post-install average value	41	na					na	na		
6. Measure Count Data		**NUMBER**									
	A. Number of measures installed by participants in Part Group	See next page									
	B. Number of measures installed by all program participants in the 12 months of the program year	See next page									
	C. Number of measures installed by Comp Group	na									
7. Market Segment Data											
	B. Distribution of participants by 3 digit SIC	See next page									

1 2 3 4 5

M&E PROTOCOLS TABLE 6 (CONTINUED)

6A/6B Measure Count Data

Measur Code	Measure Description	Participant Grou	Population
201	HVAC CONTROLS	1	1
204	INSTALL HVAC EMS	2	4
232	ADD HIGH EFFICIENCY CHILLER	2	4
241	HVAC ENERGY EFFICIENT MOTOR - FAN		1
248	HVAC ADJUSTABLE SPEED DRIVE	1	1
S13	WATER CHILLER: >= 150 TONS, AIR-COOLED W/CONDENSER	3	3
S16	A/C: CENTRAL, < 65 KBTU/HR, AIR-COOLED, SPLIT-SYS/SNGL PKG	3	39
S16	A/C: CENTRAL, >= 65 & < 135 KBTU/HR, AIR-COOLED, SPLIT-SYS/SNGL PKG		17
S16	A/C: CENTRAL, >= 135 & < 240 KBTU/HR, AIR-COOLED, SPLIT-SYS/SNGL PKG		1
S18	THERMOSTAT: SETBACK PROGRAMMABLE		28
S20	REFLECTIVE WINDOW FILM		314
S21	EVAPORATIVE COOLER		2
S22	ADJUSTABLE SPEED DRIVE: HVAC FAN, 50 HP MAX		2
S95	Cooling Tower: Oversized, Transition		1
	Totals	12	418

7B Distribution of 3 Digit SICs

SIC3	Percent
153	2.4%
208	2.4%
271	2.4%
308	2.4%
344	2.4%
357	9.8%
359	4.9%
366	24.4%
367	17.1%
369	2.4%
381	7.3%
382	12.2%
384	4.9%
394	2.4%
395	2.4%

Table 7 - Space Conditioning

M&E PROTOCOLS TABLE 7
SPACE CONDITIONING END USE

The purpose of this section is to provide the documentation for data quality and processing as required in Table 7 of the M&E Protocols. Major topics are organized and presented in the same order as they are listed in Table 7 for ease of reference and review. When responses to the items are discussed in detail elsewhere in the report, only a brief summary will be given in this section to avoid redundancy.

D.11 OVERVIEW INFORMATION

D.11.1 Study Title and ID Number

Pre-1998 Industrial Energy Efficiency Incentive Program 1998 Carry-Over Impact Evaluation, ID # 403c

D.11.2 Program, Program Year, and Program Description

Program: PG&E's Pre-1998 Industrial Energy Efficiency Incentives Program Carry-Over

Program Year: Rebates paid in 1998

Program Description: The Programs provide incentives to industrial customers to install energy-efficiency measures. The Programs include the Retrofit Express Program (RE), the Retrofit Efficiency Options Program (REO), the Advanced Performance Options Program (APO), and the Customer Efficiency Options Program (CEO).

D.11.3 End Uses Covered

Industrial Space Conditioning

D.11.4 Methods Used

Site-specific engineering approach

D.11.5 Participant and Comparison Group Definitions

Participants: Industrial customers who received rebate checks in 1998 for installing space conditioning measures

Comparison Group: None

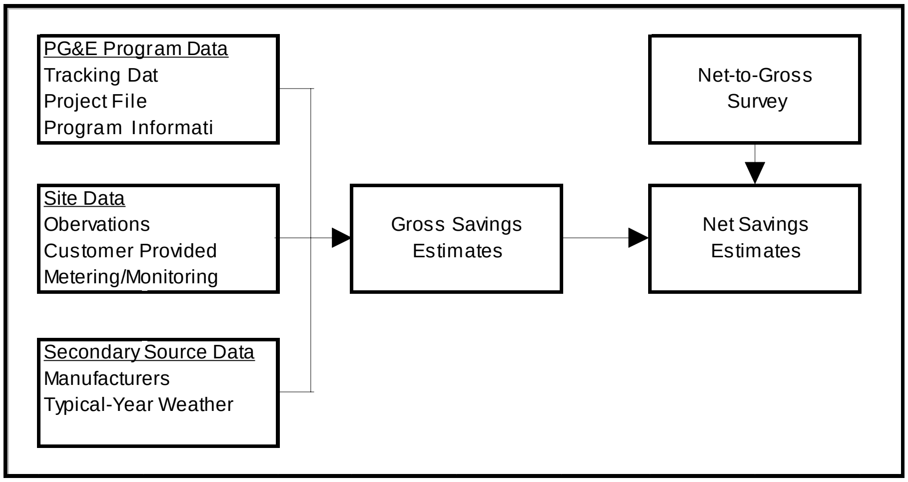
D.11.6 Analysis sample size

Nine customers, 9 installations, 12 measures installed, nine observations (project installation level); these sites accounted for over 70% of the kW, kWh, and therm savings.

D.12 DATABASE MANAGEMENT

D.12.1 Data Flow Chart

Following is a flow chart describing the project data flow.



D.12.2 Data Sources

See flowchart provided above for Item B.1.

D.12.3 Sample Attrition

Eight projects were identified for possible site analyses; a total of nine projects were analyzed.

The remaining 32 industrial space conditioning projects were targeted for verification surveys; 31 of these sites were verified. One project was not surveyed as the result of a customer refusal.

Of the 40 projects that were analyzed or verified, there were 4 projects where customers did not complete the net-to-gross surveys.

D.12.4 Quality Checks

Each site analysis was assigned to a senior engineer. This person was responsible for putting together a site analysis plan that made appropriate use of project data. The plan was reviewed by the lead evaluation engineer and the evaluation project manager. The site analysis was then conducted and a report was produced documenting all site-specific evaluation analyses and results. The site report was reviewed by the an evaluation engineer, an evaluation technical reviewer, the evaluation project manager, and PG&E staff for completeness.

D.12.5 Data Not Used

N/A

D.13 SAMPLING

D.13.1 Sampling Procedures and Protocols

Population/sampling frame: 41 industrial space conditioning projects.

Sampling strategy: A census was attempted for the two largest projects; three of the 17 next-largest projects were sampled; and three of the remaining 22 projects were sampled. Ultimately, two large projects, four medium projects, and three small projects were analyzed. An additional project was added to the sample to facilitate modeling convenience. This project was in a space adjacent to a sampled project.

Sampling basis: A project was defined as a unique combination of end use, PG&E billing Control number, and Application number.

Stratification criteria: Energy savings.

D.13.2 Survey Information

Instruments - see Appendix B of this report for survey instruments;

Response rates - see Item B.3 above for response rates.

Non-response bias - no attempts were made to account for non-response bias.

D.13.3 Statistical Descriptions

N/A

D.14 DATA SCREENING AND ANALYSIS

1. *Outliers*: N/A
2. *Background Variables*: N/A
3. *Data Screening*: N/A, all visited sites were included.
4. *Regression Statistics*: N/A; analysis method was site-specific engineering calculation supported by metering/monitoring.
5. *Specification*: N/A; regression model was not used.
6. *Error in Measuring Variables*: Complex site studies made the best use of available data an the analysis approach was chosen to minimize measurement errors. Multiple levels of site analysis review were utilized to identify potential anomalies which were further researched.
7. *Autocorrelation*: N/A
8. *Heteroskedasticity*: N/A
9. *Collinerarity*: N/A

10. *Influential Data Points*: N/A

11. *Missing Data*: N/A

12. *Precision*: Gross savings - single ratio estimators were utilized; the standard approach for calculating the variance of a ratio estimator was utilized. Net-to-gross: the standard error of the mean net-to-gross ratio was utilized in the precision calculations.

13. *Engineering Analysis*: The engineering analyses used for this evaluation followed the general guidelines provided in Section 3 of Appendix J of the M&E Protocols. Several key aspects of the guidelines are addressed here:
    Data collection: On-site surveys conducted by senior engineering staff were used as the primary source of data collection. In most cases, the analysis was supported by metering/monitoring of post-retrofit equipment. Metering periods ranged from one week to four weeks. In addition, spot measurements or observation of customer's control-panel read-outs were used to ascertain equipment performance.
    Base case definition: For each analyzed project, the ex ante base case assumptions contained in PG&E project file were carefully reviewed for reasonableness. Discussions with customer staff were utilized to support the review. For all projects, pre-retrofit equipment/system specifications were available in the project file. In some necessary cases, pre-retrofit system measurements were also available. In most cases, the ex ante base case assumptions were deemed appropriate and used for the ex post analysis. Adjustments were made in some cases to base case equipment performance to reflect site findings.
    Interactive effects: Engineering calculations were based on simulation model results and took into account interactive effects. The analyses also addressed impacts on the relevant *systems* at each site and secondary effects were taken into account.
    Changes in production: Changes in production were not an issue for space conditioning projects.

14. *Net-to-Gross Analysis*: As self-report method was utilized for this study. All projects received a standard net-to-gross survey, and the largest 12 projects were targeted for an additional custom survey and analysis. Key aspects of the net-to-gross analysis are discussed next:
    Identifying the correct respondent: The initial customer contact was asked to identify the appropriate net-to-gross respondent as part of the on-site survey.
    Set-up questions: Set-up questions regarding customer satisfaction with the measures and the Program and the customer's sources of measure and Program information were used to get the customer thinking about the measure installation decision.
    Use of multiple net-to-gross measures: Two primary questions were used to assess net-to-gross in the standard analysis. The questions addressed the significance of the Program in the customer's decision to install measures and what the customer would have done in the absence of the incentive. The intended actions questions was the primary question is setting the net-to-gross ratio. The Program significance question was used as a consistency check to adjust the net-to-gross ratio when the intended actions question appeared inconsistent with other responses. In addition, the timing of the Program influence with respect to purchase decisions was used as an additional consistency check to identify free-riders. For the custom

surveys, additional questions regarded financial assessment criteria and non-energy benefits were also factored into the net-to-gross analysis.

Use of multiple respondents: The custom net-to-gross analysis incorporated, when relevant, the input of multiple customer respondents. The most weight in the analysis was placed on the responses of the primary decision maker.

Partial and deferred free-ridership: Survey questions and analysis addressed both partial and deferred free-ridership.

Third party influence: For the custom net-to-gross analyses, if the customer respondent indicated a vendor was influential in the measure installation decision, an attempt was made to survey the vendor.

Non-responses and don't knows: customers who did not respond to the survey or did not respond to the 2 key survey questions (involving Program significance and intended actions) were dropped from the net-to-gross analysis. They essentially received the average net-to-gross ratio.

Weighting: Impact weighted-average net-to-gross ratios were calculated separately for kW, kWh, and therm impacts.

Spillover: Spillover was calculated for a project if: (1) the customer indicated they installed additional measures that were not included in the PG&E tracking records; (2) the measures were installed as a result of the PG&E Program; and (3) the customer did not plan to apply for a rebate for these additional measures.

D.15 DATA INTERPRETATION AND APPLICATION

2. E.1.c was used because the study did not require a comparison group.

E

EVALUATION DATABASE

This appendix describes the final data products associated with this evaluation. First the directory structure is show. Next each file is described. Finally the variables in the final evaluation data set are described. All data are provided on CD-ROM.

E.1 DIRECTORY STRUCTURE

The directory structure for the electronic data provided in conjunction with this evaluation is provided in Table E-1.

Table E-1
Electronic Data Directory Structure

Subdirectory	Description
DBF	dBase files used to transfer data to/from SAS to Excel/Access
\SURVEY	Survey data
\TRACKING	Program tracking data
\OTHER	Other data
EXCEL - ACCESS	Excel and Access data, programs, and variable descriptions
FINAL DATA	Final evaluation data set in SAS and Excel format
SITES	Process project reports and analysis spreadsheets
\REPORTS	Reports
\SPREADSHEETS	Analysis spreadsheets
SASDATA	SAS data sets
SASPGM	SAS programs

E.2 DESCRIPTION OF ELECTRONIC FILES

Table E-2 on the following page presents the electronic files supporting the evaluation. Descriptions of each file are provided.

Table E-2
Electronic Files

DATASET	DESCRIPTION
DBF\OTHER	Subdirectory of "other" DBF files
ARESULT.DBF	Process impact results extracted from project spreadsheets (for loading into SAS)
NTGPLUS.DBF	Standard NTG survey data for analysis sites with additional QC (for loading into SAS)
PROJTYPE.DBF	Project technology classifications (for loading into SAS)
STRATA.DBF	STRATA DETERMINATION FROM EXCEL ANALYSIS
VERREP.DBF	Data for verification reports (from SAS)
DBF\SURVEY	Subdirectory of DBF survey files
TMAIN.DBF	Site-level survey data (see INDUSTRIAL_VARIABLES.XLS for descriptions
TMEAS.DBF	Measure-level survey data (see INDUSTRIAL_VARIABLES.XLS for descriptions
TNTG.DBF	Net-to-gross survey data (see INDUSTRIAL_VARIABLES.XLS for descriptions
TPROJ.DBF	Project-level survey data (see INDUSTRIAL_VARIABLES.XLS for descriptions
DBF\TRACKING	Subdirectory of DBF tracking files - from PG&E ACCESS database
ACTION.DBF	Action code descriptions
APP97.DBF	Application-level data
CONTACT.DBF	Customer contact information
EMPLOYEE.DBF	PG&E customer rep information
END_USE.DBF	End use code descriptions
ITEM.DBF	Item-level data
ITEM2.DBF	Item-level data - second part
MEASURE.DBF	Measure-code descriptions
SEGMENT.DBF	Customer segment descriptions
SIC.DBF	SIC code descriptions
EXCEL - ACCESS	Subdirectory of Excel and ACESS files
INDUSTRIAL_VARIABLES.XLS	Description of survey and lighting analysis variables
INDUSTRL.MDB	Survey database
INDRESULT.XLS	Results workbook for Final Report
FINAL DATA	Subdirectory containing the final evaluation data sets
FNLDATA.SD2	SAS data set
FNLDATA.XLS	Excel data set
SITES\REPORTS	Subdirectory of Process site reports
R*******.DOC	Project reports; ******* identifies the PG&E Control Number for the analyzed project
SITES\SPREADSHEETS-OTHER	Subdirectory of Process site spreadsheets
*******.XLS	Project spreadsheets; ******* identifies the PG&E Control Number for the analyzed project
SASDATA	Subdirectory of SAS data sets
IND.SD2	Evaluation tracking data set from TRACKING DBF files
INDDATA1.SD2	Tracking data and survey, along with calculated Std NTGRs for use in impact calculations
SASPGM	Subdirectory of SAS data sets
LIT4REPS.SAS	Summarizes lighting analysis data for Final Report and Small Indoor Lighting Report
LITSUM.SAS	Summarizes and analyzes lighting results data for Final Report
NTGR.SAS	Calculates net-to-gross ratios from survey data
MISCSUM.SAS	Summarizes and analyzes miscellaneous outputs for the Final Report
PROCSUM.SAS	Summarizes and analyzes process results data for the Final Report
PROCBSUM.SAS	Summarizes and analyzes process boiler results data for the Final Report
RDTRAK.SAS	Reads tracking data (Tracking DBFs) into SAS
SCONDSUM.SAS	Summarizes and analyzes space conditioning results data for the Final Report
RDSURV.SAS	Reads survey data (Survey DBFs) into SAS
SAMPLE.SAS	Analyzes tracking data to create sample ensuring 70% impacts are addressed
TOEXCEL.SAS	Combines 97 tracking and 95 retention data and sets up output for survey data (T_***.SD2's)
VERIFY.SAS	Writes out verification report data

E.3 DESCRIPTION OF EVALUATION DATA SET VARIABLES

Table E-3 on the following page presents the variables provided in the final evaluation dataset. Descriptions are also provided.

Table E-3
Final Evaluation Data Set Variables

DATA TYPE	VARIABLE NAME	DESCRIPTION
IDENTIFICATION	CNTL	PG&E CONTROL NUMBER
	CODE	REBATE APPLICATION NUMBER
	EUDESC	END USE TYPE
	P_MEASUR	MEASURE CODE
	STRATA	EVAL98 EU STRATA
	STUDY	STUDY GROUP (Analysis, Verify, Not Studied)
	HAVENTGR	NTGR CALCULATED FOR PROJECT
TRACKING	ACCT	PG&E ACCOUNT NUMBER
	CHECKNO	REBATE CHECK NUMBER
	CHKCITY	REBATE CHECK CITY
	CHKIS_DT	REBATE CHECK ISSUE DATE
	CHKST	REBATE CHECK STATE
	CHKSTRT	REBATE CHECK STREET
	CHKZIP	REBATE CHECK ZIP CODE
	CONNAME	CUSTOMER CONTACT
	CONPHONE	CUST CONTACT PHONE
	CORPID	CORPORATE ID CODE
	CUSTNAME	CUSTOMER NAME - BILL SYS
	DIVISION	PG&E DIVISION CODE
	FEDTAXID	FEDERAL TAX ID
	KWH	ANNUAL KWH USAGE
	MEASDESC	MEASURE DESCRIPTION
	NETKW	EX ANTE NET KW IMPACTS
	NETKWH	EX ANTE NET KWH IMPACTS
	NETTHM	EX ANTE NET THERM IMPACTS
	P_AVOID	AVOIDED COST
	P_EUCODE	END USE CODE
	P_ICOST	INCREMENTAL COST
	P_KW	EX ANTE GROSS KW SAVINGS
	P_KWH	EX ANTE GROSS KWH SAVINGS
	P_NTG	NET-TO-GROSS RATIO
	P_NUMPUR	NUMBER PURCHASED
	P_PCOST	PROJECT COST
	P_PLIFE	PROJECT LIFE (YEARS)
	P_REBATE	REBATE AMOUNT
	P_SHARE	SHAREHOLDER INCENTIVE
	P_THM	EX ANTE GROSS THM SAVINGS
	PAYABLE	REBATE CHECK PAYABLE TO
	PCOMP_DT	PROJECT_COMPLETION_DATE
	POSTF_DT	POSTFIELD DATE
	PREF_DT	PREFIELD DATE
	PREMID	PREMISE ID CODE

Table E-3
Final Evaluation Data Set Variables

DATA TYPE	VARIABLE NAME	DESCRIPTION
TRACKING (cont.)	PRJDESC	PROJECT DESCRIPTION
	PRJDESC2	PROJECT DESCRIPTION 2
	PROGCODE	PROGRAM CODE
	PROGYR	PROGRAM YEAR
	REPNAME	PG&E REP NAME
	REPPHONE	PG&E REP PHONE
	SERADD	SERVICE ADDRESS - BILL SYS
	SERCITY	SERVICE CITY
	SERZIP	SERVICE ADDR ZIP CODE
	SIC2	SIC2
	SQFT	SQUARE FOOTAGE
	THM	ANNUAL THM USAGE
SURVEY	C1	STD NTG SURVEY QUESTION 1
	C10	STD NTG SURVEY QUESTION 10
	C10YRLAT	STD NTG SURVEY QUESTION 11
	C2	STD NTG SURVEY QUESTION 2
	C3	STD NTG SURVEY QUESTION 3
	C4	STD NTG SURVEY QUESTION 4
	C5	STD NTG SURVEY QUESTION 5
	C6	STD NTG SURVEY QUESTION 6
	C7	STD NTG SURVEY QUESTION 7
	C8	STD NTG SURVEY QUESTION 8
	C9	STD NTG SURVEY QUESTION 9
	CUSTEQP	CUSTOMER EQUIPMENT DESCRIPTOR
	DISCREP	DISCREP
	EQPDUTY	EQUIPMENT USAGE DUTY
	EQPMFR	EQUIPMENT MANUFACTURER
	EQPPOWER	EQUIPMENT NAMPLATE POWER
	EQPSIZE	SIZE OF PROCESS EQUIPMENT
	EXPECT	NUMBER EXPECTED
	INST_DT	MEASURE INSTALL DATE (PER CUSTOMER)
	MODELNUM	EQUIPMENT MODEL NUMBER
	OBSERV	NUMBER OBSERVED
	OPERABLE	NUMBER OPERABLE
	PRJNOTES	PROJECT NOTES
	REM_DT	MEASURE REMOVE DATE
	REMOVE	REMOVAL CODE
	SURVDATE	SURVEY DATE
	SURVEYOR	SURVEYOR
ANALYSIS	CNTGR	CUSTOM NET-TO-GROSS RATIO
	NPSTKW	NET KW SAVINGS - EX POST
	NPSTKWH	NET KWH SAVINGS - EX POST
	NPSTTHM	NET THM SAVINGS - EX POST
	NTGR	COMBINED NET-TO-GROSS RATIO+C39
	PSTKWH	GROSS ANNUAL KWH SAVINGS - EX POST
	PSTTHM	GROSS ANNUAL THM SAVINGS - EX POST

Table E-3
Final Evaluation Data Set Variables

DATA TYPE	VARIABLE NAME	DESCRIPTION
ANALYSIS (cont.)	CONLDKW	CHANGE IN CONNECTED LOAD PER UNIT
	PSTKW	GROSS PEAK KW SAVINGS - EX POST
	RRGKW	GROSS REALIZ RATE KWH
	RRGKWH	GROSS REALIZ RATE KWH
	RRGTHM	GROSS REALIZ RATE KWH
	RRNKW	NET REALIZ RATE KWH
	RRNKWH	NET REALIZ RATE KWH
	RRNTHM	NET REALIZ RATE KWH
	SNTGR	STANDARD NET-TO-GROSS RATIO
	SOFFPKW	SUMMER OFF-PEAK PEAK KW SAVINGS
	SOFFKWH	SUMMER OFF-PEAK KWH SAVINGS
	SOPPKW	SUMMER ON-PEAK PEAK KW SAVINGS
	SOPKWH	SUMMER ON-PEAK KWH SAVINGS
	SPPPKW	SUMMER PARTIAL-PEAK PEAK KW SAVINGS
	SPPKWH	SUMMER PARTIAL-PEAK KWH SAVINGS
	WOFFPKW	WINTER OFF-PEAK PEAK KW SAVINGS
	WOFFKWH	WINTER OFF-PEAK KWH SAVINGS
	WPPPKW	WINTER PARTIAL-PEAK PEAK KW SAVINGS
	WPPKWH	WINTER PARTIAL-PEAK KWH SAVINGS