IMPACT EVALUATION OF INDUSTRIAL SECTOR MISCELLANEOUS MEASURES IN PG&E'S 1994 RETROFIT ENERGY EFFICIENCY PROGRAMS

Final Report

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LIST OF FIGURES

LIST OF TABLES

E

EXECUTIVE SUMMARY

This report presents the 1994 impact evaluation results for the industrial sector miscellaneous measures in Pacific Gas and Electric's (PG&E) retrofit energy efficiency programs. This is one of four separate reports documenting the methodology, results, and recommendations of an evaluation of selected projects that received incentives in 1994 through PG&E's Commercial, Industrial, and Agricultural Programs (the CIA Programs). Other reports address the following end uses: Industrial Process, Industrial Miscellaneous, and Commercial Miscellaneous.

E.1 BACKGROUND

In 1994, PG&E provided retrofit incentives to commercial, industrial, and agricultural customers through two incentive programs:

- The CIA Retrofit Customized Program (the Customized Program); and
- The CIA Retrofit Express Program (the Express Program).

In 1994, a total of 183 sites installed miscellaneous measures through these programs. Measures installed affected two primary end uses: motors and refrigeration. PG&E estimated total ex ante impacts at these sites to be 1,740 kW, 11,987,050 kWh, and zero therms.

Each of the programs is described briefly below.

E.1.1 The Customized Program

The Customized Program provides incentives to commercial, industrial, and agricultural customers to install custom-designed energy-efficiency measures. The program covers both new construction and retrofit projects. Both electric and gas projects are covered by the Customized Program, although the majority of projects are electric. Any measures covered under the Express Program cannot be included in the Customized Program.

E.1.2 The Express Program

The Express Program provides incentives for commercial, industrial, and agricultural customers to retrofit their facilities with energy-efficient equipment from a pre-specified list of measures. Incentives

are provided for equipment in the areas of air conditioning, agricultural, food service, refrigeration, lighting, and motors.

E.2 PROJECT OVERVIEW

E.2.1 Evaluation Objectives

The primary objectives of the evaluation were to:

- Determine defensible estimates of the gross and net impacts (kW, kWh, and therm) resulting from industrial miscellaneous measures installed through PG&E's incentive programs;
- Identify any discrepancies between estimated and measured impacts; and
- Determine 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.

E.2.2 Gross Savings Analysis

The evaluation employed an enhanced engineering approach to quantify gross measure impacts for each study site. The principal source of data for the study came from on-site surveys. This data was supplemented with strategic monitoring data as well as data from existing data sources, including PG&E project files, customer's facility management systems, manufacturer's equipment performance data, and billing data.

For the miscellaneous measures (primarily refrigeration and motors) both site-specific analyses and engineering models were used. Refrigeration sites generally received a customized analysis due to the large variation in measures and facilities included in the study. Efficient motors were evaluated using a time-of-use engineering analysis model that relied on measured motor performance and customer-supplied operating schedules.

E.2.3 Net-to-Gross Analysis

No net-to-gross analysis was performed for miscellaneous measures. Rather, a net-to-gross ratio of 0.75 was used. This net-to-gross ratio is prescribed in the Protocols for miscellaneous measures.

E.3 KEY FINDINGS

Based on the results of the impact evaluation, the 1994 industrial miscellaneous measures are achieving net electric energy savings of 9.1 GWh per year, net summer peak demand savings of 2.182 MW, and net natural gas savings of 16,286 therms per year. Table E-1 presents key gross and net evaluation impacts.

Table E-1
1994 Industrial Miscellaneous Measures
Gross and Net Savings Estimates

	Annual kWh	Summer Peak kW	Annual Therms
1. PG&E Gross Savings	11,987,051	1,740	0
2. PG&E Net-to-Gross Ratio**	0.67	0.67	0.67
3. PG&E Net Savings (1×2)	8,031,324	1,166	0
4. Evaluation Gross Realization Rate	1.02	1.67	-
5. Evaluation Gross Savings (1×4)	12,192,259	2,909	21,715
6. Evaluation Net-to-Gross Ratio	0.75	0.75	0.75
7. Evaluation Net Savings (5×6)	9,144,194	2,182	16,286
8. Net Savings Realization Rate (7÷3)	1.14	1.87	-

Based on a weighted average of motors @ 0.78 and refrigeration @ 0.65

The table reveals the following key findings:

- One hundred two percent of gross kWh savings and 167 percent of gross summer peak kW savings are being realized;
- A small amount of gross natural gas savings, 21,715 therms, not initially expected also is attributable to the programs; and
- Net savings significantly exceed PG&E's ex ante estimates.

Evaluation results are displayed graphically in Figures E-1 and E-2. Key factors causing evaluation results to differ from PG&E estimates include:

- Operating hours for motors measures were generally higher that those assumed for the Express Program calculations;
- Motor load factors and on-peak usage also were higher than originally estimated;

- Higher than expected peak kW savings were achieved for several large refrigeration projects, based on a more detailed evaluation savings analysis methodology; and
- Unpredicted changes in operating characteristics at three of the largest refrigeration sites lowered kWh savings estimates and offset higher kWh realization rates determined at a majority of the other sites.

Figure E-1
PG&E 1994 Industrial Miscellaneous Measures
Comparison of Annual Energy Impacts

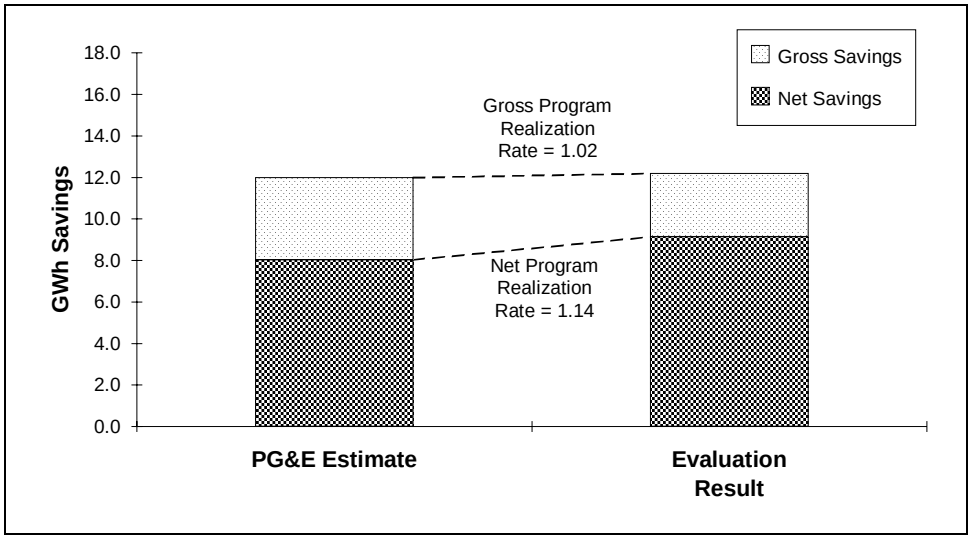
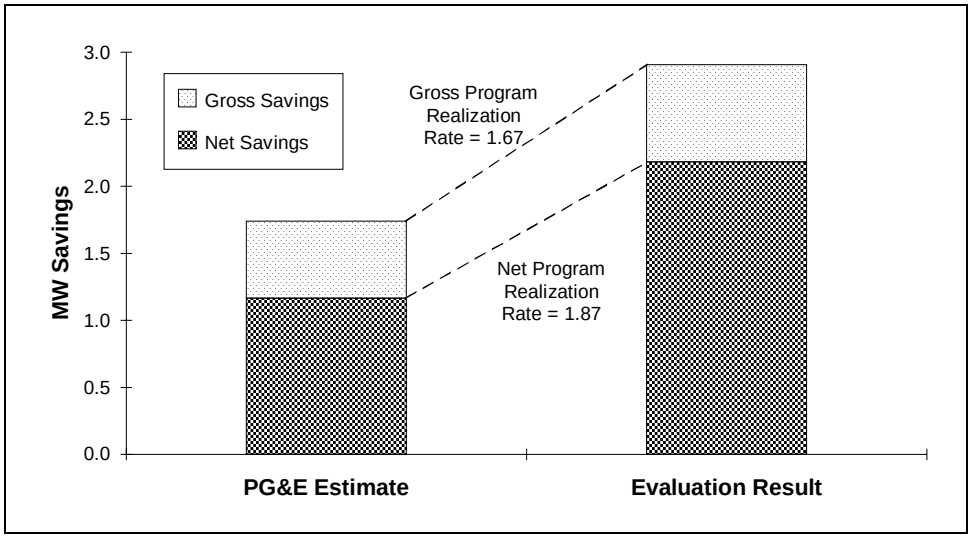


Figure E-2
PG&E 1994 Industrial Miscellaneous Measures
Comparison of Summer Peak Demand Impacts



E.4 RECOMMENDATIONS

During the course of the evaluation, the project team was able to identify several factors that could lead to improvements in the PG&E programs and aid in future evaluations of this type. Key evaluation results indicate that program savings were overestimated, especially for kW impacts. In addition, about half of the program participants appear to be free riders. Recommendations for improving the program follow.

Applicability of Express Measures to Large Sites

For large savings sites, use of the Express Program with its standardized savings estimates and standardized operating estimates can lead to large errors in initial impact estimates. For several large sites, the Express Program estimates were very low, due to higher load factor and increased operating hours at these sites.

Recommendation: Set a savings size limit for the Express Program to ensure that large sites receive Custom applications that are site specific.

Use of Equipment Performance Data

Collection of equipment performance data for some types of equipment, such as chillers, is very difficult during the evaluation, although this information can greatly improve impact estimates. Manufacturers are not inclined to release this information unless one is in the process of purchasing equipment. For larger savings sites, acquisition and use of equipment-specific performance data during the program application process could greatly improve the savings estimates associated with the customized rebate applications.

Recommendation: Require that equipment performance data be obtained and used in rebate application savings calculations for large impact sites.

Monitoring Activities

For sites where pre- and post-retrofit monitoring/metering data exist, evaluation analysis activities often can be greatly simplified. In some cases, the evaluation becomes a verification that the monitoring/metering results are still valid after the equipment has been in the field for some time. Use of monitoring/metering data in the

rebate application also can greatly improve the accuracy of the impact estimates.

Recommendation: For larger sites, PG&E should consider guidelines for when monitoring/metering activities for both pre- and post-retrofit periods might be considered or required as part of the application.

1 INTRODUCTION

1.1 INTRODUCTION

This report presents the 1994 impact evaluation results for the industrial sector miscellaneous measures in Pacific Gas and Electric's (PG&E) retrofit energy-efficiency programs. This is one of four separate reports documenting the methodology, results, and recommendations of an evaluation of selected projects that received incentives in 1994 through PG&E's Commercial, Industrial, and Agricultural Programs (the CIA Programs). The evaluation reports are segmented into the following four categories:

- Industrial Process measures;
- Industrial HVAC measures;
- Industrial Miscellaneous measures; and
- Commercial Miscellaneous measures.

1.2 PROJECT OVERVIEW

1.2.1 Evaluation Objectives

The primary objectives of the overall evaluation were to:

- Determine defensible estimates of the gross and net impacts (kW, kWh, and therm) resulting from industrial process, boiler, refrigeration, and commercial/industrial miscellaneous measures installed through PG&E's incentive programs;
- Identify any discrepancies between the evaluation results and PG&E's ex ante impact estimates; and
- Determine the 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.

1.2.2 Description

The evaluation employed an enhanced engineering approach to quantify gross measure impacts for each study site. The principal source of data for the study came from on-site surveys. This data was

supplemented with strategic monitoring data as well as data from existing data sources, including PG&E project files, customer's facility management systems, manufacturer's equipment performance data, and billing data.

For process measure sites and other "customized" applications, a site-specific engineering approach was used to the analysis. For HVAC sites, an hourly building model (DOE-2) or simpler "bin analysis" models were used, depending on the complexity of the site. For other measures such as efficient motors and refrigerator door closers/gaskets, spreadsheet-based engineering models were developed to calculate savings based on equipment performance and customer-supplied operating schedules.

To determine net program savings for the industrial process and industrial HVAC measures, a site-specific net-to-gross analysis was conducted. This analysis primarily focused on free-ridership and was based on on-site findings and structured follow-up telephone surveys of key participant decision makers.

1.3 PROGRAM DESCRIPTION

The industrial and commercial measures addressed in the overall evaluation were covered by separate PG&E incentive programs:

- The CIA Retrofit Customized Program (the Customized Program); and
- The CIA Retrofit Express Program (the Express Program).

Each of the programs is described briefly below.

1.3.1 The Customized Program

The Customized Program provides incentives to commercial, industrial, and agricultural customers to install custom-designed energy-efficiency measures. The program covers both new construction and retrofit projects. Both electric and gas projects are covered by the Customized Program, although the majority of projects are electric. Any measures covered under the Express Program cannot be included in the Customized Program.

1.3.2 The Express Program

The Express Program provides incentives for commercial, industrial, and agricultural customers to retrofit their facilities with energy-

efficient equipment from a pre-specified list of measures. Incentives are provided for equipment in the areas of air conditioning, agricultural, food service, refrigeration, lighting, and motors.

1.3.3 PG&E Savings Estimates

The number of sites and the initial PG&E savings estimates for the measure segments analyzed in this evaluation are presented in Table 1-1.

Table 1-1
Sites and Savings Estimates by Category
1994 CIA Programs

Category	# Sites	kWh	kW	Therms
Industrial Process	85	42,664,463	6,286	8,565,548
Industrial HVAC	170	12,751,077	3,889	118,026
Industrial Misc.	183	11,987,050	1,740	0
Commercial Misc.	1288	35,065,085	5,772	431,615
Total	1726	102,467,675	17,687	9,115,189

The methodology and results for industrial sector miscellaneous measures are discussed in this report.

1.4 REPORT ORGANIZATION

The remainder of the report focuses on the evaluation of the industrial sector miscellaneous measures and is organized as follows:

- Section 2 discussed the evaluation methodology;
- Section 3 presents the evaluation results;
- Appendix A includes detailed site data;
- Appendix B presents savings by PG&E costing period; and
- Appendix C presents results consistent with Tables 6 and 7 of the Protocols.

2 EVALUATION METHODOLOGY

2.1 OVERVIEW

This section presents the evaluation approach used for this study. Key topics covered are:

- Research design
- Estimating gross savings

2.2 RESEARCH DESIGN

The research design is based on the principle that evaluation, field, and analytical resources would be allocated to measure type segments and sites with those segments based on their expected resource value. The design reflects the fact that most of the expected savings come from a minority of the sites.

In the evaluation, "sites" refer to one or more process measures assigned to a PG&E control number. The control number is a unique identifier in the PG&E billing system that represents an account. It is possible to have multiple control number for a given physical site and to have multiple rebate applications per control number. For industrial sites, it often difficult to link multiple control numbers at a given physical site (because the site often can cover multiple streets); therefore to simplify the research design, each control number was designated as a "site."

As table 2-1 indicates, 6 large Refrigeration sites provide 58% of the expected avoided cost savings. The next smaller 135 sites contribute 41% to savings, and the remaining small sites contribute only 1% to savings. (The "Small-2" category in Table 2-1 consists of sites in the smaller end-use categories -- food service -- and the smallest sites in the larger end use categories.) Detailed site-specific evaluations were conducted for the 6 largest sites. A combination of site-specific analyses and model-based analyses were utilized to analyze a sample of 135 "Small-1" sites. The remaining "Small-2" sites were not included in the analysis sample.

Table 2-1
Size Distribution of Industrial Miscellaneous Savings

Size	# Sites	Avoided Cost	Percent of Total
Large	6	$3,757,213	58%
Small - 1	135	$2,616,659	41%
Small - 2	42	$70,985	1%
Total	183	$6,444,857	100%

2.2.1 Program Statistics

This section summarizes 1994 PG&E Industrial Miscellaneous project tracking data as extracted from the PG&E MDSS system. The program savings totaled 11,987 annual MWh, 1,740 peak kW, and 0.0 annual Therms. Overall, there were 519 program measure line items installed at 183 sites. Ten Customized measures were installed. The remainder of the measures were installed under the Express Program.

Table 2-2 presents expected energy and demand savings totals for both the Customized and Express Programs. At the table indicates, the Customized Program accounted for 51% of the kWh savings, but only 38% of the kW savings.

Table 2-2
Industrial Miscellaneous Energy Savings by Program

Program	# of Measures	Annual kWh		Summer Peak kW		Annual Therms	
		Amount	% of Total	Amount	% of Total	Amount	% of Total
Customized	10	6,101,028	51%	655	38%	0	0%
Express	509	5,886,022	49%	1,085	62%	0	0%
TOTAL	519	11,987,051	100%	1,740	100%	0	100%

Table 2-3 presents expected energy savings by program end use category. The refrigeration accounts for most of the kWh and kW savings with over 80% in each category.

Table 2-3
Industrial Miscellaneous Energy Savings by Measure Category

Measure Category	# of Measures	Annual kWh		Summer Peak kW		Annual Therms	
		Amount	% of Total	Amount	% of Total	Amount	% of Total
Refrigeration	31	9,964,271	83%	1,425	82%	0	0%
Motors	486	2,019,675	17%	315	18%	0	0%
Food Service	2	3,105	0%	0.3	0%	0	0%

Total	519	11,987,051	100%	1,740	100%	0	0%

2.2.2 Sample Design

The sample design utilized information on the distribution of savings across sites and across end uses. Sites were categorized by size of savings and by end use. Avoided costs were used to determine the level of detail planned for the data collection and the depth of analysis required to define energy and demand impacts to a reasonable degree of precision, and hence the amount of project budget allocated to each site. The technology (measure) guides the technical approach to the site review and the method of analysis.

The first step in the sample design was to develop the "Group A" large sites. These are the largest sites for the Refrigeration end use. The six Group A sites account for 58% of the total avoided costs for the industrial study.

The next step of the design was to develop sampling segments for the remaining sites. These sites were divided into end use and key measure-type categories. A sample was then drawn for the important program segments.

Table 2-4 summarizes the research design and sample plan for the Industrial Miscellaneous evaluation project. A discussion of each end use and measure group follows.

Table 2-4
Industrial Miscellaneous Research Design Summary

		Population				Sample		
End Use	Sub-Segment	# of Sites	Avoided Cost	% of End Use Av. Cost	% of Total Av. Cost	# of Sites	Avoided Cost	% of End Use Av. Cost
Refrigeration	R-A	6	$3,757,213	94.1%	58.3%	6	$3,757,213	58.3%
	R-1	20	$1,512,265	28.7%	23.5%	8	$564,743	8.8%
	Total	26	$5,269,478		81.8%	14	$4,321,956	67.1%
Food Service	F-2	1	$447		0.0%	0	$0	0.0%
Motors	M-1	114	$1,104,394	94.0%	17.1%	20	$313,836	4.9%
	M-X	42	$70,538	6.0%	1.1%	0	$0	0.0%
	Total	156	$1,174,932		18.2%	20	$313,836	4.9%
Total Industrial		183	$6,444,857		100%	34	$4,635,792	71.9%

Group A - Large Sites

Generally, each site included in the "Large" category contributes significantly to total program savings. These sites each have total avoided costs greater than $350,000. The measures at the large sites tend to be "Customized" and are not easily placed into sampling groups. All six of the large sites are Refrigeration sites.

A census of the Group A sites received a detailed site-specific analysis of savings, including detailed on-site surveys, engineering analysis and/or modeling, on-site monitoring where appropriate, and a detailed site report.

Refrigeration

The largest refrigeration sites are included in the Group A detailed site-specific analysis group. A sample of the 20 remaining refrigeration project sites was selected for analysis. The results from the sample group were applied to the entire population of the segment in a single ratio methodology.

Food Service

Only one site with very small savings was included in this end use. This sites was addressed in the evaluation.

Motors

The Motors measures consist of replacing existing Process and/or HVAC motors with high-efficiency equivalents. These are Express Program measures. Program data list the number of motors of each size replaced under the program. PG&E savings estimates generally are based on the difference in power required for a given motor size for an efficient motor vs. a standard motor.

A sample of 20 sites was selected for analysis from sites with motors of 15 horsepower or greater were installed (sample M-1). Site-surveys were carried out at the sampled sites to verify installation and to identify schedule and load profiles for the sample group. Spot amperage measurements also were taken. Savings results for the sample then were applied to the entire motor population to determine program savings.

Final Sample

Overall, the final sites included in the analysis account for 65% of total kWh savings and 69% of total kW savings; see Table 2-5.

Table 2-5
Expected Savings: Analysis Sites vs. Program Population

	# Sites	kWh	kW	Therms
Program Total	183	11,987,050	1,740	0
Analysis Sites	34	7,800,458	1,205	0
% of Total	19%	65%	69%	0%

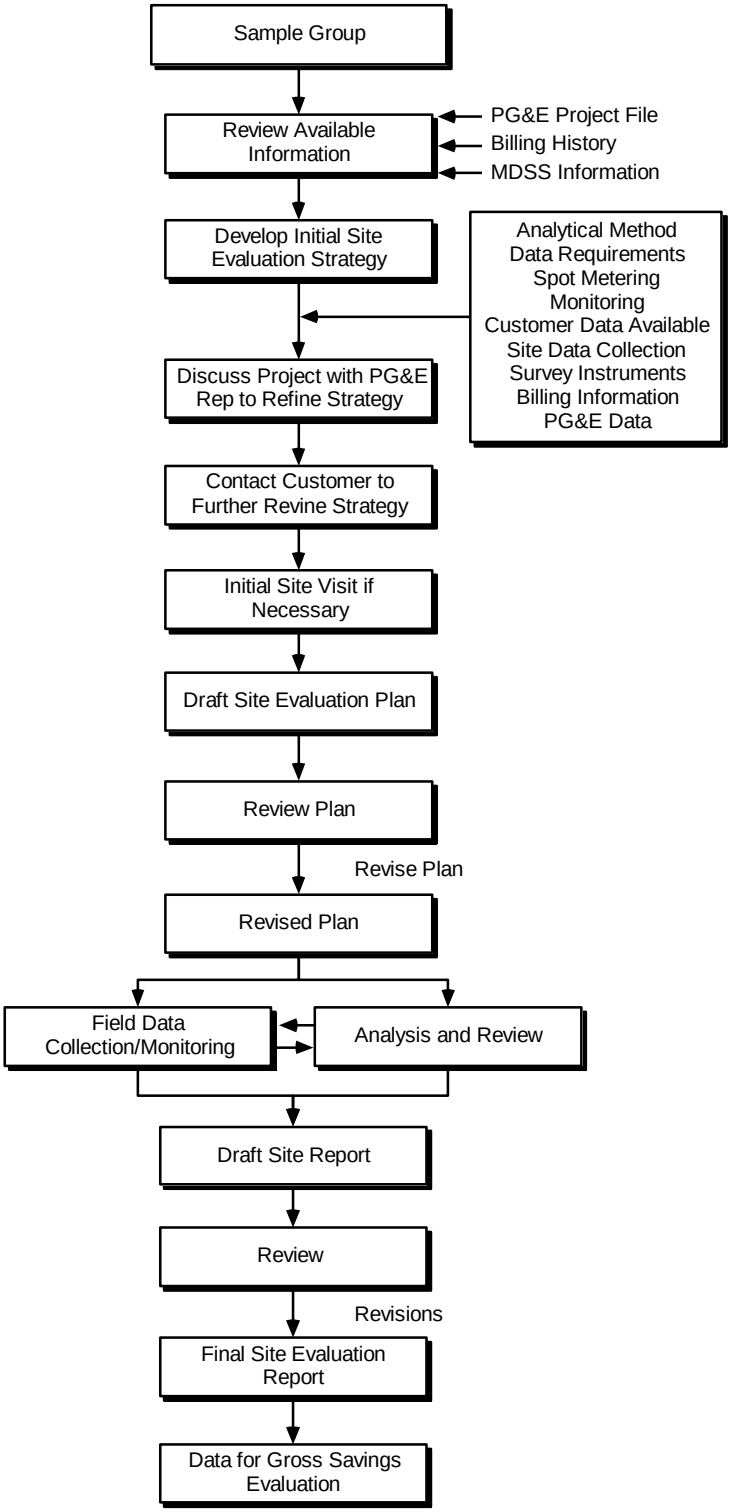
2.3 ESTIMATING GROSS SAVINGS

2.3.1 Site Analysis Procedures

As noted above, the evaluation followed a site-specific approach. Each site was evaluated somewhat differently, based on the information available, the measures installed, the size of the savings, and other pertinent factors.

All sites, however, followed two primary stages: a planning stage and an implementation stage. Figure 2-1 summarizes the site procedures. A discussion of the site analysis procedures follows.

Figure 2-1
Site Procedures



Review of Available Site Information

The first step in the site evaluation process was to review all existing data. Existing data sources include information from MDSS, hard copy of applications, and billing histories. XENERGY then assessed the type of site evaluation required for each site. The primary focus of the initial review was to obtain an understanding of the measures installed and the key assumptions made in the initial impact estimates.

Draft and Review of Site Evaluation Plan

For larger sites included in the evaluation, XENERGY developed a preliminary evaluation plan specific to the site. The strategy took into consideration any previous analyses and engineering performed, possible metering and/or monitoring strategies, data requirements, data collection approaches, billing history, amount of rebate, total energy savings, and the cost of the proposed evaluation. It then was determined what type of analysis would probably be required and what types of data collection activities would considered.

The strategy was refined after discussions with the appropriate PG&E representative. The customer then was contacted to further refine the evaluation strategy. Site logistics and customer convenience issues were factored into the evaluation plans. An initial site visit was performed at this time if it was required for development of the plans. After contact with the customer, XENERGY submitted a draft evaluation plan that was reviewed and finalized.

For the smaller sites, the smaller refrigeration sites and all the motors sites, a general analysis plan was developed by key sample segment. These plans included general data acquisition strategies and outlined the analysis methodology. The plans were not subject to as detailed a review as were the large site plans.

Implementation Stage

In coordination with the customer, all data collection and monitoring activities were scheduled and performed. The data were analyzed and evaluated and a draft site report was produced (for larger sites only). The draft site report then was reviewed for completeness, correctness, and clarity by the lead engineer and project managers. Revisions, if needed, were made, and a final site report then was developed. The results from the individual site evaluations were used in the Gross Savings Evaluation.

For the motors analysis, site specific reports were developed based on an approved template. Because the site analyses were similar, these reports mainly focused on identifying reasons for differences between the evaluation results and PG&E's ex ante savings estimates.

2.3.2 Analysis Approach

From an analytical point of view, two types of evaluations were utilized for the Industrial Miscellaneous study:

1. In-depth site-specific engineering evaluations (large refrigeration sites); and
2. Engineering model-based analyses (smaller refrigeration and motors sites).

Detailed Site-Specific Engineering Evaluations

The detailed studies began with a review of the project files and billing records. A site evaluation strategy then was developed and implemented. The final result of this process was a detailed evaluation report.

Several characteristics determined the specific analytical approach for the large and very large sites. Key factors included:

- End use
- Savings Units: kW, kWh, and Therm (kW and kWh savings were more readily monitored);
- Absolute level of savings and level of savings relative to the total metered consumption;
- Pre- and post-project documentation available;
- Site data and information available and customer cooperation;
- Verifiability of pre-and post-project equipment performance and operating assumptions. This relates to the need for spot or short term measurements to verify pre-and post-project analytical assumptions, and the resources available to take these measurements; and
- Timing/seasonality issues related to production and operating load profiles of the facility or the modified systems;

The site-specific evaluation methodology took all these factors into account. In general, the approach was to review the application documents to identify the technological mechanism through which the

savings are achieved, identify an analytical methodology based on accepted engineering principles which would document the savings, identify the key operating assumptions or measurements required to utilize the methodology with confidence, determine the best way to confirm the measurements or assumptions, conduct the site work to gather the required information, and finally to analyze the results and present the results.

A detailed site specific summary report for each site was produced. The report included a summary of the measure, a breakout of the savings by PG&E time periods, a description of the PG&E methodology and the evaluation methodology, a description of the results from the two analyses, and an explanation for any discrepancies.

Engineering Model Analysis

Engineering models were utilized to analyze measure savings in the Motors end use. The engineering model analysis entailed the development of models that use readily observable/verifiable performance and operating parameters. Site surveys at sampled sites were used to collect information on site-specific equipment inventories. Actual equipment performance characteristics from manufacturers will be used whenever available. Spot measurement of performance and operating parameters also was performed. Additionally, operating profiles were developed from interviews and customer-supplied data.

Site data were collected for each motor measure at the sampled sites. Data included:

- Manufacturers' ratings and performance curves where available for both new and existing equipment;
- Observed nameplate data for new motors including, where possible, serial numbers for future retention surveys;
- Seasonal and daily operating schedules and operator's estimate of motor loading profile during the operating period (gathered via interview); and
- Spot confirmation of actual operating volts and amps at the time of visit-at several points within the load profile-for one motor of each size at each site (where possible and where customer agrees).

A spreadsheet engineering model was developed in which the part load performance data for the post-retrofit motor was taken from the field data. The performance data for a standard motor of the same type was taken from manufacturers' literature. Both motors' performances were run against the observed load profile to define peak kW and time-of-use period kWh for the post-retrofit high efficiency motor and the standard motor under the same load profile. The savings for each period was calculated as the difference between the standard and the new high-efficiency equipment.

Study Emphasis

The primary emphasis on the analysis was to improve upon PG&E's initial impact estimates by focusing project resources on four key areas:

1. Verification of measure installations;
2. Determination of actual post-installation operating conditions versus predicted operation conditions;
3. Measurement of important operation parameters versus use of assumed values; and
4. Improvement in the analysis methodology.

Verification

As part of the on site process, measures were confirmed to be installed in a manner consistent with the Program application. For one motors site, the measure had been removed, and savings were therefore set to zero.

Post-installation Operations

Because the evaluation was conducted during the post-retrofit period, actual operating conditions and equipment usage patterns could be ascertained via monitoring, observation of equipment logs, and interviews with customers. PG&E's estimated impacts were based on forecast or assumed operations which could differ significantly from actual conditions due to changes at the site involving factors such as occupancy patterns and internal loads. Additionally, Express Program savings calculations utilized standardized operating assumptions while the evaluation used site-specific data.

Measurement of Key Parameters

In many cases, PG&E savings estimates were based on assumptions about key operating parameters. During the evaluation, measurements

of these parameters were made on a site-specific basis utilizing equipment logs, metering, and monitoring. Key measurements included motor loadings, chiller and condenser supply and return water temperatures, and building control temperature set points. In some cases, manufacturer's performance specifications, particular to the given equipment application, were collected and used to support calculations for the post-retrofit and base case technologies.

Methodology

For the evaluation, PG&E's impact methodologies were reviewed for adequacy on a site-by-site basis. Where possible, the evaluation improved upon this methodology. Often the evaluation methodology was adjusted to make the best use of available data. For example, if both pre-retrofit and post-retrofit submetered data was available, the analysis methodology could be simplified into a comparison of the metered data (with adjustments for any changes in operations).

In many cases, and especially for Express Program measures, PG&E savings were based on simplified calculations that utilized standardized efficiency changes per equipment unit (such as motor horsepower or chiller tons) times the number of units times full load hours. In these cases, evaluation methods were better able to address actual efficiency gains over a range of part load conditions and for the particular size of equipment being analyzed.

For some of the Customized Program projects, a very thorough, detailed methodology was employed to develop initial savings estimates for the Program application. In these cases, this same methodology was used for the evaluation but was updated to reflect actual post-retrofit conditions.

Key Analysis Issues

A number of important evaluation issues had to be addressed in this study, including: 1) defining baseline energy use; 2) normalizing results to the post-retrofit level of service; 3) annualization of results; 4) model calibration; and 5) locating and verifying equipment. These issues are discussed in this subsection.

Defining the Baseline Technology

Because energy savings are defined as the difference between post-retrofit energy use and baseline energy use, identifying the appropriate baseline technology/process is an important component of the analysis. For the most part, the baseline equipment used to calculate gross

savings was set to be consistent with the assumptions used in the original rebate calculation. PG&E chose this approach to provide important feedback to their engineers and program staff about the accuracy of their gross savings calculations for the given baseline equipment.

For some Express Program measures, where little to no site specific information was available from the project files, the baseline determination involved setting the baseline technology *and* the baseline operating characteristics of the affected equipment. In these cases, the site evaluator utilized information from customer and/or installation contractor interviews to gain an understanding of how the pre-retrofit equipment or standard equipment was or would be operated. This data then was used to characterize the baseline technology and its application. For example with cooling towers, PG&E Express calculations assume standard approach temperature set points that may not be applicable to a given site. For the evaluation, site-specific baseline set points were determined and used in energy impact calculations.

Normalizing Results to Post-Retrofit Service Levels

Consistent with the Protocols, energy impacts for this study were normalized to reflect post-retrofit levels of service. For the normalization process, energy usage was related to some measure of site activity (such as production levels, operating hours, or air/fluid flow rates). Then, using this relationship, baseline energy consumption was adjusted to the post-retrofit activity level.

In some cases, this approach was relatively straight forward, especially when the project was a straight retrofit with relatively similar equipment capacities and site activity levels. (The availability of pre-retrofit and/or on-site personnel knowledgeable about pre-retrofit conditions greatly facilitated this effort.)

However, many of the rebate projects were associated with significant production/operating changes at the site. In some of these cases, baseline operating levels were extrapolated past the physical limits of the pre-retrofit equipment by associating the pre-retrofit energy intensity with the new production/operating level. The guideline followed during this normalization process was to establish an adjusted baseline that maintained the efficiency of PG&E's initial baseline technology (which was usually developed based on pre-retrofit operating levels) but scaled energy usage to post-retrofit service levels.

Annualization of Results

In many cases, equipment performance and operating conditions were observed/monitored over a relatively short time frame; whereas the savings must be extrapolated to provide annual results. Similar to the normalization process, energy usage (or savings) per unit of output during the observation period is multiplied by annual output to determine annual energy usage (or savings).

At times, operating records were available to assist in the annualization process. For some sites, however, annualization of savings was based on interviews with the customers and judgmental adjustments. Annualization with limited data increased the uncertainty of the evaluation results.

Locating and Verifying Equipment

To analyze or verify measure savings, the retrofitted equipment had to be located by the on-site surveyor. In very limited instances, it was not possible to locate the equipment. When equipment could not be located, the site surveyor made a determination about the likelihood that the measure was installed based on discussions with site personnel, the thoroughness of the search given the customer's time constraints, and his assessment of the size of the measure relative to the size of the site. If it was determined that the measure was probably in place, the site was not included in the analysis, and the program realization rate was applied to the PG&E savings estimates. It was determined that the measure was not in place, site savings were set to zero. An example of a nonverifiable measure installation is a radio transmitter located at the top of a tower.

2.3.3 Aggregation of Site Findings to Program Findings

This section presents the approach for development of gross savings estimates for the overall project. The primary objective was to combine site and sample information and extrapolate to the population. The gross savings analysis was conducted for the total end use and for each measure group. Savings are reported for kWh, kW, and Therms for each group.

Ratio estimation and stratification were used to extrapolate the results from the detailed site analysis and verifications to the overall program. Because analysis was conducted for 100% of Group A sites, estimation is not required for this group. Extrapolation is required for the other groups in which only a sample of sites were evaluated.

The process involves assigning all participants to an analysis strata. The analysis strata could be the same strata used for sampling or could be based on other characteristics that are known for all members of the population. In this case, the sampling strata were used.

Once the stratification is done, a ratio estimator is developed by comparing the initial estimates of savings to the enhanced estimate obtained from site analysis. The total gross impact is derived from the following equation.

$$TOTSAV = \sum_{i} TOTSAV_i$$

$$TOTSAV_i = \sum_{j \in i} T_j * \frac{\sum_{k \in samp(i)} E_k}{\sum_{k \in samp(i)} T_k}$$

where:

$TOTSAV$ = the total gross energy or demand impact;

$TOTSAV_i$ = the total gross impact for strata i;

T_k = the tracking system impact estimate for site k; and

E_k = the evaluation results for site k.

The sampling precision level is calculated using the standard formula for a ratio estimator. The standard error of sampling is primarily a function of the correlation between T and E, the sample size, and the portion of expected savings in the sample. This standard error will under-estimate the overall uncertainty of the total gross impact, however. This under-estimation occurs because the standard error only considers the error from sampling and does not consider any inaccuracy in the enhanced engineering estimate.

3 EVALUATION RESULTS

3.1 OVERVIEW

This section presents 1994 impact results for the industrial sector miscellaneous measures in PG&E's energy-efficiency programs. The primary end uses addressed in the study were refrigeration and motors. Overall net electric energy savings are estimated to be 9.1 GWh per year, net summer on-peak demand savings are estimated to be 2.2 MW, and net natural gas savings are estimated to be 16,286 therms per year.

The following impact results are presented below:

- Gross Program savings;
- Net Program savings; and
- Other findings and recommendations.

3.2 GROSS PROGRAM SAVINGS

Gross savings estimates were based on detailed, site-specific engineering analyses (refrigeration) and site-specific model-based analyses (motors) for a sample of Program sites. Results from these studies were generalized to the population using a ratio approach. This section first presents overall results, followed by a more detailed discussion of results for sites analyzed in the study.

3.2.1 Program Results

Table 3-1 presents aggregate energy impacts and realization rates. As these numbers indicate, the kWh realization rate is slightly above 1.0 while the kW realization rate was significantly higher at 1.86. No therm savings were reported by PG&E, but 21,715 therms were estimated during the evaluation.

Table 3-1
Summary of Gross Impact Results

	PG&E Estimates	Gross Realization Rate	90% Conf. Interval	Gross Evaluation Results
Annual kWh	11,987,051	1.02	±0.11	12,192,259
Summer On-Peak kW	1,740	1.67	±0.08	2,909
Annual Therms	0	-	-	21,715

Prior to Program aggregation, realization rates and savings estimates were developed for the key program end uses. (One program site installed food service measures that were not addressed in the study. This site had expected savings of only 3,105 kWh and 0.3 kW.) Results for the end use segments are presented in Table 3-2.

Table 3-2
Realization Rates by End Use

Segment	#Program Sites	Annual kWh		Summer Peak kW		Annual Therms	
		PG&E Estimate	Realiz Rate	PG&E Estimate	Realiz Rate	PG&E Estimate	Realiz Rate
Motors	156	2,019,675	2.33	315	1.91	0	-
Refrigeration	26	9,964,271	0.75	1,424	1.62	0	-
			1.02		1.67		-

The 26 refrigeration sites account for more than 80 percent of the expected kWh and kW savings. The kWh realization rate of 0.75 and the kW realization rate of 1.62 were the major contributors to the overall program realization rates. Realization rates for motors were significantly greater than one for both kWh and kW savings.

3.2.2 Study Sites

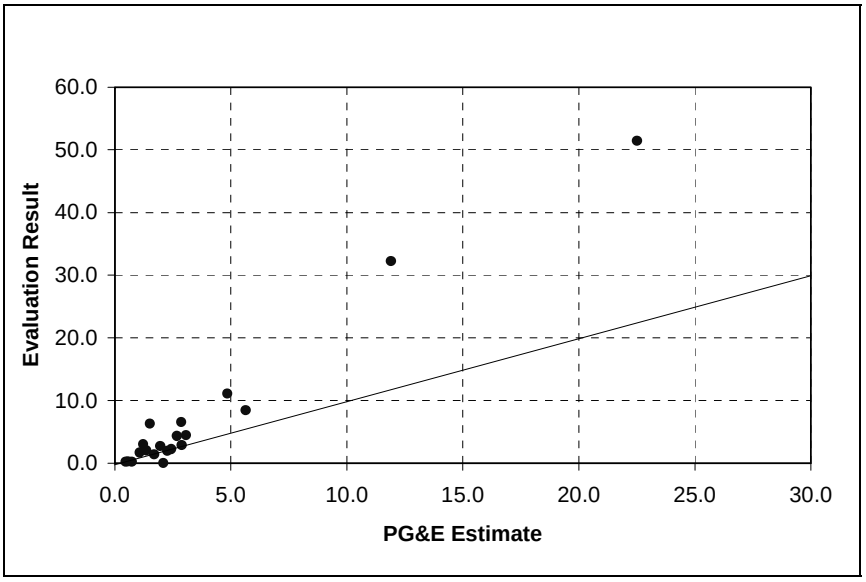
This subsection focuses on study sites that received site-specific analyses. Overall, 20 motor sites and 14 refrigeration sites were included in the study (recall that a site is defined as a PG&E control number).

Figures 3-1 through 3-4 compare evaluation results to PG&E savings estimates for kW and kWh. Results are presented by end use. The diagonal lines represent points where evaluation results and PG&E estimates are equal (realization rates equal to 1.0).

Motors

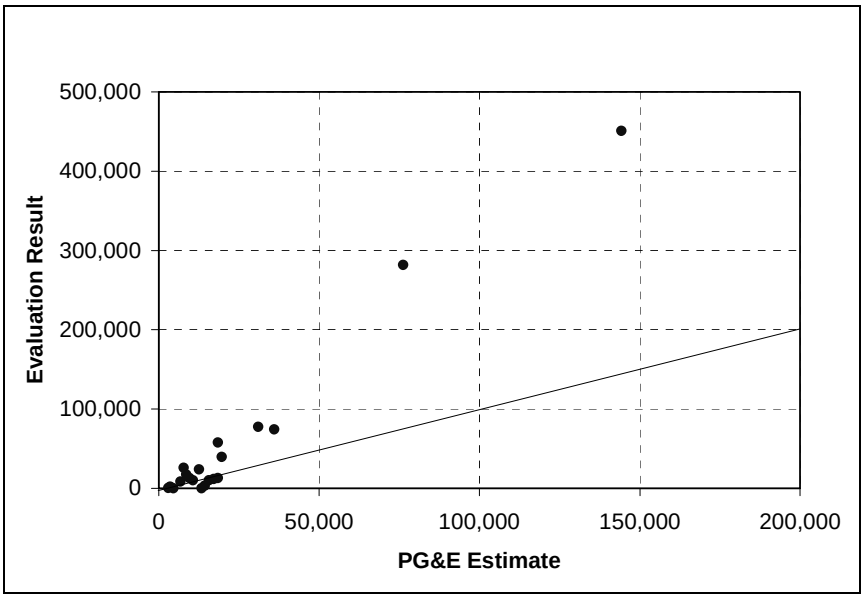
For kW savings (Figure 3-1), all of the points for the larger impact sites fall well above the diagonal line, as do a majority of smaller sites. The PG&E Express savings calculations that apply to these motors assume average load factors of 65 percent and average peak coincidence factors of 64 percent. For the evaluation, a number of motors were measured to have higher load factors and subsequently higher kW savings. More importantly, most of the motors were operating continuously during the summer peak hours, and the estimated coincidence factors were much higher that assumed by PG&E.

Figure 3-1
Summer Peak kW Savings - Motors - PG&E vs. Evaluation



The comparison of annual kWh savings (Figure 3-2) shows results similar to the kW results. Most of the points lie above the diagonal line, indicating higher than expected savings. In addition to higher measured load factors, the evaluation found that the motors tended to operation much more that expected by PG&E. The PG&E Express calculations assume 4,100 operating hours per year, but in many cases the evaluation found that the motors operated continuously or near continuously.

Figure 3-2
Annual kWh Savings - Motors - PG&E vs. Evaluation



Refrigeration

The comparison of summer peak kW savings is presented in Table 3-3. Three key sites cause overall evaluation results to greatly exceed PG&E estimates. For one site the PG&E estimate is zero, but the evaluation result shows savings of 400 kW. At this site, the Custom rebate application shows supporting savings calculations of 190 kW, but this estimate was not used in the approved impact estimates. The two other large sites use savings estimates that were based on broad averages of operating conditions (one site is an Express Program site), whereas the evaluation savings were based on an hourly load model that shows higher savings estimates during the hot summer peak hours.

Figure 3-3
Summer Peak kW Savings - Refrigeration - PG&E vs. Evaluation

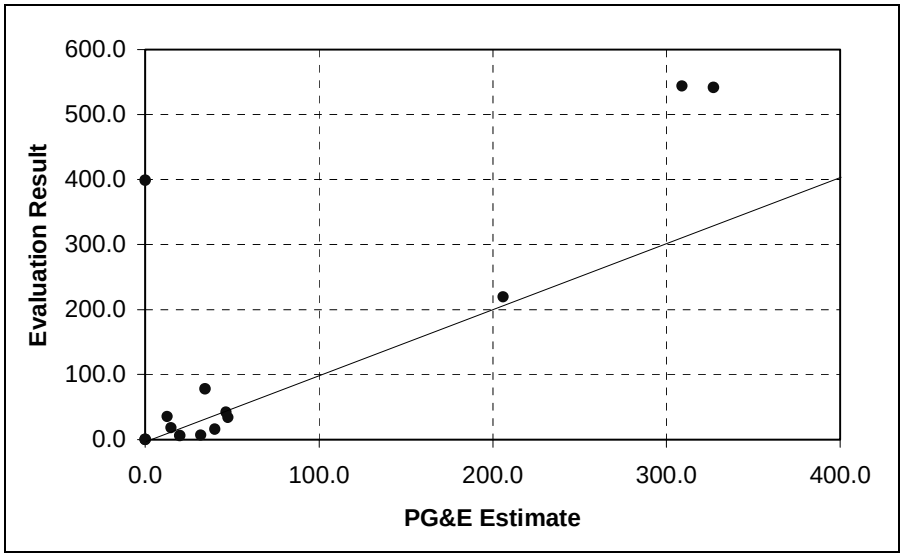


Figure 3-4 compares annual kWh savings. Three large impact projects contribute most to the refrigeration kWh realization rate falling below one (at 0.75). The first project shows zero evaluation savings because, soon after the retrofit projects, the customer converted to a natural gas driven refrigeration system. (The 21,715 in therm savings is the result of this project.) Another large projects shows lower savings because actual production levels were lower than predicted. Finally, for the largest impact site, the PG&E Express savings calculations overestimate load because the equipment only operates several months per year (during the summer).

Figure 3-4
Annual kWh Savings - Refrigeration - PG&E vs. Evaluation

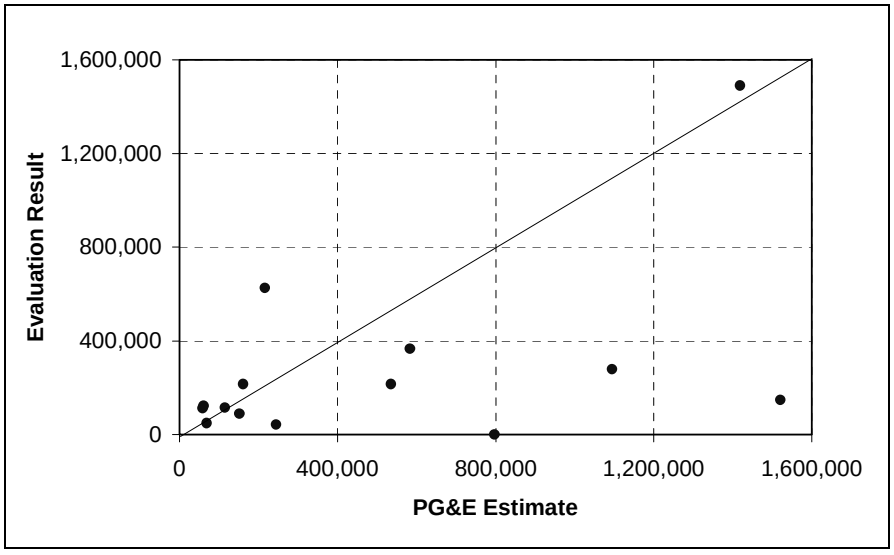


Table 3-3 shows distributions of realization rates for the Process projects. All projects for which PG&E and/or the evaluation calculated impacts are included. This table summarizes some of the relationships displayed graphically above:

- A relatively small number of sites had realization rates in the 0.75-1.25 range, indicating that the PG&E estimates did not do very well at predicting savings; this result reflects that most of the measures were Express Program measures and initial savings estimates did not incorporate site-specific data; and
- About one-third of the projects had realization rates greater than 1.75, reflecting the fairly intensive use of equipment by industry that is not captured in the PG&E estimates.

Table 3-3
Distribution of Realization Rates

Realization Rate	Number of Sites					
	kW	% Sites	kWh	% Sites	Therms	% Sites
> 1.75	9	28%	12	35%		
1.26 - 1.75	7	22%	3	9%		
0.76 - 1.25	7	22%	3	9%		
0.25 - 0.75	5	16%	9	27%		
< 0.25	3	9%	7	21%		
PG&E Impact=0 / Eval Impact>0	1	3%			1	100%
PG&E Impact=0 / Eval Impact<0						
Totals	32	100%	34	100%	1	100%

3.3 NET PROGRAM SAVINGS

This subsection presents net impact results. A net-to-gross analysis was not conducted for the miscellaneous measures. Instead, the net-to-gross ratio of 0.75 prescribed in the Protocols for miscellaneous measures was used.

Evaluation net savings are determined by applying the net-to-gross ratio to evaluation gross savings. Table 3-5 presents the results for annual kWh, summer peak kW, and annual therms.

Table 3-4
1994 Industrial Miscellaneous Programs
Net Savings Estimates

	Annual kWh	Summer Peak kW	Annual Therms
1. PG&E Gross Savings	11,987,051	1,740	0
2. PG&E Net-to-Gross Ratio**	0.67	0.67	0.67
3. PG&E Net Savings (1×2)	8,031,324	1,166	0
4. Evaluation Gross Realization Rate	1.02	1.67	-
5. Evaluation Gross Savings (1×4)	12,192,259	2,909	21,715
6. Evaluation Net-to-Gross Ratio	0.75	0.75	0.75
7. Evaluation Net Savings (5×6)	9,144,194	2,182	16,286
8. Net Savings Realization Rate (7÷3)	1.14	1.87	-

Based on a weighted average of motors @ 0.78 and refrigeration @ 0.65

3.4 OTHER FINDINGS AND RECOMMENDATIONS

During the course of the evaluation, the project team was able to identify several factors that could lead to improvements in the PG&E programs and aid in future evaluations of this type. Key evaluation results indicate that program savings were overestimated, especially for kW impacts. In addition, about half of the program participants appear to be free riders. Recommendations for improving the program follow.

Applicability of Express Measures to Large Sites

For large savings sites, use of the Express Program with its standardized savings estimates and standardized operating estimates can lead to large errors in initial impact estimates. For several large sites, the Express Program estimates were very low, due to higher load factor and increased operating hours at these sites.

Recommendation: Set a savings size limit for the Express Program to ensure that large sites receive Custom applications that are site specific.

Use of Equipment Performance Data

Collection of equipment performance data for some types of equipment, such as chillers, is very difficult during the evaluation,

although this information can greatly improve impact estimates. Manufacturers are not inclined to release this information unless one is in the process of purchasing equipment. For larger savings sites, acquisition and use of equipment-specific performance data during the program application process could greatly improve the savings estimates associated with the customized rebate applications.

Recommendation: Require that equipment performance data be obtained and used in rebate application savings calculations for large impact sites.

Monitoring Activities

For sites where pre- and post-retrofit monitoring/metering data exist, evaluation analysis activities often can be greatly simplified. In some cases, the evaluation becomes a verification that the monitoring/metering results are still valid after the equipment has been in the field for some time. Use of monitoring/metering data in the rebate application also can greatly improve the accuracy of the impact estimates.

Recommendation: For larger sites, PG&E should consider guidelines for when monitoring/metering activities for both pre- and post-retrofit periods might be considered or required as part of the application.

A

SITE SPECIFIC RESULTS

This appendix presents gross savings impact results for the analysis sites included in the study.

Site Specific Data

				kW Savings			kWh Savings			Therm Savings		
Sample Group	Site ID	SIC Code	Measure Types	PG&E	Evaluation	Realization Rate	PG&E	Evaluation	Realization Rate	PG&E	Evaluation	Realization Rate
M-1	369670	32	Motors	1.7	1.4	0.82	10,818	10,210	0.94	0	0	
M-1	371974	28	Motors	1.4	2	1.43	8,647	17,405	2.01	0	0	
M-1	659256	24	Motors	22.5	51.4	2.28	144,276	450,581	3.12	0	0	
M-1	676955	14	Motors	2.3	2	0.87	14,460	3,225	0.22	0	0	
M-1	677229	20	Motors	1.1	1.7	1.55	6,885	8,641	1.26	0	0	
M-1	682326	20	Motors	2.1	0	0.00	13,394	0	0.00	0	0	
M-1	884338	20	Motors	3.1	4.5	1.45	19,709	39,374	2.00	0	0	
M-1	904498	20	Motors	4.9	11.1	2.27	31,092	77,570	2.49	0	0	
M-1	1029317	28	Motors	0.5	0.2	0.40	3,098	633	0.20	0	0	
M-1	1052284	92	Motors	2.9	6.6	2.28	18,398	57,450	3.12	0	0	
M-1	1081514	20	Motors	2.4	2.3	0.96	15,625	9,992	0.64	0	0	
M-1	1081518	20	Motors	1.2	3	2.50	7,866	26,070	3.31	0	0	
M-1	1092411	20	Motors	0.6	0.3	0.50	3,615	2,486	0.69	0	0	
M-1	5019044	29	Motors	2	2.7	1.35	12,593	23,751	1.89	0	0	
M-1	5491138	20	Motors	2.9	2.9	1.00	18,483	12,766	0.69	0	0	
M-1	5780429	26	Motors	2.7	4.3	1.59	17,189	11,860	0.69	0	0	
M-1	5817321	36	Motors	11.9	32.2	2.71	76,177	281,857	3.70	0	0	
M-1	5925666	32	Motors	1.5	6.3	4.20	9,653	12,753	1.32	0	0	
M-1	6088692	20	Motors	5.6	8.4	1.50	36,143	73,947	2.05	0	0	
M-1	6109523	14	Motors	0.7	0.2	0.29	4,654	279	0.06	0	0	
R-1	884338	20	Refrigeration	19.8	6	0.30	151,325	88,854	0.59	0	0	
R-1	904085	20	Refrigeration	14.8	18	1.22	68,604	48,660	0.71	0	0	
R-1	909728	20	Refrigeration	46.5	42	0.90	216,039	625,263	2.89	0	0	
R-1	1081518	20	Refrigeration	31.9	7	0.22	244,214	43,095	0.18	0	0	
R-1	1119635	20	Refrigeration	12.5	35	2.80	58,170	111,915	1.92	0	0	
R-1	3905770	28	Refrigeration	0	0		115,248	114,660	0.99	0	0	
R-1	5189606	20	Refrigeration	40	16	0.40	61,013	122,537	2.01	0	0	
R-1	5768294	20	Refrigeration	34.6	78	2.25	160,935	215,280	1.34	0	0	
R-A	682329	20	Refrigeration	309	544.2	1.76	1,094,446	278,396	0.25	0	0	
R-A	746744	20	Refrigeration	47.6	33.9	0.71	584,000	365,593	0.63	0	0	
R-A	1008376	20	Refrigeration	327.1	541.6	1.66	1,520,291	148,105	0.10	0	0	
R-A	1060484	20	Refrigeration	206	219.5	1.07	534,934	215,381	0.40	0	0	
R-A	1114355	20	Refrigeration	0	398.8		1,418,755	1,489,259	1.05	0	0	
R-A	5353218	20	Refrigeration	0	0		796,885	0	0.00	0	21,715	

B

SAVINGS BY COSTING PERIOD

This appendix presents gross savings by PG&E costing period. Tables are presented in the following order:

- Total industrial miscellaneous measure savings
- Motor Measures
- Refrigeration Measures

Gross Savings by Costing Period
Total Industrial Miscellaneous Savings

Costing Period	Average kW Savings (1)	kW Savings Coincident with System Maximum in Period (2)	kW Adjustment Factor (3)	kWh Savings (4)	kWh Adjustment Factor (5)
Summer On Peak:	2,010	2,909	1.00	1,543,889	0.13
Summer Partial Peak:	1,689	2,050	0.70	1,513,374	0.12
Summer Off Peak:	1,270	2,422	0.83	3,495,628	0.29
Winter Partial Peak:	1,468	1,128	0.39	2,366,916	0.19
Winter Off Peak:	1,198	1,164	0.40	3,272,451	0.27

Annual kWh Savings (6)	12,192,259
Connected load kW Savings (7)	2,164
Summer Therm Savings	0
Winter Therm Savings	0

Costing Period Definitions

· Summer On Peak: May 1 to Oct. 31, Noon-6 p.m. Weekdays
· Summer Partial Peak: May 1 to Oct. 31, 8:30 a.m.-Noon and 6-9:30 p.m. Weekdays
· Summer Off Peak: May 1 to Oct. 31, 9:30 p.m.-8:30 a.m. Weekdays and All Saturdays/Sundays/Holidays
· Winter Partial Peak: Nov. 1 to Apr. 31, 8:30 a.m.-9:30 p.m.
· Winter Off Peak: Nov. 1 to Apr. 30, 9:30 p.m.-8:30 a.m.

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(1) For end-uses limited to either "on" or "off" operation (e.g. lighting):
(Connected load kW savings (7)* number of hours end-use is on in the costing period)/(total number of hours in the costing period)
For end-uses with part-load operating conditions (e.g. HVAC) :
(Summation for all hours in the costing period {full or part load kW savings * number of hours end-use is operating at that full or part load setting}) / (total number of hours in the costing period)
For example, for a chiller for a costing period with 10 hours, if the chiller operates 1 hour with 10 kW savings, 4 hours with 5 kW savings, and 5 hours a 0% load (with no kW savings), the average kW savings would be (1*10+4*5+5*0)/10= 3 kW
(2) The kW savings for the targeted end-use at the time of PG&E's system maximum for the costing period.
(3) (Coincident kW savings for the costing period)/ (coincident kW savings for the summer on-peak costing period)
(4) Average kW savings (1) * number of annual operating hours in period
(5) (Annual kWh savings in costing period (4)) / (total annual kWh savings (6))
(6) Total annual kWh savings
(7) Connected load kW savings

Gross Savings by Costing Period
Industrial Miscellaneous: Motors

Costing Period	Average kW Savings (1)	kW Savings Coincident with System Maximum in Period (2)	kW Adjustment Factor (3)	kWh Savings (4)	kWh Adjustment Factor (5)
Summer On Peak:	595	604	1.00	456,657	0.10
Summer Partial Peak:	581	559	0.93	520,304	0.11
Summer Off Peak:	548	544	0.90	1,507,622	0.32
Winter Partial Peak:	535	505	0.84	861,757	0.18
Winter Off Peak:	496	554	0.92	1,356,239	0.29

Annual kWh Savings (6)	4,702,579
Connected load kW Savings (7)	894
Summer Therm Savings	0
Winter Therm Savings	0

Costing Period Definitions

· Summer On Peak: May 1 to Oct. 31, Noon-6 p.m. Weekdays
· Summer Partial Peak: May 1 to Oct. 31, 8:30 a.m.-Noon and 6-9:30 p.m. Weekdays
· Summer Off Peak: May 1 to Oct. 31, 9:30 p.m.-8:30 a.m. Weekdays and All Saturdays/Sundays/Holidays
· Winter Partial Peak: Nov. 1 to Apr. 31, 8:30 a.m.-9:30 p.m.
· Winter Off Peak: Nov. 1 to Apr. 30, 9:30 p.m.-8:30 a.m.

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(1) For end-uses limited to either "on" or "off" operation (e.g. lighting):
(Connected load kW savings (7)* number of hours end-use is on in the costing period)/(total number of hours in the costing period)
For end-uses with part-load operating conditions (e.g. HVAC) :
(Summation for all hours in the costing period {full or part load kW savings * number of hours end-use is operating at that full or part load setting}) / (total number of hours in the costing period)
For example, for a chiller for a costing period with 10 hours, if the chiller operates 1 hour with 10 kW savings, 4 hours with 5 kW savings, and 5 hours a 0% load (with no kW savings), the average kW savings would be (1*10+4*5+5*0)/10= 3 kW
(2) The kW savings for the targeted end-use at the time of PG&E's system maximum for the costing period.
(3) (Coincident kW savings for the costing period)/ (coincident kW savings for the summer on-peak costing period)
(4) Average kW savings (1) * number of annual operating hours in period
(5) (Annual kWh savings in costing period (4)) / (total annual kWh savings (6))
(6) Total annual kWh savings
(7) Connected load kW savings

Gross Savings by Costing Period
Industrial Miscellaneous: Refrigeration

Costing Period	Average kW Savings (1)	kW Savings Coincident with System Maximum in Period (2)	kW Adjustment Factor (3)	kWh Savings (4)	kWh Adjustment Factor (5)
Summer On Peak:	1,391	2,305	1.00	1,068,446	0.14
Summer Partial Peak:	1,099	1,501	0.65	984,489	0.13
Summer Off Peak:	730	1,881	0.82	2,009,571	0.27
Winter Partial Peak:	929	643	0.28	1,498,235	0.20
Winter Off Peak:	706	633	0.27	1,928,940	0.26

Annual kWh Savings (6)	7,489,681
Connected load kW Savings (7)	1302.61
Summer Therm Savings	0
Winter Therm Savings	0

Costing Period Definitions

· Summer On Peak: May 1 to Oct. 31, Noon-6 p.m. Weekdays
· Summer Partial Peak: May 1 to Oct. 31, 8:30 a.m.-Noon and 6-9:30 p.m. Weekdays
· Summer Off Peak: May 1 to Oct. 31, 9:30 p.m.-8:30 a.m. Weekdays and All Saturdays/Sundays/Holidays
· Winter Partial Peak: Nov. 1 to Apr. 31, 8:30 a.m.-9:30 p.m.
· Winter Off Peak: Nov. 1 to Apr. 30, 9:30 p.m.-8:30 a.m.

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(1) For end-uses limited to either "on" or "off" operation (e.g. lighting):
(Connected load kW savings (7)* number of hours end-use is on in the costing period)/(total number of hours in the costing period)
For end-uses with part-load operating conditions (e.g. HVAC) :
(Summation for all hours in the costing period {full or part load kW savings * number of hours end-use is operating at that full or part load setting}) / (total number of hours in the costing period)
For example, for a chiller for a costing period with 10 hours, if the chiller operates 1 hour with 10 kW savings, 4 hours with 5 kW savings, and 5 hours a 0% load (with no kW savings), the average kW savings would be (1*10+4*5+5*0)/10= 3 kW
(2) The kW savings for the targeted end-use at the time of PG&E's system maximum for the costing period.
(3) (Coincident kW savings for the costing period)/ (coincident kW savings for the summer on-peak costing period)
(4) Average kW savings (1) * number of annual operating hours in period
(5) (Annual kWh savings in costing period (4)) / (total annual kWh savings (6))
(6) Total annual kWh savings
(7) Connected load kW savings

C

PROTOCOLS TABLES 6 AND 7

This appendix presents Tables 6 and 7 of the M&E Protocols for the industrial miscellaneous measure evaluation.

M&E PROTOCOLS TABLE 6

Designated Unit of Measurement: LOAD IMPACTS PER PROJECT
ENDUSE: INDUSTRIAL MISCELLANEOUS

1. Average Participant Group and Average Comaprison Group											
A. Pre-install usage:	Pre-install kW	na									
	Pre-install kWh	na									
	Pre-install Therms	na									
	Base kW	na									
	Base kWh	na									
	Base Therms	na									
	Base kW/ designated unit of measurement	na									
	Base kWh/ designated unit of measurement	na									
	Base Therms/ designated unit of measurement	na									
B. Impact year usage:	Impact Yr kW	na									
	Impact Yr kWh	na									
	Impact Yr Therms	na									
	Impact Yr kW/designated unit	na									
	Impact Yr kWh/designated unit	na		**5. A. 90% CONFIDENCE LEVEL**				**5. B. 80% CONFIDENCE LEVEL**			
	Impact Yr Therms/designated unit	na		**LOWER BOUND**	**UPPER BOUND**	**LOWER BOUND**	**UPPER BOUND**	**LOWER BOUND**	**UPPER BOUND**	**LOWER BOUND**	**UPPER BOUND**
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 - kW	2,909	2,182	2,789	3,029	2,043	2,320	2,816	3,002	2,174	2,290
	A. ii. Load Impacts - kWh	12,192,259	9,144,194	10,891,673	13,492,845	8,021,766	10,266,623	11,178,672	13,205,846	9,069,784	10,018,938
	A. iii. Load Impacts - Therms	21,715	16,286	21,715	21,715	16,286	16,286	21,715	21,715	16,286	16,286
	B. i. Load Impacts/designated unit - kW	16	8	15	17	8	9	15	16	8	9
	B. ii. Load Impacts/designated unit - kWh	66,624	33,978	59,517	73,731	29,808	38,149	61,086	72,163	33,702	37,229
	B. iii. Load Impacts/designated unit - Therms	119	61	119	119	61	61	119	119	61	61
	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	1.67	1.87	1.60	1.74	1.75	1.99	1.62	1.72	1.86	1.96
	D.A. ii. Load Impacts - kWh, realization rate	1.02	1.14	0.91	1.13	1.00	1.28	0.94	1.10	1.13	1.25
	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	1.67	1.87	1.60	1.74	1.75	1.99	1.62	1.72	1.86	1.96
	D.B. ii. Load Impacts/designated unit - kWh, real rate	1.02	1.14	0.91	1.13	1.00	1.28	0.94	1.10	1.13	1.25
	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 - kW	0.75		0.75	0.75			0.75	0.75		
	A. ii. Average Load Impacts - kWh	0.75		0.75	0.75			0.75	0.75		
	A. iii. Average Load Impacts - Therms	0.75		0.75	0.75			0.75	0.75		
	B. i. Avg Load Impacts/designated unit of measurement - kW	0.75		0.75	0.75			0.75	0.75		
	B. ii. Avg Load Impacts/designated unit of measurement - kWh	0.75		0.75	0.75			0.75	0.75		
	B. iii. Avg Load Impacts/designated unit of measurement - Therms	0.75		0.75	0.75			0.75	0.75		
	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**	**PART GRP**			**PART GRP**	**PART GRP**		
	A. Pre-install average value	1		na	na			na	na		
	B. Post-install average value	1		na	na			na	na		
6. Measure Count Data		**NUMBER**									
	A. Number of measures installed by participants in Part Group	6190									
	B. Number of measures installed by all program participants in the 12 months of the program year	18313									
	C. Number of measures installed by Comp Group	na									
7. Market Segment Data											
	B. Distribution of participants by 3 digit SIC code	See next page									

Table 6 (Cont.)
7.B. Market segment data: distribution of participants by SIC code

SIC3	Percent
0	0.5
17	1.1
19	0.5
72	0.5
131	1.1
142	0.5
144	2.1
154	0.5
201	3.7
202	2.1
203	11.7
204	6.4
205	1.1
206	1.6
207	2.7
208	9.6
209	3.7
221	0.5
242	4.3
243	1.1
244	1.1
249	1.6
262	0.5
263	0.5
265	1.6
271	0.5
272	0.5
281	1.6
282	0.5
287	1.6
289	1.1
291	3.2
295	2.7
299	0.5
301	1.1
308	4.3
321	1.1
322	0.5
325	0.5
327	3.7
329	0.5
331	0.5
335	2.1
341	0.5
347	0.5
349	1.1
356	0.5
359	1.1
367	1.6
381	0.5
382	0.5
422	1.1
495	0.5
508	0.5
509	0.5
514	0.5
521	0.5
652	1.6
734	0.5
922	0.5

M&E PROTOCOLS TABLE 7

A. OVERVIEW INFORMATION

1. Study Title and ID No: Evaluation of 1994 Industrial Miscellaneous Energy-Efficiency Projects, #320

2. Program, Program Year, and Program Description: PG&E's Commercial, Industrial, and Agricultural Programs (the CIA Programs): CIA Customized Retrofit Program and CIA Express Retrofit Program; 1994. The Customized Program provides incentives to commercial, industrial, and agricultural customers to install custom-designed energy-efficiency measures. The Express Program provides incentives for commercial, industrial, and agricultural customers to retrofit their facilities with energy-efficient equipment from a pre-specified list of measures.

3. End Uses Covered: Industrial Miscellaneous Measures

4. Methods Used: Site-specific engineering approach

5. Program Participants: Industrial customers who received rebate checks in 1994 for installing miscellaneous measures

6. Analysis sample size: 34 customers, 36 installations, 6190 measures installed, 34 observations (at the site/customer level)

B. DATABASE MANAGEMENT

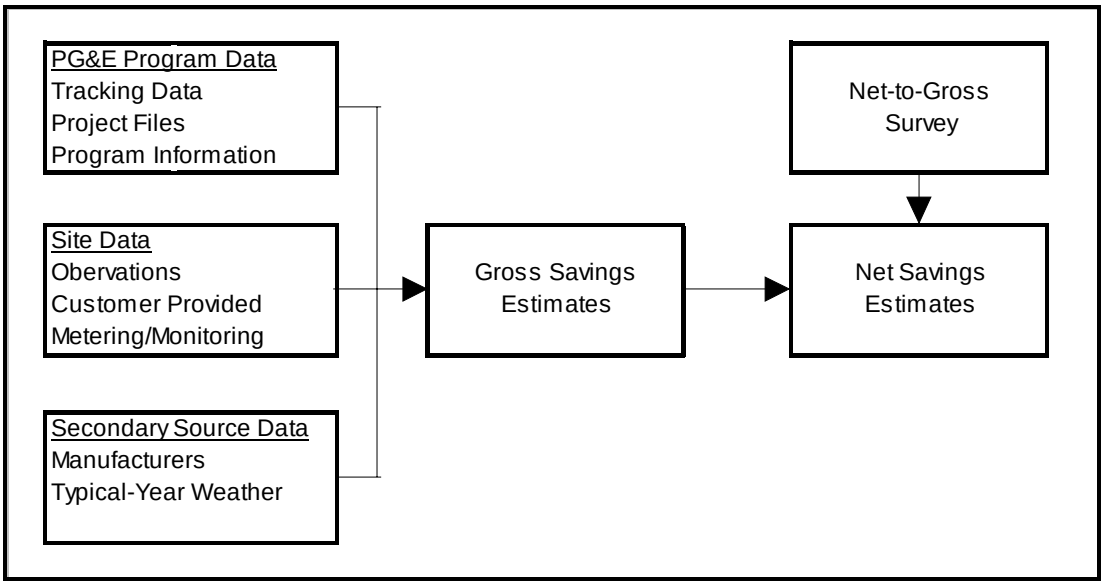
1. Data Flow Chart: See Figure C-1 for a flow chart describing the project data flow.

2. Data Sources: See Figure C-1

3. Sample Attrition: A census of the 6 larges refrigeration sites was included in the analysis. A sample of 8 additional regrigeration sites and 20 motors sites were utilized. All visited sites were included in the analysis.

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 PG&E project manager. The site analysis was then conducted and a report was produced documenting all site-specific evaluation

Figure C-1



analyses and results. The site report was reviewed by the lead engineer and the PG&E project manager for completeness.

5. Data not used: N/A

C. SAMPLING

1. Sampling procedures and protocols: Sampling frame - 183 industrial miscellaneous measure sites; Sampling strategy: a census of the 6 largest refrigeration sites; a random sample of 8 of the 20 remaining refrigeration sites and 20 of the 114 motors sites that installed motor of 15 hp or greater; Sampling basis: the site as defined by PG&E control number; Stratification criteria: avoided cost savings and measure type.

2: Survey information: na

3. Statistical descriptions: na

D. DATA SCREENING AND ANALYSIS

1. Outliers: na
2. Background variables: na
3. Data screening: na, all visited sites were included.
4. Regression statistics: na; analysis method was site-specific engineering calculation supported by metering/monitoring.

5. Specification: na; regression model was not used.
6. Error in measuring variables: na, complex site studies made the best use of available data an the analysis approach was chosed to minimize measurement errors.
7: Autocorrelation: na
8: Heteroskedasticity: na
9: Collinerarity: na
10: Influential data points: na
11: Missing data: na
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.

E. DATA INTERPRETATION AND APPLICATION

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