Customer Energy Efficiency Program
Measurement and Evaluation Program

EVALUATION OF PACIFIC GAS & ELECTRIC COMPANY'S 1997 COMMERCIAL ENERGY EFFICIENCY INCENTIVES PROGRAM: HVAC TECHNOLOGIES

PG&E Study ID number: 333B

March 1, 1999

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

All inquiries should be directed to:

Lisa K. Lieu
Revenue Requirements
Pacific Gas and Electric Company
P. O. Box 770000, Mail Code B9A
San Francisco, CA 94177

EVALUATION OF PACIFIC GAS & ELECTRIC COMPANY'S 1997 COMMERCIAL ENERGY EFFICIENCY INCENTIVES PROGRAM FOR HVAC TECHNOLOGIES

PG&E Study ID number: 333B

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" (Protocols), as adopted by California Public Utilities Commission Decision 93-05-063, revised March 1998, pursuant to Decisions 94-05-063, 94-10-059, 94-12-021, 95-12-054, 96-12-079 and 98-03-063.

This study evaluated the gross and net energy savings from HVAC energy efficiency technologies for which rebates were paid in 1997 by Pacific Gas & Electric Company's Commercial Energy Efficiency Incentive (CEEI) Programs. Retrofits were performed under three different PG&E programs: the Retrofit Express (RE), Retrofit Efficiency Options (REO), and Advanced Performance Options (APO) Programs.

Methodology

For this evaluation, there were three types of primary data collected: telephone survey data, on-site data, and end-use loggered data. An integrated sample design was implemented for the lighting and HVAC end uses, due to the number of participant crossover among these end uses. Due to low numbers of participation within the HVAC end use, a census was conducted and 443 sample points were collected. A non-participant sample was developed based upon the business type and usage strata distribution that resulted from the participant sample allocation. The HVAC end-use included 443 HVAC participant and 549 nonparticipant telephone surveys, 156 on-site audits, and 30 end-use loggered sites.

An integrated evaluation approach employed engineering, billing regression and net-to-gross (NTG) analyses. Engineering and statistically adjusted engineering (SAE) estimates were used to develop per participant gross energy, demand, and therm impacts for specified time-of-use costing periods. The engineering analysis combined information from telephone surveys with detailed on-site audit data to develop unadjusted engineering impacts. A billing regression analysis was employed to model the differences in customers' energy usage between pre- and post-installation periods. The model was specified using actual customer billing data and independent variables that explain changes in customers' energy usage including engineering estimates of unadjusted savings.

Three separate models were implemented to estimate the components of the NTG ratio (free-ridership and spillover): a model based on self-reports, a net billing analysis model applying a double inverse Mills ratio (estimating free-ridership only), and a two-stage discrete choice model. The final NTG ratios applied to the ex post gross impacts were derived from the results of the discrete choice model for those technology segments which could support discrete choice modeling (CAC technologies and Other RE Measures). Self report results were applied to the remaining HVAC technology segments.

Study Results

The results of the analyses for the HVAC technologies are summarized below:

	Gross Savings	Gross Realization Rate	Net-To-Gross 1-FR	Net-To-Gross Spillover	Net-To-Gross NTG Ratio	Net Savings	Net Realization Rate
EX ANTE							
kW	8,344	-	0.577	0.100	0.677	5,651	-
kWh	30,675,323	-	0.584	0.100	0.684	20,987,340	-
Therms	23,811	-	0.650	0.100	0.750	17,858	-
EX POST							
kW	7,445	0.892	0.636	0.177	0.813	6,052	1.071
kWh	29,698,734	0.968	0.636	0.199	0.836	24,813,777	1.182
Therms	23,811	1.000	0.601	0.208	0.809	19,267	1.079

Regulatory Waivers and Filing Variances

The CADMAC approved a waiver on January 2, 1999, that allows the use of self - report based algorithms to estimate free ridership and spillover effects in the event discrete choice and LIRM models fail to produce statistically reliable results.

There were no E-Table variances.

EVALUATION OF PG&E'S 1997 COMMERCIAL EEI PROGRAM HVAC TECHNOLOGIES

PG&E Study ID#: 333B

FINAL REPORT

March 1, 1999

Submitted to

Mary O'Drain
Market Planning and Research
Pacific Gas & Electric Co.
123 Mission Street
San Francisco, CA 94177

Prepared by

QUANTUM CONSULTING INC.
2030 Addison Street
Berkeley, CA 94704

TABLE OF CONTENTS

Section			Page
1	EXECUTIVE SUMMARY		
	1.1	Evaluation Results Summary	1-1
	1.2	Major Findings	1-2
2	INTRODUCTION		
	2.1	The Retrofit Express Program	2-1
	2.2	The Retrofit Efficiency Options Program	2-2
	2.3	Evaluation Overview	2-2
		2.3.1 Objectives	2-2
		2.3.2 Timing	2-3
		2.3.3 Role of Protocols	2-3
	2.4	Evaluation Approach – An Overview	2-4
		2.4.1 Data Sources	2-4
		2.4.2 Analysis Elements	2-6
	2.5	Report Layout	2-9
3	METHODOLOGY		
	3.1	Sample Design	3-1
		3.1.1 Existing Data Sources	3-1
		3.1.2 Sample Design Overview	3-2
		3.1.3 Sample Segmentation	3-2
		3.1.4 Technology Segmentation	3-3
		3.1.5 Sample Allocation	3-3
		3.1.6 Final Sample Distribution	3-6
		3.1.7 Relative Precision	3-7
		3.1.8 Demonstration of Protocol Compliance	3-9
	3.2	Engineering Analysis	3-10
		3.2.1 Overview of the Engineering Approach	3-11

TABLE OF CONTENTS
(continued)

Section			Page
	3.2.2	Central Air-Conditioners (CAC)	3-11
	3.2.3	Adjustable Speed Drives (ASDs) for ventilation fans	3-17
	3.2.4	Custom Measures	3-22
	3.2.5	Other RE Measures	3-23
3.3	Billing Regression Analysis		3-31
	3.3.1	Overview	3-31
	3.3.2	Data Sources for Billing Regression Analysis	3-31
	3.3.3	Data Aggregation and Analysis Dataset Development	3-33
	3.3.4	Analysis Periods	3-35
	3.3.5	Data Censoring	3-36
	3.3.6	Model Specification	3-42
	3.3.7	Billing Regression Analysis Results	3-46
	3.3.8	Alternative Gross Billing Model Specifications	3-50
	3.3.9	Net Billing Analysis	3-55
3.4	Net-to-Gross Analysis		3-65
	3.4.1	Data Sources	3-66
	3.4.2	Self-Report Methods	3-66
	3.4.3	Discrete Choice Model	3-82
	3.4.4.	Final Net-to-Gross Ratios	3-97
4	EVALUATION RESULTS		
4.1	Ex Post Gross Impact Results		4-1
4.2	Net-to-Gross Adjustments		4-3
4.3	Ex Post Net Impacts		4-4
4.4	Realization Rates		4-6
	4.4.1	Gross Realization Rates for Energy Impacts	4-6
	4.4.2	Gross Realization Rates for Demand Impacts	4-8
	4.4.3	Gross Realization Rates for Therm Impacts	4-9
	4.4.4	Net Realization Rates	4-10
4.5	Overview of Realization Rates		4-11

LIST OF EXHIBITS

Exhibit		Page
1-1	Summary of Gross Evaluation Results for Commercial HVAC Applications	1-1
2-1	Overall Impact Analysis Approach	2-7
3-1	1997 Commercial Segmentation and Distribution of Unique Sites	3-2
3-2	Proposed Standard Measure HVAC On-Sites In Support of DOE-2 Model Development	3-4
3-3	Available Custom Measure Sample Frame	3-5
3-4	Nonparticipant Survey Quotas Telephone Survey Sample	3-6
3-5	Data Collected by Program and End Use	3-7
3-6	Telephone Sample Relative Precision Levels	3-8
3-7	Key Characteristics for DOE-2.1E Prototypes	3-13
3-8	Annual Average HVAC Operating for Key Business Types	3-14
3-9	Equation for Estimating CAC Energy Savings	3-15
3-10	Equation for Estimating CAC Demand Savings	3-16
3-11	Baseline Interval Demand Estimate	3-18
3-12	Average Weekday Comparison of kW vs. kW_{100}	3-19
3-13	Equation for Estimating ASD Energy Savings	3-21
3-14	Equation for Estimating ASD Demand Impacts	3-22
3-15	Billing Analysis Sample Frame Pre-Censoring HVAC End-Use Technologies	3-34

LIST OF EXHIBITS
(continued)

Exhibit		Page
3-16	Billing Analysis Sample Frame Pre-Censoring Nonparticipants	3-35
3-17	Commercial HVAC Rebated Technologies By Estimated Installation Date	3-37
3-18	Distribution of Customers Removed from Billing Analysis By Data Censoring Criteria Customers with Invalid Billing Data	3-38
3-19	Distribution of Customers Removed from Billing Analysis By Data Censoring Criteria Customers with Billing Aggregation Problems	3-40
3-20	Distribution of Customers Removed from Billing Analysis By Data Censoring Criteria	3-41
3-21	Billing Analysis Sample Used Post-Censoring HVAC End-Use Technologies	3-41
3-22	Billing Analysis Sample Used Post-Censoring Nonparticipants	3-42
3-23	Billing Regression Analysis Final Baseline Model Outputs	3-45
3-24	Gross Billing Regression Analysis Final Model Outputs	3-47
3-25	Commercial HVAC Gross Energy Impact SAE Coefficients By Business Type and Technology Group	3-48
3-26	Relative Precision Calculation	3-50
3-27	Comparison of Alternative Gross Billing Model Specifications	3-55
3-28	Variables Used in HVAC Probit Model	3-58
3-29	HVAC Probit Estimation Results	3-59
3-30	Net Billing Regression Analysis Final Model Outputs	3-61
3-31	Net Billing Regression Analysis Estimates of (1-FR)	3-62
3-32	Comparison of Inverse Mills Ratio Approaches	3-64

LIST OF EXHIBITS
(continued)

Exhibit		Page
3-33	Comparison of Alternative Net Billing Model Specifications	3-65
3-34	Weighted Self-report Estimates of Free Ridership for HVAC Technology Groups in the 1996 EEI Commercial Retrofit Program	3-71
3-35	Participant Out-of-Program Adoption Distribution	3-79
3-36	Nonparticipant Adoption Distribution	3-80
3-37	Participant Spillover Estimate	3-82
3-38	Nonparticipant Spillover Estimate	3-82
3-39	Purchase Model Variable Definitions	3-84
3-40	Purchase Model Estimation Results	3-87
3-41	Estimated Purchase Probabilities	3-88
3-42	Equipment Choice Model Variable Definitions	3-90
3-43	Equipment Choice Model Estimation Results	3-93
3-44	Estimated NTG Ratios by Building Type	3-96
3-45	NTG Results with Alternative Model Specifications	3-97
3-46	Comparison of Net-to-Gross Ratios	3-99
3-47	Final Net-to-Gross Ratios	3-100
4-1	Ex Post Gross Energy Impacts By Business Type and Technology Group For Commercial HVAC Applications	4-1
4-2	Ex Post Gross Demand Impacts By Business Type and Technology Group For Commercial HVAC Applications	4-2
4-3	Ex Post Gross Therm Impacts By Business Type and Technology Group For Commercial HVAC Applications	4-3
4-4	NTG Adjustments by Program and Technology Group	4-4

LIST OF EXHIBITS
(continued)

Exhibit		Page
4-5	Ex Post Net Energy Impacts By Business Type and Technology Group For Commercial HVAC Applications	4-5
4-6	Ex Post Net Demand Impacts By Business Type and Technology Group For Commercial HVAC Applications	4-5
4-7	Ex Post Net Therm Impacts By Business Type and Technology Group For Commercial HVAC Applications	4-6
4-8	Gross Energy Impact Realization Rates By Business Type and Technology Group For Commercial HVAC Applications	4-7
4-9	Gross Demand Impact Realization Rates By Business Type and Technology Group For Commercial HVAC Applications	4-9
4-10	Gross Therm Impact Realization Rates By Business Type and Technology Group For Commercial HVAC Measures Paid in 1996	4-10
4-11	Net Energy Impact Realization Rates By Business Type and Technology Group For Commercial HVAC Measures Paid in 1996	4-11
4-12	Net Demand Impact Realization Rates By Business Type and Technology Group For Commercial HVAC Measures Paid in 1996	4-12
4-13	Net Therm Impact Realization Rates By Business Type and Technology Group For Commercial HVAC Applications	4-12
4-14	Commercial HVAC Impact Summary By Technology Group	4-13

ATTACHMENTS TABLE OF CONTENTS

Attachment		Page
1	CUSTOM HVAC ANALYSIS	A-1-1
2	STANDARD HVAC ALGORITHM REVIEW	A-2-1
3	RESULTS TABLES	A-3-1
4	PROTOCOL TABLES 6 & 7	A-4-1
5	PG&E RESPONSE TO VERIFICATION REPORT FOR STUDIES #349 & 351 AND INDEPENDENT REVIEWERS' REPORT TO THE CPUC REGARDING STUDIES #349 & 351	A-5-1
6	PG&E RETROACTIVE WAIVER FOR 1997 COMMERCIAL SECTOR EEI PROGRAMS LIGHTING AND HVAC END USE NET-TO-GROSS ANALYSIS	A-6-1

SURVEY APPENDICES TABLE OF CONTENTS

Appendix		Page
A	PARTICIPANT SURVEY INSTRUMENT	A-1
B	NONPARTICIPANT SURVEY INSTRUMENT	B-1
C	CANVASS SURVEY INSTRUMENT	C-1
D	ON-SITE INSTRUMENT	D-1
E	PARTICIPANT SURVEY RESPONSE FREQUENCIES	E-1
F	NONPARTICIPANT SURVEY RESPONSE FREQUENCIES	F-1
G	CANVASS SURVEY RESPONSE FREQUENCIES	G-1
H	PARTICIPANT SURVEY DISPOSITION	H-1
I	NONPARTICIPANT SURVEY DISPOSITION	I-1
J	CANVASS SURVEY DISPOSITION	J-1
K	PARTICIPANT SURVEY REFUSAL COMMENTS	K-1
L	NONPARTICIPANT SURVEY REFUSAL COMMENTS	L-1
M	CANVASS SURVEY REFUSAL COMMENTS	M-1

1. EXECUTIVE SUMMARY

This section presents a summary of the impact results for Heating, Ventilating, and Air-Conditioning (HVAC) technologies offered under Pacific Gas & Electric Company's (PG&E's) 1997 Commercial Energy Efficiency Incentive (CEEI) Programs, referred to in this report as the HVAC Program. This evaluation covers HVAC technology retrofits that were rebated during 1997. These retrofits were performed under three different PG&E programs: the Retrofit Express (RE), the Retrofit Efficiency Options (REO), and the Advanced Performance Options (APO) Programs. The results are presented in two sections: Evaluation Results Summary (covering the numerical results of the study) and Major Findings.

1.1 EVALUATION RESULTS SUMMARY

The evaluation results are summarized in terms of energy savings (kWh), demand savings (kW), therms impacts, and realization rates. Realization rates are defined as the ratio of the evaluation results (ex post) to the program design estimates (ex ante). All of these results are presented on a gross and net basis (i.e., before and after accounting for customer actions outside the program). Exhibit 1-1 presents the gross energy, demand and therm savings results (ex post and ex ante), together with each applicable gross realization rate. The net-to-gross ratio is comprised of free ridership, and participant and nonparticipant spillover effects.

Exhibit 1-1
Summary of Gross Evaluation Results
for Commercial HVAC Applications

	Gross Savings	Gross Realization Rate	Net-To-Gross 1-FR	Spillover	NTG Ratio	Net Savings	Net Realization Rate
EX ANTE							
kW	8,344	-	0.577	0.100	0.677	5,651	-
kWh	30,675,323	-	0.584	0.100	0.684	20,987,340	-
Therms	23,811	-	0.650	0.100	0.750	17,858	-
EX POST							
kW	7,445	0.892	0.636	0.177	0.813	6,052	1.071
kWh	29,698,734	0.968	0.636	0.199	0.836	24,813,777	1.182
Therms	23,811	1.000	0.601	0.208	0.809	19,267	1.079

Overall, the ex post gross energy impacts are relatively consistent with the predicted ex ante impact estimates, differing by only a few percent. Although the gross energy impact estimates are similar, ex post net energy impacts are 18 percent larger than ex ante, due to the larger ex post net-to-gross ratio. This finding is similar for demand, where the ex post gross demand estimates are 11 percent less than ex ante, but ex post net demand is 7 percent larger. For therm impacts, ex post gross is equal to ex ante, but ex post net therm impacts are larger by 8 percent due to the larger ex post net-to-gross ratio.

The ex ante numbers presented above in Exhibit 1-1 were obtained from PG&E’s Marketing Decision Support System (MDSS), PG&E’s program participant database. The values presented are identical to those filed in Table E-3 of the Technical Appendix of the Annual Summary Report on Demand Side Management Programs.

These ex post results illustrate the following key points about the gross and net commercial HVAC impacts:

Program Accomplishments: Nearly three-quarters of program energy savings are from HVAC technologies installed through the Retrofit Express program. All of the program therm savings are from HVAC technologies installed through the APO program.

Gross Impacts: Overall ex post gross impacts were only three percent less than the ex ante estimates for energy, and 11 percent less for demand. Due to significant changes made in the ex ante estimate for central air conditions (CAC), the ex post estimates were only half that of the ex ante estimate. However, larger ex post impacts were observed in the largest impact technology, Adjustable Speed Drives (ASD), balancing out the effects of the lower CAC estimates.

Net Impacts: The net ex post impacts exceed the net ex ante estimates by 18 percent for energy, 7 percent for demand, and 4 percent for therms. These results are driven by the ex ante and ex post net-to-gross (NTG) ratios. The ex ante NTG ratio was 0.68 for both demand and energy, while the ex post NTG ratio applied was much larger: 0.84 for energy and 0.81 for demand. These larger estimates significantly increase the net program effects. The NTG ratios for therms were more in line, with an ex ante NTG ratio of 0.75 and ex post NTG ratio of 0.81.

1.2 MAJOR FINDINGS

The key findings are summarized as follows:

- Overall, PG&E's ex ante estimates for the commercial HVAC technologies paid under the 1997 programs were conservative, resulting in net realization rates exceeding one.

- Gross ex post energy impacts were very close to the ex ante estimates. Changes in the ex ante estimate for energy impact for CACs resulted in a very low gross realization rate of only 51 percent. The effect was balanced by the large gross realization rate obtained for ASDs.

- Larger NTG ratios, combined with lower gross ex post values, resulted in net realization rates greater than one for energy, demand and therms.

2. INTRODUCTION

This report summarizes the impact evaluation of Pacific Gas & Electric Company's (PG&E's) Commercial Energy Efficiency Incentive (CEEI) Program for HVAC technologies (the HVAC Evaluation). These technologies are covered by three separate program options, the Retrofit Express (RE) Program, the Retrofit Efficiency Options (REO) Program, and the Advanced Performance Options (APO) Program.

The evaluation effort includes customers who were paid rebates in 1997. The APO program comprised only 13 paid applications. The RE and REO programs, which contribute most to total program impacts, are summarized below.

2.1 THE RETROFIT EXPRESS PROGRAM

The RE program offered fixed rebates to customers who installed specific electric energy-efficient equipment. The program covered the most common energy saving measures and spans lighting, air conditioning, refrigeration, motors, and food service. Customers were required to submit proof of purchase with these applications in order to receive rebates. The program was marketed to small- and medium-sized commercial, industrial, and agricultural (CIA) customers. The maximum rebate amount, including all measure types, was $300,000 per account. No minimum amount was required to qualify for a rebate.

HVAC end-use rebates were offered in the program for the following technologies:

Technology
High-efficiency central air-conditioning units in various capacity ranges
Variable speed drive HVAC fans
High-efficiency package terminal air-conditioning units
Programmable thermostats, bypass timers, and electronic timeclocks
Reflective window film
Water chillers of various capacity ranges
Direct evaporative cooler units, evaporative condensers, and evaporative cooler towers

2.2 THE RETROFIT EFFICIENCY OPTIONS PROGRAM

The REO program included nine HVAC technologies, that can be summarized into four general technology groups, described below:

Technology
Variable frequency drive supply fans
Installation of high efficiency water chillers
Variable air volume supply systems, which replace constant air volume supply systems
Evaporative cooling towers

The REO program targeted commercial, industrial, agricultural, and multi-family market segments most likely to benefit from these selected measures. Customers were required to submit calculations for the projected first-year energy savings along with their application prior to installation of the high efficiency equipment. PG&E representatives worked with customers to identify cost-effective improvements, with special emphasis on operational and maintenance measures at the customers' facilities. Marketing efforts were coordinated amongst PG&E's divisions, emphasizing local planning areas with high marginal electric costs to maximum the program's benefits.

2.3 EVALUATION OVERVIEW

The impact evaluation described in this report covers all HVAC technologies installed at commercial accounts, as determined by the Marketing Decision Support System (MDSS) sector code, that were included under the RE, REO, and APO programs, and for which rebates were *paid* during calendar year 1997.

The impact evaluation results in both gross and net impacts, and compares these estimates to the program ex ante estimates.

2.3.1 Objectives

The research objectives are as follows:

- Determine first-year gross energy, demand, and therm impacts by business type and technology group for RE, REO and APO HVAC technologies paid in 1997, as required by the California Public Utilities Commission (CPUC) Protocols.
- Determine first-year net energy, demand, and therm impacts by business type and technology group for RE, REO and APO HVAC technologies paid in 1997, as required by the CPUC Protocols.
- Compare evaluation results (ex post) with PG&E's (ex ante) estimates, and investigate and explain any discrepancies between the two.

- Assess free-ridership and spillover rates, and investigate and explain differences between ex post and ex ante estimates.

- Create an impact sample subset of participants for future retention monitoring as required by the CPUC Protocols.

- Complete tables 6 and 7 of the Protocols.

Results are segmented by technology and building type. Technologies are defined by measures offered by the RE, REO and APO programs. Building types for the commercial market sector, as defined by PG&E, are:

Office	Health Care
Retail	Hotel / Motel
College and University	Warehouse
Schools	Personal Service
Grocery	Community Service
Restaurant	Miscellaneous

While gross impacts account for program participant actions, net impacts account for customer participation choices and the effect that the HVAC Program's infrastructure has had on the HVAC retrofit market. For example, adjustments were made to the gross savings estimates to account for customers that would have installed energy-efficient measures in the absence of the program (**free-riders**). The adjustment also included participant and nonparticipant **spillover** rates, defined as energy-efficient measures installed outside the program and as a result of the presence of the program.

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

2.3.2 Timing

The 1997 HVAC Evaluation began in May 1998, completed the planning stage in June 1998, executed data collection between June and early November 1998, and completed the analysis and reporting phase in February 1998.

2.3.3 Role of Protocols

This evaluation was conducted under the rules specified in the "Protocols and Procedures for the Verification of Cost, Benefits, and Shareholder Earnings from Demand Side Management

Programs" (the Protocols).[1] The Protocols control most aspects of the evaluation. They specify the minimum sample sizes, the required precision, data collection techniques, certain minimum analysis approaches, and formats for documenting and reporting results to the CPUC. This evaluation has endeavored to meet all Protocol requirements.

2.4 EVALUATION APPROACH – AN OVERVIEW

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

2.4.1 Data Sources

The HVAC Evaluation used data supplied by PG&E to develop a sample design plan. This plan was used to specify sample points from which additional evaluation data were collected.

Existing Data

All available data supplied by PG&E were used in the analysis of the HVAC Program. Of particular importance were PG&E's historical billing data, program participant data from the Marketing Decision Support System (MDSS), paper copies of RE, REO and APO applications, and other program-related data. Each of the existing data sources is described briefly below.

Program Participant Tracking System - The participant tracking system data, maintained in the PG&E MDSS, contains program, project, and technical information about measure installation. It also provides expected impact estimates based upon the ex ante engineering algorithms. This information was used to create sample designs for data collection and to leverage calibrated impact estimates from the telephone sample to the entire participant population.

Program Marketing Data - PG&E program marketing data contain detailed descriptions of program marketing and application procedures, together with details on the measures offered. This data source also provides a general description of measures accepted by the program.

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

[1] California Public Utilities Commission Decision 93-05-063, Revised March 1998, Pursuant to Decisions 94-05-063, 94-10-059, 94-12-021, 95-12-054, 96-12-079, and 98-03-063.

PG&E 1997 Customer Energy Efficiency Programs Advice Filing[2] **-** This report documents the ex ante earnings claims, including specific information on the derivation of per-unit ex ante savings estimates and the assumptions that go into those estimates. This documentation often includes assumptions such as operating hours, operating factors, baseline SEER and EER estimates, and other program related calculations. This document supplies the best information available on ex ante estimates and assumptions, thus facilitating knowledge-based comparisons to ex post estimates derived in this study.

Industry Standards/Information **-** In order to establish baseline levels and new equipment performance levels, industry standards information from organizations such as the American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE) and American National Standards Institute (ANSI) was used, together with information from manufacturers. For all applicable measures, Title 24 standards were used to define baseline efficiencies.

Copies of RE, REO and APO Paper Application Files **-** QC requested and received complete copies of application files for a random 50 RE participants and all REO and APO participants. The RE files were used to verify the entries in the MDSS electronic files and to identify additional information that could be extracted from the file to improve the analysis. The REO applications provided additional information not found in the MDSS, predominantly on attachment equipment invoices (such as horsepower, and SEER ratings). The APO files provided detailed information on how the application estimate was computed. For premises recruited for on-site audits, these applications provided the QC engineer with enough information to determine what additional information was needed to be collected. The remaining (not visited) APO files had enough information in the documentation to support an engineering review of the impact calculations. A thorough assessment of each APO application was conducted, and unadjusted engineering estimates of impact and savings were calculated for each APO participant.

1996 Commercial HVAC Results. End-use monitored data collected on adjustable speed drives (ASDs) for the 1996 Commercial HVAC Evaluation were utilized in the estimate of unadjusted engineering estimates for ASDs.

Primary Data Collected

Based on an assessment of existing data, program evaluation requirements were established for additional data to be collected. The three primary areas of data collection included End-Use Metering, On-Site Audits, and Telephone Survey data. A brief description of each follows:

End-Use Loggers. A total of 30 sites with central air conditioners (CAC) were loggered. Within that population, specific business types (offices, retail businesses and schools) were identified as segments that could significantly contribute to a calibrated engineering model. A total of 30 sites were recruited and loggers installed for a period of 3 months. This data was used in the engineering analysis for the CAC technology segment ex post energy and demand impact and savings calculations.

[2] PG&E 1997 Customer Energy Efficiency Programs Advice Letter No. 1978-G / 1608-E, filed October 1996.

On-Site Audits. A total of 156 customer sites were visited by a QC engineer to gather site-specific data used in support of the engineering analyses, as well as to create the retention panels to be used in subsequent evaluations. The on-site visit included a customer interview and an equipment/facilities audit. Only data required for this PG&E study was collected. This sample contributes equipment details that are site-specific, and better estimates of operating hours, operating factors, equipment efficiency, missed opportunities, and other technical factors that are difficult to collect over the telephone. The on-site sample itself is not designed to be statistically representative, but rather to support the estimate of detailed engineering parameters collected within the segments with the highest projected impact

Telephone Survey Data. A significantly larger telephone survey sample was collected. A total of 443 participant, 549 nonparticipant, and 3,619 canvass surveys were completed to gather customer profiles used in all of the analyses. The participant survey was designed to gather information on the rebated installations, other changes at the facilities (during the analysis period), and factors that influenced program participation. The nonparticipant survey was similar to the participant survey, and served as a control group in the SAE analysis. The canvass survey was used in support of the net-to-gross analysis.

2.4.2 Analysis Elements

This sub-section describes the general approach used to estimate both the gross and net demand and energy impacts for the Commercial HVAC Evaluation. The application and program design data are used to create a data collection plan, which in turn guides the evaluation data collection efforts. The sample design, engineering analysis, billing analysis, and net-to-gross analysis are all described in greater detail in *Section 3, Methodology*.

The analysis approach illustrated in Exhibit 2-1 consists of three primary analysis components: the **engineering analysis**, the **billing analysis**, and the **net-to-gross analysis**. This integrated approach reduces a complicated problem into manageable components, while incorporating the comparative advantages of each method. This approach describes per-unit net impacts as:

Net Impact = (Operating Impact) * (Operating Factor) * (SAE Coefficient) * (Net-to-Gross)

Where,

Operating impact is defined as the load impact coincident with a specific hour, given that the equipment is operating. The engineering analysis will simulate equipment performance independent of premise size and customer behavioral factors to obtain operating impacts.

Operating factor is defined as the fraction of premises with equipment operating during the analysis period. This term reflects the equipment's operating schedule, and will be estimated at a high level of precision using metered data in conjunction with on-site audit and telephone survey results.

a

Exhibit 2-1
Overall Impact Analysis Approach

The Statistically Adjusted Engineering (SAE) Coefficient will be estimated for those cases in which an engineering model estimate is not used as the final result. This term is defined as the percentage of savings estimate that is detected, or realized, in the statistical analysis of actual changes in energy usage. The SAE coefficient is applied to an impact estimate based upon the program baseline, equipment purchased under the program, and typical weather.

The Net-to-Gross (NTG) Ratio adjusts the program baseline derived from estimates of free ridership and spillover associated with the program.

Engineering Analysis

Gross energy estimates were developed using two distinct analysis steps. First, engineering estimates were developed for each participant. Second, these estimates were then adjusted using billing data-derived SAE coefficients.

Gross, unadjusted engineering impacts were developed for each retrofit measure. Gross impacts were developed for CAC technologies using calibrated DOE-2.1E simulations. These simulations were carried out for Office, School, and Retail business types; and then leveraged to additional business types using telephone survey data and MDSS information. A similar methodology was developed for Adjustable Speed Drive (ASD) technologies using End-Use Metered (EUM) data. Ideally, estimates for all business types and measures would be generated based on calibrated models (either DOE-2.1E or EUM), given sufficient resources (and sample sizes). In this evaluation, the optimal solution was to leverage the models for business types with sufficient participation to all other business types, and then adjust the results with the SAE analysis. The engineering methods used are described in greater detail in *Section 3.2*.

Site specific engineering impact estimates were generated for 33 selected premises. The results of these analyses are provided in *Attachment 1, Custom HVAC Analysis*. Included in the attachments are, for each facility visited, an on-site summary and resulting impact estimate. The detailed engineering calculations to determine impact and savings are also provided.

For all other measures, such as Reflective Window Film and Evaporative Coolers, the algorithms used to generate the ex ante estimates were extensively reviewed and modified to include new and more accurate information. A complete evaluation of these algorithms and the associated adjusted algorithms are included in *Attachment 2, HVAC Algorithm Review*. These modified algorithms were then applied to the MDSS participants to produce site-specific estimates of impact and savings.

Gross demand estimates are based solely upon unadjusted hourly engineering estimates. Whenever possible, engineering demand estimates were developed using EUM or site survey data in conjunction with the methods used for the gross energy estimates.

Like gross demand estimates, therm estimates are not adjusted using SAE coefficients. For each TOU costing period, therm estimates were aggregated using methods similar to energy estimates.

Billing Analysis

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

Net-to-Gross Analysis

The NTG analysis is designed to adjust gross program impacts for free ridership and actions taken by PG&E customers outside the HVAC Program. Self-reported data were initially used to estimate the percentage of free-riders in the program; that is, the number of participants who would have undertaken the energy efficiency action promoted by the program in the absence of the program. In addition, self-reported data are used to calculate the percent of participant and nonparticipant spillover attributable to the program.

A more sophisticated estimate of NTG for selected high-participation measures was developed through the application of discrete choice analysis. The discrete choice model estimates the probability that a customer will purchase a particular energy efficient HVAC measure, both with and without the incentive program in place. The results of the discrete choice model are estimates of free-ridership and spillover, independent of those found through the self report method. Because the discrete choice model requires a sufficient sample size of nonparticipant adoptions, only CAC and evaporative cooler technologies yielded significant results. The remaining estimates of net were based on the self-report model. Also, the CADMAC approved a waiver that allows the use of self -report based algorithms to estimate free ridership and spillover effects in the event discrete choice and LIRM models fail to produce statistically reliable results. (The approved waiver is presented in Attachment 6.)

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

2.5 REPORT LAYOUT

This report presents the results of the HVAC Evaluation. It is divided into four sections, plus attachments and appendices. *Sections 1* and *2* are the *Executive Summary* and the *Introduction*. *Section 3* presents the *Methodology* of the evaluation. *Section 4* presents the detailed results and a discussion of important findings. *Attachment 1* are a collection custom site write-ups on each site reviewed and/or audited by QC engineers. *Attachment 2* are the results of the engineering algorithm review of standard (RE/REO) HVAC measures. *Attachment 3* are the results tables for the gross ex ante, net ex ante, and unadjusted engineering impacts, as well as the SAE coefficients, gross ex post, NTG adjustments, net ex post, and gross and net realization rates. The attachment also contains gross demand and energy savings by costing period for commercial indoor HVAC measures. *Attachment 4* contains the Protocol Tables 6 and 7 for the HVAC end use. *Attachment 5* contains PG&E's rebuttal to the ORA's verification report and the Independent Reviewer's testimony for the 1996 CEEI Evaluation. The *Survey Appendices* provide the survey and on-site data collection instruments, and the survey call dispositions, frequencies, and refusal comments.

3. METHODOLOGY

This section provides the specifics surrounding the methods used to conduct the 1997 Pacific Gas & Electric Company (PG&E) Commercial Energy Efficiency Incentives (CEEI) Program Evaluation for HVAC Technologies (the HVAC Evaluation). This section begins with a detailed discussion on the sampling plan for the HVAC Evaluation. From there, details regarding the Engineering Analysis (*Section 3.2*), the Billing Analysis (*Section 3.3*), and the Net-to-Gross Analysis (*Section 3.4)* are discussed.

3.1 SAMPLE DESIGN

This section presents the sample design for the HVAC Evaluation. An integrated sample design was implemented for the Lighting and HVAC end uses, due to the number of participant crossover amongst the various end uses. First, the overall sample design approach is discussed, followed by the resulting sample allocation. The section concludes with a discussion of the California Public Utilities Commission (CPUC) Evaluation and Measurement Protocols (the Protocols) requirements.

3.1.1 Existing Data Sources

The participant tracking system for the Retrofit Express (RE), Retrofit Efficiency Options (REO), and Advanced Performance Options (APO) Programs are maintained as part of PG&E's Marketing Decision Support System (MDSS). Henceforth, the RE program components (excluding Chillers and including ASDs) are referred to as simply Retrofit, with the remaining program components referred to as Custom. The MDSS contains program application, rebate, and technical information regarding installed measures, including measure description, quantities, rebate amount, and ex ante demand, energy, and therm savings estimates. The MDSS extract used in this evaluation is consistent with data used in the PG&E Annual Earning Assessment Proceedings (AEAP) Report.

For the Retrofit and Custom programs, participation was tracked at both an application and measure level. They are linked by application code and program year. Each application can cover multiple measures and accounts, and each measure is linked to a PG&E electrical or gas service location where the measures are supposed to be installed. The account location is designated by its account number, or a unique seven-digit identification number (PG&E's control number). Unlike customer accounts, control numbers are used to identify service locations and serve as stable identifiers for linking datasets.

The billing series requested in support of the HVAC Evaluation cover a period from January 1993 to September 1998. PG&E's billing data contain monthly energy-consumption as well as other customer information, such as customer name, service location, rate schedule, and Standard Industrial Classification (SIC) code.

3.1.2 Sample Design Overview

The objectives of the sample design were to:

- Determine the optimal sample allocation for first-year gross impact analysis, based upon sample size and evaluation accuracy requirements of the Protocols and available project resources.
- Allocate sufficient sample points to meet net-to-gross (NTG) objectives.
- Reallocate available resources, wherever feasible, to focus on measures and/or program features deemed most important by PG&E staff, while not compromising the overall accuracy of the evaluation.

3.1.3 Sample Segmentation

Evaluation of the HVAC Program at the participant segment level allows more precise, and insightful, analyses than those undertaken at the aggregate PG&E system level. The sample segmentation consists of two primary components: participant segmentation and technology segmentation. As will become apparent, a key feature of the sample design is that the sampling unit is a unique customer site. Significant effort was undertaken to aggregate billing and participation records to this level.

The first step in the participant segmentation process grouped firms by business type, as recorded in the MDSS. There are a total of 12 business types used to segment a customer. A total of 11 technology groups were defined (see definition following Exhibit 3-1) to classify measures. Exhibit 3-1 presents the distribution of unique customer sites across the business type and technology group segmentation.

Exhibit 3-1
1997 Commercial HVAC Segmentation and Distribution of Unique Sites

Technology	Business Type	Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
HVAC End Use Unique Sites		385	147	26	139	28	93	115	83	65	73	141	42	1,337
HVAC	Central A/C	216	101	16	102	22	74	80	10	44	53	116	29	863
	Adjustable Speed Drives	53	9	2	1	0	0	3	3	0	0	3	1	75
	Package Terminal A/C	5	0	1	2	1	4	0	68	1	0	1	1	84
	Set-Back Thermostat	84	49	8	58	11	34	39	4	22	30	56	13	408
	Reflective Window Film	99	26	5	4	3	11	21	1	18	15	12	11	226
	Water Chillers	8	2	3	0	0	0	7	1	0	1	3	0	25
	Customized EMS	2	0	1	0	0	0	0	0	0	0	1	0	4
	Convert To VAV	0	0	0	0	0	0	0	0	0	0	1	0	1
	Other Customized Equip	0	0	0	0	0	0	0	0	0	1	0	0	1
	Cooling Towers	2	0	0	0	0	0	0	0	0	0	1	0	3
	Other HVAC Technologies	2	1	0	0	2	4	0	1	1	2	1	0	14

Annual energy consumption values were used to group customers into four usage/size strata based upon a Dalenius-Hodges[1] stratification procedure. The comparison group customers are then selected to mirror the underlying distribution of the participant target population by size and business type.

3.1.4 Technology Segmentation

Program measures are classified into technology groups through combining measures with similar energy reduction characteristics. This grouping strengthens the analysis by creating homogenous analysis segments in terms of electricity use. The three elements of the technology segmentation are as follows:

Technology Groups consist of those measures that comprise, in the case of the HVAC end use, those specific measures that are expected to have similar energy saving characteristics. For example, all Central Air Conditioning (CAC) retrofit measures are grouped together under a single CAC Technology Group. The projected energy savings differences will be accounted for in the engineering estimates, yielding similar per-unit estimates.

Measure Group, the second level of segmentation, groups measures by the PG&E program measure description.

Measure, the finest level of segmentation, is the actual measure offered by the PG&E program.

The technology segmentation presented in Exhibit 3-1 above shows the level of segmentation that was performed for this evaluation. While the engineering analysis was conducted at the finest level of segmentation (the measure level), the statistical billing analysis was conducted at a much coarser level (the technology group), or in some cases, at an even higher level of aggregation.

3.1.5 Sample Allocation

For the HVAC Evaluation, there were three types of primary data collected: telephone survey data, on-site audit data, and end-use metered data. These data sources formed the basis for the various analyses conducted as part of this evaluation (e.g., billing analysis, free-rider analysis, and spillover analysis). The sample design for each of these primary data sources was developed to meet each of the analysis objectives. The following sections describe these objectives and sampling strategies for each of the primary data sources collected.

Participant Telephone Sample

The telephone sample was designed to be used for the engineering, billing and net-to-gross analyses. For each of these analyses, it was necessary for a representative sample of participants to be collected. To allow for more accurate results, a total of at least 400 HVAC participants were desired, which far exceeded the Protocol requirement of 350. Because only 1,337 sites were available for the HVAC sample frame, a census was conducted.

---

[1] Cochran, W.G *Sampling Techniques*, Third Edition, John Wiley & Sons, 1997. pp. 127-134.

Participant Standard On-Site and EUM Samples

The on-site audits and End Use Metering (EUM) are designed to collect detailed information regarding installed HVAC technologies under the Program. The on-site audit data is used to validate the telephone survey data for information such as operating hours and factors to be used in the engineering analysis. The on-site samples were drawn for only certain technologies which contributed the majority of the gross impacts and avoided costs. For this evaluation, the HVAC technologies focused on Central Air Conditioners (S160), Set-Back Thermostat (S17 & S18), and Reflective Window Film (S20). The combined gross impacts and avoided costs of the lighting and HVAC technologies contributed to more than 50 percent of their respective end use totals.

With EUM having the highest accuracy in terms of operating hour measurements, the metered data will be employed to calibrate the on-site data which in turn will validate the telephone survey data. Only the CAC technology was selected for the sample of 30 EUM points.

Exhibit 3-2 summarizes the standard on-site and EUM sample allocation for the HVAC end use. A total of 120 standard on-site audits are allocated with 30 points specifically targeted for EUM within the CAC technology group. The 30 points will also be part of the standard on-site audit. The other 90 points are distributed to the Central Air Conditioning (CAC), Reflective Window Film (WF), and Set-Back Thermostat (SB) by business types and climate zones. The three technologies contributed to more than 50 percent of the total HVAC end use gross impacts and avoided costs. The selected business types and climates zones were chosen to best represent the HVAC population and to offer the most robust data for analysis.

Exhibit 3-2
Proposed Standard Measure HVAC On-Sites
In Support of DOE-2 Model Development

Segment Description	Business Type	Climate Zone	Number of Available Sites	Standard On-Sites	EUM Points
Central A/C	Office	3	28	8	8
	Office	13	63	10	10
	Retail	13	25	6	6
	School	13	33	6	6
	Total	-	149	30	30
Central A/C, Reflective Window Film, Set-Back Thermostat	Office	2,3,4	90	26	-
	Office	11,12	88	26	-
	Retail	11,12	53	16	-
	School	11,12	34	10	-
	Office, Retail, School	13	29	12	-
	Total	-	294	90	-
TOTALS	**-**	**-**	**443**	**120**	**30**

Participant Custom On-Site and EUM Samples

The custom on-site sample consists of technologies with unique operating characteristics and technologies with complex installations under PG&E's custom programs. Custom HVAC measures were installed in only 33 sites. Therefore, a census of these customers was attempted during on-site recruitment with the goal of completing 30 on-site audits. The Custom measures are distributed across the 33 sites as illustrated below in Exhibit 3-3.

Exhibit 3-3
Available Custom Measure Sample Frame

Program	Technology Group	Number of Available Sites
Retrofit Express	Water Chillers	11
Retrofit Efficiency Options	Cooling Towers	3
	Water Chillers	9
Advanced Performance Options	Convert To VAV	1
	Customized EMS	3
	Other Customized	1
	Other HVAC Technologies	2
	Water Chillers	3
TOTALS		33

Comparison (nonparticipant) Sample

The primary objective of the nonparticipant telephone sample is to provide a control group for the net and gross billing analyses. The final comparison group sample frame consists of 187,524 commercial customers drawn from an eligible population of over 400,000. Since comparison group surveys were conducted only for customers in the commercial sector, the first step in creating the sample frame is to limit eligibility to only those accounts having SIC codes representing commercial business activities. In addition to the aforementioned criteria, the following screening rules were also used:

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

Quality of usage readings: Customers are required to have annual non-missing, non-zero usage values for 1995, 1996 and 1997. Customers with zero, or missing billing data, were removed from the sample.

In drawing the sample frame, targets are established for each business type and usage segment, so that the nonparticipant distribution, by business type and usage segment, is the same as that of the program participant population. The drawing is conducted in this manner to ensure sufficient representation of each business type / usage segment combination in the sample frame and allows for survey data collection in accordance with the sample design. The final sample design includes 48 segments classified by size according to energy usage.

Exhibit 3-4 below illustrates the 48 segments by business type and size, the available nonparticipant sample, the calculated quota (based on the participant population), and the desired sample size to draw. Gray cells indicate nonparticipant segments where the available population to quota ratio is low. The desired nonparticipant quota was 500 points, but the quota was targeted at 600 points with the assumption that for certain segments, such as the "Very Large" segment, the quota would not be filled. The final sample allocation was randomly selected within each customer segment.

Exhibit 3-4
Nonparticipant Survey Quotas
Telephone Survey Sample

Small				Medium				Large				Very Large			
Business Type	Avail.	Quota	N	Business Type	Avail.	Quota	N	Business Type	Avail.	Quota	N	Business Type	Avail.	Quota	N
Office	18,976	57	1,140	Office	2,071	59	1,180	Office	300	22	440	Office	123	28	560
Retail	18,528	38	760	Retail	1,877	35	700	Retail	203	7	140	Retail	51	6	120
Col/Univ	375	6	120	Col/Univ	74	7	140	Col/Univ	10	1	20	Col/Univ	21	8	160
School	1,615	11	220	School	972	50	1,000	School	50	13	260	School	5	5	100
Grocery	5,593	8	160	Grocery	1,313	14	280	Grocery	345	6	120	Grocery	11	3	60
Restaurant	10,049	9	180	Restaurant	2,056	15	300	Restaurant	6	2	40	Restaurant	0	0	0
Health Care/Hosp	7,360	15	300	Health Care/Hosp	624	8	160	Health Care/Hosp	51	3	60	Health Care/Hosp	61	7	140
Hotel/Motel	1,637	9	180	Hotel/Motel	475	13	260	Hotel/Motel	39	3	60	Hotel/Motel	26	5	100
Warehouse	6,285	13	260	Warehouse	653	6	120	Warehouse	70	1	20	Warehouse	22	3	60
Personal Service	12,425	13	260	Personal Service	420	7	140	Personal Service	34	2	40	Personal Service	20	2	40
Community Service	13,945	28	560	Community Service	1,130	21	420	Community Service	95	4	80	Community Service	47	6	120
Misc. Commercial	11,237	11	220	Misc. Commercial	1,068	6	120	Misc. Commercial	185	2	40	Misc. Commercial	96	2	40
SUB-TOTAL		218	4,360	SUB-TOTAL		241	4,820	SUB-TOTAL		66	1,320	SUB-TOTAL		75	1,500
GRAND TOTAL		600	12,000												

The canvass sample included 50,000 randomly drawn customers within PG&E's service territory. It's primary function was to support the net-to-gross analysis by identifying nonparticipants who have installed program qualifying measures outside of the rebate programs. The sample design focused on identifying only nonparticipants who were not rebated in 1997. From a sample of 50,000 customers, the sample quota was targeted for 3,500 total completes with about 500 of the 3,500 having made lighting or HVAC changes.

3.1.6 Final Sample Distribution

The sample design outlined above complies with the Protocols and meets the program evaluation objectives. In this evaluation, the sampling unit is a customer site, which defines a unique service address. Applications in the MDSS database may cover more than one control number.

The final sample distribution for the telephone, on-site, and end-use metering are summarized in Exhibit 3-5 by end-use element.

Telephone Survey Sample – Telephone surveys were collected for a total of 1,409 customers, 860 of which were participants, with the remaining 549 in the comparison group. Among the 860 participants, 443 were HVAC participants. In addition, another 3,619 customers were contacted as part of the canvass survey.

Exhibit 3-5
Data Collected by Program and End Use

Program	End Use	Available Population	Data Collected: Telephone Survey	Data Collected: On-Site Audits	Data Collected: End-Use Metering	Data Used in HVAC Analysis: Telephone Survey	Data Used in HVAC Analysis: On-Site Audits	Data Used in HVAC Analysis: End-Use Metering
Custom	Lighting	3	-	-	-	-	-	-
	HVAC	33	-	28	-	-	28	-
Retrofit	Lighting	2,794	481	163	-	481	0	-
	HVAC	1,309	443	128	30	443	128	30
Total	Lighting	2,796	481	163	-	481	0	-
	HVAC	1,337	443	156	30	443	156	30
Total Participants		3,957	860	262	30	860	156	30
Total Nonparticipants		411,188	549	-	-	549	-	-
Total Sites		415,145	1,409	262	30	1,409	156	30

On-site Audit Sample – Within the Custom program, a census of HVAC participants was attempted for recruitment, with a total of 28 on-site audits completed. An additional 128 Standard measure on-sites were completed amongst sites that installed HVAC technologies. In all, a total of 156 HVAC on-site surveys were conducted.

End-Use Metering – This sample was not intended to be a random sample, nor strictly proportional to the program-avoided cost. Rather, the sample allocations were manipulated in order to assure adequate sample sizes for calibration of engineering models. A total of 30 participant sites were end-use metered.

3.1.7 Relative Precision

Given a sample design, the relative precision, based upon total annual energy use, reflects the uncertainty regarding the extent to which the allocated sample sizes are large enough to control for the population variance in terms of annual energy usage. Precision for the telephone sample was calculated using the following procedure. First, the 1995 annual energy consumption was computed for all participants in the analysis dataset.

Next, four strata were constructed based on a customers' annual usage using the Delanius-Hodges procedure. Then, the program level mean and standard error were calculated using classic stratified sample techniques[2]. Finally, the relative precision at a 90 percent confidence level was calculated as a two-tailed test. The very large customers (with annual energy usage greater than 3,000,000 kWh) were excluded from these calculations.

By survey, the following relative precision was achieved:

[2] Ibid. pp. 91-95

- For nonparticipants, the relative precision is 5.0 percent based upon a survey sample of 505[3].

- For HVAC, the relative precision is 5.7 percent based upon a survey sample of 396[4].

Exhibit 3-6 presents the stratum-level sample size, sample weight, sample mean, and estimated standard errors for each end use evaluated.

Exhibit 3-6
Telephone Sample Relative Precision Levels

Nonparticipants

Weight	Sample	Mean	STD	Standard Error	Relative Precision
89.1%	217	37,380	34,146	2,315	10.2%
9.8%	241	386,620	253,047	16,086	6.8%
1.1%	47	1,723,721	578,609	82,428	7.9%
TOTAL	505	89,863		2,746	5.0%
Large Customers					
Population = 684	38	5,538,526	3,616,668	554,106	16.5%

HVAC Participants

Weight	Sample	Mean	STD	Standard Error	Relative Precision
62.0%	224	60,952	73,197	3,497	9.4%
32.6%	145	540,333	552,477	29,772	9.1%
5.4%	27	1,596,748	464,035	54,359	5.6%
TOTAL	396	300,664		10,367	5.7%
Large Customers					
Population = 63	23	9,894,418	10,937,533	1,448,021	24.1%

[3] The nonparticipant sample size, 505, is the total sample of 549, less 38 large customers, less 6 customers with missing billing data.

[4] The HVAC participant sample size, 396, is the total sample of 443, less 23 large customers, less 24 customers with missing billing data.

3.1.8 Demonstration of Protocol Compliance

Sampling Procedures Adopted

The sample design follows the rules established by the CPUC in the March 1998 revisions to the "Protocols and Procedures for the Verification of Costs, Benefits, and Shareholder Earnings from Demand Side Management Programs."

Sample Definitions

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

Participants - According to Table 5, part C, paragraph 1 of the Protocols, participants are defined as "those who received utility financial assistance to install a measure or group of measures during the program year."

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

Overall Sampling Procedures

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

Detailed Protocol Sample Requirement

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

Analysis Dataset Sample for Commercial Participants: The Protocols require that a program with more than 450 participants has a randomly drawn sample sufficiently large to achieve minimum energy use precision of ±10 percent at the 90 percent confidence level, and at least 350 contributing points in the analysis dataset. This requirement was exceeded.

As illustrated in Exhibit 3-6, the sample collected for the HVAC end use achieved a relative precision of at least 6 percent at a 90 percent confidence level. This is below the 10 percent required by the Protocols, Table 5, part C, paragraph 4. Each participant chosen for the telephone sample is required to have at least nine months of post-installation billing data, and 12 months of pre-installation data, as per the Protocols, Table 5, part D, paragraphs 2 and 1, respectively. This requirement is met, with a pre- and post-installation period of 1 year used in the statistical billing analysis.

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

The analysis dataset meets the sample size requirement in Table 5, part C, paragraph 3. The calculated relative precision meets the precision requirement in Table 5, part C, paragraph 4. Exhibit 3-6 illustrates a relative precision of 5 percent at a 90 percent confidence interval, well below the 10 percent allowable.

To ensure compliance with comparison group protocols, the telephone survey sample frame is drawn to meet the billing data requirements of Table 5, part D, paragraphs 3 and 4 of the Protocols. All customers in the analysis dataset have billing data from January 1993 to September 1998, which ensures an adequate pre- and post-installation billing period for customers who installed applicable measures between 1995 and 1998.

3.2 ENGINEERING ANALYSIS

The technical approach and engineering results that support realized gross impacts in the 1997 Evaluation of Pacific Gas and Electric Company (PG&E) Commercial HVAC Technologies (HVAC Evaluation) are presented in this section. This section will provide detailed intermediate results that either verify or contradict the methods used to generate program design demand and energy impact estimates in the Marketing Decision Support System (MDSS). Results are presented to ensure that future program design and evaluation activities will benefit from the engineering parameters generated during the 1997 evaluation.

Additional documentation for the custom on-site analyses are found in Attachment 1. The bin weather analyses and supporting ASHRAE documentation that contributed to the RE and REO “standard” measure algorithm review can be found in Attachment 2.

This section is structured as follows:

- First, an overview of the engineering approach is presented.
- Then, details surrounding the development of impacts for central air conditioners and adjustable speed drives for fans are discussed.
- The methods used and the engineering estimates developed for REO and APO program participants or participants who installed “custom[5]” measures is then presented.
- Finally, an overview of the methods used and the engineering estimates developed for other RE and REO measures are summarized.

3.2.1 Overview of the Engineering Approach

The HVAC Evaluation consisted of the analysis of three separate PG&E programs, Retrofit Express (RE), Retrofit Efficiency Options (REO), and Advanced Performance Options (APO).

[5] Refer to *Section 3.1, Sample Design* for a discussion of “custom” vs. “standard” measures.

Where measures offered in different programs are similar (such as water chillers and adjustable speed drives), identical analysis methods were applied across all programs.

Listed below are each measure type studied and an overview of the evaluation done for each:

Central Air-Conditioners - Estimates of energy use were derived using the DOE-2.1E building energy simulation model, calibrated to logger data (see *Section 3.2.2*).

Adjustable Speed Drives (ASDs) for HVAC Fans - This measure was offered in all three of PG&E's primary programs. A calibrated engineering model was used to develop estimates based on End-Use Metering (EUM) data (see *Section 3.2.3*).

"Custom" Measures - The analysis method used data gathered from on-site audits, along with ex ante calculations, to develop engineering estimates (see *Section 3.2.4*). Measures that were included in this category included the following: Water Chillers (RE, REO, and APO), Convert to VAV, Cooling Towers, Customized EMS, and other customized technologies.

Other Measures - A detailed review of the algorithms used to develop ex ante impacts was performed for the remaining RE measures (see *Section 3.2.5*), including Window Film, Package Terminals, Set Back Thermostats, Time Clocks, and Evaporative Coolers.

It is noteworthy to mention that on-site audits and/or a detailed application review was performed for every applicant who installed a "custom" measure.

3.2.2 Central Air-Conditioners (CAC)

Demand and energy estimates of savings and impact for the program measures associated with Central Air Conditioning (CAC) were determined on a per unit basis using the DOE-2 building energy simulation program.

The engineering analysis combines end-use logger data, and detailed on-site audit data with information from telephone surveys to supply reliable engineering estimates of both *savings* and *impact*. There is an important distinction between these two values. Estimates of *savings* are used as inputs to a statistically-adjusted engineering (SAE) regression model, and use the pre-existing unit's efficiency. This estimate will be larger than the *impact* estimate, whose calculation is based on current Title 24 efficiencies. The *impact* estimate is used for calculating ex post energy and demand.

The engineering estimates for CAC were developed as follows:

- Develop DOE-2 models
- Calibrate DOE-2 models
- Create undiversified and diversified energy models
- Calculate CAC energy savings
- Compute energy and demand impacts

On-site audit data were used to develop DOE-2 models of office, school, and retail facilities that participated in the program. These models were then calibrated using end-use logger data from 30 sites, in conjunction with California Energy Commission (CEC) weather data adjusted for local temperatures[6]. The resulting hourly estimates were then diversified and leveraged to additional building types using telephone survey data cooling system operating schedules. Finally, the DOE-2.1E model estimates were regenerated using long term weather (TMY) data and CEC baseline equipment efficiencies to compute program impacts.

Develop DOE-2 Models

Audit and weather data were analyzed to determine the number of DOE-2.1E prototypes needed to represent typical participating office, school, and retail facilities. The primary variables reviewed were conditioned square footage, cooling degree days across climate zone, and building size and construction characteristics.

For CAC Measures it was determined that Office participants could be represented by two prototypes, segmented by climate zones (climate zones 1-5 versus 11-16). It was determined that for School and Retail, participants could be represented by one prototype since the relationship between energy use and building size appears to be relatively linear, and due to the more limited sample size for these two building types.

For all prototypes, lighting density was entered using equipment holdings and lighting schedules collected during each on-site. Lighting schedules were based on segment average operating profiles using on-site audit data that were collected in support of both the Lighting and HVAC Evaluations.

Key characteristics for the three prototypes are detailed in Exhibit 3-7.

Calibrate DOE-2 Models

To ensure that the modeled results were accurate and reasonable, models were calibrated to end-use logger data for CAC technologies and current billing data. Calibration was performed by comparing DOE-2 simulations run under weather data from different climate zones with the respective logger data. Minimum ventilation, miscellaneous equipment watts per square foot, and economizer control strategies were used in calibrating the model.

Billing data were then used to verify the accuracy of the calibration across climate zones. This was accomplished by comparing the annual estimates of HVAC and lighting usage to annual billing data for the sites that contributed to each prototype.

---

[6] This approach is consistent with the approach used for the 1995 and 1996 HVAC Program year evaluation. Observed dry bulb temperatures from PG&E local office weather stations were integrated along with addition weather parameters from WYEC climate zone data.

Exhibit 3-7
Key Characteristics for DOE-2.1E Prototypes

Variable	Office03 CAC	Office13 CAC	Retail CAC	School CAC
Conditioned Area (Sq Ft)	41,263	5,291	4,478	8,953
Slab Floor Area (Sq Ft)	7,749	4,565	4,063	7,737
Gross Wall Area (Sq Ft)	19,841	2,610	2,972	5,305
Frame Wall Area	41%	58%	34%	83%
Block Wall Area	59%	42%	66%	17%
Frame Insulation	R-3	R-9	R-7	R-4
Block Insulation	R-1	R-2	R-1	R-2
Roof Area (Sq Ft)	9,045	4,692	4,364	8,895
Roof Insulation	R-7	R-11	R-14	R-19
Ceiling Height (Ft)	9	9	11	13
Window Type	Single Shaded	Single Shaded	Single Clear	Single Clear
Cooling Capacity (Btuh)	837,122	231,917	181,565	465,744
Number of Occupants	165	19	15	119
Thermostat Setpoint (°F)	71	74	75	73

Create Undiversified and Diversified Energy Estimates

Using the calibrated DOE-2.1E prototypes discussed above, undiversified energy usage estimates were created by setting the HVAC system to operate 24 hours a day. Other operational aspects of the building, such as lighting and miscellaneous equipment schedules, were based on audit data and information calculated in the Lighting Evaluation. The calibrated DOE-2 models were run using the adjusted CEC weather data in each climate zone. The weather data covered October 1, 1997, through September 30, 1998, the post-retrofit period used in the SAE model.

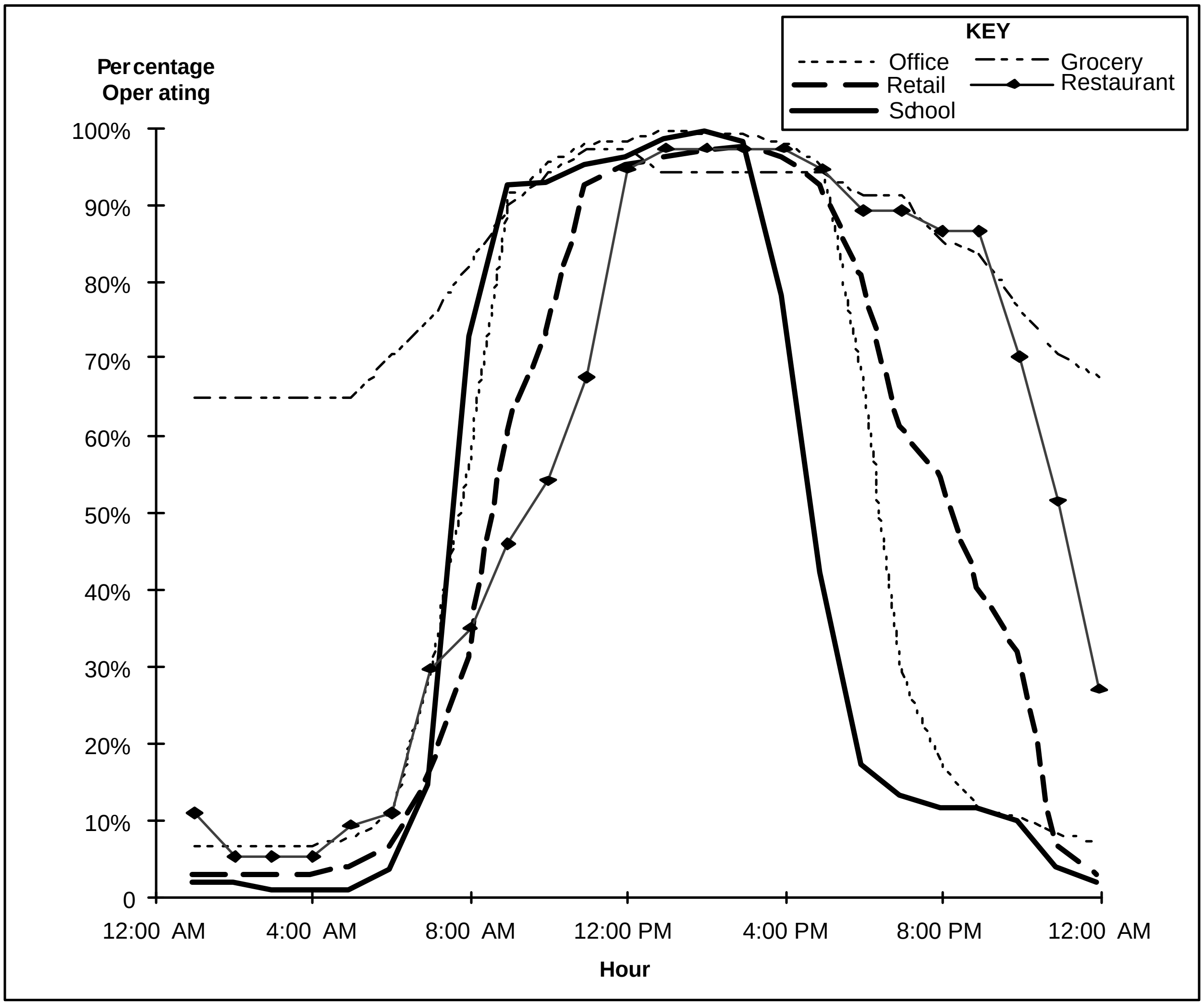
Undiversified CAC savings estimates (used in the SAE model) were generated using the installed efficiencies of the retrofit equipment taken from the MDSS and estimated existing efficiencies based on the size of the retrofit unit. The existing efficiencies used were based on 1988 Title 24 standards, downgraded to reflect a 15 year old CAC system, the assumed equipment life for these types of systems. Impact estimates used in the calculation of ex post gross impacts were based on Title 24 efficiencies, providing relatively smaller impact than the savings estimates.

For CAC, the DOE-2.1E prototypes provide simulated annual energy usage, at an hourly level for Office, School, and Retail business types in all climate zones where there was program participation. All other business types are mapped to either the Office, School or Retail prototypes.

The simulated, hourly cooling and fan energy use was diversified for each business type by hourly self-reported operating factors gathered through telephone surveys. The operating factor is defined as the percentage of facilities reporting the availability of space conditioning for a given hour and season. Business type specific hourly operating factors for key business types are illustrated in Exhibit 3-8. Note that these are average, annual profiles. The School business type underwent an additional adjustment for the summer months of June, July, and August. For those months, the diversified load was multiplied by 27 percent, which is the telephone survey reported peak operating factor. This additional factor reflects the large reduction in occupancy within schools during the summer months.

The result of this step are a series of hourly loads for CACs adjusted for the occupancy and operational patterns of participants.

Exhibit 3-8
Annual Average HVAC Operating for Key Business Types



CAC Energy Savings

For all CAC energy usage and savings estimates, a method of calculation incorporating Equivalent Full Load Hours (EFLH) was developed. The EFLH is defined as the total annual cooling energy usage, divided by the connected load for the CAC unit. The diversified CAC energy model produced an annual equivalent full load hour (EFLH) estimate for each business type and climate zone.

Energy savings estimates for each site in the SAE sample were calculated using estimated EFLH, total tons retrofit, post retrofit EER, and an assumed existing EER as discussed previously. Energy savings were computed for each participant in the SAE sample using the equation in Exhibit 3-9.

Exhibit 3-9
Equation for Estimating CAC Energy Savings

$$kWh_{sav,i} = U * \left[EFLH_j * T * 12 * \left(\frac{1}{EER_1} - \frac{1}{EER_{MDSS}} \right) \right]$$

Where,

$kWh_{sav,i}$ = Annual energy savings for participant "j" (kWh / yr.);

U = Number of units installed;

$EFLH_j$ = Diversified Equivalent Full Load Hours for business type j;

T = Number of tons installed;

12 = Conversion of tons to kBtuh;

EER_1 = Existing System EER; and,

EER_{MDSS} = Post-retrofit EER.

Compute Energy and Demand Impacts

The final step in the analysis of CAC measures was the calculation of energy and demand impacts for each participant for use in the ex-post gross impacts. The energy savings estimates described above were based on actual adjusted weather data for dates between October 1, 1997 through September 30, 1998; that were then used as inputs to the SAE analysis. The following steps were taken to convert the energy *savings* estimates to *impact* estimates:

Current CEC - CEC weather data[8] were used to generate the calibrated DOE-2.1E energy estimates, instead of actual adjusted CEC weather data.

---

[8] Approved for use with the 1992 and 1995 Energy Efficiency Standards for Residential and Nonresidential Buildings. Referred to on magnetic media as CZxxRV2.WY2, where xx indicates the climate zone.

Baseline - CAC savings estimates were adjusted to reflect the difference between post-retrofit conditions and minimum efficiencies defined by Title 24, rather than the pre-retrofit equipment.

CAC peak demand impacts were based on an undiversified peak duty cycle calculated from the logger data. For each loggered CAC unit, the five highest weekday duty cycles occurring between 3 and 4 PM were selected as representing undiversified peak duty cycles. The average of these duty cycles was calculated by business type. In order to develop Coincident Diversity Factors (CDF), the undiversified peak duty cycles by business type were multiplied by operating factors. The operating factors were developed by business type and climate zone, which resulted in CDFs for each combination of business type and climate zone. Demand impacts were computed for each participant in the MDSS using the equation in Exhibit 3-10.

Exhibit 3-10
Equation for Estimating CAC Demand Savings

$$kW_{sav,i,j,k} = U * \left[CDF_{j,k} * T * 12 * \left(\frac{1}{EER_1} - \frac{1}{EER_{MDSS}} \right) \right]$$

Where,

$kW_{sav,i,j,k}$ = Peak demand impact for participant I, in business type j, climate zone k;

U = Number of units installed;

$CDF_{j,k}$ = Coincident Diversity Factor for business type j, climate zone k;

T = Number of tons per installed unit;

EER_1 = Baseline EER; and,

EER_{MDSS} = Post-retrofit EER.

3.2.3 Adjustable Speed Drives (ASDs) for Ventilation Fans

Demand and energy impacts for the Adjustable Speed Drive measures for all programs were computed using empirical relationships drawn from observed metered data and weather data. These estimates were normalized by motor horsepower and then leveraged to the entire participant population.

The engineering analysis combines detailed on-site audit data with information from telephone surveys to supply reliable engineering estimates of both *savings* and *impact*. There is an important distinction between these two values. Estimates of *savings* are used as inputs to a statistically-adjusted engineering (SAE) regression model, and use actual adjusted CEC weather data. This estimate will be different from the *impact* estimate, whose calculation is based on long term weather data. The *impact* estimate is used for calculating ex post energy and demand.

The engineering estimates for ASD measures were developed as follows:

- Clean metered frequency and demand data
- Compute fully loaded demand for each fan
- Calculate fan savings normalized by motor HP
- Correlate frequency data with outdoor temperature or time
- Compute annual undiversified savings and impact
- Diversify savings and impact estimates with operating factors
- Compute energy and demand impacts for all participants

EUM data collected for the 1996 HVAC Evaluation were used to develop an ASD model of hourly savings broken out by peak and off-peak usage and binned by weather temperature. These models were then calibrated using CEC weather data adjusted for local temperatures. The resulting hourly estimates were then diversified (to get an annual kWh estimate of savings) and leveraged to additional building types using telephone survey data of operating factors. Finally, ASD model estimates were regenerated using long term weather to compute program impacts.

Clean Metered Frequency and Demand Data

EUM data were collected for Office and Grocery building types. At each site, data were collected for both interval kWh and output frequency of the ASD. After the data had been successfully downloaded, a cleaning process was carried out to screen for unreasonable data. Based on field logs and observations within the data, small amounts of data were censored and omitted from the analysis. Typically, missing data were the result of meter read errors that resulted in unrecognizable character output.

Compute Fully Loaded Demand For Each Fan

In order to compute impacts and savings associated with the ASD installations, the demand for each fan running at constant volume had to be estimated. Based on the well established ASD operating curve, the fully loaded or 100 percent flow case, was computed for each observation of operating fan data. A fan was defined as "operating" if the observed frequency at interval i was greater than 15 Hertz (Hz). The equation shown in Exhibit 3-11 was then applied to estimate the percentage of power drawn by the ASD during that interval.

Exhibit 3-11
Baseline Interval Demand Estimate

$$kW_{100,i} = \frac{kW_i}{PER_{kW,i}} \text{ and}$$

$$PER_{kW,i} = 0.2198 - \left[0.8748 * \left(\frac{Hz_i}{60}\right)\right] + \left[1.6526 * \left(\frac{Hz_i}{60}\right)^2\right]$$

Where,

$kW_{100,i}$ = Fully loaded draw of the fan during interval i;

kW_i = Observed frequency during interval i;

$PER_{kW,i}$ = The percent of ASD load in operation during interval i; and

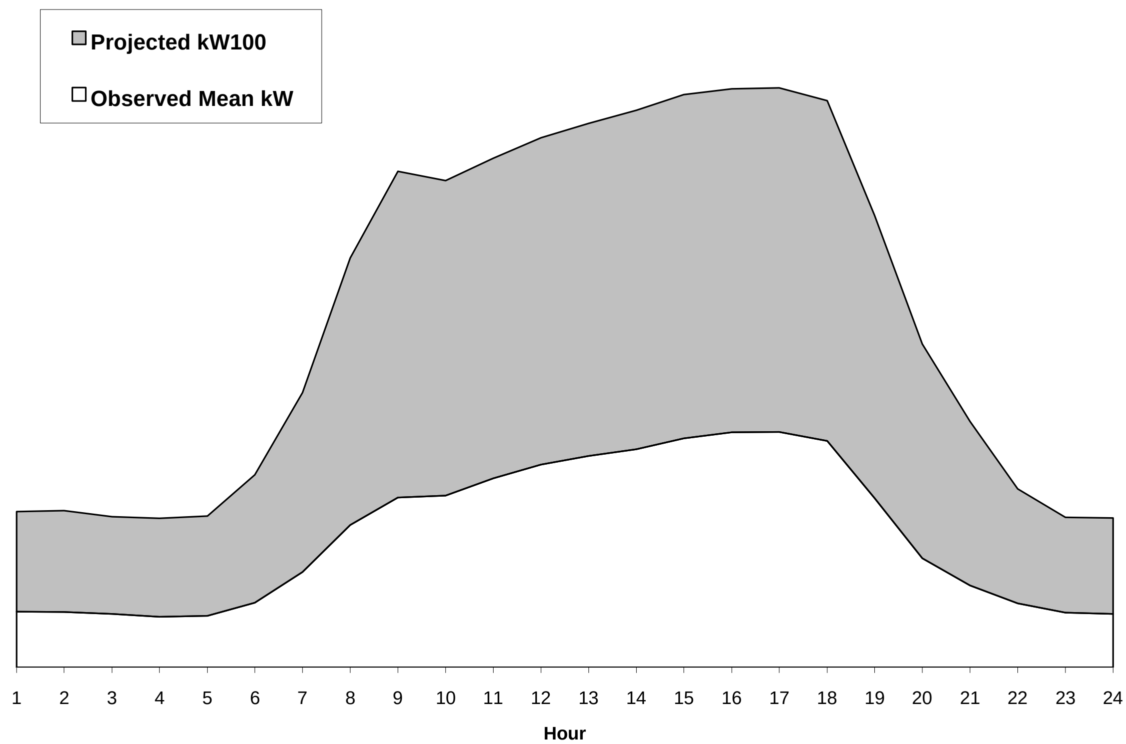
Hz_i = The recorded Hz during interval i;

The fully loaded draw of the fan is the observed energy use for that interval divided by the percent power in operation. The percent of frequency is computed as the observed frequency divided by a base of 60 Hz. The final step is to take the mean of the fully loaded fan estimates for each observation, and use this value as the constant volume case.

Calculate Fan Savings Normalized by Motor HP

After the mean, fully loaded demand for each fan is calculated, savings estimates are generated by subtracting the observed demand for each hour from the computed fully loaded demand. This difference, for each observation, is the gross savings associated with the given fan. Exhibit 3-12 below illustrates the mean weekday fully loaded demand profile for all fans in the EUM sample, compared to the observed demand.

Exhibit 3-12
Average Weekday Comparison of
kW vs. kW$_{100}$



This process of calculating gross savings was carried out for all of the observed data for each of the fans. Since few of the fans were of the same motor horsepower, the data had to be normalized in order to average the results. This was accomplished by simply dividing the savings estimate for each fan by the fans' motor horsepower. The resulting hourly dataset of savings estimates was then represented as kW savings per motor horsepower.

Correlate Average Fan Savings with Outdoor Temperature or Time

In order to compute annual savings and typical year impacts, the monitored data needed to be correlated with another parameter to project savings for the unmonitored period, and for a typical weather year. The first step in correlating the observed fan usage with another parameter was to assess the data for usage patterns. An initial investigation revealed that the metered data could be divided into two categories, those that varied with time, and those that varied with temperature. The division of these sites clearly indicated that the grocery stores operated fans on fixed schedules, while the office sites allowed the fans to adjust throughout the course of the day. Based on these observations, the sample was divided into two categories, fixed operation for the grocery stores and variable operation for the office facilities. For the grocery stores, projecting savings and impacts for other time periods was very simple, since the assumption was made that the per-horsepower savings were consistent over time. For the variable case, the following process was used to project impacts.

For each of the metered sites, real-time weather data collected from various sites throughout PG&E's service territory was merged onto the calculated normalized hourly savings estimates by date and time. Similar to the calculation of full load, the data was then flagged as either operating or not operating based on the observed frequency. In addition, the data were also subdivided based on the hour of day, with daytime being defined as 8:00 AM to 7:00 PM, and nighttime as the remaining hours.

The data were then sorted by temperature and average, per-horsepower savings estimates were generated in 5 degree temperature bins. That is, for all observations of savings, within a given temperature bin and time of day, the average per-horsepower savings was calculated. The result was two curves, one for daytime and one for nighttime, of per-horsepower savings as a function of temperature.

Compute Annual Undiversified Savings and Impact

The next step in the process was to use the savings relationships identified above, to estimate annual savings and impacts. At this point it should be noted that the only difference between savings estimates and impact estimates is in the weather data used in the computation. Savings estimates, to be consistent with the billing data used in the SAE analysis, were computed using actual weather data from October 1, 1997 through September 30, 1998. Impact estimates were computed using the current California Energy Commission (CEC) approved long-term average weather data. In both cases, estimates were generated by climate zone for representative weather stations.

Using the temperature dependent savings curves developed above and both sets of weather data, full year savings estimates were generated with the actual weather data and impact estimates were generated using the CEC weather data. This was accomplished by simply selecting the appropriate temperature dependent savings estimate for the given temperature associated with the particular hour of weather data. Note that no restrictions were placed on the savings calculations for operating conditions, meaning that the equipment is assumed to always be available. The resulting datasets were hourly savings estimates on a per-horsepower basis.

Diversified Savings and Impact Estimates with Operating Factors

The last step in the process, prior to computing participant specific impacts, was to diversify the fully loaded operating savings estimates to reflect the best information available in terms of operating hours. This was accomplished by first collapsing the full year savings estimates into representative daytypes and then applying the survey-derived operating factor. For this study, average daytypes were developed for weekdays, Saturdays, and Sundays/Holidays. To do this, the savings estimates for each contributing day for a given month and daytype were simply averaged by hour of day. After the averaging had been accomplished, the daytype specific operating factor for each business type was applied to the average daytype savings estimate.

These diversified savings estimates were then summed to produce daily, total, per-horsepower savings estimates for each month, daytype, and business type. The final step in this process was to multiply the daily totals for each daytype by the number of days in each month/daytype to generate monthly totals. These totals were in turn summed, to produce monthly, per-horsepower savings estimates by business type and climate zone.

Compute Savings and Impact Estimates for All Participants

The final step in the process was to produce annual savings and impact estimates for each participant in the MDSS. Using the savings and impact estimates generated above, final participant-specific estimates were generated by selecting the appropriate annual savings value by business type and climate zone, and then multiplying by the installed number of horsepower. Savings estimates, generated with 1997-1998 weather data were used as input for the SAE analysis, while impact estimates provided the gross engineering estimate of impact that supported the ex post analysis.

The final step in the analysis of ASD measures is the calculation of energy and demand impacts. The energy savings estimates described above were based on weather data for dates between October 1, 1997, through September 30, 1998; and were used as inputs to the SAE analysis. To convert the energy *savings* estimates to *impact* estimates, long term weather data was used in lieu of adjusted CEC weather data. Separate estimates of kWh and kWh_{100} were calculated, and energy impacts calculated using the same equation applied in Exhibit 3-13.

Exhibit 3-13
Equation for Estimating ASD Energy Savings

$$kWh_{sav,i} = U_i * \left[kWh_{100,jz} - kWh_{jz} \right]$$

Where,

$kWh_{sav,i}$ = Annual energy impact for customer i (kWh / yr.);

U_i = Total retrofit Horsepower for customer i;

$kWh_{100,jz}$ = Annual diversified energy use per horsepower for business type j (kWh / yr.) and climate zone z for fans without adjustable speed drives;

kWh_{jz} = Annual diversified energy use per horsepower for business type j (kWh / yr.) and climate zone z for fans with adjustable speed drives;

To calculate ASD peak demand, the ten hottest weekday temperatures (observed any time between the hours of 12PM to 6PM) for each climate zone were averaged together. This average represents the hottest temperature at peak time (where, presumably the fan would be operating at its maximum capacity). The savings estimate from the correct temperature bin (which the hottest mean temperature fell into) was selected as an estimate of peak demand.

This was done for each climate zone, with the resulting estimate adjusted by the mean operating factor of the premise's business type, as shown in Exhibit 3-14.

Exhibit 3-14
Equation for Estimating ASD Demand Impacts

$$kW_{imp,i} = OF_j * [kW_{100} - kW]$$

Where,

$kW_{imp,i}$ = Peak demand impact for participant i;

OF_j = Mean weekday operating factor between the hours of 12PM to 6PM for business type j;

kW_{100} = Estimated mean peak demand of the fan without an ASD; and,

kW = Observed mean peak demand of the fan with an ASD.

3.2.4 Custom Measures

The following RE, REO and APO technologies were considered part of the "custom" measure segment:

- Chillers;
- Convert to VAV;
- Cooling Towers;
- Customized EMS; and,
- Other Customized Equipment and HVAC Technologies.

Every application that installed a "custom" measure was requested for thorough engineering review. Because only 33 sites installed custom measures, a census was conducted for conducting the on-site audits, which resulted in a total of 28 site visits.

When on-site data were available, a comparison was made between on-site data and data found in the MDSS and on the application forms. If a discrepancy was found between the audit data and the ex ante impacts, then one or both of the following were developed on a premise-specific basis:

- Temperature bin models

- Spreadsheet-based algorithms

If a participant site did not receive an on-site audit, the application form was thoroughly reviewed for errors in calculations. Generally, the custom applications were well documented, and an independent estimate of both savings and impacts could be derived. In some instances for chillers, average “realization rates” (defined as the ratio of the engineering estimate to the ex-ante estimate) from on-site surveys conducted at several sites would be transferred to the remaining chillers that did not undergo an on-site audit.

Attachment 1 contains a summary of information regarding the development of impacts for each custom measure participant who had an on-site visit. Details surrounding the site-specific calculations (including the spreadsheets used to generate the QC unadjusted engineering impacts) can also be found in Attachment 1.

3.2.5 Other RE Measures

For RE measures other than CAC, ASDs, and Water Chillers, the evaluation approach was based on a review of the algorithms and input assumptions used to develop the ex ante impacts. The aim of the evaluation was to either confirm or correct the methods and inputs used in the ex ante estimates.

When applicable, the engineering algorithms used by PG&E to develop ex ante impacts for RE measures were reviewed thoroughly (algorithms were taken from the 1997 Advice Filing[9]). For each measure, the following analysis steps were performed in an algorithm review:

- Ex ante impacts were re-calculated using methods and inputs listed in the Advice Filing.

- Evaluation impacts are developed using revised methods and inputs when applicable. When possible, inputs and methods were verified using either sources referenced in the Advice Filing or alternate sources such as ASHRAE, the CEC or ARI.

The following pages contain a written one page summary of information regarding the development of impacts for each algorithm-based RE measure. The summary provides an overview of the algorithm review used to develop per unit impacts which were in turn applied to the contents of the MDSS to determine unadjusted engineering estimates of impact and savings. Detailed information surrounding the development of the algorithms used in the unadjusted engineering estimates (including bin analysis and per-unit comparisons of advice filing recommendations on program evaluation) can be found in Attachment 2.

---

[9] PG&E 1997 Customer Energy Efficiency Programs Advice Letter No. 1978-G / 1608-E, filed October 1996.

Setback Programmable Thermostats

Measure Description: Installation of setback programmable thermostats in spaces with regular occupied and unoccupied periods.

Summary of Advice Filing Calculations: A bin analysis method was employed to create per thermostat energy and therm impacts. Demand impacts were not calculated, as setback thermostats do not affect peak demand.

Comments on Advice Filing Calculations: Program review has shown that the per-unit impacts were applied to each participant with the assumption that each thermostat controlled the conditioning of 5,000 sq ft of office space, regardless of building size or type. These impacts were not adjusted to account for different climate zones.

Comments on Advice Filing Inputs: Incorrect return air values were used to determine the heating and cooling loads during setback hours. Weather data was for San Jose, and thus only represented one climate zone.

Evaluation Process: Energy and therm impacts were developed using modified return air values during setback hours and binned weather data from all 16 California climate zones. A conditioned square footage value was developed for each participant using MDSS, survey, and audit data. Climate zone-specific impacts (leveraged by square footage) were then applied.

Additional Notes: If the ex ante assumptions for a given premise indicated only energy impacts, then no therm impact was developed.

Package Terminal AC Units

Measure Description:	Installation of high efficiency packaged terminal air-conditioners and heat-pumps. This measure provides an incentive to install PTAC and PTHP units that exceed Title 20 standards.
Summary of Advice Filing Calculations:	Demand and energy impacts were developed using equivalent full load hours (ELFHs), coincident demand factors (CDFs), and system efficiency.
Comments on Advice Filing Calculations:	Calculation methods cited in the Advice Filing do not accurately model participant specific retrofits. This is due to a generalized assumption regarding typical efficiency and capacity upgrades.
Comments on Advice Filing Inputs:	Sufficient data are not available to verify either the CDF or the EFLH values used in the calculation. ELFHs do not take climate zone variation into account.
Evaluation Process:	Using the change in EER for each site (based upon the MDSS), a revised equation was used in conjunction with Advice Filing EFLH and CDF values, to estimate per participant impacts.
Additional Notes:	

Reflective Window Film

Measure Description:	Provides an incentive for the installation of reflective window film on clear non-North facing glazing.
Summary of Advice Filing Calculations:	Cooling loads attributable to solar heat gain were calculated using equation 27.41 of the ASHRAE Fundamentals Handbook (p.27.24). Per square foot energy and demand impacts were estimated for applied reflective film.
Comments on Advice Filing Calculations:	Methods used to determine energy and demand impacts are valid.
Comments on Advice Filing Inputs:	A review of the inputs from ASHRAE revealed a discrepancy between the annual solar heat gains listed in ASHRAE and those used in Advice Filing calculations.
Evaluation Process:	Energy and demand estimates were developed using the correctly applied ASHRAE method.
Additional Notes:	

Direct Evaporative Coolers

Measure Description:	Provides an incentive for the replacement of an existing AC unit with an equally sized direct evaporative cooler system. Measure participation is restricted to certain climate zones.
Summary of Advice Filing Calculations:	Demand and energy savings were developed on a per ton basis for each climate zone using fan operating characteristics, temperature design conditions, and cooling degree hours.
Comments on Advice Filing Calculations:	Calculation methods cited in the Advice Filing do not accurately model participant specific retrofits. In some cases, negative demand and energy savings are calculated.
Comments on Advice Filing Inputs:	The inputs used in the calculations do not account for variations in evaporative cooler fan size.
Evaluation Process:	Demand and energy savings were determined using climate zone-specific cooling degree hours, fan motor horsepower and the efficiency of the existing AC unit. Impacts were developed using motor efficiency values listed in the baseline assumptions for the RE Motors program.
Additional Notes:	

Bypass Timer

Measure Description:	Installation of a bypass timer to control the fans of a space which is intermittently occupied after hours when the space conditioning system is off.
Summary of Advice Filing Calculations:	Using fan motor horsepower, assumed hours of operation and a fan load/efficiency value, energy savings were developed. No demand savings are estimated since bypass timers do not affect the peak demand.
Comments on Advice Filing Calculations:	The percent a fan is loaded is generally independent from efficiency.
Comments on Advice Filing Inputs:	The fan load/efficiency value is not substantiated with documentation. Assumed hours of operation are poorly documented.
Evaluation Process:	Energy impacts were developed using fan load and motor efficiency values listed in the baseline assumptions for RE HVAC measures and the RE Motors program, respectively.
Additional Notes:	

Timeclocks

Measure Description: Installation of timeclocks, which regulate HVAC usage in spaces with regular occupied and unoccupied periods.

Summary of Advice Filing Calculations: A bin analysis method was employed to create per timeclock energy impacts. Demand impacts were not calculated, as timeclocks do not affect peak demand.

Comments on Advice Filing Calculations: Program review has shown that the per-unit impacts were applied to each participant with the assumption that each timeclock controlled the conditioning of 5,000 sq ft of office space, regardless of building size or type. These impacts were not adjusted to account for different climate zones.

Comments on Advice Filing Inputs: Weather data was for San Jose, and thus only represented one climate zone.

Evaluation Process: Energy and therm impacts were developed using modified return air values during setback hours and binned weather data from all 16 California climate zones. A conditioned square footage value was developed for each participant using MDSS data. Climate zone-specific impacts (leveraged by square footage) were then applied.

Additional Notes: If the ex ante assumptions for a given premise indicated only energy impacts, then no therm impact was developed.

Water and Evaporative Cooled Single Package AC Unit

(135,000 Btu/hr)

Remote Condensing Unit (RCU); Air-Cooled

(135,000 Btu/hr)

Remote Condensing Unit (RCU); Water- and Evaporative- Cooled (135,000 Btu/hr)

Measure Description: All three measures involve the replacement of an existing standard-efficiency AC unit with a high-efficiency unit that exceeds Title 20 specifications.

Summary of Advice Filing Calculations: Demand and energy impacts were developed using equivalent full load hours (ELFHs), coincident demand factors (CDFs), and system efficiency.

Comments on Advice Filing Calculations: Calculation methods cited in the Advice Filing do not accurately model participant specific retrofits. This is due to a generalized assumption regarding typical efficiency and capacity upgrades.

Comments on Advice Filing Inputs: Baseline efficiencies are consistent with Title 20 standards.

Sufficient data are not available to verify either the CDF or the EFLH values used in the calculation.

ELFHs do not take climate zone variation into account.

Evaluation Process: Using the change in EER for each site (based upon the MDSS), a revised equation was used in conjunction with EFLHs (developed as part of the evaluation of the RE Central AC measures), to estimate per participant impacts.

3.3 BILLING REGRESSION ANALYSIS

This section documents the detailed analytical steps undertaken in the billing regression analysis of Pacific Gas and Electric Company's (PG&E's) 1997 CEEI Programs. The section begins with a discussion of the analysis periods and data sources used in the billing regression model. Then, the results of the data censoring that was applied to the analysis sample are provided. Next, the gross billing analysis regression model specification and SAE coefficients are presented, along with the relative precision calculations. Finally, the net billing analysis regression model specification and results are presented.

3.3.1 Overview

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

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

As discussed in detail below, the billing regression analysis was conducted on a sample of telephone surveyed participants and nonparticipants. Because many Commercial Program participants installed measures under multiple end uses, one integrated billing analysis approach was used to model both the Lighting and HVAC end uses. This section of the report presents the analysis findings for both end uses – as each was an essential input to the overall model used.

3.3.2 Data Sources for Billing Regression Analysis

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

Program Participant Tracking System

The participant tracking system for the Retrofit Express (RE), Retrofit Efficiency Options (REO), and Advanced Performance Options (APO) Programs are maintained as part of the MDSS. It contains program applications, rebate and technical information about installed measures; including measure descriptions, quantities installed, rebated amounts, and ex ante demand, energy, and therm savings estimates. The MDSS database is linked to the billing database and other program databases through PG&E's customer specific control number.

PG&E Billing Data

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

A second billing dataset was later obtained from PG&E Load Data Services for use in the SAE analysis. This billing dataset contains bill readings that run from January 1998 through September 1998. The resulting combined dataset represents the billing series of PG&E pro-rated monthly usage data for each calendar month from January 1993 to September 1998.

Weather Data

The hourly dry bulb temperature collected for 25 PG&E load research weather sites was used in the billing regression analysis to calculate total monthly cooling degree days for each month in the analysis period. For each customer in the analysis dataset, the appropriate weather site was linked to that customer by using the PG&E-defined weather site to PG&E local office mapping (embedded in the account code for each customer).

Telephone Survey Data

All available telephone surveys collected as part of the evaluation for the HVAC Program (except for the Canvass surveys, which do not collect detailed information regarding changes that have occurred at the premise) were used as inputs to the billing regression analysis. Two telephone survey samples totaling 1,409 sample points (443 of which were HVAC participants and 549 nonparticipants) were collected for the HVAC Evaluation. Because of cross-over among participants across Commercial Program end uses, one integrated billing regression model was developed to evaluate both the Lighting and HVAC Program end uses.

The data collected in the telephone survey supplies information on energy-related changes at each site for the billing period covered by the billing regression analysis. For a detailed discussion of the telephone survey and the final sample disposition, see *Survey Appendices*. A discussion of the sample design can be found in *Section 3.1*.

Engineering Estimates

Engineering estimates of savings were estimated for each of the 443 HVAC participants. Separate estimates of energy savings were calculated for every measure installed under a Commercial Program. The engineering estimates were calculated based on expected savings from the pre-installation technology to the post-installation technology. For some technologies, such as Central A/C's installed in the HVAC Program, these savings estimates will differ from the impact estimates. This is due to the impacts being calculated relative to a baseline efficiency, compared to the savings estimates, which are based on a pre-existing unit's efficiency. In the example above, many CAC's existing efficiency had a SEER rating much lower than the program baseline estimate. Consequently, the savings estimate for energy would be much higher. The engineering analysis (*Section 3.2*) discusses the calculation of the savings estimates used in the billing analysis in greater detail.

3.3.3 Data Aggregation and Analysis Dataset Development

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

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

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

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

Of the three, the premise number serves as the best indicator of a unique site. However, there are some premise numbers that contain multiple sites. To address this issue, the customer's service address was also used to help identify a unique site. If there was more than one service address for a premise number, it was broken out into multiple sites. Therefore, a unique site was defined as all of the control numbers within a unique combination of service address,[10] premise number, and corporation number. A unique Site ID was created based on this combination of address, premise, and corporation to serve as the key variable for linking data.

The billing data was provided at the control number level. To meet the needs of the analysis team, the monthly billing data had to be aggregated to the Site ID level. One concern with aggregating to the Site ID level is that there may be control numbers associated with a different premise number, service address, or corporation number that are in the same physical site and are being affected by the installed measures. If this is the case, the billing analysis will have the effect of underestimating the impacts. This a topic that will be discussed further in the *Data Censoring* section below.

[10] Because of potential data entry errors in the billing system, or inconsistencies in tracking service addresses in the billing system, only the first eight characters of the service address were used. Generally, this would contain the numeric portion of the address and the first few characters of the street name. For the large majority of records in the billing system, premise number and service address were unique.

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

The engineering estimates of change were also aggregated to the Site ID level. However, prior to aggregating to the Site ID level, the installation dates for each individual measure were analyzed to ensure that only the impacts occurring within the billing analysis periods were being aggregated. The selection of analysis periods is discussed in the next section.

All data elements mentioned above were linked to the final analysis database by Site ID. Exhibits 3-15 and 3-16 below provide the sample frame that was available for the billing analysis for HVAC participants and nonparticipants. The sample sizes are provided by business type and technology (for participants) and by business type only for nonparticipants. The values presented are the unique number of the Site IDs within a given segment.

Exhibit 3-15
Billing Analysis Sample Frame
Pre-Censoring
HVAC End-Use Technologies

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	70	31	5	43	4	23	18	5	18	14	48	11	290
	Adjustable Speed Drives	25			1			1	2					29
	Package Terminal A/C	2			1	1	1		16					21
	Set-Back Thermostat	6	1	2	8			4		2	2	1	2	28
	Reflective Window Film	29	4	1		1	1	8		5	3	4	3	59
	Water Chillers													
	Other HVAC Technologies		1			1	2		1					5
Retrofit Express Program Total		132	37	8	53	7	27	31	24	25	19	53	16	432
REO	Adjustable Speed Drives	3												3
	Water Chillers							1			1	1		3
	Cooling Towers													
Retrofit Efficiency Options Program Total		3						1			1	1		6
APO	Adjustable Speed Drives	2												2
	Water Chillers													
	Customized EMS	1												1
	Convert To VAV													
	Other Customized Equip										1			1
	Other HVAC Technologies									1				1
Advanced Performance Options Program Total		3								1	1			5
Total		138	37	8	53	7	27	32	24	26	21	54	16	**443**

Exhibit 3-16
Billing Analysis Sample Frame
Pre-Censoring
Nonparticipants

Program and Technology Group	Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Nonparticipant Total	146	84	15	62	28	24	30	28	22	24	59	27	**549**

3.3.4 Analysis Periods

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

In accordance with the Protocols, participants are defined by the "paid date" instead of "installation date." Therefore, all customers paid in 1997 actually installed measures in 1993, 1994, 1995, 1996 or 1997. HVAC installations prior to 1996 accounted for less than 1 percent of the total program.

Selection of Installation Date

While the billing regression analysis is used to model the change of consumption attributable to the program measures, the first step is to isolate the pre- and post-installation periods for each customer in the analysis database, so that the impact of these measures can be verified. For customers who installed these energy saving measures during the pre- or post-installation period, their energy savings must be prorated to account for energy consumption using the older technologies.

Although installation date is a field in the MDSS, it is rarely populated (less than 6 percent of the time). And because the "paid date" (another field in the MDSS) can vary from the installation date by as much as 4 years, another approach had to be developed to estimate an installation date. For 70 percent of the MDSS records, a pre- and post-installation inspection date was collected. In most cases where the installation date was populated, it's value fell between the pre- and post-installation inspection dates. Therefore, we can derive from these two variables a time interval containing the installation date.

Another variable found in the MDSS, project completion date, is populated 85 percent of the time. Analysis of the project completion date lead us to believe it was the best "largely populated" variable. It was very similar to the project completion date, and fell within the pre- and post-installation inspection dates. However, another variable was needed to fill in the remaining 15 percent of installation dates. Yet another date field in the MDSS that is populated 100 percent of the time is the date the application was received by PG&E. This date almost always occurs after the pre-installation inspection date (when populated) and rarely exceeds the post-installation inspection date (when populated) by more than a month (only 4 percent of the time). Consequently, the application received date served as an excellent proxy for the remaining installation dates, when the project completion date was not populated.

In addition to the dates recorded in the MDSS, the telephone survey asked every participant to estimate the installation date. If their self-reported installation date fell between the pre- and post-installation inspection dates (as recorded in the MDSS), the customer reported date was used.

Selection of Analysis Periods

The selection of the primary analysis period has to be defined in such a way that allows for the inclusion of the majority of the sample with high-quality data.

Billing data were available from January 1993 through September 1998. To maximize the number of post installation months in the regression model, a post period of October 1997 through September 1998 was used. As illustrated in Exhibit 3-17, this post period occurs after 80 percent of the installation dates.

Based on the selection of post period, there are only two feasible pre-periods that could have been used: October 1994 through September 1995 (a 1995 pre-period), and October 1995 through September 1996 (a 1996 pre-period). Exhibit 3-17 suggests that almost every installation occurred between January 1996 and December 1997. In order to minimize the number of installation periods for which the engineering estimate would have to be pro-rated, it was decided to use the 1995 pre-period.

For installations that occurred prior to the pre-installation period, the engineering impact is set to zero. For installations that occurred during either the pre- or post-installation period, the engineering impact is only aggregated over the months for which there is an impact that should be realized.

Exhibit 3-17 provide the cumulative participation by month for the participants that are part of the billing analysis sample frame.

3.3.5 Data Censoring

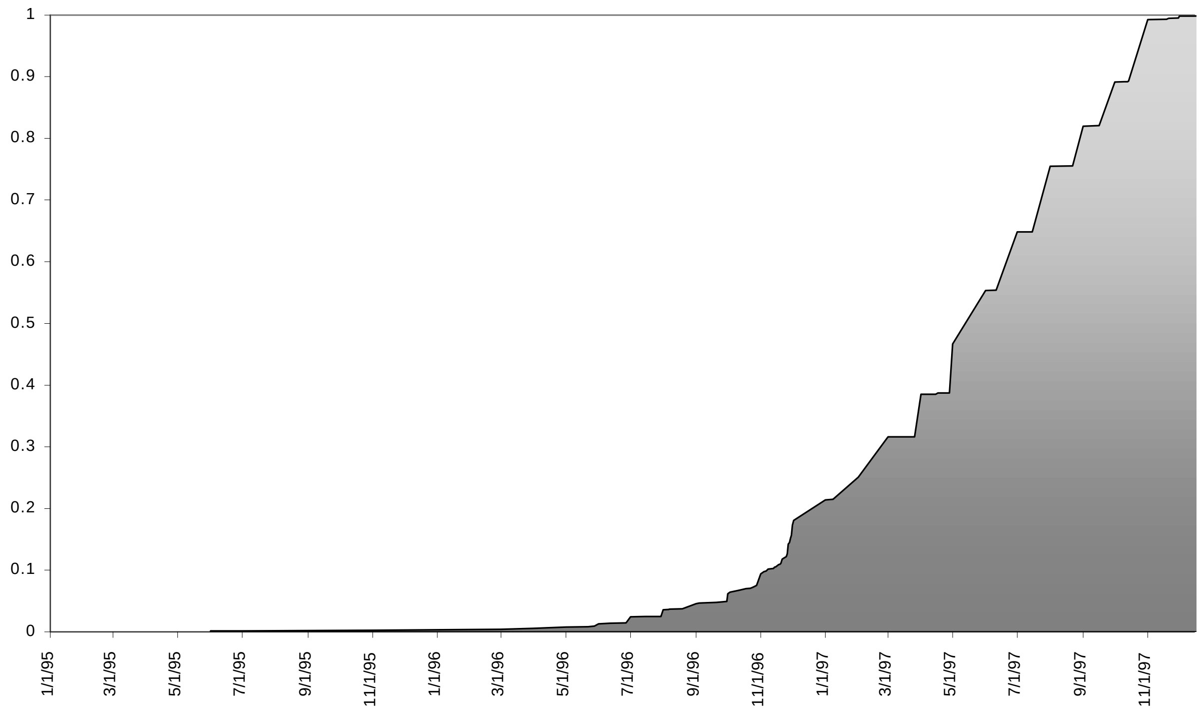
Three types of data censoring screens were applied to the billing analysis sample frame to remove customers: those that had invalid billing data, those that may not have had their bill properly aggregated to the Site ID level, or those that were extremely large users.

Invalid Usage

For customers to be included in the final billing analysis, customers had to have billing data that met the following criteria:

The pre- and post-installation annual bills had to have been comprised of at least nine non-zero monthly bills. If there were four or more monthly bills with zero energy, the customer was removed from the analysis. If there were between one and three monthly bills with zero energy, the remaining months were prorated to an annual estimate.

Exhibit 3-17
Commercial HVAC Rebated Technologies
By Estimated Installation Date



The pre-installation annual bill could not be more than three times or less than one third the post-installation bill. If this occurred, the customer was removed from the analysis.

The number of employees at the facility could not have doubled, or been cut in half. This criteria is only applied to customers with at least 100 employees. Furthermore, the size of the facility in square feet could not have doubled, or been cut in half. If either of these criteria occurred, the customer was removed from the analysis.

Finally, customers were removed from the analysis if they had a measure installed under the program that would result in an increase in usage. These individuals were identified through customer interviews.

Exhibit 3-18 presents the number of participants and nonparticipants that were deleted for each of the above criteria. Note that only 29 nonparticipants were deleted, whereas 99 participants were deleted. This is due to the fact that the nonparticipants were pre-screened to have relatively valid billing data prior to being selected into the nonparticipant survey sample frame. The participants, however, were often a census and no pre-screening was done on their billing data prior to being selected into the participant survey sample frame. Of the 99 participants, 69 were deleted due to the zero bill criteria.

Large Customers

Customers whose annual pre-installation energy consumption exceeded three million kWh were excluded from the billing analysis. A total of 49 participants and 34 nonparticipants were dropped for this reason. This decision was made *a priori* to collecting the survey data, as is documented in the Evaluation Research Plan; and is based upon the results of the previous three Lighting Evaluations, all of which were unsuccessful in obtaining reliable results when including customers with usage above this level. This is also consistent with the recommendations made by the Verification Reports of PG&E's 1995 and 1996 Commercial Lighting Evaluation, which stated in 1995 that "program effects can be difficult to detect for large customers," and recommended censoring large customers for the final billing analyses.

Although the decision to censor these customers was made *a priori*, large participants and nonparticipants were still surveyed (as discussed above in the *Section 3.1, Sample Design*) in order to meet other evaluation objectives.

Exhibit 3-18
Distribution of Customers Removed from Billing Analysis
By Data Censoring Criteria
Customers with Invalid Billing Data

Participant or Nonparticipant	Zero Monthly Bills >= 4	Employee or Square Footage Double or Cut in Half	Usage Tripled or Cut by a Third	Measure Caused Increase in Usage	Number Removed From Analysis
NP	NO	NO	YES	NO	1
NP	NO	YES	NO	NO	2
NP	YES	NO	NO	NO	18
NP	YES	NO	YES	NO	8
TOTAL					29
P	NO	NO	NO	YES	4
P	NO	NO	YES	NO	19
P	NO	YES	NO	NO	7
P	YES	NO	NO	NO	14
P	YES	NO	YES	NO	55
TOTAL					99

Aggregation to Site ID Level

As mentioned above, one concern with aggregating to the Site ID level is that there may be control numbers associated with a different premise number, service address, or corporation number that are in the same physical site and are being affected by the installed measures. Therefore, a comparison was made between the engineering energy impact and the aggregated pre- and post-installation bills to identify any customers where this problem of bill aggregation may exist. In addition, both a ratio of energy to square feet (from the MDSS and the survey), and energy to employee was calculated for each participant to further aid in the identification of poorly aggregated sites.

There were 241 HVAC and/or lighting participants that were identified as having total Commercial Sector Program energy impacts that were either more than 50 percent of their pre-installation usage or whose energy to square foot or energy to employee ratio was in the bottom 10th percentile of the participant population. These 241 participants were further analyzed to determine whether the impact was large relative to usage because of a problem in aggregating the bill, or if the engineering estimates were just over-estimated. In the latter case, the customer would **not** be removed from the billing analysis.

Three criteria were used to determine if there was a problem with aggregating the bill for these 241 participants. If a participant failed any of these criteria, the customer was removed from the analysis on the basis that their billing data were not properly aggregated to the Site ID level, and the entire impact would not be detected in an analysis of the customer's billing data.

- If the customer's energy impacts were greater than 100 percent of their pre-installation usage and any one of their annual kWh per square foot or annual kWh per employee was in the bottom tenth percentile of all participants, the customer was removed.

- If the customer's energy impacts were greater than 50 percent of their pre-installation usage and either their annual kWh per square foot or annual kWh per employee was in the bottom tenth percentile of all participants, the customer was removed.

- If the customer's energy impacts were greater than 25 percent of their pre-installation usage and all three of the annual kWh per square foot and annual kWh per employee ratios were in the bottom tenth percentile of all participants, the customer was removed.

As a result of these three criteria, 61 of the 241 premises were removed. Of the 61 removed customers, 24 also failed the invalid usage data screening checks. Therefore, only an additional 37 premises were removed based solely upon the data screening criteria described above.

Exhibit 3-19 presents the number of participants that were removed from the analysis for each of the above criteria.

In summary, out of the original sample frame of 549 nonparticipants, 62 were removed for bad billing data or for being an extremely large customer. This low attrition rate can be attributed to the fact that the nonparticipant sample was pre-screened for invalid billing data (though not for large usage, as they may have served as a control group for the participants). Of the original sample of 860 HVAC and lighting participants, 181 were removed because of bad billing, improper site aggregation, or because they were large customers. Of these 181 customers, 94 were HVAC participants.

Exhibit 3-19
Distribution of Customers Removed from Billing Analysis
By Data Censoring Criteria
Customers with Billing Aggregation Problems

Low Usage Per Sqft (MDSS)	Low Usage Per Sqft (Survey)	Low Usage Per Employee	Estimated Savings Greater Than Usage	Low Usage Relative to Estimated Savings	Number Removed From Analysis
NO	NO	NO	YES	NO	2
YES	NO	NO	NO	YES	7
YES	NO	NO	YES	NO	3
NO	NO	YES	NO	YES	1
YES	NO	YES	NO	YES	2
YES	NO	YES	YES	NO	3
NO	YES	NO	NO	YES	1
YES	YES	NO	NO	YES	7
YES	YES	NO	YES	NO	7
NO	YES	YES	NO	YES	2
NO	YES	YES	YES	NO	1
YES	YES	YES	NO	NO	8
YES	YES	YES	NO	YES	6
YES	YES	YES	YES	NO	11
TOTAL					61

Exhibit 3-20 summarizes the total number of participants and nonparticipants that were removed from the billing analysis. Exhibits 3-21 and 3-22 present the final sample sizes used in the billing analysis by business type and technology for HVAC participants and by business type for nonparticipants.

Exhibit 3-20
Distribution of Customers Removed from Billing Analysis By Data Censoring Criteria

Participant or Nonparticipant	Zero Monthly Bills >= 4	Employee or Square Footage Double or Cut in Half	Usage Tripled or Cut by a Third	Measure Caused Increase in Usage	Large Customer	Bill Not Aggregated Properly	Number Removed From Analysis
NP	NO	NO	NO	NO	YES	NO	33
NP	NO	NO	YES	NO	NO	NO	1
NP	NO	YES	NO	NO	NO	NO	1
NP	NO	YES	NO	NO	YES	NO	1
NP	YES	NO	NO	NO	NO	NO	18
NP	YES	NO	YES	NO	NO	NO	8
TOTAL							62
P	NO	NO	NO	NO	NO	YES	37
P	NO	NO	NO	NO	YES	NO	45
P	NO	NO	NO	YES	NO	NO	4
P	NO	NO	YES	NO	NO	NO	8
P	NO	NO	YES	NO	NO	YES	10
P	NO	NO	YES	NO	YES	NO	1
P	NO	YES	NO	NO	NO	NO	4
P	NO	YES	NO	NO	YES	NO	3
P	YES	NO	NO	NO	NO	NO	11
P	YES	NO	NO	NO	NO	YES	3
P	YES	NO	YES	NO	NO	NO	44
P	YES	NO	YES	NO	NO	YES	11
TOTAL							181

Exhibit 3-21
Billing Analysis Sample Used Post-Censoring HVAC End-Use Technologies

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	52	25	2	38	4	18	16	3	14	13	38	9	232
	Adjustable Speed Drives	18			1			1						20
	Package Terminal A/C	2			1		1		13					17
	Set-Back Thermostat	5	1	2	6			4		2	2	1	1	24
	Reflective Window Film	23	3			1	1	6		4	3	4	1	46
	Water Chillers													
	Other HVAC Technologies		1			1	1		1					4
Retrofit Express Program Total		100	30	4	46	6	21	27	17	20	18	43	11	343
REO	Adjustable Speed Drives	2												2
	Water Chillers							1				1		2
	Cooling Towers													
Retrofit Efficiency Options Program Total		2						1				1		4
APO	Adjustable Speed Drives	1												1
	Water Chillers													
	Customized EMS													
	Convert To VAV													
	Other Customized Equip													
	Other HVAC Technologies									1				1
Advanced Performance Options Program Total		1								1				2
Total		103	30	4	46	6	21	28	17	21	18	44	11	**349**

Exhibit 3-22
Billing Analysis Sample Used
Post-Censoring
Nonparticipants

Program and Technology Group	Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Nonparticipant Total	130	81	15	59	27	24	23	23	16	19	51	19	**487**

3.3.6 Model Specification

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

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

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

Baseline Model

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

$$kWh_{post,i} = \sum_j (b_j kWh_{pre,i}) + g(\Delta CDD_i) * kWh_{pre,i} + \sum_k h_k NChg_{i,k} + e$$

Where,

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

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

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

b , g and h are the estimated slopes on their respective independent variables. Separate slopes on pre-usage are estimated by business type; and,

e is the random error term of the model.

For each customer in the analysis dataset (participants and nonparticipants), a post-installation predicted usage value is calculated using the parameters of the baseline models estimated for the 1995 to 1998 analysis period. They both take the same functional form with different segment-level intercept series and slopes (b and g):

$$k\hat{W}h_{post,i} = F_{pre}(kWh_{pre}, \Delta CDD) = \sum_j (b_j kWh_{pre,i}) + g(\Delta CDD_i) * kWh_{pre,i}$$

It should be noted that the post-installation predicted usage is not a function of changes that occurred at the premise. As was discussed in *Section 3.1, Sample Design*, the control group was chosen to represent the participant sample with respect to business type and usage. It is very unlikely that the control group could be considered a representative control group for the types of changes that have occurred at the premise, simply because the participants are all installing some type of equipment and only a fraction of the nonparticipants are making changes. Furthermore, participants are installing rebated high efficiency equipment (HVAC, Lighting, and other) through the program, so it is unlikely that the other HVAC and Lighting equipment changes made outside the program are similar to those made by nonparticipants. Finally, it is likely that changes made by participants outside the program will have interaction effects with the measures rebated. Therefore, the incremental effects of participant changes made outside the program on energy usage will be different than those of the nonparticipants. For these reasons, the customer self-reported change variables from the survey data ($NChg_{i,k}$), were not included in the estimate post-installation predicted usage. The SAE model discussed below did include the participant and nonparticipant self-reported change variables to control for the differences between actual and predicted post-installation usage.

This issue was a major point of contention during the verification study of the 1996 CEEI Evaluation. The recommendation made by the verification study was to include the change variables in the estimation of the post-installation predicted usage. However, the Independent Reviewers agreed with PG&E that these change variables should not be included in the post-installation predicted usage. Attachment 5 provides PG&E's rebuttal to the verification study, which provides a detailed justification for the model specification used in both this year's and previous years' evaluations.

PG&E and Quantum Consulting, who has acted as PG&E's evaluation contractor for the past four years, met with the ORA's verification contractor, ECONorthwest, to discuss this issue in more detail. ECONorthwest agreed that applying the nonparticipant parameters for the change variables to the participants was not correct for the reasons described above and in PG&E's

rebuttal in Attachment 5. However, ECONorthwest raised an additional concern regarding the lack of inclusion of nonparticipants in the second stage SAE Model. ECONorthwest suggested the use of a switching regression[11] to address their concerns with the inclusion of the nonparticipants. PG&E and Quantum Consulting have researched this approach and implemented various alternative models, including the model suggested in the 1996 verification study, which are presented in Section 3.3.8.

Exhibit 3-23 summarizes the final baseline model results that were estimated using 487 nonparticipant customers, as discussed in the *Data Censoring* section. Exhibit 3-23 summarizes the independent variables used in the baseline model, together with the t-statistics and the sample sizes available for each parameter estimate used to predict the post-period usage. The final functional relation is estimated as follows:

Baseline Model (1995 to 1998):

$$
\begin{aligned}
k\hat{W}h_{98,i} = {} & 1.04 * SM\_OFF5 + 1.13 * OTH\_OFF5 + 1.00 * SM\_RET5 + 1.11 * OTH\_RET5 \\
& + 1.05 * SM\_SCH5 + 1.01 * OTH\_SCH5 + 1.07 * GROCERY5 + 1.19 * RESTRNT5 \\
& + 0.99 * HOSP5 + 1.20 * HOTMOT5 + 0.90 * WHRSE5 + 1.09 * PERSVC5 \\
& + 1.09 * SM\_COM5 + 1.03 * OTH\_COM5 + 1.19 * MISC5 \\
& + 0.001419 * CDD2_{98-95,i} * kWh_{95,i} + 0.001144 * CDD3_{98-95,i} * kWh_{95,i} \\
& - 0.003439 * CDD4_{98-95,i} * kWh_{95,i} + 0.000667 * CDD11_{98-95,i} * kWh_{95,i} \\
& - 0.001024 * CDD12_{98-95,i} * kWh_{95,i} + 0.000034 * CDD13_{98-95,i} * kWh_{95,i} \\
& + 0.001732 * PDD1_{98-95,i} * kWh_{95,i} - 0.000353 * PDD11_{98-95,i} * kWh_{95,i}
\end{aligned}
$$

[11] For a fuller explanation of switching regressions refer to:

Green, W., "Econometric Analysis," Macmillan Publishing Company, NY, 1990, pp. 748-750.

Maddala, G. S., "Limited-Dependent and Qualitative Variables in Econometrics," Cambridge University Press, Cambridge, 1987, pp. 283-290.

Exhibit 3-23
Billing Regression Analysis Final Baseline Model Outputs

Parameter Descriptions	Analysis Variable Name	Units	Parameter Estimate	t-Statistic	Sample Size
Pre-Usage					
Small Office	SM_OFF5	kWh	1.043700	1.95	47
Large Office	OTH_OFF5	kWh	1.130374	48.30	83
Small Retail	SM_RET5	kWh	1.003485	1.40	32
Large Retail	OTH_RET5	kWh	1.108575	41.15	49
Small Schools	SM_SCH5	kWh	1.052200	26.71	72
Large Schools	OTH_SCH5	kWh	1.009962	18.71	2
Grocery	GROCERY5	kWh	1.066998	33.19	27
Restaurant	RESTRNT5	kWh	1.192380	22.15	24
Hospital	HOSP5	kWh	0.993186	16.78	23
Hotel/Motel	HOTMOT5	kWh	1.198843	30.87	23
Warehouse	WHRSE5	kWh	0.903872	4.68	16
Personal Service	PERSVC5	kWh	1.092735	18.37	19
Small Comm. Service	SM_COM5	kWh	1.091094	2.36	23
Large Comm. Servcie	OTH_COM5	kWh	1.028249	26.66	28
Miscellaneous	MISC5	kWh	1.191013	16.24	19
Weather Changes					
Change in CDD CliZone 2	CDD2_85	CDD*kWh	0.001419	2.09	37
Change in CDD CliZone 3	CDD3_85	CDD*kWh	0.001144	2.23	137
Change in CDD CliZone 1,4,5	CDD4_85	CDD*kWh	-0.003439	-3.04	48
Change in CDD CliZone 11	CDD11_85	CDD*kWh	0.000667	1.06	41
Change in CDD CliZone 12	CDD12_85	CDD*kWh	-0.001024	-3.59	70
Change in CDD CliZone 13,16	CDD13_85	CDD*kWh	0.000034	0.08	48
Positive Change in CDD CliZone 1-5	PDD1_85	CDD*kWh	0.001732	3.55	43
Positive Change in CDD CliZone 11-16	PDD11_85	CDD*kWh	-0.000353	-1.37	63
Other Site Changes					
Lighting Changes	LGT_CHG5	kWh	-0.042143	-1.66	47
HVAC Changes	AC_CHG5	kWh	-0.022783	-0.76	60
Other Equipment Changes	OTH_CHG5	kWh	0.137414	3.74	40
Square Footage Changes	SQFT_CH5	# Sqft*kWh	12.151441	4.58	31
Employee Changes	EMP_CHG5	# Emp*kWh	574.101061	1.88	91

SAE Model

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

$$
\begin{aligned}
kWh_{98,i} - k\hat{W}h_{98,i} &= kWh_{98,i} - F_{95}(kWh_{95}, \Delta CDD) \\
&= \sum_m b'_m Eng_m + \sum_k r'_k PChg_{i,k} + \sum_k h'_k NChg_{i,k} + m_i
\end{aligned}
$$

Where,

$kWh_{98,i}$ and $kWh_{95,i}$ are customer i's annualized energy usage for the post- and pre-installation periods, respectively;

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

$b'_m Eng_m$ are the participant engineering impacts;

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

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

The difference between predicted and actual usage in 1998 was used as the dependent variable in a SAE model. Based upon the estimated participation month, the pro-rated engineering estimates and change variables were used to explain the deviation of the actual usage from the predicted usage. As discussed above, the predicted usage is estimated using only the comparison group to forecast the 1998 usage as a function of 1995 usage and change of cooling degree days from 1995 to 1998. This usage prediction presents what would have happened in the absence of any changes made at the facility, either rebated or done outside of the program.

3.3.7 Billing Regression Analysis Results

The coefficients of the engineering impact, termed the SAE coefficients, are then used to calculate the ex post gross energy impacts. Independent realization rates are estimated to provide PG&E with business type- and technology group-level results. Exhibit 3-24 summarizes the final SAE model results that were estimated using 1,166 customers (679 participants and 487 nonparticipants), as discussed in the *Data Censoring* section. The exhibit illustrates the independent variables used in the SAE model, together with the t-statistics and the sample sizes available for each parameter estimate.

The dependent variable is the difference between the actual and predicted 1998 usage using the 1995 baseline model.

SAE coefficients are calculated for seven different combinations of business type and measure. Primarily those measures that have broad participation and relatively high expected impacts were supported by separate SAE coefficients. In addition, a separate SAE coefficient was calculated for other Commercial Program measures outside the Lighting and HVAC end uses.

Exhibit 3-24
Gross Billing Regression Analysis Final Model Outputs

Parameter Descriptions	Analysis Variable Name	Units	Parameter Estimate	t-Statistic	Sample Size
SAE Coefficients					
Lighting End Use					
Lighting Offices	LGTOFF5	kWh	-0.856125	-5.15	154
Lighting Retails	LGTRET5	kWh	-1.357155	-2.10	78
Lighting Schools	LGTSCH5	kWh	-0.613314	-1.91	51
Lighting Miscellaneous	LGTMSC5	kWh	-0.859361	-2.35	92
HVAC End Use					
Retrofit Express Measures	RETX5	kWh	-1.061511	-3.43	324
ASDs	ASD5	kWh	-0.853041	-2.94	25
Custom HVAC	CSTHVC5	kWh	-10.290247	-4.05	3
Other End Uses					
Other Impacts	OTHMEAS5	kWh	1.413001	2.45	22
Change Variables					
Part Lighting Changes	LGT_CHG5	kWh	-0.174985	-8.83	74
Part HVAC Changes	AC_CHG5	kWh	-0.004323	-0.22	123
Part Other Equipment Changes	OTH_CHG5	kWh	0.148858	5.00	39
Part Square Footage Changes	SQFT_CH5	# Sqft*kWh	2.540250	0.92	32
Part Employee Changes	EMP_CHG5	# Emp*kWh	138.243740	0.92	137
Nonpart Lighting Changes	LGT_NON5	kWh	-0.042143	-2.06	47
Nonpart HVAC Changes	AC_NON5	kWh	-0.022783	-1.01	60
Nonpart Other Equipment Changes	OTH_NON5	kWh	0.137414	4.27	40
Nonpart Square Footage Changes	SQFT_NO5	# Sqft*kWh	12.151441	4.57	31
Nonpart Employee Changes	EMP_NON5	# Emp*kWh	574.101061	1.97	91

Attempts were made to estimate the SAE coefficients at a finer level of segmentation, but generally either one of two problems were encountered. First, available sample sizes were too small to support a finer level of segmentation. Or second, certain parameters were correlated with each other and needed to be combined into a single parameter (a standard econometric solution to solving the problem of collinearity). For example, it was determined that there was a high incidence of central air conditioners and setback thermostat installations at the same site in office buildings. Therefore, there was enough correlation between the central air conditioners and setback thermostat engineering estimates to warrant combining the two estimates into a single office estimate in the model.

Because of the high incidence of many types of standard HVAC measures being installed at the same premise and some of the low sample sizes, the HVAC analysis was conducted for three distinct technology groupings: ASDs, other RE measures, and other Custom measures. ASDs were modeled separately because the model indicated a highly significant result for ASDs, and there was little cross participation among ASDs and other HVAC measures. Other RE measures were modeled separately from Custom measures because the application of the technologies is very different, and there is a lower rate of incidence of RE measures being installed with Custom measures.

All of the HVAC SAE coefficients are significant at the 95 percent confidence level, and all were of the correct sign. The Custom HVAC parameter estimate, however, was found to be extremely large, 10.3, indicating that the actual impact was ten times as large as the engineering estimate. Because the sample for Custom HVAC consisted of only 3 sites, and because the engineering estimates were based on calibrated engineering models, the SAE results for Custom HVAC were not used. Instead, the calibrated engineering estimates were used as the ex-post energy estimates (which is equivalent to setting the SAE coefficient to one). It should be noted that this approach is Protocol compliant, as the Protocols accept calibrated engineering estimates in lieu of a statistically adjusted engineering impact.

Impact estimates from the MDSS for other end uses were included in the model for customers that installed measures outside the Lighting and HVAC end uses. It is not recommended that this value be used because the sample may not be representative of the population of participants installing these measures.

In addition to the SAE Coefficients, independent variables were included to capture changes in lighting, HVAC and other equipment, made outside of the program, as well as changes made to the size (square footage) of the building and with the number of employees. Separate change variables were developed for participants and nonparticipants for the reasons discussed above and provided in Attachment 5. Section 3.3.8 below discusses in more detail the decision to include nonparticipants in the SAE model.

Of these change variables, the parameter estimates for participant and nonparticipant lighting and other equipment changes, and for nonparticipant square footage and employee changes are significant at the 90 percent confidence level. All of the signs on these coefficients were as expected. The final SAE coefficients for the HVAC end use is provided in Exhibit 3-25. The SAE coefficient is multiplied by the evaluation estimates of gross energy impact to calculate the gross ex post energy impacts.

Exhibit 3-25
Commercial HVAC Gross Energy Impact SAE Coefficients
By Business Type and Technology Group

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.
Retrofit Express	Central A/C	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
	Adjustable Speed Drives	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
	Package Terminal A/C	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
	Set-Back Thermostat	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
	Reflective Window Film	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
	Water Chillers	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	Other HVAC Technologies	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Retrofit Express Program Total													
REO	Adjustable Speed Drives	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
	Water Chillers	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	Cooling Towers	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Retrofit Efficiency Options Program Total													
APO	Adjustable Speed Drives	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
	Water Chillers	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	Customized EMS	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	Convert To VAV	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	Other Customized Equip	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	Other HVAC Technologies	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Advanced Performance Options Program Total													
Total													

Relative Precision Calculation

Relative precision at 90 percent and 80 percent confidence levels for the adjusted gross energy impact estimates are calculated for each of the SAE analysis segments. As mentioned above, there are a total of three analysis segments that were explicitly modeled, and the relative precision estimates based upon the model output are presented in Exhibit 3-26 below. In order to calculate the total program level adjusted gross impact and relative precision, the segment-level results were weighted by their unadjusted engineering energy impact estimates in the following equations.

$$\text{Total Adjusted Energy Impact} = \sum_i \hat{a}_i Eng_i$$

Where b_i and Eng_i are the SAE coefficients and unadjusted engineering impact estimates for segment i, respectively. The program level standard error can be estimated as:[12]

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

Where,

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

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

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

Where,

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

Exhibit 3-26 presents the relative precision calculations.

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

Exhibit 3-26
Relative Precision Calculation

SAE Analysis Level	Gross Engineering Energy Impact (kWh)	SAE Coefficient	t-Statistic	Relative Precision at 80%	Relative Precision at 90%
HVAC End Use					
Retrofit Express Measures	13,513,342	-1.06	3.43	37%	48%
ASDs	11,221,575	-0.85	2.94	44%	56%
Custom HVAC	5,781,710	-1.00	n/a	-	-
HVAC Total	30,516,627	-0.97	4.54	28%	36%

3.3.8 Alternative Gross Billing Model Specifications

As discussed above, the manner in which the nonparticipant change variables were applied in the estimate of the post-period usage, was a major point of contention during the verification study for the 1996 CEEI Evaluation. One of the major recommendations made in the verification study was to include the change variables in the estimation of the post-installation predicted usage. However, the Independent Reviewers agreed with PG&E that these change variables should not be included in the post-installation predicted usage. Attachment 5 provides PG&E's rebuttal to the verification study, which gives a detailed justification for the model specification used in both this year's and previous years' evaluations, along with the Independent Reviewers' testimony regarding this decision.

PG&E, Quantum Consulting (QC) and ECONorthwest met prior to conducting this year's analysis to discuss this issue in more detail in an attempt to resolve any issues that may arise in the future. ECONorthwest agreed that applying the nonparticipant parameters for the change variables to the participants was not correct for the reasons described above and in PG&E's rebuttal in Attachment 5. As discussed above, ECONorthwest raised an additional concern regarding the lack of inclusion of nonparticipants in the second stage SAE Model, and suggested the use of a switching regression to address this issue.

PG&E and QC have researched this approach and implemented various alternative models, which are presented here. All together five separate model specifications were attempted, as described below.

The first model implemented, referred to as the "**1996 QC Model**", was identical to that implemented for the 1996 evaluation. This model did not apply the nonparticipant changes to the estimate of post-period usage. In the second stage SAE Model, only participants were included, and the change variables were also included.

1996 QC MODEL

Baseline Model

$$kWh_{post,i} = \sum_j (b_j kWh_{pre,i}) + g(\Delta CDD_i) * kWh_{pre,i} + \sum_k h_k Chg_{i,k} + e$$

Predicted Participant Post Usage

$$k\hat{W}h_{post,i} = F_{pre}(kWh_{pre}, \Delta CDD) = \sum_j (b_j kWh_{pre,i}) + g(\Delta CDD_i) * kWh_{pre,i}$$

SAE Model – Participants Only

$$kWh_{post,i} - k\hat{W}h_{post,i} = kWh_{post,i} - F_{pre}(kWh_{pre}, \Delta CDD) = \sum_m b'_m Eng_m + \sum_k h'_k Chg_{i,k} + m_i$$

Where,

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

The second, third and fourth models implemented, referred to as “SR Model 1” through “SR Model 3”, implemented switching regressions. Each model was similar in that it did not apply the nonparticipant changes to the estimate of post-period usage, and in the second stage SAE Model, both participants and nonparticipants were included. However, the three models differed in the way that the change variables were handled in the second stage SAE Model.

SR Model 1 included five common change variables (lighting, HVAC, other equipment, SQFT, and employees), which indicated that the change occurred at either a participant or nonparticipant facility. Therefore, the participants and nonparticipants had the same parameter estimates for each change variable. This model is specified as follows:

SR MODEL 1

Baseline Model

$$kWh_{post,i} = \sum_j (b_j kWh_{pre,i}) + g(\Delta CDD_i) * kWh_{pre,i} + \sum_k h_k Chg_{i,k} + e$$

Predicted Participant and Nonparticipant Post Usage

$$k\hat{W}h_{post,i} = F_{pre}(kWh_{pre}, \Delta CDD) = \sum_j (b_j kWh_{pre,i}) + g(\Delta CDD_i) * kWh_{pre,i}$$

SAE Model – Participants and Nonparticipants

$$kWh_{post,i} - k\hat{W}h_{post,i} = kWh_{post,i} - F_{pre}(kWh_{pre}, \Delta CDD)$$
$$= \sum_m b'_m Eng_m + \sum_k h'_k Chg_{i,k} + m_i$$

Where,

$Chg_{i,k}$ in the baseline model includes only nonparticipant self-reported change variables from the survey data, including adding, replacing, or removing equipment associated with major end uses, and changes in number of employees and in facility square footage; and in the SAE model, both participant and nonparticipant change variables are included;

SR Model 2 included ten change variables, which were the same five change variables (lighting, HVAC, other equipment, SQFT, and employees) interacted with participation type. Therefore, the participants and nonparticipants had different parameter estimates for each change variable. This model is specified as follows:

SR MODEL 2

Baseline Model

$$kWh_{post,i} = \sum_j (b_j kWh_{pre,i}) + g(\Delta CDD_i) * kWh_{pre,i} + \sum_k h_k NChg_{i,k} + e$$

Predicted Participant and Nonparticipant Post Usage

$$k\hat{W}h_{post,i} = F_{pre}(kWh_{pre}, \Delta CDD) = \sum_j (b_j kWh_{pre,i}) + g(\Delta CDD_i) * kWh_{pre,i}$$

SAE Model – Participants and Nonparticipants

$$kWh_{post,i} - k\hat{W}h_{post,i} = kWh_{post,i} - F_{pre}(kWh_{pre}, \Delta CDD)$$

$$= \sum_m b'_m Eng_m + \sum_k r'_k PChg_{i,k} + \sum_k h'_k NChg_{i,k} + m_i$$

Where,

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

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

SR Model 3 included eight change variables. This model included the same five change variables (lighting, HVAC, other equipment, SQFT, and employees); however, the lighting, HVAC and other equipment variables were interacted with participation type, but the SQFT and employee variables were shared. Therefore, the participants and nonparticipants had different parameter estimates for the lighting, HVAC and other equipment variables, but the same parameter estimate for the SQFT and employee variables. This model is specified as follows:

SR MODEL 3

Baseline Model

$$kWh_{post,i} = \sum_j (b_j kWh_{pre,i}) + g(\Delta CDD_i) * kWh_{pre,i}$$

$$+ \sum_k s_k GChg_{i,k} + \sum_k h_k NChg_{i,k} + e$$

Predicted Participant and Nonparticipant Post Usage

$$k\hat{W}h_{post,i} = F_{pre}(kWh_{pre}, \Delta CDD) = \sum_j (b_j kWh_{pre,i}) + g(\Delta CDD_i) * kWh_{pre,i}$$

SAE Model – Participants and Nonparticipants

$$kWh_{post,i} - k\hat{W}h_{post,i} = kWh_{post,i} - F_{pre}(kWh_{pre}, \Delta CDD)$$

$$= \sum_m b'_m Eng_m + \sum_k s'_k GChg_{i,k} + \sum_k r'_k PChg_{i,k} + \sum_k h'_k NChg_{i,k} + m_i$$

Where,

$GChg_{i,k}$ are the participant and nonparticipant self-reported change variables from the survey data associated with changes in number of employees and in facility square footage;

$PChg_{i,k}$ are the participant self-reported change variables from the survey data, including adding, replacing, or removing equipment associated with major end uses;

$NChg_{i,k}$ are the nonparticipant self-reported change variables from the survey data, including adding, replacing, or removing equipment associated with major end uses;

The fifth model implemented, referred to as the "**ORA Model**", was identical to that recommended in the verification study. This model applied the nonparticipant changes to the estimate of post-period usage. In the second stage SAE Model, only participants were included, and no change variables were included.

ORA MODEL

Baseline Model

$$kWh_{post,i} = \sum_j (b_j kWh_{pre,i}) + g(\Delta CDD_i) * kWh_{pre,i} + \sum_k h_k NChg_{i,k} + e$$

Predicted Participant Post Usage

$$k\hat{W}h_{post,i} = F_{pre}(kWh_{pre}, \Delta CDD) = \sum_j (b_j kWh_{pre,i}) + g(\Delta CDD_i) * kWh_{pre,i} + \sum_k h_k NChg_{i,k}$$

SAE Model – Participants Only

$$kWh_{post,i} - k\hat{W}h_{post,i} = kWh_{post,i} - F_{pre}(kWh_{pre}, \Delta CDD) = \sum_m b'_m Eng_m + m_i$$

Where,

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

Obviously, we feel strongly that results of the ORA Model should *not* be applied to the final ex post gross estimates for reasons stated above and in Attachment 4. Similarly, we do *not* recommend SR Model 1 because the participants and nonparticipants share the same parameter estimates for each of the five change variables.

We developed and tested SR Model 3 because it was more of a compromise between the 1996 QC Model and the ORA Model, where some of the change variables were shared. We felt that if any of the effects due to the five changes would be similar, it might be for the SQFT and employee changes. Because the effects of changing equipment (lighting, HVAC and other) are dependent on the decision maker who selects the equipment, and because we believe a participant and nonparticipant decision maker are inherently different, we do not feel that the effects of changing equipment are similar for participants and nonparticipants. However, the effects of SQFT and employee changes are not as dependent on the decision maker, and may therefore be more likely to be similar across participants and nonparticipants.

We still believe, however, that these changes may differ across these two groups. For example, a space expansion may include more efficient equipment in participant facility than in a nonparticipant facility. Furthermore, additional employees placed in a participant facility may increase energy consumption less than in a nonparticipant facility, because of the more efficient equipment at the participating facility. For these reasons, we do *not* recommend SR Model 3.

Exhibit 3-27 provides the parameter estimates for each model, along with the resulting ex post gross energy impact for the HVAC and Lighting end uses. Interestingly, the ORA Model results in the highest total ex post gross energy impacts across the two end uses. Furthermore, the model we have recommended, SR Model 2, results in the lowest total ex post gross energy impacts across the two end uses.

To address the concerns raised by the ORA and ECONorthwest, we recommend SR Model 2. However, this specification yields the same SAE coefficients as the 1996 QC Model. As such, the results do not show that one specification is superior to the other.

Exhibit 3-27
Comparison of Alternative Gross Billing Model Specifications

Parameter Descriptions	Analysis Variable Name	Units	Models				
			QC Model	SR Model 1	SR Model 2	SR Model 3	ORA Model
Lighting End Use							
Lighting Offices	LGTOFF5	kWh	0.856125	0.931647	0.856125	0.852326	0.961982
Lighting Retails	LGTRET5	kWh	1.357155	1.402516	1.357155	1.383929	1.445053
Lighting Schools	LGTSCH5	kWh	0.613314	0.69299	0.613314	0.604266	0.721422
Lighting Miscellaneous	LGTMISC5	kWh	0.859361	0.879648	0.859361	0.859597	0.900617
HVAC End Use							
Retrofit Express Measures	RETX5	kWh	1.061511	1.026778	1.061511	1.061579	1.014407
ASDs	ASD5	kWh	0.853041	0.862949	0.853041	0.830127	0.827548
Custom HVAC	CSTHVC5	kWh	10.290247	10.270224	10.290247	10.336554	10.341767
Lighting Total		kWh	29,698,734	29,340,559	29,698,734	29,442,522	28,776,130
HVAC Total		kWh	113,984,414	121,441,034	113,984,414	114,259,229	125,263,935
TOTAL		**kWh**	**143,683,148**	**150,781,593**	**143,683,148**	**143,701,751**	**154,040,065**

Model Definitions	QC Model	SR Model 1	SR Model 2	SR Model 3	ORA Model
Apply NP change parameter estimates to Part post-usage	No	No	No	No	Yes
Run 2nd Stage Model with NP change variables					
- Same change variables as Part					
- All different change variables as Part					
- Different change variables but with EMP & SQFT the same					
- No Nonpart					
- No changes without Nonpart					

3.3.9 Net Billing Analysis

In addition to conducting a billing analysis to estimate gross energy impacts, a net billing analysis was performed, with the objective of estimating SAE coefficients that could be applied to gross engineering estimates to calculate net energy impact. As with the gross billing model, the net billing model specification also incorporates both participants and nonparticipants into one model.

A disadvantage of combining both participants and nonparticipants into one model of net energy savings is that the resulting sample is not randomly determined. In particular, participants self-select into the program and therefore are unlikely to be randomly distributed. There are certain unobserved characteristics that influence the decision to participate. If these characteristics are not accounted for in the model, the net savings model could produce biased coefficient estimates.

One solution to this problem is to include an Inverse Mills Ratio in the model to correct for self-selection bias. This method was developed by Heckman (1976, 1979)[13] and is used by others (Goldberg and Train, 1996[14]) to address the problem of self-selection into energy retrofit programs. This assumes that the unobserved factors that are influencing participation are distributed normally. Including an Inverse Mills Ratio in the model as an explanatory variable controls for the influence of the characteristics that cause participants to self-select into the retrofit program. This corrects for the self-selection bias in the net savings regression as the unobserved factors affecting participation are now controlled for in the model. As a result, standard regression techniques should produce unbiased coefficient estimates.

Goldberg and Train (1996) developed the technique of including a second Inverse Mills Ratio in the savings regression to account for the possibility that participation is correlated with the size of energy savings. The second Mills Ratio is interacted with a measure of energy savings, which allows the amount of net savings to vary with participation. The rationale for the second term is that those customers who have potentially large savings are more likely to participate in the program. Consequently, the unobserved factors that are influencing participation are also affecting the amount of savings.

To calculate the Inverse Mills Ratios, a probit model of program participation is estimated separately for the Lighting and HVAC retrofit programs. Once the probit model is estimated, the parameters of the participation model are used to calculate an Inverse Mills Ratio for both participants and nonparticipants. This Mills Ratio is included in a net savings regression that combines both participants and nonparticipants into one model. If the Mills Ratio controls for those unobserved factors that determine participation (i.e. the self-selection bias), and the other model assumptions are met, then the net savings model will produce unbiased estimates of net savings.

A description of the methods used for this application are given in the following sections. The following sections describe the data and variables used for the probit participation model and give the estimation results. A description of how the Inverse Mills Ratio is used in the Net Billing Model is also discussed, along with the estimation results from the Net Billing Model. Finally, a presentation of alternative model specifications is provided.

Probit Model of Participation

The first stage of calculating the Mills Ratio is to develop a probit model of HVAC Program participation. The probit model is a discrete choice model with a dependent variable of either zero or one indicating whether or not an event occurred. In this application, individuals receive a value of one if they participated in the HVAC Program and a zero otherwise. The sample includes 443 HVAC Program participants and 3,367 HVAC nonparticipants (which includes

[13] Heckman, J. 'The Common Structure of Statistical Models of Truncation, Sample Selection and Limited Dependent Variables and a Simple Estimator for Such Models.", Annals of Economic and Social Measurement, Vol. 5, pp. 475-492, 1976.

Heckman, J. "Sample Selection Bias as a Specification Error." Econometrica, Vol. 47, pp. 153-161, 1979.

[14] Goldberg, Miriam and Kenneth Train. 'Net Savings Estimation: An analysis of Regression and Discrete Choice Approaches', prepared for the CADMAC Subcommittee on Base Efficiency by Xenergy, Inc. Madison, WI, March 1996.

Lighting participants that did not have HVAC measures rebated), and includes information obtained from the telephone surveys, as well as billing data. All but 34 of the 3,844 survey respondents were used to estimate the participation probit for the HVAC Program[15].

Using the probit specification, the decision to participate in the HVAC Program is given by:

$$\text{PARTICIPATION} = a + b'\text{X} + g'\text{Y} + J'\text{Z} + e$$

A description of the explanatory variables is given in Exhibit 3-28. The dependent variable PARTICIPATION has a value of one if the customer participated in the 1997 HVAC Program and a zero if they did not participate. The independent variables used are those characteristics that are likely to influence program participation. The first set of variables (X) used in the participation probit indicate whether a respondent was aware of the HVAC program prior to 1997. There are three of these variables. The first is AWARE, which takes a value of one if a respondent indicates awareness. The second and third awareness variables also take on values of either zero or one. They will take a value of one if the respondent is aware prior to 1997, **and** claims to have been informed of the program by their HVAC contractor (HV_INFO) or their PG&E representative (PGE_INFO). Including these variables allows the model to differentiate between respondents who simply claim they were aware, and those who also state the source of their information. The latter group is likely to have more complete and accurate information about the program, and therefore will be affected in a different way by their awareness. Moreover, these variables are intended to assuage concerns evaluaters commonly have regarding the dependability of self-reported awareness.

The second group of variables (Y) reflect the building characteristics. Examples of these include ownership, recent changes at the facility, as well as total energy use. The third group of variables (Z) contain information on business type. Finally, the error term (ε) is assumed to be normally distributed for the probit specification.

Probit Estimation Results

The estimation results for the HVAC probit are given in Exhibit 3-29. The results are partially supportive of a priori expectations. For the HVAC probit, customers who were aware of the program prior to 1997 are more likely to participate in the HVAC program. Further, those who were aware of the program prior to 1997 and received program information from their HVAC contractor or their PG&E representative were more likely to participate. Size, as indicated by energy use, has a small but positive effect on the probability of participation. Additionally, those that have short-term leases were less likely to participate. These results all conform to expectations. However, the effects of ownership, tenant activity, and changes at the facility do not conform to expectations, all producing negative coefficient estimates. All of the building types also yielded negative and statistically significant coefficient estimates. Our results show that size, as indicated by energy use, and awareness, are very strong predictors of participation in the HVAC program, while the the effect of other factors is less easily understood.

[15] These 34 respondents were excluded due to incomplete billing data, which was necessary for constructing one of the independent variables (USE) in the probit regression model.

Exhibit 3-28
Variables Used in HVAC Probit Model

Variable Name	Units	Variable Type	Description
AWARE	0,1	X	Aware of Program Prior to 1997
ARLIGHT	0,1	Y	Lighting equipment was added and removed since 1/95
ARHEAT	0,1	Y	Heating equipment was added and removed since 1/95
B4_78	0,1	Y	Building was constructed before 1978
EMPCHG	0,1	Y	Employee change by 10% since 1/95
GROCERY	0,1	Z	Grocery
HEALTH	0,1	Z	Health Care Building
HOTEL	0,1	Z	Hotel
HV_INFO	0,1	X	Made aware by HVAC contractor prior to 1997
MISCCOM	0,1	Z	Miscellaneous commercial building
OFFICE	0,1	Z	Office building
OWN	0,1	Y	Own building
PERSONL	0,1	Z	Personal services building
PGE_INFO	0,1	X	Made aware by PG&E representative prior to 1997
RESTR	0,1	Z	Restaurant
RETAIL	0,1	Z	Retail building
SCHOOL	0,1	Z	School
SFADD	0,1	Y	Square footage added to the facility
SHTLEASE	0,1	Y	Lease less than 1 year long
USE	kWh	Y	Energy use in 1995
TENACT	0,1	Y	Tenants active in equipment purchse decisions
WARE	0,1	Z	Warehouse

Once the probit model is estimated, the coefficient estimates are used to calculate the Inverse Mills Ratio for use in the net savings regression. The product of all of the independent variables and respective coefficient estimates are used in the following calculation:

$$\text{Mills Ratio} = f(Q) / \Phi(Q) \text{ (for participants)}$$

$$= - f(Q) / \Phi(-Q) \text{ (for nonparticipants)}$$

Where,

$$Q = a + b'X + g'Y + J'Z$$

Exhibit 3-29
HVAC Probit Estimation Results

Variable Name	Units	Variable Type	Coefficient Estimate	Standard Error	Significance Level
AWARE	0,1	X	0.37	0.09	1%
ARLIGHT	0,1	Y	-0.42	0.09	1%
ARHEAT	0,1	Y	-0.32	0.11	1%
B4_78	0,1	Y	-0.26	0.06	1%
EMPCHG	0,1	Y	-0.10	0.07	14%
GROCERY	0,1	Z	-1.50	0.18	1%
HEALTH	0,1	Z	-0.86	0.12	1%
HOTEL	0,1	Z	-0.56	0.14	1%
HV_INFO	0,1	X	0.44	0.09	1%
MISCCOM	0,1	Z	-1.30	0.13	1%
OFFICE	0,1	Z	-0.81	0.07	1%
OWN	0,1	Y	-0.27	0.06	1%
PERSONL	0,1	Z	-1.16	0.13	1%
PGE_INFO	0,1	X	0.19	0.10	4%
RESTR	0,1	Z	-1.08	0.12	1%
RETAIL	0,1	Z	-1.20	0.09	1%
SCHOOL	0,1	Z	-0.47	0.12	1%
SFADD	0,1	Y	-0.10	0.11	37%
SHTLEASE	0,1	Y	-0.46	0.13	1%
USE	kWh	Y	0.00	0.00	18%
TENACT	0,1	Y	-0.45	0.09	1%
WARE	0,1	Z	-1.06	0.12	1%

The function f is the standard normal probability density function and Φ is the standard normal cumulative density function. Again, this Inverse Mills Ratio is used to control for unobserved factors that may influence both program participation and the amount of energy savings achieved for measures done within the program. In the following sections, the Inverse Mills Ratio is included in the net billing regression as an additional explanatory variable to correct for the problem of self-selection into the HVAC Program.

Net Billing Model Specification

The net billing regression analysis for the Commercial Program Evaluation uses the same two-stage approach as the gross billing analysis, with two significant differences. In fact, the net billing model uses the exact same model specification as the baseline model (for the first stage). Refer to the previous section for baseline model results. The SAE models differ between the net and gross billing analyses in the following ways:

- The Mills Ratios, corresponding to each end use, are included as two separate independent variables.

- The Mills Ratios are also interacted with the engineering impact estimates for each corresponding technology. The engineering impacts alone are not used in the second stage model.

The resulting SAE coefficients on the energy impacts (that have been interacted with the Mills ratios) are then used to adjust the engineering estimates of expected annual energy impacts (the original SAE coefficients) for the entire participant population. This is one estimate of net ex post energy impacts. The net billing analysis model has the following functional form:

$$\begin{aligned} kWh_{98,i} - k\hat{W}h_{98,i} &= kWh_{98,i} - F_{95}(kWh_{95,i}, \Delta CDD_i) \\ &= J_1 Mills_{Light,i} + J_2 Mills_{HVAC,i} + \sum_m d_m Mills_{Light,i} * Eng_{Light,m,i} \\ &\quad + \sum_m d_m Mills_{HVAC,i} * Eng_{HVAC,m,i} + \sum_k h_k^{'} NChg_{i,k} + \sum_k r_k^{'} PChg_{i,k} + e \end{aligned}$$

Where

$kWh_{98,i}$ and $kWh_{95,i}$ are customer i's annualized energy usage for the post- and pre-installation periods, respectively;

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

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

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

$Mills_{Light,i}$ is the Mills Ratio for the Lighting end use for customer i;

$Mills_{HVAC,i}$ is the Mills Ratio for the HVAC end use for customer i;

$Eng_{Light,m,i}$ are the engineering impact estimates for Lighting technology m, customer i;

$Eng_{HVAC,m,i}$ are the engineering impact estimates for HVAC technology m, customer i;

J and d are the coefficients on the individual Mills ratios, and on the Mills ratios interacted with the engineering energy impacts, respectively;

e is the random error term of the model.

This net SAE model was run with the same set of 487 nonparticipants and 679 participants that were used in the gross billing analysis model. The results of the model are presented below. The parameter estimates, t-statistics and sample sizes are presented for all of the net SAE coefficients and Mills ratios.

Exhibit 3-30
Net Billing Regression Analysis Final Model Outputs

Parameter Descriptions	Analysis Variable Name	Units	Parameter Estimate	t-Statistic	Sample Size
Mills Ratios					
Lighting	LRMILLS	Unitless	-5562.883553	-1.04	1166
HVAC	HRMILLS	Unitless	-177.727669	-0.04	1166
SAE Coefficients					
Lighting End Use					
Lighting Offices	LGTOFFM	Mills* kWh	-0.638500	-4.88	154
Lighting Retails	LGTRETM	Mills* kWh	-0.831063	-1.64	78
Lighting Schools	LGTSCHM	Mills* kWh	-0.329297	-1.63	51
Lighting Miscellaneous	LGTMSCM	Mills* kWh	-0.692109	-2.15	92
HVAC End Use					
Retrofit Express Measures	RETXM	Mills* kWh	-0.614631	-2.64	324
ASDs	ASDM	Mills* kWh	-0.687758	-2.66	25
Custom HVAC	CSTHVCM	Mills* kWh	-7.594930	-3.98	3
Change Variables					
Part Lighting Changes	LGT_CHG5	kWh	-0.168599	-8.56	74
Part HVAC Changes	AC_CHG5	kWh	-0.012201	-0.64	123
Part Other Equipment Changes	OTH_CHG5	kWh	0.168041	5.94	39
Part Square Footage Changes	SQFT_CH5	# Sqft*kWh	2.717169	0.98	32
Part Employee Changes	EMP_CHG5	# Emp*kWh	128.395011	0.85	137
Nonpart Lighting Changes	LGT_NON5	kWh	-0.042238	-2.06	47
Nonpart HVAC Changes	AC_NON5	kWh	-0.023976	-1.06	60
Nonpart Other Equipment Char	OTH_NON5	kWh	0.137176	4.26	40
Nonpart Square Footage Chang	SQFT_NO5	# Sqft*kWh	12.034442	4.51	31
Nonpart Employee Changes	EMP_NON5	# Emp*kWh	558.696396	1.91	91

It was found that the net billing model results were significant at the 90 percent level in all cases. The parameter coefficients from the net billing model represent net participation within that technology (having accounted for self-selection). From these estimates, we can now "back out" an estimate of free-ridership, by taking the product of these coefficients with their Mills ratio and dividing by the regression coefficients from the gross model. This equation has the following functional form:

$$(1 - FR)_m = \frac{Mills_m * d_m}{b_m}$$

Where,

$Mills_m$ is the mean Mills coefficient for all customers with technology m;

b_m is the SAE coefficient from the Gross Billing model for technology m; and,

d_m is the regression coefficient from the Mills Model 1 regression for technology m.

Exhibit 3-31 illustrates the resulting estimate of net, or one minus free-ridership.

Exhibit 3-31
Net Billing Regression Analysis Estimates of (1-FR)

	Mills Model 1		Gross Model		From Probit	
Parameter Descriptions	Variable Name	Parameter Estimate	Variable Name	Parameter Estimate	Mean Mills	Resulting (1-FR)
Retrofit Express Measures	RETXM	-0.615	RETX5	-1.062	1.445	0.837
ASDs	ASDM	-0.688	ASD5	-0.853	1.133	0.914
Custom HVAC	CSTHVCM	-7.595	CSTHVC5	-10.290	1.267	0.935

Alternative Net Billing Model Specifications

As discussed above, Goldberg and Train (1996) developed the technique of including a second Inverse Mills Ratio in the savings regression, interacted with the energy savings estimate, to account for the possibility that participation is correlated with the size of energy savings. The specification suggested by Goldberg and Train is:

$$
\begin{aligned}
kWh_{post,i} - k\hat{W}h_{post,i} &= kWh_{post,i} - F_{pre}(kWh_{pre,i}, \Delta CDD_i) \\
&= J_1 Mills_{Light,i} + J_2 Mills_{HVAC,i} + \sum_m b'Eng_m \\
&\quad + \sum_m d_m Mills_{Light,i} * Eng_{Light,m,i} + \sum_m d_m Mills_{HVAC,i} * Eng_{HVAC,m,i} \\
&\quad + \sum_k h'_k Chg_{i,k} + e
\end{aligned}
$$

Where

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

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

Eng_m are engineering saving estimates of participants ;

$Mills_{Light,i}$ is the Mills Ratio for the Lighting end use for customer i;

$Mills_{HVAC,i}$ is the Mills Ratio for the HVAC end use for customer i;

$Eng_{Light,m,i}$ are the engineering impact estimates for Lighting technology m, customer i;

$Eng_{HVAC,m,i}$ are the engineering impact estimates for HVAC technology m, customer i;

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

J and d are the coefficients on the individual Mills ratios, and on the Mills ratios interacted with the engineering energy impacts, respectively;

e is the random error term of the model.

We found that there was considerable correlation between the engineering estimate of savings and the Inverse Mills Ratio interacted with the engineering estimate. Therefore, we altered the model specification by only including the Inverse Mills Ratio interacted with savings, and dropped the engineering estimate. To test the sensitivity of this change, we ran the net billing model both ways: with and without the engineering estimate of savings. Furthermore, we decided to test the Inverse Mills Ratio approach without interacting the Inverse Mills Ratio with the engineering estimate at all, following Heckman's approach (1976, 1979).

These three models can be specified as follows:

MILLS ONLY METHOD:

$$
\begin{aligned}
kWh_{post,i} - k\hat{W}h_{post,i} &= kWh_{post,i} - F_{pre}(kWh_{pre,i}, \Delta CDD_i) \\
&= J_1 Mills_{Light,i} + J_2 Mills_{HVAC,i} + \sum_m b'_m \, Eng_m + \sum_k h'_k Chg_{i,k} + e
\end{aligned}
$$

MILLS + MILLS*ENG METHOD:

$$
\begin{aligned}
kWh_{post,i} - k\hat{W}h_{post,i} &= kWh_{post,i} - F_{pre}(kWh_{pre,i}, \Delta CDD_i) \\
&= J_1 Mills_{Light,i} + J_2 Mills_{HVAC,i} + \sum_m d_m Mills_{Light,i} * Eng_{Light,m,i} \\
&\quad + \sum_m d_m Mills_{HVAC,i} * Eng_{HVAC,m,i} + \sum_k h'_k Chg_{i,k} + e
\end{aligned}
$$

MILLS + ENG + MILLS*ENG METHOD:

$$
\begin{aligned}
kWh_{post,i} - k\hat{W}h_{post,i} &= kWh_{post,i} - F_{pre}(kWh_{pre,i}, \Delta CDD_i) \\
&= J_1 Mills_{Light,i} + J_2 Mills_{HVAC,i} + \sum_m b' Eng_m \\
&\quad + \sum_m d_m Mills_{Light,i} * Eng_{Light,m,i} + \sum_m d_m Mills_{HVAC,i} * Eng_{HVAC,m,i} \\
&\quad + \sum_k h'_k Chg_{i,k} + e
\end{aligned}
$$

The results of each of these models is provided in Exhibit 3-32. The method we recommend (Mills + Mills*Eng), provided the lowest estimate of ex post net energy impacts, indicating that our methodology is more conservative than either of the other two model specifications.

Exhibit 3-32
Comparison of Inverse Mills Ratio Approaches

Parameter Descriptions	Analysis Variable Name	Models: Mills + Eng	Mills + Mills*Eng	Mills + Eng + Mills*Eng
Lighting End Use				
Lighting Offices	LGTOFF	1.01	1.01	0.94
Lighting Retails	LGTRET	0.90	0.85	0.97
Lighting Schools	LGTSCH	0.94	0.71	0.76
Lighting Miscellaneous	LGTMISC	0.94	1.31	1.71
HVAC End Use				
Retrofit Express Measures	RETX	1.25	1.04	1.23
ASDs	ASD	1.26	1.12	1.20
Custom HVAC	CSTHVC	1.21	1.14	1.16
Lighting Total		109,310,568	111,013,275	119,378,265
HVAC Total		36,959,206	32,327,751	35,912,280
TOTAL		146,269,775	143,341,026	155,290,545

The verification study recommended a completely different alternative net billing model. They recommended that the probability of participating estimated in the probit model be used to replace the Inverse Mills Ratio, as follows:

PROB + PROB*ENG METHOD:

$$\begin{aligned} kWh_{post,i} - k\hat{W}h_{post,i} &= kWh_{post,i} - F_{pre}(kWh_{pre,i}, \Delta CDD_i) \\ &= J_1 \Pr ob_{Light,i} + J_2 \Pr ob_{HVAC,i} + \sum_m d_m \Pr ob_{Light,i} * Eng_{Light,m,i} \\ &\quad + \sum_m d_m \Pr ob_{HVAC,i} * Eng_{HVAC,m,i} + \sum_k h_k^{'} Chg_{i,k} + e \end{aligned}$$

Where

$\Pr ob_{Light,i}$ is the Probability of Participation for the Lighting end use for customer i;

$\Pr ob_{HVAC,i}$ is the Probability of Participation for the HVAC end use for customer i;

Even though no theory exists on how the use of the probability of participating in the model specification corrects for self-selection bias, we decided to test the sensitivity of our model by implementing ECONorthwest's model specification. Exhibit 3-33 compares the results of the Double Inverse Mills Ratio model specification we recommend, with the net billing model specification recommended in the verification study. Overall, the approach suggested in the verification study results in higher net ex post energy impacts.

Exhibit 3-33
Comparison of Alternative Net Billing Model Specifications

Parameter Descriptions	Analysis Variable Name	Models Mills + Mills*Eng	Prob + Prob*Eng
Lighting End Use			
Lighting Offices	LGTOFF	1.01	1.00
Lighting Retails	LGTRET	0.85	1.04
Lighting Schools	LGTSCH	0.71	0.45
Lighting Miscellaneous	LGTMISC	1.31	0.44
HVAC End Use			
Retrofit Express Measures	RETX	1.04	0.74
ASDs	ASD	1.12	1.00
Custom HVAC	CSTHVC	1.14	1.66
Lighting Total		111,013,275	120,608,585
HVAC Total		32,327,751	34,205,794
TOTAL		143,341,026	154,814,379

3.4 NET-TO-GROSS ANALYSIS

An important step in estimating total impacts from the HVAC Program is the calculation of net to gross ratios. Estimated net to gross ratios represent the proportion of net participants in the program. A net participant is defined to be a customer who engaged in retrofit activities as a direct result of the program. In order to calculate a net to gross ratio, estimates of both free ridership and spillover resulting from the program must be made.

The methods used to derive net-to-gross (NTG) results for the HVAC Evaluation are presented in this section. The NTG ratios derived using these methods are applied to the gross ex post energy, demand, and therm impacts to derive net program impacts after customer actions outside the program are accounted for. After a brief discussion of data sources, estimates of free ridership and spillover from self-reported survey data are presented. This is followed by a discussion of more sophisticated statistical modeling techniques that were used to estimate program net effects. A third approach for estimating free ridership, using a net billing model, was discussed in the previous section. Finally, a comparison of the three sets of results is presented along with the final selection of NTG ratios.

3.4.1 Data Sources

The primary data sources used in the net-to-gross analysis include the 860 HVAC and lighting participant surveys, 549 nonparticipant surveys and 3,619 canvass telephone surveys collected in 1998. Other data used in this analysis include the MDSS and CIS databases, and information from the Advice Filings.

3.4.2 Self-report Methods

On January 20, 1999 the CADMAC approved a waiver that allows the use of self -report based algorithms to estimate free ridership and spillover effects in the event discrete choice and LIRM models fail to produce statistically reliable results. The approved waiver is presented in Attachment 6.

Self-report Method for Scoring Free Ridership

The following discussion explains the methods employed to calculate "self-report" estimates of free ridership amongst program participants (as opposed to "modeled" free ridership estimates based on the discrete choice model). Definitions used for free ridership and net participation among the participant population are presented. Specific scoring algorithms and questions used to identify free riders in the participant survey are also discussed.

<u>Overview of Methodology</u>

Participants involved in the CEEI retrofit program can be classified into four basic categories depending on the actions they would have taken in the absence of the CEEI program:

1. In the absence of the CEEI program, the participant would not have installed any new equipment

2. In the absence of the CEEI program, the participant would have installed standard efficiency equipment

3. In the absence of the CEEI program, the participant would have installed high efficiency equipment, but not as soon (more than one year later)

4. In the absence of the CEEI program, the participant would have installed high efficiency equipment at the same time (within the year)

Customers who fall into the first three categories can be considered net program participants. Customers who fall into the fourth category should be considered free riders. The self-report estimates of free ridership were based on these four categories. Data used to calculate the self-report free ridership estimates was collected as part of a comprehensive telephone survey of CEEI program participants. The survey collected information on the participants' likely HVAC retrofit behavior, with regards to the CEEI program. Responses consistent with category 4 were counted towards free ridership. Responses consistent with categories one through three were counted towards net participation.

The questions used to classify responses directly reflect the definitions of net participation and free ridership presented above. Respondents were asked what they would have done in the absence of the program. They were asked whether or not they would have adopted high efficiency HVAC equipment, and when they would have installed that equipment. Generally, the answers to both of these questions allowed the responses to be classified based on the categories described above. Specific scoring algorithms and the exact text of the corresponding questions are presented below.

Raw results from the self-report free ridership estimates were weighted by the avoided cost associated with a given respondent. Results of the weighted self-report free ridership estimates were then calculated for each technology group. Results are presented at the technology group level, allowing differences in free ridership rates by technology to be examined.

Scoring Method and Scoring Algorithms

Responses were initially scored based on the following questions:

pd310	*Which of the following statements best describes actions your firm would have undertaken had the HVAC Program NOT existed...* 1 = We would not have changed our HVAC system 2 = We would have bought high-efficiency HVAC equipment 3 = We would have bought standard efficiency HVAC 8 = (Refused) 9 = (Don't Know)
pd315	*Which of the following statements best describes your firm's plans to install HIGH EFFICIENCY HVAC had the program NOT existed...* 1 = We would have installed high efficiency HVAC at the same time we did it through the program 2 = We would have installed high efficiency HVAC within the year 3 = We would have installed high efficiency HVAC, but not within the year 4 = We wouldn't have installed high efficiency HVAC at all 8 = (Refused) 9 = (Don't Know)

A response counted towards **net participation** (consistent with categories 1 through 3) if:

pd310 = 1 or 3

pd310 = 2 AND pd315 = 3

Under the first condition, the respondent indicated that, in the absence of the program, they would have made no equipment changes, or would have installed standard efficiency equipment. Under the second condition, the respondent indicated that, had the program not existed, they would have installed high efficiency equipment, but not within the year.

A response counted towards **free ridership** if:

pd310 = 2 AND pd315 = 1 or 2

Under this condition the respondent indicated that, in the absence of the program, they would have bought high efficiency equipment, and would have installed it at the same time, or within the year.

In the event the participant was unable to answer question pd310, or provided contradictory answers to pd310 and pd315, the data was considered inconclusive. Specifically, data was considered inconclusive if:

pd310 = 2 AND pd315=4
pd310=2 AND pd315=Refused/Don't Know
pd310 = Refused /Don't Know

Under the first condition the respondent indicated that in the absence of the program, they would have purchased high efficiency equipment. However, when the respondent was asked when they would have purchased this equipment, they stated that they would not have installed high efficiency HVAC equipment at all. Under the second condition the participant answered "don't know" or refused to give a response to question pd310. If either of these conditions applied, a second set of questions was examined to determine free ridership:

pd300	*Before you knew about the HVAC Program, which of the following statements best describes your company's plans to install HVAC fixtures? (READ RESPONSES).* 1 = You hadn't even considered purchasing new HVAC equipment. 2 = You were interested in installing HVAC equipment, but hadn't yet decided on energy efficient HVAC equipment. (i.e. you were considering all your options.) 3 = You had already decided to install HIGH efficiency HVAC, but probably not within the year. 4 = You had already decided to install HIGH efficiency HVAC within the year. 8 = (Refused) 9 = (Don't Know)

A response counted toward **net participation** if:

pd300 = 1 or 3

Under this condition, the respondent indicated that, before they knew about the program, they hadn't even considered purchasing high efficiency equipment, or were planning on purchasing high efficiency equipment, but not within the year.

A response counted toward **free ridership** if:

pd300 = 4

Under this condition, the respondent indicated that, before they knew about the program, they had already decided to install high efficiency equipment within the year.

The respondent's answer to pd300 was considered inconclusive if:

pd300 = 2
pd300=Refused/Don't Know

Under the first condition the respondent has not clearly indicated what their behavior would be in the absence of the program. Under the second condition, the respondent answered a "don't know" or refused to give an answer to question pd300. If either of these conditions held, a third survey question was used to determine free ridership:

pd250	*If you had not replaced this equipment under the program how long would you have waited to replace it?* 1 = You would have replaced the equipment at the same time 2 = You would have replaced the equipment at a year or within a year 3 = You would have replaced the equipment more than a year later 4 = You would not have replaced the equipment at all

The response counted towards **net participation** if:

pd250 = 3 or 4

In other words, the respondent indicated that, if they had not replaced their equipment under the program, they would have replaced it at least a year later, or not at all.

The response was not used if :

pd250 = 1 or 2

In this case, the respondent indicated that, had they not replaced the equipment under the program, they would have made the replacement at the same time, or within the year. However, it is unclear whether this question applies to new high efficiency equipment or new standard efficiency equipment. For this reason, the additional condition was not used.

The scoring routine described above classified responses in accordance with the four categories described at the beginning of this section. Respondents who indicated that, in the absence of the program, they 1) would not have done a retrofit; 2) would have bought standard efficiency equipment instead; or 3) would have installed high efficiency equipment, but at a later time; were counted as net participants. Customers who fit the fourth classification; those who, in the absence of the program, would have installed high efficiency equipment within one year, were counted as free riders.

If the initial combination of questions (pd310 and pd315), could not classify a response because of contradictory, or "don't know" or "refusal" responses, then the responses to the additional questions were used. Question pd300 made almost the same distinctions as the initial questions. The only difference is that the respondent was asked what they intended to do "before they knew about the retrofit program," as opposed to what they would have done "in the absence of the program." The pd250 questions determined when those responding to the additional classification questions would have made the retrofit.

In the absence of a clear response to the first set of questions, the additional classification questions served as an appropriate way to assign responses to one of the four categories described at the beginning of this section. The form of the additional questions was very similar to that of the initial questions.

Data Sources

Data used in deriving the self-report estimates of free ridership included responses from 860 completed telephone surveys of CEEI program participants. The responses included 443 HVAC end use adopters. The surveys were conducted between July and September of 1998 as part of a comprehensive telephone survey of CEEI program participants.

HVAC Results

Self-reported estimates of free ridership are presented below by technology group. Adjustable speed drives, set-back thermostats, and reflective window film had the lowest rates of free ridership: between 29 and 39 percent. The highest rate of free ridership was observed in Package Terminals with a rate of 70.6 percent. These free ridership rates were developed within technology group by weighting by each site's avoided cost associated with the technology retrofit.

.

Exhibit 3-34
Weighted Self-report Estimates of Free Ridership

for HVAC Technology Groups in the 1997 CEEI Program

Technology Group	***Sample***	***Free Ridership***
Adjustable Speed Drives	36	28.7%
Central Air Conditioning	262	67.7%
Evaporative Cooler	5	55.2%
Other Custom Measures	6	52.5%
Package Terminals	23	70.6%
Set Back Thermostats	101	38.5%
Reflective Window Film	48	31.8%

Self-report Method for Scoring Spillover

In determining the total net-to-gross ratio for the CEEI program, spillover impacts resulting from the program must be estimated for both program participants and nonparticipants. The overall impact of spillover represents an additional social benefit from the CEEI program, contributing towards total market transformation. The following discussion explains the methods employed to calculate "self-report" estimates of spillover amongst program participants and nonparticipants (as opposed to "modeled" spillover estimates based on the discrete choice model). Definitions used for spillover and net participation among the participant and nonparticipant population are presented. Specific scoring algorithms, and questions used to identify spillover in the participant and nonparticipant surveys are also discussed. The final calculation of these impacts is also described.

Overview of Methodology

The self-report methodology is composed of three steps:

- Identification of the spillover rate
- Calculation of the impact per unit of spillover
- Estimation of the spillover contribution to the net-to-gross ratio

The spillover rate is simply the percentage of the participant or nonparticipant population that are identified as being influenced by the CEEI program to install high-efficiency equipment outside of the program. The spillover rate is estimated using self-reported survey results, as described below. Multiplying the participant or nonparticipant population by the respective spillover rate provides an estimate of the total number of participants or nonparticipants influenced by the CEEI program to install non-rebated high-efficiency equipment.

To estimate the contribution towards the net-to-gross ratio represented by these participants and nonparticipants, a per participant or nonparticipant estimate of impact is required. The per unit impact estimate is based on the equipment installed as reported in the surveys, as described below. The contribution of spillover to the net-to-gross ratio can then be estimated as:

Participant Spillover:

NTGpart_spill = SP_RATEpart * POPpart*IMPACTpart_spill / IMPACTpop

Where,

NTGpart_spill = the participant contribution of spillover to the net-to-gross ratio

SP_RATEpart = the participant spillover rate

POPpart = the participant population, in number of sites

IMPACTpart_spill = the per participant site impact associated with spillover

IMPACTpop = the total CEEI Program impact

Nonparticipant Spillover:

NTGnp_spill = SP_RATEnp * POPnp*IMPACTnp_spill / IMPACTpop

Where,

NTGnp_spill = the nonparticipant contribution of spillover to the net-to-gross ratio

SP_RATEnp = the nonparticipant spillover rate

POPnp = the nonparticipant population, in number of sites

IMPACTnp_spill = the per nonparticipant site impact associated with spillover

IMPACTpop = the total CEEI program impact

Identification of the Spillover Rate

The participant and nonparticipant spillover rates were estimated as the percentage of participants or nonparticipants surveyed that indicated that they were influenced by the CEEI program to install high-efficiency equipment outside of the program.

In general, a spillover action was defined as any action taken outside of the program that increases energy efficiency, and occurred as a direct result of the program' s influence. In counting the total number of surveyed participants and nonparticipants contributing towards spillover, the following three conditions, which reflect this definition of spillover, were used:

1. the action involved the installation of **high efficiency equipment**, as recognized by the CEEI program

2. The respondent was **aware** of the program **before** making the decision to purchase new HVAC equipment

3. the action was **not rebated** as part of the program

4. the respondent stated that this action was taken as a result of the **CEEI program's influence**

In other words, the respondent's knowledge of, awareness of, or participation in the CEEI program encouraged them to install high efficiency equipment outside the program.

After identifying all the equipment adoptions that meet the spillover criteria, the spillover rate was calculated by dividing the total number of spillover adoptions for each end use by the total population surveyed. This was done for both participants and nonparticipants.

Identifying Participant Spillover Actions

The three spillover conditions were evaluated in the participant survey by using the following questions:

For Condition 1:

Questions cr020 and cr099 were used to determine whether or not additional, program qualifying, high efficiency HVAC equipment was installed. For HVAC equipment that might be either high efficiency or standard efficiency, question cr117 was used to determine the efficiency of the additional technology. If an HVAC response qualified as a spillover, it was checked against question cr117 to ensure that it was a high efficiency installation. The text for these questions were as follows:

cr020	*Since January 1995, did you add to, replace, or remove any cooling equipment?*
cr099	*What type of units were added?*
cr117	*Just to confirm, the additional technology standard efficiency or did you have to pay extra for a high efficiency unit?*

For Condition 2:

Participants were assumed to be aware of the program at the time they participate. If the non-rebated adoption occurred after their participation, it could be assumed they were aware of the program at the time they made the decision to purchase the non-rebated equipment. Question cr050 was used to determine whether the non-rebated adoption was made before or after their participation in the program:

cr050	*Were these changes made after you participated in the Retrofit Program?*

For Condition 3:

Question cr060 was used to determine whether or not additional participant HVAC installations were rebated. The question text for cr060 was as follows:

cr060	*Was your firm paid a rebate by PG&E for these changes in your HVAC equipment ?*

For Condition 4:

The fourth condition, whether or not the program influenced the respondent's equipment selection, was tested with question sp110. Only those respondents who installed non-rebated HVAC equipment after they participated in the program were asked the final spillover question. Respondents who installed standard efficiency equipment types were not counted as spillover. Because of this design, spillover could be calculated based on the response to question sp110 in conjunction with data on the efficiency of the installed HVAC equipment. The question text for sp110 was as follows:

sp110	*How influential was the Retrofit Express Program in your selection of the additional equipment?* 1= Not at all influential 2= Slightly influential 3= Moderately influencial 4= Very influential R= Refused D=Don't know

Participant Spillover Scoring Algorithm

The final scoring algorithm for participant spillover was based on question sp110, in conjunction with data on the efficiency of the installed HVAC equipment. This question was used because, as explained above, it was only asked of participants who made a **non-rebated** adoption **after** their participation in the program. The scoring algorithm is as follows:

If sp110 = 2,3 or 4

AND equipment is high efficiency,

then spillover = 1

else spillover = 0

If a respondent scores a 1 for spillover, they have met all four spillover conditions set forth above. As described above, the total number of spillovers counted using this algorithm was divided by the total number of participant's surveyed to obtain the participant spillover rate.

Participant Self-report Spillover Results

Of the 860 HVAC and lighting participants surveyed, a total of 22 respondents met all of the spillover criteria excluding efficiency. Five of these 22 respondents installed standard efficiency equipment and 11 installed high efficiency equipment. The remaining 6 respondents had inconclusive data regarding efficiency. These 6 were divided between standard and high efficiency categories based upon the distribution of respondents who met all spillover criteria and had conclusive efficiency information. Thus 4.1 of the 6 remaining respondents were categorized as spillover actions. Finally, a total of 15.1 respondents were identified as contributing to HVAC spillover. This results in a participant spillover rate of 1.8 percent. Because there were a total of 5,308 participants, this is equivalent to a total of 93 participant spillover HVAC actions.

Identifying Nonparticipant Spillover Actions

For Condition 1:

As with the participant spillover, questions cr020 and cr099 were used to determine whether or not additional HVAC equipment was installed. Also similarly, question cr117 was used to clarify the efficiency of the additional technology. The text for these questions and their response values were identical to the ones used in calculating the participant spillover. The text can be found in the explanation of the participant spillover methodology given in the preceding section.

For Condition 2:

Questions is005 and sp160 were used to verify that the respondent was aware of the program before the HVAC technology was adopted. The text for these questions was as follows:

is005	*Have you heard of PG&E's Retrofit Express programs?*
sp160	*Did you become aware of the Retrofit Express program before or after you made the decision to purchase your new HVAC equipment?*

For Condition 3:

Question cr060 was used to determine whether or not the HVAC installation was rebated. The text for this question was identical to the one used in calculating the participant spillover. The text can be found in the explanation of the participant spillover methodology given in the preceding section.

For Condition 4:

The fourth condition, whether or not the program influenced the respondent's equipment selection, was tested with question sp180. Only those respondents who were aware of the program before making the decision to purchase new HVAC equipment, and did not receive a rebate for this purchase were asked sp180. Respondents who answered this question but installed standard efficiency equipment were not counted as spillover. Because of this design, spillover could be calculated based on the response to question sp180, together with data on the efficiency of the installed HVAC equipment. The question text for sp180 was as follows:

sp180	*Did your knowledge of the Retrofit Express program at all influence your additional HVAC equipment selection?* 1= Not at all influential 2= Slightly influential 3= Moderately Influential 4= Very Influential R= Refused D=Don't Know

Nonparticipant Spillover Scoring Algorithm

The final scoring algorithm for nonparticipant spillover was based on question sp180, in conjunction with data on the efficiency of the installed HVAC equipment. Again, only respondents who stated that they were aware of the program before making the decision to purchase new HVAC equipment, and were not rebated for this purchase, were asked sp180. Thus, the final spillover scoring algorithm was as follows:

If sp180 = 2,3, or 4

AND equipment is high efficiency,

then spillover = 1,

else spillover = 0

If a respondent scores a 1 for spillover, they have met all four spillover conditions set forth above. The number of spillover adoptions resulting from this algorithm was divided by the number of nonparticipants surveyed to obtain the nonparticipant spillover rate.

Nonparticipant Self-report Spillover Results

Of the 4,168 nonparticipants surveyed, there were 13 respondents who met all of the spillover criteria excluding efficiency. Five of these 13 respondents installed standard efficiency equipment, and 5 installed high efficiency equipment. The remaining 3 respondents had inconclusive data regarding efficiency. These 3 were divided between standard and high efficiency categories based upon the distribution of respondents who met all spillover criteria and had conclusive efficiency information. Thus 1/2 of the 3 remaining respondents were categorized as spillover actions. Finally, a total of 6.5 respondents were identified as contributing to nonparticipant HVAC spillover.

Nonparticipants' reported installations that spanned approximately a 43-month period (since January 1995). In order to calculate the 1997 spillover rate, the portion of all reported high efficiency HVAC adoptions occurring in 1997 was used as an estimator. The portion of out-of-program, high efficiency adoptions that occurred in 1997 was 32.9 percent. That is, the 1997 rate was estimated by multiplying the spillover rate for the entire period by 0.329. This results in a nonparticipant spillover rate of 0.051 percent.

The approach to distributing the spillover across the 43-month analysis period is conservative relative to alternative allocation methods. For example, one alternative method for allocating spillover across the analysis period would be to mimic the distribution of all HVAC adoptions, both standard and high efficiency. Approximately 39 percent of all reported HVAC adoptions occurred in 1997. Applying this result yields a higher spillover rate, 0.061 percent. In addition, we could have applied the year distribution of the 13 adoptions that qualified as spillover under all criteria excluding efficiency. This method would have also resulted in an even higher 1997 spillover rate because 46 percent of these adoptions occurred in 1997.

From PG&E's 1997 CIS, there were 416,496 unique sites identified, resulting in a total of 411,188 nonparticipant sites less the 5,308 participants. Therefore, because there were a total of 411,188 nonparticipants, the spillover rate of 0.051 percent is equivalent to a total of 211 nonparticipant spillover HVAC actions.

Calculation of Impacts Associated With Spillover

Self reported installation information and the MDSS database were used to calculate the impacts associated with spillover. The reported equipment type and number of units installed from the telephone surveys were used to estimate an impact for each installation occurring outside of the program. From these estimates, the average impact associated with a spillover adoption could be calculated.

Participant Spillover Impact Calculation

About 15 participants were identified as contributing to spillover. Rather than using these 15 installations to calculate an average spillover impact, the survey sample of participant, out-of-program, high efficiency HVAC installations was used. There were a total of 77 high efficiency installations, for which valid responses were obtained for equipment type and number of units installed. These 77 installations were used to estimate the average participant impact associated with spillover. To calculate the impacts associated with spillover, avoided cost was used as a proxy for impact.

The MDSS was used to determine the average avoided cost per unit installed for each equipment type. When calculating average avoided cost per unit for water chiller and adjustable speed drives (ASDs), data from the REO and APOS programs was excluded. This was a conservative decision. Including data from the REO and APOS programs would have more than doubled the average avoided cost for both water chillers and ASDs.

The 77 participant out-of-program installations were used to determine the average number of units installed by equipment type. Multiplying the number of units by the average avoided cost per unit from the MDSS yielded an estimate of the average avoided cost per participant installation by equipment type. The 77 participant installations were also used to determine the distribution of installations across equipment type. This method resulted in an average avoided cost per participant installation.

Exhibit 3-35 below, presents the average avoided cost per participant installation by equipment type, along with the distribtuion of installations across equipment type. The average avoided cost per participant was estimated at $9,062.

Exhibit 3-35
Participant Out-of-Program Adoptions

Equipment Type	*Ave # Units Per Prt Install*	*Per Unit Av Cost*	*Ave Av Cost Per Install*	*Distribution of Installs*
Split System A/C	3	$1,497	$4,043	13.0%
Single Package A/C	4	$1,497	$5,756	42.9%
Individual A/C	7	$1,497	$10,981	13.0%
Package Terminal	2	$161	$383	10.4%
Remote Condensing Unit	2	$8,809	$17,619	1.3%
Evaporative Coolers	1	$1,758	$2,461	6.5%
Water Chillers	2	$18,244	$36,488	10.4%
Evaporative Condensers	0	$8,809	$0	0.0%
Window Film	0	$3	$0	0.0%
Cooling Towers	1	$13,691	$13,691	1.3%
ASD	6	$3,171	$19,027	1.3%
EMS	0	$76,357	$0	0.0%
Set Back Thermostat	0	$654	$0	0.0%
Weighted Average *by Distribution of Installs*			$9,062	

Nonparticipant Spillover Impact Calculation

Fewer than 7 nonparticipants were identified as contributing to spillover. Rather than using these 7 installations to calculate an average spillover impact, the survey sample of non-rebated, out-of-program, high efficiency HVAC installations was used. There were a total of 220 high efficiency installations, for which valid responses were obtained for equipment type and number of units installed. These 220 installations were used to estimate the average nonparticipant impact associated with spillover. To calculate the impacts associated with spillover, avoided cost was used as a proxy for impact.

The MDSS was used to determine the average avoided cost per unit installed for each equipment type. The 220 nonparticipant installations were used to determine the average number of units per installation by equipment type. Multiplying the number of units by the average avoided cost per unit from the MDSS yielded an estimate of the average avoided cost per nonparticipant installation by equipment type. The nonparticipant installations were also used to determine the distribution of installations across equipment type. This method resulted in an average avoided cost per nonparticipant installation.

Exhibit 3-36 below, presents the average avoided cost per nonparticipant installation by equipment type, along with the distribution of installations across equipment type. The average avoided cost per nonparticipant was estimated at $6,932.

Exhibit 3-36
Nonparticipant Adoption Distribution

Equipment Type	***Ave # Units Per NP Install***	***Per Unit Av Cost***	***Ave Av Cost Per Install***	***Distribution of Installs***
Split System A/C	3	$1,497	$4,016	10.0%
Single Package A/C	2	$1,497	$2,274	24.5%
Individual A/C	11	$1,497	$16,644	13.6%
Package Terminal	3	$161	$530	19.5%
Remote Condensing Unit	1	$8,809	$8,809	1.8%
Evaporative Coolers	2	$1,758	$3,380	18.6%
Water Chillers	2	$18,244	$27,366	7.3%
Evaporative Condensers	2	$8,809	$19,821	1.8%
Window Film	4	$3	$12	0.5%
Cooling Towers	1	$13,691	$13,691	0.5%
EMS	1	$76,357	$76,357	0.5%
Set Back	6	$654	$3,599	1.4%
Weighted Average *by Distribution of Installs*			$6,932	

Calculating the Contribution of Spillover to the Total Net to Gross Ratio

As discussed above, the contribution of spillover to the total net-to-gross ratio can be estimated as follows:

Participant Spillover:

NTGpart_spill = SP_RATEpart * POPpart*AV_COSTpart_spill / AV_COSTpop

Where,

NTGpart_spill = the participant contribution of spillover to the net-to-gross ratio

SP_RATEpart = the participant spillover rate

POPpart = the participant population, in number of sites

AV_COSTpart = the per participant site avoided cost associated with spillover

AV_COSTpop = the total avoided cost for the CEEI program

Nonparticipant Spillover:

NTGnp_spill = SP_RATEnp * POPnp*AV_COSTnp_spill / AV_COSTpop

Where,

NTGnp_spill = the nonparticipant contribution of spillover to the net-to-gross ratio

SP_RATEnp = the nonparticipant spillover rate

POPnp = the nonparticipant population, in number of sites

AV_COSTnp = the per nonparticipant site avoided cost associated with spillover

AV_COSTpop = the total avoided cost for the CEEI program

These equations are identical to those presented earlier, with the exception of using avoided cost as a proxy for impact. Each of the components to calculating the contribution to participant and nonparticipant spillover have been identified and are discussed above, except for the total avoided cost. The total avoided cost as reported in the MDSS is $11,106,223 for HVAC.

<u>Participant Spillover NTG Calculation</u>

Exhibit 3-37 presents the participant spillover contribution to the net-to-gross ratio applying the equation above and using all of the previously described results. The total resulting contribution to the net-to-gross ratio made by participants is 7.62 percent.

Exhibit 3-37
Participant Spillover Estimate

Avoided Cost Per Participant	$9,062
Spillover Rate	1.76%
Number of Participants	5,308
Number Contributing to Spillover	93
Spillover Avoided Cost	$845,986
HVAC Avoided Cost	$11,106,223
NTG Contribution from ParticipantSpillover	**7.62%**

Nonparticipant Spillover NTG Calculation

Exhibit 3-38 presents the nonparticipant spillover contribution to the net-to-gross ratio applying the equation above and using all of the previously described results. The total resulting contribution to the net-to-gross ratio made by nonparticipants is 13.2 percent.

Exhibit 3-38
Nonparticipant Spillover Estimate

Avoided Cost Per Nonparticipant	$6,932
Spillover Rate	0.051%
Number of Nonparticipants	411,188
Number Contributing to Spillover	211
Spillover Avoided Cost	$1,462,654
HVAC Avoided Cost	$11,106,223
NTG Contribution from Nonparticipant Spillover	**13.17%**

3.4.3 Discrete Choice Model

A two-stage discrete choice model is used to simulate the decision to purchase commercial HVAC equipment. The results of this model are used to estimate a net-to-gross ratio as well as spillover and free ridership rates associated with the HVAC Program. This section contains a detailed description of the two-stage model used in the discrete choice analysis.

The probability of purchasing any given equipment option A can be expressed as the product of two separate probabilities: the probability that a purchase is made, multiplied by the probability that equipment option A is chosen given that a purchase has been made. This can be written as:

$$Prob\ (Purchase\ \&\ Equipment\ A\ ) = Prob(Purchase) * Prob(Equipment\ A\ \mid Purchase)$$

The two stage model adopted for this analysis estimates both of the right hand side probabilities separately. The first stage of the model estimates the probability that a customer makes an HVAC equipment purchase and is referred to as the **purchase probability**. The second stage of the model estimates the type of HVAC equipment chosen given that the decision to purchase has already been made, and is referred to as the **equipment choice probability**. The product of the purchase probability and the equipment choice probability is the **total probability** and reflects the probability that any one HVAC equipment option is purchased. Once estimated, the model is used to determine the probability of purchasing high-efficiency equipment in the absence of the HVAC Program. This is simulated by setting both the rebate and program awareness variables to zero in both stages of the model.

The net-to-gross ratio is calculated using the total probability of purchasing high-efficiency HVAC equipment both with and without the existence of the retrofit program. The expected impact with the program is the total probability of choosing high-efficiency equipment multiplied by the energy impact of the equipment. Similarly, the expected energy impact in the absence of the HVAC Program is the total probability of purchasing high-efficiency equipment without the program multiplied by the energy impact of the equipment. The net-to-gross ratio is the net savings due to the program divided by the expected energy savings that results from having the program. As discussed below, this method is also used to determine free ridership rates and spillover.

Data Sources for the Net-to-Gross Analysis

The data used for the net-to-gross analysis are a combination of telephone survey information and the program information contained in the MDSS dataset. The sample is divided into purchase and nonpurchase groups. Those that purchased HVAC equipment either inside or outside the program are in the purchase group, while those that made no purchases are in the nonpurchase group.

The sample used to estimate the purchase model originally contained information on 2,795 customers. Of these, 640 were excluded because survey data indicated there was no air conditioning system at the site. The remaining 2,155 customers made a total of 602 HVAC purchases. The sample contains 1,696 customers that are nonparticipants and did not make any HVAC equipment purchases. The other 459 customers purchased new HVAC equipment between January 1995 and July of 1998. Of those that did make HVAC equipment purchases, 251 customers did so within the HVAC Program. An additional 118 customers purchased high-efficiency HVAC equipment outside the program. Finally, 107 customers reported purchasing standard HVAC equipment. Some customers made more than one type of purchase.

Stage 1 -- Purchase Model Specification

The purchase decision is specified as a logit model with a dependent variable having a value of either zero or one. In this application, customers are given a value of one if they made an HVAC equipment purchase either inside or outside the program and a zero if they did not purchase any HVAC equipment. The purchase decision model specification is defined as:

$$PURCHASE = a + b'X + g'U + J'Z + e$$

Variable definitions are given in Exhibit 3-39. The explanatory variables X contain information on rebate and program awareness that capture the effect of the HVAC Program. Building characteristics such as square footage and changes to the facility are contained in Y. Variable group Z contains variables indicating building type. The error term ε is assumed to be distributed logistic consistent with the logit model specification

Exhibit 3-39
Purchase Model Variable Definitions

Variable Name	Units	Variable Type	Description
AWARE	0,1	X	Aware of program prior to purchase
ARLIGHT	0,1	Y	Lighting equipment was added and removed since 1/95
ARHEAT	0,1	Y	Heating equipment was added and removed since 1/95
B4_78	0,1	Y	Building was constructed before 1978
CINDEX	ratio	X	(Cost-Rebate)/Cost
EMPCHG	0,1	Y	Employee change by 10% since 1/95
GROCERY	0,1	Z	Grocery
HEALTH	0,1	Z	Health Care Building
HOTEL	0,1	Z	Hotel
HV_INFO	0,1	X	Made aware by HVAC contractor prior to purchase
MISCCOM	0,1	Z	Miscellaneous commercial building
OFFICE	0,1	Z	Office building
OWN	0,1	Y	Own building
PERSONL	0,1	Z	Personal services building
PGE_INFO	0,1	X	Made aware by PG&E representative prior to purchase
RESTR	0,1	Z	Restaurant
RETAIL	0,1	Z	Retail building
SCHOOL	0,1	Z	School
SFADD	0,1	Y	Square footage added to the facility
SHTLEASE	0,1	Y	Lease less than 1 year long
SQFEET	Square ft.	Y	Square footage of facility
TENACT	0,1	Y	Tenants active in equipment purchse decisions
WARE	0,1	Z	Warehouse

There are four variables specified to capture the effect of the Lighting Program on the decision to make a purchase, AWARE, HV_INFO, PGE_INFO and CINDEX. For AWARE, customers are given a value of one if they indicated that they were aware of the retrofit program before they made the decision to purchase new HVAC equipment. If they became aware of the program after or at the same time they selected the equipment, they are given a value of zero for AWARE. This definition of awareness is used to take into account that the process of shopping for HVAC equipment will result in some customers becoming aware of the HVAC Program. When awareness is set to zero to simulate the absence of the program, only those who started shopping after they became aware of the program will be affected since it is assumed that the program influenced them to shop for new HVAC equipment. This definition of program awareness avoids the problem of having program awareness affect those customers who were already looking for HVAC equipment when they became aware of the program.

Relative to the 1996 HVAC Program Evaluation, two new awareness variables have been added. The variables HV_INFO and PGE_INFO are included to enhance the model's ability to identify the effects of program awareness. These two variables can take the value of either zero or one. HV_INFO takes on a value of one if:

1) the respondent was aware of the program prior to making the decision to purchase new HVAC equipment, and

2) the respondent indicated they were informed of the program by their HVAC contractor

PGE_INFO is defined similarly, but indicates that the respondent received program information from their PG&E representative. Respondents who state they were aware of the program **and** are also able to state their source of information are likely to be more accurately and completely informed about the program. Perhaps more importantly, the addition of these two variables reduces the concern evaluators commonly have with customers falsely claming they are aware of the program. Allowing the impact of awareness to vary over these types of respondents improves the model's ability to interpret the impact of awareness. We expect that those who state they were aware of the program, and cite one or both of these two sources of information, will be more affected by their awareness.

Using this restricted definition of awareness, 73 percent of program participants were aware of the HVAC Program at the time that they selected their HVAC equipment. For those that did not make any HVAC purchases, 17 percent were aware of the program. For the entire sample, 25 percent of the customers were coded as being aware of the HVAC Program.

Of those participants who were aware of the program, 41 percent claimed to have been made aware of the program by their HVAC contractor. Those who stated that their PG&E representative told them about the program comprised 45 percent of the participants who were aware. Among those who made out-of-program purchases and were aware, 35 percent received program information from their HVAC contractor; 50 percent from their PG&E representative. Overall, 37 percent of those who were aware received information from their PG&E representative, and 25 percent from their HVAC contractor.

The variable CINDEX gives the fraction of the incremental cost of the HVAC equipment that is paid by the customer and is defined by the incremental cost of the equipment minus any rebate divided by the incremental cost:

CINDEX = (Incremental Cost – Rebate) / Incremental Cost

For those that did not purchase HVAC equipment or were unaware of the program when the HVAC equipment was selected, the expected rebate is zero. This results in a CINDEX value of one since the entire cost of the measure is paid by the customer. Similarly, for those that made a purchase and are aware of the program, the expected rebate is nonzero and CINDEX takes on a value less than one.

Purchase Model Estimation Results

The estimation results from the purchase model are given in Exhibit 3-40. A likelihood ratio test yields a test statistic of over 1387 with 23 degrees of freedom, which is well above the critical value at any of the conventional levels of significance. In addition, Exhibit 3-41 shows that the estimated probability of making a purchase is high for those customers who made purchases both inside and outside the program, which conforms to *a priori* expectations. These factors suggest that the purchase model does have significant explanatory power.

The coefficient estimates from the purchase model are shown in Exhibit 3-40, and the results generally conform to expectations As expected, program awareness has a strong positive effect on the decision to purchase HVAC equipment. Further, this effect is greater if either their HVAC contractor or PG&E representative informed the respondent of the program.

The coefficient estimate for CINDEX is negative. This suggests that the greater the percentage of costs that are paid by the customer, the less attractive it is to make a purchase. The variables reflecting building ownership (OWN) and the role tenants play in equipment decisions (TENACT) also have a positive and significant effect on the likelihood of a HVAC purchase. The facility size variable (SQFEET) is also positive, indicating that larger facilities are more likely to make lighting purchases. Not surprisingly, changes to the facility (ARLIGHT, ARHEAT, SFADD, EMPCHG) are also likely to lead to an HVAC equipment purchase.

Relative to the 1996 Lighting Program Evaluation, two new building characteristics variables were added to the purchase model specification. These are B4_78 and SHTLEASE. The first, B4_78, is a dummy variable indicating whether a building was constructed before 1978. The coefficient for this variable is positive, confirming our expectation that older buildings would be more likely to be in need of new lighting equipment. The second new variable, SHTLEASE, is a dummy variable indicating whether a tenant has a lease less than one year long. Our expectation was that tenants with shorter leases would be less likely to purchase new HVAC equipment. Our expectations were not borne out by the results, although the coefficient estimate is small and not statistically different from zero.

The estimated model parameters are used to calculate the probability of making an HVAC equipment purchase. With the logit model, the probability of purchasing is given by:

$$PURCHASE = exp(Q) / 1 + exp(Q)$$

$$\text{where } Q = a + b'X + g'U + J'Z$$

Exhibit 3-40
Purchase Model Estimation Results

Variable Name	Variable Type	Coefficient Estimate	Standard Error	Significance Level
AWARE	X	1.02	0.16	1%
ARLIGHT	Y	0.10	0.16	55%
ARHEAT	Y	1.47	0.19	1%
B4_78	Y	0.76	0.13	1%
CINDEX	X	-3.93	0.27	1%
EMPCHG	Y	0.35	0.15	2%
GROCERY	Z	-1.23	0.46	1%
HEALTH	Z	0.09	0.27	12%
HOTEL	Z	-0.44	0.46	34%
HV_INFO	X	0.95	0.23	1%
MISCCOM	Z	-0.56	0.29	6%
OFFICE	Z	-0.12	0.21	55%
OWN	Y	1.88	0.22	1%
PERSONL	Z	0.17	0.28	53%
PGE_INFO	X	0.51	0.21	1%
RESTR	Z	0.06	0.26	81%
RETAIL	Z	-0.04	0.23	87%
SCHOOL	Z	0.09	0.26	74%
SFADD	Y	0.30	0.21	16%
SHTLEASE	Y	0.12	0.27	66%
SQFEET	Y	0.00	0.00	27%
TENACT	Y	1.36	0.23	1%
WARE	Z	0.13	0.27	64%

The estimated probabilities for different customer groups are given in Exhibit 3-41. As expected, HVAC Program participants have a high probability of making an equipment purchase with an estimated purchase probability of 0.62. Conversely, those that did not make any purchases have a low estimated probability of purchasing high-efficiency equipment at 0.16.

The probability of making an HVAC equipment purchase in absence of the program is calculated by removing the effect of the HVAC Program from the purchase decision model. This is done by setting AWARE, HV_INFO and PGE_INFO equal to zero and setting CINDEX equal to one to reflect the absence of a rebate. The probability of making an HVAC purchase is then recalculated using the logistic density function given above. All other variable values remain the same, as they are not expected to change in absence of the program.

The new probabilities of a high-efficiency purchase in the absence of the HVAC Program are also given in Exhibit 3-41. In the absence of the HVAC Program, the probability of participants purchasing HVAC equipment drops from 0.62 to 0.22. This result suggests that the HVAC program has a measurable effect on participants' liklihood of making a purchase. As we would expect, the effect of the program on nonparticipants' purchase probability is more minor.

Among those purchasing high-efficiency HVAC equipment outside the program, removing the program decreases the purchase probability from 0.35 to 0.24.

Exhibit 3-41
Estimated Purchase Probabilities

Customer Group	With Program	Without Program
No Purchase	0.16	0.13
Participants	0.62	0.22
Purchase HE Outside Program	0.35	0.24
Purchase Std Efficiency	0.36	0.27

Stage 2 -- Equipment Choice Model Specification

The second stage of the model is devoted to estimating the probability that a specific HVAC equipment option is chosen given that the decision to purchase HVAC equipment has already been made. This second stage of the model is specified as a conditional logit and is described below.

A conditional logit specification is used to model the equipment choice decision given that the decision has already been made to purchase HVAC equipment. The choice set for the equipment choice model contains three different options: high-efficiency single and split AC units, evaporative coolers, and standard efficiency single and split AC units. These equipment options were selected for the model as they comprised a large portion of the purchases made inside and outside the program and were judged to be reasonable substitute technologies. In the logit model, customers are given a value of one for the dependent variable for the option they actually chose and a zero for the remaining two nonchosen alternatives.

The conditional logit model specification for equipment choice is:

$$\text{EQUIPMENT CHOICE} = \beta'\text{AWARE} + + \beta'\text{HV\_INFO} + \beta'\text{PGE\_INFO} + \beta'\text{PREDISP} + \beta'\text{SQFEET} + \beta'\text{CINDEX} + \beta'\text{SAVINGS} + \Sigma\, \beta'\text{BLDTYPE} + \varepsilon$$

Where AWARE = Awareness of the retrofit program

HV_INFO = Respondent was made aware by HVAC contractor prior to purchase

PGE_INFO = Respondent was made aware by a PG&E representative prior to purchase

PREDISP = Predisposition towards high-efficiency equipment

SQFEET = Square footage of the facility

CINDEX = (Incremental Cost – Rebate) / Incremental Cost

SAVINGS = Annual dollar amount of electricity savings expected from equipment

BLDTYPE = Vector of dummy variables indicating building type

ε = Random error term assumed logistically distributed.

The explanatory variables used in the equipment choice model are described in Exhibit 3-42. In this stage of the model, a customer is considered aware of the program (AWARE = 1) if he became aware of the program before or at the same time they selected the HVAC equipment. This is slightly different from the definition of awareness used in the purchase model, where a customer is coded as aware only if they became aware before they start shopping for HVAC equipment. Awareness is redefined in the equipment choice model since, although program awareness does not encourage all customers to make a purchase, it will tend to influence more people to purchase high-efficiency if they are aware of the program at the time they make the purchase. This modified definition of aware is applied to the other awareness variables: HV_INFO and PGE_INFO. That is, HV_INFO was given a value of one if the respondent was aware of the program at the time new HVAC equipment was purchased **and** received program information from their HVAC contractor. PGE_INFO takes a value of one if the respondent was similarly aware, **and** was informed of the program by their PG&E representative.

Exhibit 3-42
Equipment Choice Model Variable Definitions

Variable Name	Units	Description
AWARE	0,1	Aware of program at time of purchase
CINDEX	ratio	(Incremental Cost-Rebate)/Incremental Cost
GROCERY	0,1	Grocery
HEALTH	0,1	Health Care Building
HOTEL	0,1	Hotel
HV_INFO	0,1	Made aware of program by HVAC contractor
MISCCOM	0,1	Miscellaneous commercial building
OFFICE	0,1	Office building
PERSONL	0,1	Personal services building
PGE_INFO	0,1	Made aware of program by PG&E representative
PREDISP	0,1	Predisposition to buying high efficiency
RESTR	0,1	Restaurant
RETAIL	0,1	Retail building
SCHOOL	0,1	School
SAVINGS	dollars	Expected dollar amount of electricity savings
SQFEET	Square ft.	Square footage of facility
WARE	0,1	Warehouse

A characteristic of the conditional logit specification is that variables that do not vary over choices will drop out of the model.[19] For instance, firmographic variables such as size do not vary across the equipment options and therefore cannot be included in the model. One way to avoid this problem is to interact firmographic variables with choice specific dummy variables. This method is used in this application to allow for firm specific variables such as size, building type, and program awareness to influence equipment choice. All of the variables except CINDEX and SAVINGS are interacted with a dummy variable for the high efficiency equipment options. As a result, these variables have positive values for two of the three choices and values of zero for the standard efficiency option.

For those that purchased high-efficiency HVAC within the retrofit program, survey information was available that helped identify those customers that might be predisposed to purchasing high-efficiency equipment even if the program did not exist. For those customers that indicated that they would have installed high-efficiency HVAC even if the program had not existed, the variable PREDISP has a value of one, otherwise PREDISP has a value of zero.

As in the purchase model, cost and rebate information is combined into one variable called CINDEX. As before, CINDEX is determined by calculating the fraction of the incremental cost that the customer must pay for equipment installation after any rebate has been paid. For those that are unaware of the retrofit program and for standard equipment options not covered by the program, CINDEX has a value of one.

[19] For a fuller explanation of the conditional logit model and its properties, see Greene (1990) pp. 699-703.

Estimation of Cost, Savings, and Rebates

A requirement of the conditional logit specification is that information must be included in the model for all of the choices in the choice set and not just for the option that is actually selected. As a result, data on equipment characteristics is needed for the nonchosen equipment alternatives as well as for the equipment option actually chosen. How this information is calculated for nonchosen equipment alternatives is described below.

For those customers that installed high-efficiency equipment within the HVAC Program, the incremental cost is calculated for the equipment purchased. This is referred to as the calculated incremental cost in the discussion below. Along with the calculated incremental cost, savings are calculated using the impact estimate from the MDSS. Rebate amount is also taken from the MDSS.

Incremental costs and savings are also calculated for high-efficiency equipment purchased outside the HVAC Program. Incremental costs and savings are determined using survey information and per unit cost and savings information from the Advice Filings. The per unit incremental cost is multiplied by the number of reported units installed to determine the total incremental cost of the HVAC retrofit. Energy savings are calculated by multiplying the annual energy savings for that technology as given in the Advice Filings by the electricity rate and the number of units installed as reported in the survey.

For those outside the program that reported installing high-efficiency equipment, the equipment is assigned an efficiency rating based on the minimum EER rating required for the program for that technology. Equipment capacity is estimated based on the square footage of the facility. If a customer did not specifically indicate in the survey that the equipment installed outside the program was high-efficiency, then the equipment is assumed to be standard efficiency. This results in a more conservative estimate of nonparticipant spillover. For those that installed standard efficiency equipment, the incremental cost, savings, and rebate values are all set to zero.

For the nonchosen equipment options, cost, savings, and rebate information is assigned based on available data in the MDSS and customer surveys. For each of the HVAC equipment options, the cost per square foot is determined from those who reported installing the technology. Based on these customers, the median incremental cost per square foot is calculated for each technology. Finally, an incremental cost for each nonadopted technology is estimated by multiplying the square footage of the site by the median cost per square foot for that technology. The estimated savings for nonadopted technologies are estimated in a similar manner using the median savings per square foot based on those who reported installing the technology.

To calibrate these estimates, the incremental cost for the equipment actually chosen by the customer is estimated using the method described above. The estimated incremental cost is then compared with the calculated incremental cost for participants. The ratio of the estimated incremental costs to the calculated costs is used as an adjustment factor for the estimated costs and savings for all nonchosen equipment alternatives for that customer. In the event that the calculated incremental cost is greater than the total installation cost reported in the MDSS, the calculated incremental cost is multiplied by the average ratio of the incremental cost to reported installation cost for that technology based on installations found in the MDSS.

Expected rebate amounts are determined using a similar method. The average ratio of rebate to the calculated incremental cost is calculated for program participants for each technology. To get an estimated rebate for those that did not choose the technology, the rebate-to-cost ratio for the technology is multiplied by the estimated incremental cost to get the expected rebate associated with the installation of that equipment option. If a person was unaware of the program, the expected rebate amount is automatically set to zero for all equipment options. The costs, savings, and rebate calculations are summarized below.

Actual Equipment Option Chosen – In Program: Incremental costs and savings are calculated using the reported capacity, efficiency, and number of units installed as reported in the MDSS. Rebate amount is also taken from the MDSS.

Actual Equipment Option Chosen – Outside Program: Incremental costs and savings are calculated using estimated capacity based on square footage and per unit costs and savings information from the Advice Filings.

Non Chosen Equipment Alternatives: Incremental costs are estimated by multiplying the square footage of the facility by the median cost per square foot from the MDSS associated with that technology. Savings are assigned using the same method. Rebate amount is determined by multiplying the expected cost of the technology by the rebate-to-cost ratio for that technology. For those unaware of the retrofit program, rebate is set to zero for all program qualifying equipment options.

Equipment Choice Model Estimation Results

The estimation results for the equipment choice model are given in Exhibit 3-43. The coefficient estimate on CINDEX is negative, indicating that the greater portion of the incremental cost a customer must pay himself, the less attractive the equipment option. However, the estimate is relatively small in magnitude. The estimate for SAVINGS is negative, but small in magnitude.

Exhibit 3-43
Equipment Choice Model Estimation Results

Variable Name	Coefficient Estimate	Standard Error	Significance Level
AWARE	2.25	0.40	1%
CINDEX	-0.18	0.09	5%
GROCERY	-0.83	0.99	40%
HEALTH	0.06	0.49	90%
HOTEL	0.48	1.04	65%
HV_INFO	1.59	0.36	1%
MISCOM	0.45	0.63	48%
OFFICE	-0.60	0.31	5%
PREDISP	2.08	0.52	1%
PGE_INFO	1.88	0.39	1%
RETAIL	-0.26	0.38	49%
RESTR	0.74	0.51	15%
SAVINGS	0.00	0.00	1%
SCHOOL	-0.67	0.44	13%
SQFEET	0.00	0.00	1%
WARE	-0.34	0.52	51%

The remaining variables are all interacted with a dummy variable indicating a high-efficiency equipment option. The coefficient estimate on AWARE is positive and significant, indicating that those that are aware of the retrofit program are more likely to purchase high-efficiency equipment. Further, both HV_INFO and PGE_INFO are positive, indicating the effect of awareness is greater for those who were made aware of the program through either their HVAC contrator or their PG&E representative.

Similarly, the coefficient estimate on PREDISP is positive, indicating that those identified as predisposed to purchasing high-efficiency do in fact tend to choose high-efficiency equipment. SQFEET is the square footage of the facility interacted with a dummy variable for the high-efficiency equipment options. The coefficient estimate on SQFEET is positive (although small in magnitude), indicating a tendency for larger buildings to purchase high efficiency equipment. The remaining variables indicate business type. Of these, HEALTH, HOTEL, MISCOM (miscellaneous commercial), and RESTR (restaurant) have positive coefficient estimates. Of all the business types, only OFFICE is statistically significant.

Using the coefficient estimates from the purchase model, the probability of choosing any particular equipment option is calculated. Using the conditional logit density function, the probability of selecting equipment option j is given by:

$$P_j = exp(b'X_j) / S\ exp(b'X)$$

where $\beta' X_j$ is the product of the variables and coefficient estimates used in the equipment choice model for equipment option j and the denominator is the sum of $\beta' X$ across all three equipment options in the choice set.

As is done with the purchase probability, the equipment choice probability is calculated both with and in absence of the program. To simulate the absence of the program, AWARE is set to zero and CINDEX is set to one for all of the HVAC equipment options. For program participants, the probability of choosing high-efficiency equipment is the sum of the individual probabilities for the two high-efficiency options. The probability of choosing standard equipment is the probability of choosing the remaining standard efficiency option. For participants, the probability of purchasing high-efficiency equipment is 0.58 with the program and falls over 70 percent to 0.17 without the program. This suggests that the HVAC Program is having a significant effect on high-efficiency HVAC equipment purchases.

Net-to-Gross Calculation

Once both the purchase probability and the equipment choice probability are estimated, the two probabilities are multiplied together to determine the total probability that a purchase is made and that an individual equipment option is selected. This total probability is calculated twice. First, the total probability is calculated using the original values for the program variables AWARE HV_INFO, PGE_INFO and CINDEX. This gives the total probability with the existence of the program. Next, the total probability is calculated in absence of the program. This is done by setting the awareness variables to zero and CINDEX equal to one to reflect the absence of rebates. While the awareness variables are set to zero, PREDISP retains its original value since this variable captures the effect of those that are predisposed to high-efficiency equipment and who would likely purchase the equipment even if the HVAC Program did not exist.

The estimated impacts are weighted up to the population based on participation. Participants are weighted to reflect the HVAC Program participation population in the MDSS. Nonparticipants are assigned weights based on the nonparticipant population represented in the sample. For those that reported making a lighting purchase since January of 1995, the weight was scaled down to reflect the portion of those adoptions which would have occurred during the 1997 program year. To estimate this portion, the survey data regarding high efficiency HVAC adoptions that occurred in 1997 were used. The percentage of all self-reported high efficiency adoptions that occurred in 1997 was 32.9 percent. The nonparticipant weight is scaled to adjust for the fact that only 32.9 percent of these actions were likely to have been done during the 1997 program year. Finally, those that reported purchasing HVAC outside the program since 1995 and receiving a rebate from PG&E were given a weight of zero since these impacts were already counted toward a program other than the 1997 HVAC Program.

To calculate expected impacts, the total probability of making a purchase with the program is multiplied by the gross impact associated with the technology. The expected impact is then summed across the eight high-efficiency equipment options to get a total expected impact for each customer. The calculation is given by:

$$\text{EXPECTED IMPACT}^{W} = \Sigma\, P^{W}_{j} * \text{IMPACT}_{j}$$

Where P^{W}_{j} = Total probability of choosing equipment option j with the program

IMPACT_{j} = One year impact associated with equipment option j.

The expected impact without the program is calculated in the same manner using the total probability in absence of the program:

$EXPECTED\ IMPACT^{WO} = \Sigma\ P^{WO}{}_j{*}IMPACT_j$

Where $P^{WO}{}_j$ = Total probability of choosing equipment option j without the program.

The net impact associated with program is simply the difference in expected impacts with and without the program:

$NET\ IMPACT = EXPECTED\ IMPACT^{W} - EXPECTED\ IMPACT^{WO}{}_j$

The net-to-gross ratio is then the net impact divided by the expected impact with the program:

$NTG = NET\ IMPACT\ /\ EXPECTED\ IMPACT$

The contributions to net made by participants (less free ridership), and through participant and nonparticipant spillover, can all be calculated separately using the two stage model.

For rebated participant actions, net impacts are calculated using the same method shown above:

$NET\ IMPACT_P = EXPECTED\ IMPACT^{W}{}_P – EXPECTED\ IMPACT^{WO}{}_P$

For actions done outside the program, net impacts are calculated as:

$NET\ IMPACT_{P\_SP} = EXPECTED\ IMPACT^{W}{}_{P\_SP} – EXPECTED\ IMPACT^{WO}{}_{P\_SP}$

$NET\ IMPACT_{NP\_SP} = EXPECTED\ IMPACT^{W}{}_{NP\_SP} – EXPECTED\ IMPACT^{WO}{}_{NP\_SP}$

Spillover is broken out into participant spillover (P_SP), which reflects actions done by current program participants outside the program, and nonparticipant spillover (NP_SP). The net impact for actions done outside the program is then incorporated into the net-to-gross calculations:

$NTG = (NET\ IMPACT_P + NET\ IMPACT_{P\_SP} + NET\ IMPACT_{NP\_SP})\ /\ EXPECTED\ IMPACT^{W}{}_P$

Using the above formulas, net-to-gross ratios are calculated for both single and split package air conditioners as well as for evaporative coolers. The combined net-to-gross ratios for both technologies are shown by building type in Exhibit 3-44. The net-to-gross ratios range from 0.37 for warehouses to 1.02 for personal services buildings. For split and single package units, the overall estimated net-to-gross ratio is 0.78 while for evaporative coolers the net-to-gross ratio is 0.67.

Exhibit 3-44
Estimated NTG Ratios by Building Type

Building Type	NTG
Office	0.81
Retail	0.68
College/univ	0.74
School	0.77
Grocery	0.78
Restaurant	0.78
Healthcare	0.77
Hotel	1.18
Warehouse	0.98
Personal Service	1.55
Community Service	0.85
Misc. Com.	0.70

Alternative Model Specifications

As discussed above, we added four new variables to the discrete choice model relative to the 1996 Lighting Program Evaluation. Two of these four variables (HV_INFO and PGE_INFO) are included to enhance the model's ability to accurately interpret the impact of program awareness. We believe that respondents who claim they were aware of the program **and** can cite the source of their program information are likely to be more completely and accurately informed than respondents who simply claim to be aware. Perhaps more importantly, the addition of these two variables reduces the concern evaluators commonly have with customers falsely claiming they are aware of the program. By including these additional dummy variables, the model can assign different impacts to the different quality awareness these information sources produce. We expected the coefficients for both of these variables to be positive, reflecting a greater impact from awareness that can be traced to a reliable source. This expectation was validated by our results in both the purchase model and the equipment choice model.

Also as discussed above, we added two new building characteristics variables to the purchase model. These are SHTLEASE and B4_78. SHTLEASE takes a value of one if the respondent has a lease for the property that is shorter than one year, and a zero otherwise. We expect that tenants with short leases will be less likely to purchase new lighting equipment. This expectation was not borne out by the results, althought the coefficient is small and not statistically significant. The second variable, B4_78, is also a dummy variable. This variable takes on a value of one if the building was constructed prior to 1978. Our expectation was that older buildings would be more likely to remodel and/or be in need of new lighting, and therefore be more likely to make a lighting purchase. This expectation was borne out by the results.

We explored the marginal impact of including these four new variables in the model by examining the results using alternative model specifications. Specifically, we ran the model with the following four different specifications to measure the marginal impacts of the new variables. The "baseline model" referred to below is the model described in the preceding section, which includes all four new variables. The four alternative specifications are:

1) The baseline model without the HV_INFO and PGE_INFO
2) The baseline model without SHTLEASE
3) The baseline model without B4_78
4) The baseline model without all four new variables

The net-to-gross ratios resulting from these four alternative model specifications are shown in Exhibit 3-45 below. The new awareness variables have the effect of moderately increasing the net to gross ratio, while the new building characteristics variables each moderately reduce the final result. Overall, the four new variables slightly decrease the net to gross ratio, but the effect is only about one half of one percent.

Exhibit 3-45
NTG Results with Alternative Model Specifications

	NTG Ratio
Base Case	0.836
Without HV_INFO and PGE_INFO	0.840
Without SHTLEASE	0.835
Without B4_78	0.837
Without All New	0.841

3.4.4 Final Net-to-Gross Ratios

As mentioned previously, three separate models were implemented to estimate the components of the net-to-gross ratio (free ridership and spillover). The first methodology relied on self-reported estimates of free ridership, participant spillover, and nonparticipant spillover to estimate the net-to-gross ratios. The second approach relied on a net billing regression analysis model and applied the double inverse Mills ratio methodology, which resulted in estimates of free ridership only. The final approach relied on a two-stage discrete choice model to estimate free ridership, participant spillover, and nonparticipant spillover.

The most sophisticated, and preferred, of the three approaches is the two-stage discrete choice model. The Mills ratios lack the estimate of spillover, and are also run on a reduced set of the data due to the censoring of customer billing data. The self-report values rely on customers to provide an accurate and unbiased response to their hypothetical actions in the absence of the program. Recall that the discrete choice model was only estimated for the CAC and Other RE (evaporative coolers) technology segments.

Exhibit 3-46 presents the results of each model, by business type, and for the total program. Results (both within business type and overall) are weighted by the ex-post gross energy impacts. The exhibit illustrates the total net-to-gross ratio, as well as the two primary components, free ridership and spillover. For the Mills ratio methodology, only free ridership is presented, as discussed above.

A comparison of the three models shows that the discrete choice results are generally supported by the other approaches. The results can be compared for the technologies where a discrete choice result was obtained: Central Air Conditioners and Other HVAC technologies. The rate of spillover for both technology categories is only moderately lower compared to the self-report technique; spillover is 21 percent using self-report versus 13 percent with discrete choice. Free ridership, however, is significantly lower compared to the self-report technique, but greater than the Mills approach. In the self-report analysis, however, the CAC result is driven by a handful of large customers. Of the 262 participant installations in our sample, the largest 11 installations increase the free ridership rate from 48 percent to 68 percent. All 11 of these customers are also included in the discrete choice analysis. However, unlike the self-report analysis where they are categorized as either 100 percent free riders or 100 percent net participants, they may be assigned a partial net value in the discrete choice analysis. This explains a large portion of the difference between the self-report and discrete choice rates of free ridership.

Overall, self report techniques yield a lower overall net to gross ratios for both central air conditioners and Other HVAC technologies. The impact on the total net to gross ratio of implementing the discrete choice results is minor. The total net to gross ratios calculated with self-report techniques are within 5 percent of those calculated using discrete choice results. This is true for the Retrofit Express Program, as well as all programs combined.

As mentioned above, the free ridership estimates using the Mills approach provide significantly higher estimates of net participation. This in part due to the large net estimates for custom measures.

Exhibit 3-46
Comparison of Net-to-Gross Ratios

Program and Technology Group		Discrete Choice Model NTG	Discrete Choice Model 1-FR	Discrete Choice Model Spill	Self Report NTG	Self Report 1-FR	Self Report Spill	Mills 1-FR
Retrofit Express	Central A/C	0.85	0.73	0.13	0.53	0.32	0.21	0.91
	Adjustable Speed Drives	-	-	-	0.92	0.71	0.21	0.96
	Package Terminal A/C	-	-	-	0.50	0.29	0.21	0.91
	Set-Back Thermostat	-	-	-	0.82	0.61	0.21	0.91
	Reflective Window Film	-	-	-	0.89	0.68	0.21	0.91
	Water Chillers	-	-	-	0.68	0.47	0.21	1.00
	Other HVAC Technologies	0.89	0.75	0.13	0.66	0.45	0.21	0.91
Retrofit Express Program Total		0.87	0.67	0.20	0.82	0.61	0.21	0.93
REO	Adjustable Speed Drives	-	-	-	0.92	0.71	0.21	0.96
	Water Chillers	-	-	-	0.68	0.47	0.21	1.00
	Cooling Towers	-	-	-	0.68	0.47	0.21	1.00
Retrofit Efficiency Options Program Total		0.75	0.54	0.21	0.75	0.54	0.21	0.99
APO	Adjustable Speed Drives	-	-	-	0.92	0.71	0.21	0.96
	Water Chillers	-	-	-	0.68	0.47	0.21	1.00
	Customized EMS	-	-	-	0.68	0.47	0.21	1.00
	Convert To VAV	-	-	-	0.68	0.47	0.21	1.00
	Other Customized Equip	-	-	-	0.68	0.47	0.21	1.00
	Other HVAC Technologies	-	-	-	0.68	0.47	0.21	1.00
Advanced Performance Options Program Total		0.75	0.54	0.21	0.75	0.54	0.21	0.99
Total		**0.84**	**0.64**	**0.20**	**0.80**	**0.59**	**0.21**	**0.94**

Final NTG

The resulting net-to-gross ratios that were applied to the gross ex-post impacts are based on two models: the discrete choice model and the self report model. The discrete choice estimates for CAC technologies and RE Other HVAC technologies were considered to be the most accurate. To be both conservative and consistent, the self-report estimates of NTG were applied to the remaining HVAC technology segments. Also, the CADMAC has approved a waiver that allows the use of self -report based algorithms to estimate free ridership and spillover effects in the event discrete choice and LIRM models fail to produce statistically reliable results. (The approved waiver is presented in Attachment 6.)

Based on the discussions above, the only technologies for which we could apply the Mills estimates of (1-FR) are the RE segments set-back programmable thermostats, window film, and PTAC. In all but the case of window film, the Mills results are significantly larger than the estimates of (1-FR) derived in the self-report model. Additionally, the self-report method was conducted at a finer level of segmentation, and was thus selected over the Mills results. This is consistent with the most conservative approach.

Overall program net-to-gross ratios are presented, weighted across business type by ex-post gross energy, demand and therm savings, respectively, in Exhibit 3-47.

Exhibit 3-47
Final Net-to-Gross Ratios

		Discrete Choice Model		
Program and Technology Group		***NTG***	***1-FR***	***Spill***
Retrofit	Central A/C	0.85	0.73	0.13
Express	Adjustable Speed Drives	0.92	0.71	0.21
	Package Terminal A/C	0.50	0.29	0.21
	Set-Back Thermostat	0.82	0.61	0.21
	Reflective Window Film	0.89	0.68	0.21
	Water Chillers	0.68	0.47	0.21
	Other HVAC Technologies	0.89	0.75	0.13
Retrofit Express Program Total		0.87	0.67	0.20
REO	Adjustable Speed Drives	0.92	0.71	0.21
	Water Chillers	0.68	0.47	0.21
	Cooling Towers	0.68	0.47	0.21
Retrofit Efficiency Options Program Total		0.75	0.54	0.21
APO	Adjustable Speed Drives	0.92	0.71	0.21
	Water Chillers	0.68	0.47	0.21
	Customized EMS	0.68	0.47	0.21
	Convert To VAV	0.68	0.47	0.21
	Other Customized Equip	0.68	0.47	0.21
	Other HVAC Technologies	0.68	0.47	0.21
Advanced Performance Options Program Total		0.75	0.54	0.21
Totals Weighted by:				
Energy		**0.84**	**0.64**	**0.20**
Demand		**0.80**	**0.64**	**0.18**
Therm		**0.79**	**0.60**	**0.21**

4. EVALUATION RESULTS

This section contains the results of the HVAC Evaluation, beginning with ex post gross impacts, then presenting the net-to-gross (NTG) adjustments, and concluding with the program realization rates (ratio of ex post evaluation findings to the ex ante program design estimates), for both gross and net impacts. Explanation surrounding the differences between the ex ante and ex post estimates are discussed in the presentation of program realization rates.

Where segment analysis could be supported, results are presented by technology group and business type. All results are segmented by program: Retrofit Express (RE), Retrofit Efficiency Options (REO), and Advanced Performance Options (APO). All results are aggregated to the total commercial sector.

4.1 EX POST GROSS IMPACT RESULTS

Ex post gross energy and demand impacts for the RE, REO, and APO programs for HVAC applications, are presented in Exhibits 4-1 and 4-2, respectively. The ex post gross energy and demand impacts by PG&E costing period are provided in *Attachment 3*. *Attachment 3* also provides all of the results tables in this section (as well as the ex ante impacts, not included in the main body of this report), in a larger, more readable format.

Exhibit 4-1
Ex Post Gross Energy Impacts
By Business Type and Technology Group
For Commercial HVAC Applications

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	1,157,127	178,264	26,096	216,179	69,270	284,229	211,742	57,827	123,893	163,763	448,332	62,951	2,999,672
	Adjustable Speed Drives	3,843,931	1,531,129	92,761	24,046	-	-	322,207	1,339,685	-	-	150,677	4,279	7,308,715
	Package Terminal A/C	3,622	-	657	2,374	97	18,489	-	425,709	3,407	-	694	1,448	456,496
	Set-Back Thermostat	1,301,916	482,644	265,506	2,163,596	64,596	237,787	249,454	50,423	207,882	381,883	638,023	138,986	6,182,696
	Reflective Window Film	3,230,467	240,189	113,136	25,739	30,355	32,005	133,404	1,281	138,758	421,113	91,294	86,974	4,544,714
	Water Chillers	50,318	-	33,957	-	-	-	133,381	13,595	-	-	3,945	-	235,196
	Other HVAC Technologies	2,129	3,194	-	-	28,534	53,098	-	3,663	-	15,382	54,982	-	160,983
Retrofit Express Program Total		9,589,510	2,435,420	532,114	2,431,933	192,851	625,608	1,050,188	1,892,185	473,940	982,140	1,387,947	294,637	21,888,473
REO	Adjustable Speed Drives	936,696	-	-	-	-	-	-	-	-	-	-	-	936,696
	Water Chillers	289,619	43,302	663,928	-	-	-	34,410	-	-	1,187,535	28,493	-	2,247,286
	Cooling Towers	5,300	-	-	-	-	-	-	-	-	-	13,261	-	18,562
Retrofit Efficiency Options Program Total		1,231,616	43,302	663,928	0	0	0	34,410	0	0	1,187,535	41,754	0	3,202,544
APO	Adjustable Speed Drives	1,327,052	-	-	-	-	-	-	-	-	-	-	-	1,327,052
	Water Chillers	892,937	-	110,489	-	-	-	96,232	-	-	-	-	-	1,099,657
	Customized EMS	795,479	-	375,348	-	-	-	-	-	-	-	118,500	-	1,289,327
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	174,298	-	174,298
	Other Customized Equip	-	-	-	-	-	-	-	-	-	260,131	-	-	260,131
	Other HVAC Technologies	47,833	-	-	-	-	-	-	-	409,419	-	-	-	457,252
Advanced Performance Options Program Total		3,063,301	0	485,837	0	0	0	96,232	0	409,419	260,131	292,798	0	4,607,717
Total		13,884,427	2,478,722	1,681,879	2,431,933	192,851	625,608	1,180,829	1,892,185	883,360	2,429,806	1,722,498	294,637	**29,698,734**

As shown in Exhibits 4-1 and 4-2, the RE program technologies represent nearly three-quarters of the energy and demand impacts. The REO and APO programs represent 11 percent and 16 percent of the energy impacts, respectively. These two program each represent about 13 percent of the total demand impacts. By business segment, offices alone represents almost half of the overall energy and demand impacts.

Adjustable Speed Drives (ASDs), which were offered through all three programs, contributed more to energy impacts than any other technology, with about one-third of the total. Programmable thermostats (including timeclocks, bypass timers, and setback programmable thermostats) was the second largest contributor, having a total program impact representing 20 percent of the total. Other technologies with relatively large shares of the impact were reflective window film, chillers and central air conditioners, accounting for 15, 12 and 10 percent of the program total, respectively.

Exhibit 4-2
Ex Post Gross Demand Impacts
By Business Type and Technology Group
For Commercial HVAC Applications

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	919	226	27	345	31	163	142	30	71	90	281	39	2,363
	Adjustable Speed Drives	1,189	397	21	11	-	-	40	99	-	-	28	1	1,785
	Package Terminal A/C	3	-	0	1	0	8	-	444	8	-	0	1	466
	Set-Back Thermostat	-	-	-	-	-	-	-	-	-	-	-	-	0
	Reflective Window Film	587	30	10	2	4	6	24	0	17	51	13	10	755
	Water Chillers	18	-	3	-	-	-	61	8	-	-	9	-	99
	Other HVAC Technologies	2	2	-	-	13	24	-	5	-	8	9	-	62
	Retrofit Express Program Total	2,719	655	61	359	48	200	267	586	96	149	341	50	5,531
REO	Adjustable Speed Drives	230	-	-	-	-	-	-	-	-	-	-	-	230
	Water Chillers	116	143	116	-	-	-	74	-	-	219	28	-	696
	Cooling Towers	14	-	-	-	-	-	-	-	-	-	7	-	21
Retrofit Efficiency Options Program Total		360	143	116	0	0	0	74	0	0	219	35	0	946
APO	Adjustable Speed Drives	264	-	-	-	-	-	-	-	-	-	-	-	264
	Water Chillers	207	-	130	-	-	-	-	-	-	-	-	-	337
	Customized EMS	-	-	-	-	-	-	-	-	-	-	-	-	0
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	-	-	0
	Other Customized Equip	-	-	-	-	-	-	-	-	-	177	-	-	177
	Other HVAC Technologies	56	-	-	-	-	-	-	-	135	-	-	-	191
Advanced Performance Options Program Total		527	0	130	0	0	0	0	0	135	177	0	0	968
Total		3,605	798	306	359	48	200	340	586	231	545	376	50	**7,445**

Central air conditioners (CACs), contributed more to demand impacts than any other technology, with about one-third of the total. ASDs contributed nearly as much as CACs, making up 30 percent of the total. Other technologies with relatively large shares of the impact were chillers and reflective window film, accounting for 15 and 10 percent of the program total, respectively.

Therm impacts associated with the installation of HVAC technologies paid in 1997 are presented next in Exhibit 4-3.

Gross therm impacts are associated only with program participants who have gas heating. Since accurate fuel type/heating equipment saturation data were not available for program participants in such RE measures as programmable thermostats and reflective window film (which would presumably have negative therm impacts), ex post therm impacts were calculated only for those segments for which ex ante therm impacts were estimated.

Exhibit 4-3
Ex Post Gross Therm Impacts
By Business Type and Technology Group
For Commercial HVAC Applications

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	-	-	-	-	-	-	-	-	-	-	-	-	0
	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	0
	Package Terminal A/C	-	-	-	-	-	-	-	-	-	-	-	-	0
	Set-Back Thermostat	-	-	-	-	-	-	-	-	-	-	-	-	0
	Reflective Window Film	-	-	-	-	-	-	-	-	-	-	-	-	0
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	0
	Other HVAC Technologies	-	-	-	-	-	-	-	-	-	-	-	-	0
Retrofit Express Program Total		0	0	0	0	0	0	0	0	0	0	0	0	0
REO	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	0
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	0
	Cooling Towers	-	-	-	-	-	-	-	-	-	-	-	-	0
Retrofit Efficiency Options Program Total		0	0	0	0	0	0	0	0	0	0	0	0	0
APO	Adjustable Speed Drives	12,649	-	-	-	-	-	-	-	-	-	-	-	12,649
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	0
	Customized EMS	-	-	-	-	-	-	-	-	-	-	5,553	-	5,553
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	5,609	-	5,609
	Other Customized Equip	-	-	-	-	-	-	-	-	-	-	-	-	0
	Other HVAC Technologies	-	-	-	-	-	-	-	-	-	-	-	-	0
Advanced Performance Options Program Total		12,649	0	0	0	0	0	0	0	0	0	11,162	0	23,811
Total		12,649	0	0	0	0	0	0	0	0	0	11,162	0	**23,811**

Therm impacts were only estimated for three APO applicants with EMS and convert to VAV measures. One applicant was filed under the ASD action code in the MDSS, but also installed an EMS. These measures were found in the office and community services business types.

4.2 NET-TO-GROSS ADJUSTMENTS

The NTG results are designed to account for all of the market effects (free-ridership, participant spillover, and nonparticipant spillover) by measure. Exhibit 4-4 presents the NTG values by business type, separating out the effects of free ridership and spillover (note that due to rounding, values may not sum properly). Also shown are the overall program level NTG results, weighted across business type by the ex-post gross energy, demand and therm savings.

For this HVAC Evaluation, the results from the discrete choice analysis were used for the CAC and Other RE HVAC technology groups (which were the only two technologies modeled in the discrete choice analysis). The remaining technology groups applied the results from the self-report analysis. Refer to *Section 3.4, Net-to-Gross Analysis* for additional information surrounding the decision-making process.

The overall NTG ratio ranged from 0.79 based on therm savings, to 0.84 based on energy savings. On average, spillover was approximately 20 percent, overall. Free-ridership ranged from 36 percent for energy savings to 40 percent for therm savings. This variation is due to the distribution of ex-post energy, demand and therm savings across technologies.

Exhibit 4-4
NTG Adjustments by Program and Technology Group

Program and Technology Group		Discrete Choice Model NTG	1-FR	Spill
Retrofit Express	Central A/C	0.85	0.73	0.13
	Adjustable Speed Drives	0.92	0.71	0.21
	Package Terminal A/C	0.50	0.29	0.21
	Set-Back Thermostat	0.82	0.61	0.21
	Reflective Window Film	0.89	0.68	0.21
	Water Chillers	0.68	0.47	0.21
	Other HVAC Technologies	0.89	0.75	0.13
Retrofit Express Program Total		0.87	0.67	0.20
REO	Adjustable Speed Drives	0.92	0.71	0.21
	Water Chillers	0.68	0.47	0.21
	Cooling Towers	0.68	0.47	0.21
Retrofit Efficiency Options Program Total		0.75	0.54	0.21
APO	Adjustable Speed Drives	0.92	0.71	0.21
	Water Chillers	0.68	0.47	0.21
	Customized EMS	0.68	0.47	0.21
	Convert To VAV	0.68	0.47	0.21
	Other Customized Equip	0.68	0.47	0.21
	Other HVAC Technologies	0.68	0.47	0.21
Advanced Performance Options Program Total		0.75	0.54	0.21
Totals Weighted by:				
Energy		**0.84**	**0.64**	**0.20**
Demand		**0.80**	**0.64**	**0.18**
Therm		**0.79**	**0.60**	**0.21**

4.3 EX POST NET IMPACTS

Exhibits 4-5, 4-6, and 4-7 present the ex post net energy, demand, and therm HVAC impacts for the RE, REO and APO programs. These exhibits show reductions of 16 percent in ex post program energy impacts and 20 percent in ex post program demand impacts (when compared to Exhibits 4-1 and 4-2), as a result of the application of the NTG adjustments presented in Exhibit 4-4.

The measures that contributed the majority of gross demand and energy savings provide the largest net impacts as well. These measures, which include ASDs, programmable thermostats, reflective window film, and central air conditioners, all had relatively high net-to-gross ratios. Chillers were the only measure that made up more than 10 percent of demand or energy impacts that had a net-to-gross ratio less than 80 percent.

Exhibit 4-5
Ex Post Net Energy Impacts
By Business Type and Technology Group
For Commercial HVAC Applications

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	938,488	121,841	19,182	165,916	54,240	221,573	162,195	68,437	120,878	253,558	381,822	43,842	2,551,973
	Adjustable Speed Drives	3,539,296	1,409,785	85,410	22,140	-	-	296,672	1,233,514	-	-	138,735	3,940	6,729,492
	Package Terminal A/C	1,816	-	330	1,191	48	9,272	-	213,497	1,709	-	348	726	228,937
	Set-Back Thermostat	1,070,981	397,032	218,410	1,779,815	53,138	195,608	205,206	41,479	171,008	314,144	524,850	114,332	5,086,003
	Reflective Window Film	2,873,885	213,677	100,648	22,898	27,004	28,472	118,678	1,140	123,442	374,630	81,217	77,373	4,043,064
	Water Chillers	34,354	-	23,183	-	-	-	91,063	9,282	-	-	2,694	-	160,575
	Other HVAC Technologies	1,727	2,183	-	-	22,343	41,393	-	4,335	-	23,816	46,825	-	142,624
	Retrofit Express Program Total	8,460,546	2,144,519	447,163	1,991,959	156,773	496,319	873,814	1,571,684	417,037	966,149	1,176,491	240,214	18,942,668
REO	Adjustable Speed Drives	862,462	-	-	-	-	-	-	-	-	-	-	-	862,462
	Water Chillers	197,732	29,563	453,283	-	-	-	23,492	-	-	810,765	19,453	-	1,534,288
	Cooling Towers	3,619	-	-	-	-	-	-	-	-	-	9,054	-	12,673
Retrofit Efficiency Options Program Total		1,063,813	29,563	453,283	0	0	0	23,492	0	0	810,765	28,507	0	2,409,422
APO	Adjustable Speed Drives	1,221,882	-	-	-	-	-	-	-	-	-	-	-	1,221,882
	Water Chillers	609,634	-	75,434	-	-	-	65,700	-	-	-	-	-	750,768
	Customized EMS	543,097	-	256,261	-	-	-	-	-	-	-	80,903	-	880,261
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	118,998	-	118,998
	Other Customized Equip	-	-	-	-	-	-	-	-	-	177,599	-	-	177,599
	Other HVAC Technologies	32,657	-	-	-	-	-	-	-	279,522	-	-	-	312,179
Advanced Performance Options Program Total		2,407,269	0	331,695	0	0	0	65,700	0	279,522	177,599	199,901	0	3,461,687
Total		11,931,628	2,174,082	1,232,141	1,991,959	156,773	496,319	963,007	1,571,684	696,559	1,954,512	1,404,899	240,214	**24,813,777**

Exhibit 4-6
Ex Post Net Demand Impacts
By Business Type and Technology Group
For Commercial HVAC Applications

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	746	154	20	265	24	127	109	36	69	140	239	27	1,954
	Adjustable Speed Drives	1,095	365	19	10	-	-	37	91	-	-	26	1	1,643
	Package Terminal A/C	1	-	0	1	0	4	-	223	4	-	0	0	234
	Set-Back Thermostat	-	-	-	-	-	-	-	-	-	-	-	-	0
	Reflective Window Film	522	27	9	1	4	5	21	0	16	46	12	9	671
	Water Chillers	12	-	2	-	-	-	42	5	-	-	6	-	68
	Other HVAC Technologies	2	1	-	-	10	19	-	6	-	12	8	-	57
	Retrofit Express Program Total	2,378	548	50	277	38	154	208	361	88	197	291	37	4,628
REO	Adjustable Speed Drives	211	-	-	-	-	-	-	-	-	-	-	-	211
	Water Chillers	79	98	79	-	-	-	50	-	-	150	19	-	475
	Cooling Towers	9	-	-	-	-	-	-	-	-	-	5	-	14
Retrofit Efficiency Options Program Total		300	98	79	0	0	0	50	0	0	150	24	0	701
APO	Adjustable Speed Drives	243	-	-	-	-	-	-	-	-	-	-	-	243
	Water Chillers	142	-	88	-	-	-	-	-	-	-	-	-	230
	Customized EMS	-	-	-	-	-	-	-	-	-	-	-	-	0
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	-	-	0
	Other Customized Equip	-	-	-	-	-	-	-	-	-	121	-	-	121
	Other HVAC Technologies	38	-	-	-	-	-	-	-	92	-	-	-	130
Advanced Performance Options Program Total		423	0	88	0	0	0	0	0	92	121	0	0	724
Total		3,101	646	218	277	38	154	258	361	180	467	315	37	**6,052**

This has had an effect of increasing the overall net-to-gross ratio relative to previous years. For example, in 1996 Customized EMS systems had a net-to-gross ratio of only 25 percent, and it was the second largest measure in terms of gross ex post energy, contributing over 14 percent towards the total program gross energy impact. In 1997, EMS systems comprised only 4 percent of the total. Another factor causing the relative increase in the overall net-to-gross ratio is the increase in the ASD net-to-gross ratio. In 1996, free ridership for ASDs was 87 percent, based on a sample of only 11 customers. In 1997, free ridership decreased to 29 percent based on a sample of 32 customers. Because ASDs comprise nearly one-third of the total program impacts, this has a significant effect on the overall net-to-gross ratio.

The net demand picture remained the same as gross. Net therm impacts, summarized in Exhibit 4-7, differ from the gross therm impacts by 21 percent, overall.

Exhibit 4-7
Ex Post Net Therm Impacts
By Business Type and Technology Group
For Commercial HVAC Applications

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	-	-	-	-	-	-	-	-	-	-	-	-	0
	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	0
	Package Terminal A/C	-	-	-	-	-	-	-	-	-	-	-	-	0
	Set-Back Thermostat	-	-	-	-	-	-	-	-	-	-	-	-	0
	Reflective Window Film	-	-	-	-	-	-	-	-	-	-	-	-	0
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	0
	Other HVAC Technologies	-	-	-	-	-	-	-	-	-	-	-	-	0
Retrofit Express Program Total		0	0	0	0	0	0	0	0	0	0	0	0	0
REO	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	0
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	0
	Cooling Towers	-	-	-	-	-	-	-	-	-	-	-	-	0
Retrofit Efficiency Options Program Total		0	0	0	0	0	0	0	0	0	0	0	0	0
APO	Adjustable Speed Drives	11,647	-	-	-	-	-	-	-	-	-	-	-	11,647
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	0
	Customized EMS	-	-	-	-	-	-	-	-	-	-	3,791	-	3,791
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	3,829	-	3,829
	Other Customized Equip	-	-	-	-	-	-	-	-	-	-	-	-	0
	Other HVAC Technologies	-	-	-	-	-	-	-	-	-	-	-	-	0
Advanced Performance Options Program Total		11,647	0	0	0	0	0	0	0	0	0	7,621	0	19,267
Total		11,647	0	0	0	0	0	0	0	0	0	7,621	0	**19,267**

4.4 REALIZATION RATES

Exhibits 4-8 through 4-13 present the gross and net realization rates for energy, demand, and therm impacts for the RE, REO and APO programs. Exhibit 4-14, at the end of this section, summarizes the gross and net ex ante impacts, ex post impacts, and realization rates for the entire HVAC Program.

4.4.1 Gross Realization Rates for Energy Impacts

The gross energy realization rates are presented in Exhibit 4-8. These values represent, by segment, the ratio of the ex post gross impact findings to the gross ex ante estimates. These realization rates illustrate how well the ex ante estimates predicted energy savings, before taking into account customer behavior effects, both inside and outside the rebate programs.

Exhibit 4-8
Gross Energy Impact Realization Rates
By Business Type and Technology Group
For Commercial HVAC Applications

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	0.56	0.44	0.18	0.24	1.56	0.58	0.39	1.24	2.15	0.57	0.58	0.45	0.51
	Adjustable Speed Drives	1.53	1.77	2.07	1.07	-	-	2.87	4.45	-	-	2.12	1.91	1.86
	Package Terminal A/C	0.80	-	1.20	0.98	1.12	1.00	-	0.94	0.87	-	0.86	1.08	0.94
	Set-Back Thermostat	0.79	1.30	0.82	1.03	0.93	0.90	0.91	1.03	0.96	0.84	1.09	1.04	0.95
	Reflective Window Film	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.19	1.13
	Water Chillers	1.01	-	1.32	-	-	-	0.43	1.74	-	-	0.10	-	0.54
	Other HVAC Technologies	1.03	1.03	-	-	1.00	1.21	-	0.66	-	1.13	1.64	-	1.24
Retrofit Express Program Total		1.05	1.31	0.83	0.80	1.14	0.74	0.78	2.18	1.18	0.87	0.87	0.84	1.02
REO	Adjustable Speed Drives	0.44	-	-	-	-	-	-	-	-	-	-	-	0.44
	Water Chillers	1.48	0.18	1.20	-	-	-	0.22	-	-	1.94	0.26	-	1.20
	Cooling Towers	0.13	-	-	-	-	-	-	-	-	-	0.48	-	0.27
Retrofit Efficiency Options Program Total		0.52	0.18	1.20	-	-	-	0.22	-	-	1.94	0.31	-	0.79
APO	Adjustable Speed Drives	1.75	-	-	-	-	-	-	-	-	-	-	-	1.75
	Water Chillers	1.00	-	0.35	-	-	-	0.15	-	-	-	-	-	0.59
	Customized EMS	1.00	-	1.00	-	-	-	-	-	-	-	1.00	-	1.00
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	1.00	-	1.00
	Other Customized Equip	-	-	-	-	-	-	-	-	-	0.33	-	-	0.33
	Other HVAC Technologies	0.70	-	-	-	-	-	-	-	1.44	-	-	-	1.30
Advanced Performance Options Program Total		1.22	-	0.70	-	-	-	0.15	-	1.44	0.33	1.00	-	0.88
Total		0.99	1.18	0.89	0.80	1.14	0.74	0.55	2.18	1.29	0.96	0.85	0.84	**0.97**

Exhibit 4-8 illustrates that the ex post impacts are very close to the ex ante estimates overall, but that the realization rates by business type and technology group vary dramatically, ranging from 0.10 to 4.45. This variation cannot be explained by a general, sweeping statement, as the individual results are due to a complex integration of individual ex post simplified and calibrated engineering models, ex ante forecasts applied in the MDSS, and the results of the SAE billing model. Explanations are provided below for specific technology and/or business type segments that have ex post impacts that vary significantly from the ex ante values.

Central Air Conditions: Overall, the ex post energy impacts are only about half that of the ex ante estimates. This result is almost entirely explained by the changes that occurred in the ex ante design algorithms from 1996 to 1997. Although the operating hour assumptions remained the same, the noncoincident demand savings for the most commonly installed CAC increased from 0.102 to 0.212 kW per ton per change in SEER; an increase of over 100 percent. Had the ex ante algorithm stayed consistent with the 1996 advice filing, the gross realization rate would have been very close to one.

Adjustable Speed Drives: The end-use metered data for ASDs, and the calibrated engineering models developed using the EUM results, indicate that the gross engineering estimates of savings are two times higher than the RE and APO program design estimates. The resulting SAE coefficient of 0.85, which was based on a sample of 25 customers and was statistically significant at the 95 percent confidence level, reduced this difference slightly.

In contrast, the ex post adjustable speed drive results are less than half of the ex ante REO estimates. The REO ex ante estimates were developed using a different program design method. While the RE program design and evaluation methods rely upon the fan motor horse power (hp), the REO program design estimates rely upon the building conditioned area served.

The evaluation applied a consistent method for determining RE, REO and APO engineering estimates of savings (by applying an annual energy per horsepower estimate to the fan's total hp). It is recommended that the program design methods be applied for ASD measures using a consistent strategy, rather than separate methods for each. For further details surrounding the ASD estimates, refer to *Section 3.2, Engineering Analysis.*

Water Chillers: The water chiller realization rates differed significantly by program, ranging from 54 percent for RE to 120 percent for REO. These differences are due to the variety of ex ante methodologies being applied across program and chiller type. For example, the RE program savings are based on the tonnage of the unit installed, whereas the REO program savings are based on the square footage of the facility. The ex post estimates are based upon calibrated engineering results that included a careful review of the original application calculations, an on-site audit to supplement the application information, and revisions using a temperature bin model. Across all water chiller measures, however, the realization rate is 86 percent. Because the resulting SAE coefficient was unreasonably high and based on a sample of only 3 customers, no SAE adjustment was made and the calibrated engineering estimates were accepted.

Other REO and APO Measures: In general, the differences observed between ex post impacts and ex ante estimates for other REO and Customized Incentives measures are due to improved information contributing to the ex post estimates or updated calculation methods. Each REO and APO site underwent a thorough engineering review of the application, generally supplemented with an on-site audit to improve the application records. This yielded a calibrated engineering estimate for each site. The interested reader can refer to the individual application-level analyses in the attachments to this report, for any additional explanations surrounding the realization rates reported here.

4.4.2 Gross Realization Rates for Demand Impacts

Gross demand realization rates are presented next in Exhibit 4-9. These values represent, by segment, the ratio of the ex post gross impact evaluation findings to the gross ex ante program design estimates. These realization rates illustrate how well the ex ante estimates predicted demand savings, before taking into account customers' actions within the HVAC market. Refer to Exhibit 4-14 for an individual presentation of both the ex ante and ex post impacts.

Overall, the gross demand estimates are 11 percent lower than the ex ante values, as illustrated above.

Some of the results can be explained using information from review of the ex ante estimates and the evaluation engineering analysis. Specific comments and justifications are as follows:

Central Air Conditions: As discussed above, the ex post energy impacts are only about half that of the ex ante estimates due to the changes that occurred in the ex ante design algorithms from 1996 to 1997. The coincident demand savings for the most commonly installed CAC increased from 0.075 to 0.159 kW per ton per change in SEER; an increase of over 100 percent. Had the ex ante algorithm stayed consistent with the 1996 advice filing, the gross realization rate would have been very close to one.

Exhibit 4-9
Gross Demand Impact Realization Rates
By Business Type and Technology Group
For Commercial HVAC Applications

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	0.59	0.60	0.30	0.26	0.55	0.57	0.67	0.60	0.49	0.50	0.58	0.46	0.49
	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	-
	Package Terminal A/C	0.83	-	0.63	0.41	0.70	0.79	-	0.91	0.79	-	0.74	0.95	0.90
	Set-Back Thermostat	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reflective Window Film	1.43	0.99	0.67	0.51	1.10	1.35	1.42	1.23	0.99	0.95	1.13	0.96	1.30
	Water Chillers	0.48	-	0.19	-	-	-	0.50	0.93	-	-	0.39	-	0.48
	Other HVAC Technologies	1.29	0.77	-	-	1.29	1.00	-	1.05	-	0.66	0.79	-	0.95
Retrofit Express Program Total		1.35	1.59	0.50	0.27	0.69	0.62	0.76	1.06	0.56	0.61	0.64	0.53	0.89
REO	Adjustable Speed Drives	1.79	-	-	-	-	-	-	-	-	-	-	-	1.79
	Water Chillers	1.05	0.82	0.74	-	-	-	2.04	-	-	0.52	0.64	-	0.74
	Cooling Towers	0.45	-	-	-	-	-	-	-	-	-	1.12	-	0.57
Retrofit Efficiency Options Program Total		1.33	0.82	0.74	-	-	-	2.04	-	-	0.52	0.70	-	0.86
APO	Adjustable Speed Drives	3.01	-	-	-	-	-	-	-	-	-	-	-	3.01
	Water Chillers	1.00	-	0.58	-	-	-	-	-	-	-	-	-	0.66
	Customized EMS	-	-	-	-	-	-	-	-	-	-	-	-	-
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	-	-	-
	Other Customized Equip	-	-	-	-	-	-	-	-	-	0.63	-	-	0.63
	Other HVAC Technologies	0.65	-	-	-	-	-	-	-	3.13	-	-	-	1.48
Advanced Performance Options Program Total		1.38	-	0.58	-	-	-	-	-	3.13	0.63	-	-	0.96
Total		1.35	1.36	0.61	0.27	0.69	0.62	0.72	1.06	1.08	0.58	0.64	0.53	**0.89**

Reflective Window Film: A review of the inputs from ASHRAE revealed a discrepancy between the annual solar heat gains listed in ASHRAE and those used in Advice Filing calculations. For details, refer to *Attachment 2, Standard HVAC Algorithm Review*.

Water Chillers - In the engineering analysis for chillers, data collected during on-site visits were used to determine peak loading factors, which were utilized in each applications' ex post temperature bin model. The resulting ex post estimates generally were much less than the ex ante estimates for each program with chiller measures.

Adjustable Speed Drives (ASDs): Relatively large impacts were observed for ASD measures installed under the RE, REO, and APO programs. The ex ante estimates assumed that, for the majority of measures, at peak loads there is zero demand impact since the ASD is operating at 100 percent. If the existing fans are oversized, there will be a demand impact since the ASD will only operate the fan at the level required to meet space conditioning needs. This trend was observed in the EUM data collected, and verified following the application of the calibrated engineering ASD model. In Exhibit 4-9, some very large realization rates are presented, which reflects the fact that many ASD installations had no ex ante demand impact.

4.4.3 Gross Realization Rates for Therm Impacts

Gross realization rates for therm impacts are provided in Exhibit 4-10. Therm impacts were only estimated for three APO applicants with EMS and convert to VAV measures. One applicant was filed under the ASD action code in the MDSS, but also installed an EMS. These measures were found in the office and community services business types. Each site underwent a thorough engineering review of the application, which resulted in accepting the ex ante estimate in each case.

Exhibit 4-10
Gross Therm Impact Realization Rates
By Business Type and Technology Group
For Commercial HVAC Measures Paid in 1996

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	-	-	-	-	-	-	-	-	-	-	-	-	-
	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	-
	Package Terminal A/C	-	-	-	-	-	-	-	-	-	-	-	-	-
	Set-Back Thermostat	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reflective Window Film	-	-	-	-	-	-	-	-	-	-	-	-	-
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	-
	Other HVAC Technologies	-	-	-	-	-	-	-	-	-	-	-	-	-
Retrofit Express Program Total		-	-	-	-	-	-	-	-	-	-	-	-	-
REO	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	-
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	-
	Cooling Towers	-	-	-	-	-	-	-	-	-	-	-	-	-
Retrofit Efficiency Options Program Total		-	-	-	-	-	-	-	-	-	-	-	-	-
APO	Adjustable Speed Drives	1.00	-	-	-	-	-	-	-	-	-	-	-	1.00
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	-
	Customized EMS	-	-	-	-	-	-	-	-	-	-	1.00	-	1.00
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	1.00	-	1.00
	Other Customized Equip	-	-	-	-	-	-	-	-	-	-	-	-	-
	Other HVAC Technologies	-	-	-	-	-	-	-	-	-	-	-	-	-
Advanced Performance Options Program Total		1.00	-	-	-	-	-	-	-	-	-	1.00	-	1.00
Total		1.00	-	-	-	-	-	-	-	-	-	1.00	-	**1.00**

4.4.4 Net Realization Rates

The difference between the gross and net realization rates is due to the differences between the ex ante and the ex post NTG adjustments, in combination with the differences already exhibited between the ex ante gross impacts and their corresponding ex post values.

The net energy realization rates by segment are presented in Exhibit 4-11, with the net demand realization rates illustrated in Exhibit 4-12. Net therm realization rates are presented in Exhibit 4-13. These values represent, by segment, the ratio of net impact evaluation findings to the net ex ante program design estimates. The realization rates illustrate how well the ex ante estimates predict savings, after taking into account customers' actions within the HVAC market.

To the extent that they build upon the gross evaluation results, many of the results presented in Exhibits 4-11, 4-12, and 4-13 can be explained using information from the review of the ex ante estimates and the evaluation engineering and billing analyses, as discussed under the review of the gross realization rates. Most of the comments made previously are applicable to the calculation of the net realization rates. Since the same NTG ratio was applied to the energy and demand impacts, the comments and justifications for the net realization rates discussed below apply to all three exhibits.

The differences between the net realization rates and the gross realization rates discussed earlier are, by definition, determined by differences between the ex ante and the ex post estimates of the NTG adjustment. For the HVAC Program, these differences reflect the higher ex post NTG ratio applied to several key analysis segments. Specifically, the 0.92 ASD, 0.89 reflective window film, 0.85 CAC, and 0.82 set-back thermostat NTG ratios caused a significant increase in the net realization rates (when compared with the gross impact realization rates across all programs). These segments account for 83 percent of the ex post net energy impacts.

Exhibit 4-11
Net Energy Impact Realization Rates
By Business Type and Technology Group
For Commercial HVAC Measures Paid in 1996

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	0.69	0.46	0.20	0.29	1.87	0.69	0.46	2.24	3.21	1.35	0.75	0.48	0.66
	Adjustable Speed Drives	2.16	2.49	2.91	1.51	-	-	4.04	6.26	-	-	2.98	2.68	2.62
	Package Terminal A/C	0.62	-	0.92	0.75	0.86	0.77	-	0.72	0.66	-	0.66	0.83	0.72
	Set-Back Thermostat	0.99	1.64	1.03	1.29	1.17	1.13	1.15	1.30	1.21	1.06	1.37	1.30	1.20
	Reflective Window Film	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.61	1.53
	Water Chillers	1.05	-	1.38	-	-	-	0.45	1.82	-	-	0.11	-	0.57
	Other HVAC Technologies	1.27	1.07	-	-	1.20	1.44	-	1.19	-	2.67	2.14	-	1.67
	Retrofit Express Program Total	1.41	1.77	1.06	1.00	1.42	0.90	0.99	2.78	1.59	1.31	1.13	1.05	1.35
REO	Adjustable Speed Drives	0.54	-	-	-	-	-	-	-	-	-	-	-	0.54
	Water Chillers	1.34	0.16	1.09	-	-	-	0.20	-	-	1.76	0.24	-	1.09
	Cooling Towers	0.12	-	-	-	-	-	-	-	-	-	0.44	-	0.25
Retrofit Efficiency Options Program Total		0.60	0.16	1.09	-	-	-	0.20	-	-	1.76	0.28	-	0.79
APO	Adjustable Speed Drives	2.13	-	-	-	-	-	-	-	-	-	-	-	2.13
	Water Chillers	0.91	-	0.32	-	-	-	0.14	-	-	-	-	-	0.54
	Customized EMS	0.91	-	0.91	-	-	-	-	-	-	-	0.91	-	0.91
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	0.91	-	0.91
	Other Customized Equip	-	-	-	-	-	-	-	-	-	0.30	-	-	0.30
	Other HVAC Technologies	0.63	-	-	-	-	-	-	-	1.30	-	-	-	1.17
Advanced Performance Options Program Total		1.27	-	0.64	-	-	-	0.14	-	1.30	0.30	0.91	-	0.88
Total		1.24	1.55	0.91	1.00	1.42	0.90	0.65	2.78	1.46	1.09	1.03	1.05	**1.18**

4.5 OVERVIEW OF REALIZATION RATES

The ex post gross impacts are relatively consistent with the predicted ex ante impact estimates, differing by only a few percent for energy. The ex post net impacts, however, exceed ex ante by 18 percent for energy and 7 percent for demand, driven by the higher ex post NTG ratios. Exhibit 4-14 summarizes all of the gross and net energy, demand, and therm impacts discussed above. Results are also presented for the net-to-gross adjustments and the realization rates.

Exhibit 4-12
Net Demand Impact Realization Rates
By Business Type and Technology Group
For Commercial HVAC Measures Paid in 1996

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	0.73	0.62	0.33	0.31	0.66	0.68	0.78	1.08	0.74	1.19	0.75	0.49	0.62
	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	-
	Package Terminal A/C	0.64	-	0.48	0.32	0.54	0.61	-	0.70	0.60	-	0.57	0.73	0.69
	Set-Back Thermostat	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reflective Window Film	1.95	1.35	0.91	0.70	1.50	1.84	1.93	1.68	1.35	1.30	1.54	1.30	1.78
	Water Chillers	0.50	-	0.19	-	-	-	0.52	0.98	-	-	0.41	-	0.50
	Other HVAC Technologies	1.61	0.80	-	-	1.55	1.19	-	1.91	-	1.57	1.04	-	1.34
Retrofit Express Program Total		1.81	2.04	0.63	0.32	0.84	0.73	0.91	1.00	0.79	1.23	0.83	0.59	1.14
REO	Adjustable Speed Drives	2.19	-	-	-	-	-	-	-	-	-	-	-	2.19
	Water Chillers	0.95	0.75	0.67	-	-	-	1.85	-	-	0.48	0.58	-	0.67
	Cooling Towers	0.41	-	-	-	-	-	-	-	-	-	1.02	-	0.52
Retrofit Efficiency Options Program Total		1.48	0.75	0.67	-	-	-	1.85	-	-	0.48	0.64	-	0.84
APO	Adjustable Speed Drives	3.69	-	-	-	-	-	-	-	-	-	-	-	3.69
	Water Chillers	0.91	-	0.53	-	-	-	-	-	-	-	-	-	0.60
	Customized EMS	-	-	-	-	-	-	-	-	-	-	-	-	-
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	-	-	-
	Other Customized Equip	-	-	-	-	-	-	-	-	-	0.58	-	-	0.58
	Other HVAC Technologies	0.59	-	-	-	-	-	-	-	2.84	-	-	-	1.35
Advanced Performance Options Program Total		1.48	-	0.53	-	-	-	-	-	2.84	0.58	-	-	0.96
Total		1.72	1.62	0.60	0.32	0.84	0.73	0.81	1.00	1.25	0.68	0.81	0.59	**1.07**

Exhibit 4-13
Net Therm Impact Realization Rates
By Business Type and Technology Group
For Commercial HVAC Applications

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	-	-	-	-	-	-	-	-	-	-	-	-	-
	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	-
	Package Terminal A/C	-	-	-	-	-	-	-	-	-	-	-	-	-
	Set-Back Thermostat	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reflective Window Film	-	-	-	-	-	-	-	-	-	-	-	-	-
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	-
	Other HVAC Technologies	-	-	-	-	-	-	-	-	-	-	-	-	-
Retrofit Express Program Total		-	-	-	-	-	-	-	-	-	-	-	-	-
REO	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	-
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	-
	Cooling Towers	-	-	-	-	-	-	-	-	-	-	-	-	-
Retrofit Efficiency Options Program Total		-	-	-	-	-	-	-	-	-	-	-	-	-
APO	Adjustable Speed Drives	1.23	-	-	-	-	-	-	-	-	-	-	-	1.23
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	-
	Customized EMS	-	-	-	-	-	-	-	-	-	-	0.91	-	0.91
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	0.91	-	0.91
	Other Customized Equip	-	-	-	-	-	-	-	-	-	-	-	-	-
	Other HVAC Technologies	-	-	-	-	-	-	-	-	-	-	-	-	-
Advanced Performance Options Program Total		1.23	-	-	-	-	-	-	-	-	-	0.91	-	1.08
Total		1.23	-	-	-	-	-	-	-	-	-	0.91	-	**1.08**

Exhibit 4-14
Commercial HVAC Impact Summary
By Technology Group

Program and Technology Group		Gross Program Impact kWh	kW	Therm	NTG Adjustment* (1-FR)	Spillover	Net Program Impact kWh	kW	Therm
			EX ANTE						
Retrofit	Central A/C	5,894,829	4,862	0	0.55	0.10	3,854,022	3,170	0
Express	Adjustable Speed Drives	3,925,424	0	0	0.55	0.10	2,566,431	0	0
	Package Terminal A/C	486,845	519	0	0.55	0.10	318,298	338	0
	Set-Back Thermostat	6,501,391	0	0	0.55	0.10	4,250,591	0	0
	Reflective Window Film	4,038,809	579	0	0.55	0.10	2,640,561	377	0
	Water Chillers	432,855	209	0	0.55	0.10	282,999	136	0
	Other HVAC Technologies	130,271	66	0	0.55	0.10	85,171	43	0
Retrofit Express Program Total		21,410,424	6,234	0	0.55	0.10	13,998,073	4,064	0
REO	Adjustable Speed Drives	2,111,770	128	0	0.65	0.10	1,593,080	96	0
	Water Chillers	1,868,622	939	0	0.65	0.10	1,409,653	707	0
	Cooling Towers	67,757	36	0	0.65	0.10	51,115	27	0
Retrofit Efficiency Options Program Total		4,048,149	1,104	0	0.65	0.10	3,053,848	830	0
APO	Adjustable Speed Drives	758,725	88	12,649	-	-	572,368	66	9,487
	Water Chillers	1,851,350	511	0	0.65	0.10	1,396,624	385	0
	Customized EMS	1,289,327	0	5,553	0.65	0.10	972,644	0	4,165
	Convert To VAV	174,298	0	5,609	0.65	0.10	131,487	0	4,207
	Other Customized Equip	790,105	278	0	0.65	0.10	596,041	209	0
	Other HVAC Technologies	352,945	129	0	0.65	0.10	266,255	97	0
Advanced Performance Options Program Total		5,216,750	1,006	23,811	0.65	0.10	3,935,419	757	17,858
Total		30,675,323	8,344	23,811	0.58	0.10	20,987,340	5,651	17,858
			EX POST						
Retrofit	Central A/C	2,999,672	2,363	0	0.73	0.13	2,551,973	1,954	0
Express	Adjustable Speed Drives	7,308,715	1,785	0	0.71	0.21	6,729,492	1,643	0
	Package Terminal A/C	456,496	466	0	0.29	0.21	228,937	234	0
	Set-Back Thermostat	6,182,696	0	0	0.61	0.21	5,086,003	0	0
	Reflective Window Film	4,544,714	755	0	0.68	0.21	4,043,064	671	0
	Water Chillers	235,196	99	0	0.47	0.21	160,575	68	0
	Other HVAC Technologies	160,983	62	0	0.75	0.13	142,624	57	0
Retrofit Express Program Total		21,888,473	5,531	0	0.67	0.20	18,942,668	4,628	0
REO	Adjustable Speed Drives	936,696	230	0	0.71	0.21	862,462	211	0
	Water Chillers	2,247,286	696	0	0.47	0.21	1,534,288	475	0
	Cooling Towers	18,562	21	0	0.47	0.21	12,673	14	0
Retrofit Efficiency Options Program Total		3,202,544	946	0	0.54	0.21	2,409,422	701	0
APO	Adjustable Speed Drives	1,327,052	264	12,649	0.71	0.21	1,221,882	243	11,647
	Water Chillers	1,099,657	337	0	0.47	0.21	750,768	230	0
	Customized EMS	1,289,327	0	5,553	0.47	0.21	880,261	0	3,791
	Convert To VAV	174,298	0	5,609	0.47	0.21	118,998	0	3,829
	Other Customized Equip	260,131	177	0	0.47	0.21	177,599	121	0
	Other HVAC Technologies	457,252	191	0	0.47	0.21	312,179	130	0
Advanced Performance Options Program Total		4,607,717	968	23,811	0.54	0.21	3,461,687	724	19,267
Total		29,698,734	7,445	23,811	0.64	0.20	24,813,777	6,052	19,267

*The NTG adjustment presented here is weighted by gross kWh.

Exhibit 4-14 cont'd
Commercial HVAC Impact Summary
By Technology Group

Program and Technology Group		Gross Program Impact kWh	Gross Program Impact kW	Gross Program Impact Therm	NTG Adjustment* (1-FR)	NTG Adjustment* Spillover	Net Program Impact kWh	Net Program Impact kW	Net Program Impact Therm
		REALIZATION RATES							
Retrofit	Central A/C	0.51	0.49	-	-	-	0.66	0.62	-
Express	Adjustable Speed Drives	1.86	-	-	-	-	2.62	-	-
	Package Terminal A/C	0.94	0.90	-	-	-	0.72	0.69	-
	Set-Back Thermostat	0.95	-	-	-	-	1.20	-	-
	Reflective Window Film	1.13	1.30	-	-	-	1.53	1.78	-
	Water Chillers	0.54	0.48	-	-	-	0.57	0.50	-
	Other HVAC Technologies	1.24	0.95	-	-	-	1.67	1.34	-
Retrofit Express Program Total		1.02	0.89	-	-	-	1.35	1.14	-
REO	Adjustable Speed Drives	0.44	1.79	-	-	-	0.54	2.19	-
	Water Chillers	1.20	0.74	-	-	-	1.09	0.67	-
	Cooling Towers	0.27	0.57	-	-	-	0.25	0.52	-
Retrofit Efficiency Options Program Total		0.79	0.86	-	-	-	0.79	0.84	-
APO	Adjustable Speed Drives	1.75	3.01	1.00	-	-	2.13	3.69	1.23
	Water Chillers	0.59	0.66	-	-	-	0.54	0.60	-
	Customized EMS	1.00	-	1.00	-	-	0.91	-	0.91
	Convert To VAV	1.00	-	1.00	-	-	0.91	-	0.91
	Other Customized Equip	0.33	0.63	-	-	-	0.30	0.58	-
	Other HVAC Technologies	1.30	1.48	-	-	-	1.17	1.35	-
Advanced Performance Options Program Total		0.88	0.96	1.00	-	-	0.88	0.96	1.08
Total		0.97	0.89	1.00	-	-	1.18	1.07	1.08

*The NTG adjustment presented here is weighted by gross kWh.

Attachments

Attachment 1

Custom HVAC Analysis

HVAC System Optimization (Site 392)

Program	Advanced Performance Options
Measure	HVAC System Optimization
Site Description	Office Building

Measure Description

Replace 5 package roof top units' fans and compressors with three high-efficiency compressors, one condenser fan, one condenser water pump and two exhaust fans.

Summary of Rebate Calculations

Demand estimates were calculated using the full load KW demand for the existing 5 condenser fans and 5 compressors. Energy was calculated by applying 802 full load hours. The existing EER was below that of Title 24 minimum requirement. The Existing KW Demand was multiplied by the ratio of existing EER to the Title 24 minimum EER. This new Demand was used as the base line. The retrofit demand estimates were calculated using the full load KW demand for the 3 new compressors, condenser fan, water pump and exhaust fan. Energy was calculated by applying 802 full load hours.

Comments on Calculations

The calculations do not take into effect the part load performance of the retrofit compressors. This size of the compressors in the analysis does not agree with the compressors installed. The compressors in the analysis were two 35 hp and one 40 hp. Two 40 hp and one 50 hp compressors were verified during an on-site inspection.

Evaluation Process

The evaluation process consisted of a review of the application form and supporting documentation, conducting an on-site survey and reviewing the results from the spreadsheets accompanying the application. The calculations were rerun with the actual compressors and respective full load amps. Energy estimates were calculated using the CAC EFLH of 851.4 hours.

The on-site survey was conducted on December 16, 1998 with the Chief Engineer and system designer. The retrofit compressor sizes were found to be significantly different via an inspection of the central plant and through discussions with the Engineer.

To compute the impacts, the following assumptions were used:

- The full load amp, voltage and power factor ratings of the new equipment, were used to calculate the demand estimates.
- Energy use was calculated using the equivalent full load hours used in the CAC analysis of 851.4 hours.
- Full load amp, voltage and power factor ratings for the old equipment, multiplied by the EER ratio of existing to T24 minimum was used to

calculate the demand estimates.

The above assumptions were incorporated into a spreadsheet where energy and demand impacts were calculated. Evaluation- based demand and energy impacts were lower than Ex Ante estimates. Results from these calculations are summarized below and documented in the attached workbook.

Additional Notes

Impact Results

	KW	KWh	Therm
MDSS	85.78	68,599.3	0
Adjusted Engineering	56.18	47,833.1	0
Engineering Realization Rate	0.65	0.70	N/A

Compressor, Condensor Fan, and Water Pump Retrofit (Site 394)

Existing HVAC KW Demand

Description	Quantity	Full Load Amps	Volts	Phase	Power factor	Kw Demand
Compressors - Unit #1	2	37	460	3	0.79	46.52
Condensor Fans - Unit #1	3	3.3	460	3	0.68	5.36
Compressors - Unit #2	2	17.5	460	3	0.77	21.45
Condensor Fans - Unit #2	3	1.5	460	3	0.82	2.94
Compressors - Unit #3	2	34	460	3	0.8	43.29
Condensor Fans - Unit #3	3	2.6	460	3	0.72	4.47
Compressors - Unit #4	2	34	460	3	0.8	43.29
Condensor Fans - Unit #4	3	2.6	460	3	0.72	4.47
Compressors - Unit #4	2	34	460	3	0.8	43.29
Condensor Fans - Unit #4	3	2.6	460	3	0.72	4.47
						219.55 **= Total KW Demand**

Existing EER/ Title 24 minimun EER 8.0 EER / 8.5 EER 206.63 = Total KW Demand

Retrofit HVAC KW Demand

Description	Quantity	Full Load Amps	Volts	Phase	Power factor	Kw Demand
Compressor 1 & 2	2	55.7	460	3	0.89	78.90
Compressor 3	1	68.5	460	3	0.89	48.52
Evap. Cond. Fan	1	23.5	460	3	0.89	16.64
Water Pump	1	6.4	460	3	0.87	4.43
Exhaust fans	2	1.5	460	3	0.82	1.96
						150.45 **= Total KW Demand**

Pre and Post Retrofit KWH

	Demand KW	EFL Hours	Annual KWH
Base Case	206.63	851.40	175,925.53
Retrofit	150.45	851.40	128,092.43
Savings	**56.18**		**47,833.10**

Chiller Replacement (Site 974)

Program	Retrofit Express Program
Measure	High Efficiency Air-Cooled Chiller
Site Description	Office Building

Measure Description

Replace existing chiller with high-efficiency air–cooled chiller.

Summary of Ex Ante Impact Calculations

Demand calculations were estimated based upon the chiller tonnage and the difference between the new unit and a baseline qualifying Title 24 chiller, in conjunction with and assumed 0.75 diversity factor. Energy calculations are based upon all but the latter, in conjunction with standard PG&E EFLH values.

Comments on Calculations

The correct chiller size category and compressor only, full load (under ARI conditions) were used in the application. Fan energy should be included in the KW/Ton rating yielding an ARI efficiency value of 1.18 verses the application value of 1.08.

Evaluation Process

The evaluation process consisted of reviewing the application form and supporting documentation, conducting an on-site survey and then computing impacts using the on-site data. Models were calibrated with actual weather, number of compressor hours as well as an observed operating point, %load @ the outside air temperature. Peak demand was calculated for actual peak temperatures. Energy savings were based on typical weather data. A Title 24 baseline, IPLV at ARI conditions, and typical year bin weather data were used in the bin analysis.

The on-site survey was conducted on December 21, 1998. Information on the retrofit equipment and operating conditions were collected through an inspection of the chiller and through an interview with the Chief Engineer.

Discussions provided data for development of a relationship between chiller loading and outdoor dry bulb temperatures. The chiller is available to operate 24 hours a day all year. Chiller use generally begins at 55 degrees outside air temperature and reaches 92% loading at 105 Degrees F.

To compute the impacts, the following assumptions were used:

- A linear loading strategy was used for the analysis of both the baseline and rebated chillers, which assumed 10% loading at 55 degrees and 92% loading at 105 Degrees F.
- For the baseline chiller case a Title 24 baseline efficiency of 1.302 KW/ton was used, based on an air-cooled chiller less than 150 tons.

- Chiller efficiencies at various temperatures were interpolated from values provided at 25%, 50%, 75%, and 100% loading at ARI conditions. These calculated efficiencies were used to develop a chiller efficiency curve for the Rebate case. The baseline chiller efficiency curve was based on minimum Title 24 full load efficiency requirements, matched to a typical chiller performance curve.

The above assumptions were incorporated into a spreadsheet where energy and demand impacts were calculated. Evaluation- based demand impacts were lower than Ex Ante estimates, while energy impacts were greater. Results from these calculations are summarized below and documented in the attached workbook.

Additional Notes

Impact Results

	KW	KWh	Therm
MDSS	12.95	17,213.4	0
Adjusted Engineering	6.50	23,350.5	0
Engineering Realization Rate	0.50	1.36	N/A

Site # 974	WYEC Weather		
	kWh	kW	therms
PG&E	17213.44	12.95	-
QC Impact	23350.46	6.50	-
			-
I-Eng. Real. Rat	1.36	0.50	

New Chiller Efficiency			
	%	Tons	kW/Ton
	25%	19.68	1.101
	50%	39.35	0.930
	75%	59.03	1.111
	100%	78.70	1.188
iplv (kW/Ton	1.05399648		

Operational Parameters	New Chiller	
	Minimum	Maximum
Chiller Output (Ton)	7.9	78.7
OSA Temp	55	105
% Of Capacity	10%	92%

Base Case 14 Deg Approach Temp.

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-		0.0	0	-
32	0.00%	-		0.0	0	-
37	0.00%	-		0.0	0	-
42	0.00%	-		0.0	0	-
47	0.00%	-		0.0	0	-
52	0.00%	-		0.0	0	-
57	10.00%	8	2.535	20.0	1384.00	27,611
62	18.20%	14	1.738	24.9	1020.00	25,392
67	26.40%	21	1.365	28.4	707.00	20,045
72	34.60%	27	1.206	32.8	545.00	17,902
77	42.80%	34	1.089	36.7	428.00	15,700
82	51.00%	40	1.079	43.3	407.00	17,621
87	59.20%	47	1.101	51.3	254.00	13,027
92	67.40%	53	1.128	59.8	165.00	9,874
97	75.60%	59	1.165	69.3	81.00	5,613
102	83.80%	66	1.209	79.7	26.00	2,073
107	92.00%	72	1.253	90.7	0.00	-
				90.7	5017.00	154,857

Rebate Case

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	#1	0	0.0	0	-
32	0.00%	-	0.000	#1	0	0.0	0	-
37	0.00%	-	0.000	#1	0	0.0	0	-
42	0.00%	-	0.000	#1	0	0.0	0	-
47	0.00%	-	0.000	#1	0	0.0	0	-
52	0.00%	-	0.000	#1	0	0.0	0	-
57	10.00%	8	2.025	#1	2.025	15.9	1384.00	22,056
62	18.20%	14	1.388	#1	1.388	19.9	1020.00	20,277
67	26.40%	21	1.091	#1	1.091	22.7	707.00	16,032
72	34.60%	27	1.035	#1	1.035	28.2	545.00	15,364
77	42.80%	34	0.979	#1	0.979	33.0	428.00	14,117
82	51.00%	40	0.937	#1	0.937	37.6	407.00	15,310
87	59.20%	47	0.997	#1	0.997	46.4	254.00	11,794
92	67.40%	53	1.056	#1	1.056	56.0	165.00	9,242
97	75.60%	59	1.113	#1	1.113	66.2	81.00	5,363
102	83.80%	66	1.138	#1	1.138	75.1	26.00	1,952
107	92.00%	72	1.163	#1	1.163	84.2	0.00	-
						84.2	5017.00	131,507
	Act. Max Temp = 107		Hrs w/in 6%					

	Eff base ca	% Loading	Eff rebate case		rebate	% Loading	base
10.000	2.535	10.000	2.025		2.025	10.00%	2.535
20.000	1.563	20.000	1.248		1.388	18.20%	1.738
25.000	1.389	25.000	1.101		1.091	26.40%	1.365
30.000	1.302	30.000			1.035	34.60%	1.206
40.000	1.094	40.000			0.979	42.80%	1.089
50.000	1.076	50.000	0.930		0.937	51.00%	1.079
60.000	1.103	60.000			0.997	59.20%	1.101
70.000	1.137	70.000			1.056	67.40%	1.128
75.000	1.163	75.000	1.111		1.113	75.60%	1.165
80.000	1.189	80.000			1.138	83.80%	1.209
90.000	1.241	90.000			1.163	92.00%	1.253
100.000	1.302	100.000	1.188				

WYEC-Clz12 Site 974

Total		Month													
		1	2	3	4	5	6	7	8	9	10	11	12	Total	
Tempe	22	0	0	0	0	0	0	0	0	0	0	0	0	0	
	27	10	0	0	0	0	0	0	0	0	0	0	5	15	
	32	48	22	1	0	0	0	0	0	0	0	5	35	111	
	37	90	47	21	22	0	0	0	0	0	1	44	100	325	
	42	219	94	103	42	9	0	0	0	0	12	98	219	796	
	47	205	180	138	126	39	12	0	0	12	82	139	182	1115	
	52	123	138	175	153	145	60	40	50	70	125	164	138	1381	
	57	36	103	136	109	133	138	106	140	144	150	143	46	1384	1384
	62	13	71	107	83	103	106	115	109	118	107	70	18	1020	1020
	67	0	16	42	78	77	92	100	91	80	100	30	1	707	707
	72	0	1	19	55	73	71	76	76	77	77	20	0	545	545
	77	0	0	2	39	73	67	68	57	78	37	7	0	428	428
	82	0	0	0	12	65	73	77	77	70	33	0	0	407	407
	87	0	0	0	1	14	56	72	60	35	16	0	0	254	254
	92	0	0	0	0	11	24	51	48	27	4	0	0	165	165
	97	0	0	0	0	2	18	30	22	9	0	0	0	81	81
	102	0	0	0	0	0	3	9	14	0	0	0	0	26	26
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0
								704	694	638	524	270	0	5017	5017
								2830							

01-08		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Tempe	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	10	0	0	0	0	0	0	0	0	0	0	5	15
	32	40	22	1	0	0	0	0	0	0	0	5	30	98
	37	54	41	21	22	0	0	0	0	0	1	41	63	243
	42	88	67	91	34	9	0	0	0	0	12	64	102	467
	47	52	76	84	87	34	11	0	0	12	77	62	37	532
	52	4	11	45	76	113	49	34	45	64	87	56	11	595
	57	0	7	6	16	58	94	87	102	100	61	12	0	543
	62	0	0	0	4	28	54	64	53	57	8	0	0	268
	67	0	0	0	1	5	23	44	35	5	2	0	0	115
	72	0	0	0	0	1	5	17	11	2	0	0	0	36
	77	0	0	0	0	0	4	2	2	0	0	0	0	8
	82	0	0	0	0	0	0	0	0	0	0	0	0	0
	87	0	0	0	0	0	0	0	0	0	0	0	0	0
	92	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

09-16		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Tempe	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	13	3	0	0	0	0	0	0	0	0	0	7	23
	42	53	10	0	0	0	0	0	0	0	0	10	41	114
	47	77	27	10	0	0	0	0	0	0	0	19	74	207
	52	68	59	47	20	2	0	0	0	0	2	44	69	311
	57	26	61	66	41	14	2	2	6	1	19	73	38	349
	62	11	52	73	44	26	7	4	5	12	36	47	18	335
	67	0	11	35	52	36	29	15	17	25	57	23	1	301
	72	0	1	15	40	52	31	23	30	39	60	17	0	308
	77	0	0	2	31	50	38	36	28	52	27	7	0	271
	82	0	0	0	11	47	51	50	55	53	28	0	0	295
	87	0	0	0	1	11	47	49	44	26	15	0	0	193
	92	0	0	0	0	8	17	40	37	23	4	0	0	129
	97	0	0	0	0	2	15	23	16	9	0	0	0	65
	102	0	0	0	0	0	3	6	10	0	0	0	0	19
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

17-24		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Tempe	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	8	0	0	0	0	0	0	0	0	0	0	5	13
	37	23	3	0	0	0	0	0	0	0	0	3	30	59
	42	78	17	12	8	0	0	0	0	0	0	24	76	215
	47	76	77	44	39	5	1	0	0	0	5	58	71	376
	52	51	68	83	57	30	11	6	5	6	36	64	58	475
	57	10	35	64	52	61	42	17	32	43	70	58	8	492
	62	2	19	34	35	49	45	47	51	49	63	23	0	417
	67	0	5	7	25	36	40	41	39	50	41	7	0	291
	72	0	4	0	15	20	35	36	35	36	17	3	0	201
	77	0	0	0	8	23	25	30	27	26	10	0	0	149
	82	0	0	0	1	18	22	27	22	17	5	0	0	112
	87	0	0	0	0	3	9	23	16	9	1	0	0	61
	92	0	0	0	0	3	7	11	11	4	0	0	0	36
	97	0	0	0	0	0	3	7	6	0	0	0	0	16
	102	0	0	0	0	0	0	3	4	0	0	0	0	7
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

Chiller Replacement (Site 1109)

Program	Retrofit Express Program
Measure	High Efficiency Air-Cooled Chiller
Site Description	Health Care/ Hospital

Measure Description

Replace existing chiller with high-efficiency air-cooled chiller.

Summary of Ex Ante Impact Calculations

Demand calculations were estimated based upon the chiller tonnage and the difference between the new unit and a baseline qualifying Title 24 chiller, in conjunction with and assumed 0.75 diversity factor. Energy calculations are based upon all but the latter, in conjunction with standard PG&E EFLH values.

Comments on Calculations

The correct chiller size category and compressor only, full load (under ARI conditions) were used in the application. Fan energy should be included in the KW/Ton rating yielding an ARI efficiency value of 1.25 verses the application value of 1.137.

Evaluation Process

The evaluation process consisted of reviewing the application form and supporting documentation, conducting an on-site survey and then computing impacts using the on-site data. Models were calibrated with actual weather, number of compressor hours as well as an observed operating point, %load @ the outside air temperature. Peak demand was calculated for actual peak temperatures. Energy savings were based on typical weather data. A Title 24 baseline, IPLV at ARI conditions, and typical year bin weather data were used in the bin analysis.

The on-site survey was conducted on December 14. Information on the retrofit equipment and operating conditions were collected through an inspection of the chiller and through an interview with the Chief Engineer.

Discussions provided data for development of a relationship between chiller loading and outdoor dry bulb temperatures. The chiller is available to operate from 6am to 6pm on Monday, 7:30 am Tuesday to Friday, 7:30 am to Noon on Saturday year round. Chiller use generally begins at 50 degrees outside air temperature and reaches 100% loading at 97 Degrees F.

To compute the impacts, the following assumptions were used:

- A linear loading strategy was used for the analysis of both the baseline and rebated chillers, which assumed 10% loading at 50 degrees and 100% loading at 97 Degrees F.

- For the baseline chiller case a Title 24 baseline efficiency of 1.302 KW/ton was used, based on an air-cooled chiller of less than 150 tons.

- Chiller efficiencies at various temperatures were interpolated from values provided at 25%, 50%, 75%, and 100% loading at ARI conditions. These calculated efficiencies were used to develop a chiller efficiency curve for the Rebate case. The baseline chiller efficiency curve was based on minimum Title 24 full load efficiency requirements, matched to a typical chiller performance curve.

The above assumptions were incorporated into a spreadsheet where energy and demand impacts were calculated. Evaluation- based demand and energy impacts were lower than Ex Ante estimates. Results from these calculations are summarized below and documented in the attached workbook.

Additional Notes

Impact Results

	KW	KWh	Therm
MDSS	12.13	30,636.2	0
Adjusted Engineering	5.19	20,241.9	0
Engineering Realization Rate	0.66	0.43	N/A

Site # 1109	WYEC Weather		
	kWh	kW	therms
PG&E	30636.18	12.13	-
QC Impact	20241.90	5.19	-
			-
I-Eng. Real. Rate	0.66	0.43	

New Chiller Efficiency			
	%	Tons	kW/Ton
	25%	25	0.976
	50%	50	0.992
	75%	75	1.177
	100%	100	1.250
iplv (kW/Ton	1.09528454		

Operational Parameters	New Chiller (Air Cooled)	
	Minimum	Maximum
Chiller Output (Ton)	9.95	99.5
OSA Temp (F)	52	97
% Of Capacity	10%	100%

Basecase

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-		0.0	0.00	-
32	0.00%	-		0.0	0.00	-
37	0.00%	-		0.0	0.00	-
42	0.00%	-		0.0	0.00	-
47	0.00%	-		0.0	0.00	-
52	10.00%	10	2.535	25.2	459.23	11,583
57	20.00%	20	1.563	31.1	752.48	23,400
62	30.00%	30	1.302	38.9	664.21	25,818
67	40.00%	40	1.094	43.5	463.91	20,196
72	50.00%	50	1.076	53.6	278.56	14,918
77	60.00%	60	1.103	65.8	124.75	8,211
82	70.00%	70	1.137	79.2	43.14	3,417
87	80.00%	80	1.189	94.7	21.39	2,025
92	90.00%	90	1.241	111.2	0.79	87
97	100.00%	100	1.302	129.6	0.00	-
102	100.00%	100	1.302	129.6	0.00	-
107	100.00%	100	1.302	129.6	0.00	-
				129.6	2808.47	109,657

Rebate Case

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	#1	0.00	0.0	0.00	-
32	0.00%	-	0.000	#1	0.00	0.0	0.00	-
37	0.00%	-	0.000	#1	0.00	0.0	0.00	-
42	0.00%	-	0.000	#1	0.00	0.0	0.00	-
47	0.00%	-	0.000	#1	0.00	0.0	0.00	-
52	10.00%	10	1.781	#1	1.781	17.7	459.23	8,138
57	20.00%	20	1.098	#1	1.098	21.9	752.48	16,442
62	30.00%	30	0.979	#1	0.979	29.2	664.21	19,414
67	40.00%	40	0.986	#1	0.986	39.2	463.91	18,198
72	50.00%	50	0.992	#1	0.992	49.3	278.56	13,743
77	60.00%	60	1.066	#1	1.066	63.6	124.75	7,939
82	70.00%	70	1.140	#1	1.140	79.4	43.14	3,426
87	80.00%	80	1.192	#1	1.192	94.9	21.39	2,029
92	90.00%	90	1.220	#1	1.220	109.3	0.79	86
97	100.00%	100	1.250	#1	1.250	124.4	0.00	-
102	100.00%	100	1.250	#1	1.250	124.4	0.00	-
107	100.00%	100	1.250	#1	1.250	124.4	0.00	-
						124.4	2808.47	89,415
	max @97							

		Eff base ca	% Loading	Eff rebate case		rebate	% Loading	base
1.302	10.000	2.535	10.000	1.781		1.781	10.00%	2.535
1.241	20.000	1.563	20.000	1.098		1.098	20.00%	1.563
1.189	25.000	1.389	25.000	0.976		0.979	30.00%	1.302
1.163	30.000	1.302	30.000	0.979		0.986	40.00%	1.094
1.137	40.000	1.094	40.000	0.986		0.992	50.00%	1.076
1.103	50.000	1.076	50.000	0.992		1.066	60.00%	1.103
1.076	60.000	1.103	60.000	1.066		1.140	70.00%	1.137
1.094	70.000	1.137	70.000	1.140		1.192	80.00%	1.189
1.302	75.000	1.163	75.000	1.177		1.220	90.00%	1.241
1.389	80.000	1.189	80.000	1.192		1.250	100.00%	1.302
1.563	90.000	1.241	90.000	1.220		1.250	100.00%	1.302
2.535	100.000	1.302	100.000	1.250		1.250	100.00%	1.302

WYEC-Clz 3 site 1109

Total

		Month														
		1	2	3	4	5	6	7	8	9	10	11	12	Total	Actual	Schedule
Temperature Range	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	32	2	0	0	0	0	0	0	0	0	0	0	5	7	0.5628	
	37	31	6	5	0	0	0	0	0	0	0	10	55	107	10.683	
	42	130	44	43	26	4	0	0	0	0	1	33	118	399	55.14	
	47	183	157	124	109	55	5	1	0	1	35	121	150	941	175.67	at 52 Deg
	52	209	194	232	225	244	133	91	61	57	101	171	226	1944	459.23	459.23
	57	155	212	185	161	174	230	260	267	194	225	232	166	2461	752.48	752.48
	62	29	39	114	121	145	154	144	176	208	200	106	21	1457	664.21	664.21
	67	5	17	34	50	69	101	136	122	113	92	31	3	773	463.91	463.91
	72	0	3	7	18	27	61	74	79	77	48	15	0	409	278.56	278.56
	77	0	0	0	9	14	25	29	33	42	22	1	0	175	124.75	124.75
	82	0	0	0	1	6	8	7	5	17	14	0	0	58	43.142	43.142
	87	0	0	0	0	6	3	2	1	10	6	0	0	28	21.393	21.393
	92	0	0	0	0	0	0	0	0	1	0	0	0	1	0.7857	0.7857
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
															3050.5	2808.5

01-08

		Month													
		1	2	3	4	5	6	7	8	9	10	11	12	Total	Mon 6am,T,W,TH,Fri& Sat 7:30am Start
Temperature Range	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	2	0	0	0	0	0	0	0	0	0	0	5	7	0.5628
	37	30	6	5	0	0	0	0	0	0	0	8	43	92	7.3968
	42	80	40	40	26	2	0	0	0	0	1	31	74	294	23.638
	47	70	107	88	81	46	5	1	0	1	35	86	64	584	46.954
	52	46	50	81	120	156	93	72	52	55	81	68	50	924	74.29
	57	20	20	27	13	43	104	158	164	126	113	44	12	844	67.858
	62	0	1	7	0	1	36	14	32	49	15	3	0	158	12.703
	67	0	0	0	0	0	1	3	0	7	3	0	0	14	1.1256
	72	0	0	0	0	0	1	0	0	2	0	0	0	3	0.2412
	77	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	92	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0

09-16

		Month													
		1	2	3	4	5	6	7	8	9	10	11	12	Total	Sat stop Noon
Temperature Range	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	0	0	0	0	0	0	0	0	0	0	0	1	1	0.7857
	42	10	1	1	0	0	0	0	0	0	0	0	9	21	16.5
	47	43	9	14	1	0	0	0	0	0	0	5	35	107	84.07
	52	73	60	68	22	10	1	0	0	0	0	19	81	334	262.42
	57	97	109	77	66	40	19	7	9	6	29	93	100	652	512.28
	62	20	28	59	91	96	57	48	52	53	90	78	19	691	542.92
	67	5	14	23	37	57	78	93	81	59	59	30	3	539	423.49
	72	0	3	6	14	22	53	65	68	59	35	14	0	339	266.35
	77	0	0	0	8	12	22	26	32	36	17	1	0	154	121
	82	0	0	0	1	5	7	7	5	17	12	0	0	54	42.428
	87	0	0	0	0	6	3	2	1	9	6	0	0	27	21.214
	92	0	0	0	0	0	0	0	0	1	0	0	0	1	0.7857
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0

17-24

		Month													
		1	2	3	4	5	6	7	8	9	10	11	12	Total	M-F Stop 6pm
Temperature Range	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	1	0	0	0	0	0	0	0	0	0	2	11	14	2.5004
	42	40	3	2	0	2	0	0	0	0	0	2	35	84	15.002
	47	70	41	22	27	9	0	0	0	0	0	30	51	250	44.65
	52	90	84	83	83	78	39	19	9	2	20	84	95	686	122.52
	57	38	83	81	82	91	107	95	94	62	83	95	54	965	172.35
	62	9	10	48	30	48	61	82	92	106	95	25	2	608	108.59
	67	0	3	11	13	12	22	40	41	47	30	1	0	220	39.292
	72	0	0	1	4	5	7	9	11	16	13	1	0	67	11.966
	77	0	0	0	1	2	3	3	1	6	5	0	0	21	3.7506
	82	0	0	0	0	1	1	0	0	0	2	0	0	4	0.7144
	87	0	0	0	0	0	0	0	0	1	0	0	0	1	0.1786
	92	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0

EMS System Upgrade (Site 1157)

Program	Advance Performance Options
Measure	EMS And Convert CVRH to VAVRH
Site Description	Community Service

Measure Description

Convert the perimeter zones form Constant Air Volume to Variable Air Volume. Install an energy management system to reduce the number of operating hours.

Summary of Ex Ante Impact Calculations

Demand and energy impacts were determined from Visual DOE simulations and the appropriate climate zone weather data. The first model was developed to simulated the building as is. The model was then calibrated to match the billing data. The baseline model was then modified to incorporate the planned changes before the rebated retrofit actions were taken. These modifications consisted of installing VSD drives on the air handlers, replacement of the existing chillers with new standard efficiency chillers and re-activating the economizer.
Savings were based on the reduced number of operating hours in selected zones to correspond to occupancy schedules, as well as reduced air flow to the perimeter zone. Due to VSD drives on the air handlers reduced flow results in fan energy savings. Electricity is saved by reducing the number of operating hours of the boiler, compressors, fans and pumps; as well as reducing the number of hours that some portions of the building are conditioned. Connected loads were based on detailed audits of the facility.

Comments on Calculations

The results from the simulations are reasonable and accurate. Savings calculations were based on the reduction of operating hours and a temperature set back for unoccupied hours.

Evaluation Process

The evaluation process consisted of reviewing the application form and supporting documentation and conducting an on-site. Pre and post retrofit schedules, economizer settings, air-handler VSD's, and new chillers were reconfirmed through interviews with the chief engineer. The on-site survey was conducted on October 28, 1998 with the Chief Engineer.

The engineering calculation and bin methods used for the analyses were accepted as an accurate representation of pre- and post-retrofit conditions and were adopted as the evaluation-based savings estimates.

Additional Notes

Impact Results

	KW	KWh	Therm
MDSS	0.0	292,797.56	11,162
Adjusted Engineering	0.0	292,797.56	11,162
Engineering Realization Rate	1.0	1.0	1.0

Chiller Replacement (Site 1184)

Program	Retrofit Express Program
Measure	High Efficiency Air-Cooled Chiller
Site Description	Health care/ Hospital

Measure Description

Replace existing chiller with high-efficiency evaporatively cooled chiller.

Summary of Ex Ante Impact Calculations

Demand calculations were estimated based upon the chiller tonnage and the difference between the new unit and a baseline qualifying Title 24 chiller, in conjunction with and assumed 0.75 diversity factor. Energy calculations are based upon all but the latter, in conjunction with standard PG&E EFLH values.

Comments on Calculations

The incorrect correct chiller size category and chiller efficiency (100% Load) were used in the application to calculate the rebate, ARI rating were not used, this over estimated the tonnage and underestimated the KW/ton. In addition the chiller efficiency included KW input for compressors only. Fan energy should be included in the KW/Ton rating. An ARI efficiency value of .8529 vs. 0.68 should have been used. The actual tonnage of 165 not 176.6 should have been used.

Evaluation Process

The evaluation process consisted of a review of the application form and supporting documentation, conducting an on-site survey and then computing impacts using the on-site data. Models were calibrated with actual weather, number of compressor hours as well as an observed operating point, %load @ the outside air temperature. Peak demand was calculated for actual peak temperatures. Energy savings were based on typical weather data. A Title 24 baseline, IPLV at ARI conditions and typical year bin weather were used in the bin analysis.

The on-site survey was conducted on January 5, 1999. Information on the retrofit equipment and operating conditions were collected through an inspection of the chiller and through an interview with the Chief Engineer.

Discussions provided data for development of a relationship between chiller loading and outdoor dry bulb temperatures. The chiller is available to operate 24 hours a day, all year. Chiller use generally begins at 55 degrees outside air temperature and reaches 100% loading at 82 Degrees F.

To compute the impacts, the following assumptions were used:

- A linear loading strategy was used for the analysis of both the original, baseline and rebated chillers, which assumed 10% loading at 55 degrees and 100% loading at 82Degrees F.
- For the baseline chiller case a Title 24 baseline efficiency of 0.837

KW/ton was used, based on a water-cooled chiller between 150 and 300 tons.

- Chiller efficiencies at various temperatures were interpolated from values provided at 25%, 50%, 75%, and 100% loading at ARI conditions. These calculated efficiencies were used to develop a chiller efficiency curve for the Rebate case. The baseline chiller efficiency curve was based on minimum Title 24 full load efficiency requirements, matched to a typical chiller performance curve.

The above assumptions were incorporated into a spreadsheet where energy and demand impacts were calculated. Evaluation- based demand and energy impacts were lower than Ex Ante estimates. Results from these calculations are summarized below and documented in the attached workbook.

Additional Notes

An evaporatively cooled chiller was installed. There are no Title 24 standards for this chiller type. Water-cooled chiller (compressor only KW input) characteristics were applied in the bin models. The same strategy was applied to the baseline chiller condition.

Impact Results

	KW	KWh	Therm
MDSS	81.87	206,826.6	0
Adjusted Engineering	9.70	32,229.6	0
Engineering Realization Rate	0.12	0.16	N/A

Site 1184						New Chiller Efficiency		
	kWh	kW	therms			%	Tons	kW/Ton
PG&E	206,826.58	81.87	-			25%	41.25	0.671
QC Impact	32,229.63	9.70	-			50%	82.5	0.658
						75%	123.75	0.647
						100%	165	0.778
QC Realization	0.16	0.12						
Rate					iplv (kW/Ton	0.67262791		
Operational Parameters		New Chiller (Evap cooled)			Old Chiller			
Base Case		Minimum	Maximum		Minimum	Maximum		
Chiller Output (Ton)		16.5	165		17	165		
OSA Temp		50	85		50	85		
% Of Capacity		10%	100%		10%	100%		

Basecase						
Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-		0.0	24	-
32	0.00%	-		0.0	234	-
37	0.00%	-		0.0	458	-
42	0.00%	-		0.0	721	-
47	0.00%	-		0.0	1166	-
52	0.00%	-		0.0	1690	-
57	10.00%	17	1.629	26.9	1424	38,275
62	28.00%	46	0.859	39.7	894	35,496
67	46.00%	76	0.696	52.9	633	33,458
72	64.00%	106	0.718	75.8	463	35,095
77	82.00%	135	0.769	104.0	395	41,098
82	100.00%	165	0.837	138.1	285	39,360
87	100.00%	165	0.837	138.1	216	29,831
92	100.00%	165	0.837	138.1	111	15,330
97	100.00%	165	0.837	138.1	46	6,353
102	100.00%	165	0.837	138.1	0	-
				138.1	4467	274,295

Rebate Case								
Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	#1	0	0.0	24	-
32	0.00%	-	0.000	#1	0	0.0	234	-
37	0.00%	-	0.000	#1	0	0.0	458	-
42	0.00%	-	0.000	#1	0	0.0	721	-
47	0.00%	-	0.000	#1	0	0.0	1166	-
52	0.00%	-	0.000	#1	0	0.0	1690	-
57	10.00%	17	1.224	#1	1.224	20.2	1424	28,759
62	28.00%	46	0.669	#1	0.669	30.9	894	27,648
67	46.00%	76	0.682	#1	0.682	51.8	633	32,762
72	64.00%	106	0.652	#1	0.652	68.8	463	31,868
77	82.00%	135	0.684	#1	0.684	92.5	395	36,539
82	100.00%	165	0.7782	#1	0.7782	128.4	285	36,595
87	100.00%	165	0.7782	#1	0.7782	128.4	216	27,735
92	100.00%	165	0.7782	#1	0.7782	128.4	111	14,253
97	100.00%	165	0.7782	#1	0.7782	128.4	46	5,907
102	100.00%	165	0.7782	#1	0.7782	128.4	0	-
						128.4	4467	242,066
		Actual temp Max 102DegF						

	base case		rebate case	rebate		base	rebate		base
10	1.629	10	1.224	1.224	10.00%	1.629		0.00%	
20	1.004	20	0.755	0.671	25.00%	0.893	1.224	10.00%	1.629
25	0.893	25	0.671		40.00%	0.703	0.669	28.00%	0.859
30	0.837	30			55.00%		0.682	46.00%	0.696
40	0.703	40			70.00%	0.731	0.652	64.00%	0.718
50	0.692	50	0.658		85.00%		0.684	82.00%	0.769
60	0.709	60		0.778	100.00%	0.837	0.7782	100.00%	0.837
70	0.731	70		0.778	100.00%	0.837	0.7782	100.00%	0.837
75	0.748	75	0.647	0.78	100.00%	0.837	0.7782	100.00%	0.837
80	0.764	80		0.78	100.00%	0.837	0.7782	100.00%	0.837
90	0.789	90		0.7782	100.00%	0.837	0.7782	100.00%	0.837
100	0.837	100	0.778						

WYEC-clz 2 Site 1184

Total

		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperature	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	14	0	0	0	0	0	0	0	0	0	0	10	24
	32	99	25	3	1	0	0	0	0	0	0	19	87	234
	37	107	67	59	32	11	0	0	0	0	4	81	97	458
	42	179	76	71	96	37	3	0	0	6	59	109	85	721
	47	127	163	133	152	81	42	32	13	45	85	121	172	1166
	52	99	160	191	127	144	110	108	107	141	144	165	194	1690
	57	77	109	153	83	134	129	115	161	139	141	113	70	1424
	62	35	51	68	77	94	85	93	108	92	105	65	21	894
	67	7	18	45	44	85	91	88	88	69	62	28	8	633
	72	0	3	15	57	66	76	72	59	54	47	14	0	463
	77	0	0	6	37	42	74	72	57	68	34	5	0	395
	82	0	0	0	14	25	62	71	57	38	18	0	0	285
	87	0	0	0	0	19	28	51	43	42	33	0	0	216
	92	0	0	0	0	6	17	27	30	19	12	0	0	111
	97	0	0	0	0	0	3	15	21	7	0	0	0	46
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0
														8760

01-08

		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperature	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	14	0	0	0	0	0	0	0	0	0	0	10	24
	32	74	24	3	1	0	0	0	0	0	0	18	74	194
	37	51	53	57	22	11	0	0	0	0	4	68	47	313
	42	67	35	41	72	33	3	0	0	6	57	55	16	385
	47	18	67	69	94	59	41	32	13	40	53	32	52	570
	52	8	37	72	44	88	89	83	104	96	78	51	43	793
	57	8	8	6	7	51	73	66	104	82	55	15	6	481
	62	8	0	0	0	5	27	44	22	16	1	1	0	124
	67	0	0	0	0	1	5	16	5	0	0	0	0	27
	72	0	0	0	0	0	2	4	0	0	0	0	0	6
	77	0	0	0	0	0	0	3	0	0	0	0	0	3
	82	0	0	0	0	0	0	0	0	0	0	0	0	0
	87	0	0	0	0	0	0	0	0	0	0	0	0	0
	92	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

09-16

		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperature	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	15	0	0	0	0	0	0	0	0	0	0	7	22
	37	20	0	0	0	0	0	0	0	0	0	2	17	39
	42	38	12	1	3	0	0	0	0	0	0	13	20	87
	47	46	31	5	20	1	0	0	0	4	3	24	42	176
	52	51	48	40	25	5	0	0	0	12	18	44	80	323
	57	56	66	85	28	25	4	4	6	11	29	60	53	427
	62	15	46	56	45	45	13	10	27	24	53	51	21	406
	67	7	18	40	31	53	43	25	34	27	41	27	8	354
	72	0	3	15	44	44	47	41	37	33	29	14	0	307
	77	0	0	6	31	35	48	40	32	45	21	5	0	263
	82	0	0	0	13	21	47	50	39	26	13	0	0	209
	87	0	0	0	0	13	22	40	32	34	29	0	0	170
	92	0	0	0	0	6	13	23	21	17	12	0	0	92
	97	0	0	0	0	0	3	15	20	7	0	0	0	45
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

17-24

		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperature	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	10	1	0	0	0	0	0	0	0	0	1	6	18
	37	36	14	2	10	0	0	0	0	0	0	11	33	106
	42	74	29	29	21	4	0	0	0	0	2	41	49	249
	47	63	65	59	38	21	1	0	0	1	29	65	78	420
	52	40	75	79	58	51	21	25	3	33	48	70	71	574
	57	13	35	62	48	58	52	45	51	46	57	38	11	516
	62	12	5	12	32	44	45	39	59	52	51	13	0	364
	67	0	0	5	13	31	43	47	49	42	21	1	0	252
	72	0	0	0	13	22	27	27	22	21	18	0	0	150
	77	0	0	0	6	7	26	29	25	23	13	0	0	129
	82	0	0	0	1	4	15	21	18	12	5	0	0	76
	87	0	0	0	0	6	6	11	11	8	4	0	0	46
	92	0	0	0	0	0	4	4	9	2	0	0	0	19
	97	0	0	0	0	0	0	0	1	0	0	0	0	1
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

Chiller Replacement (Site 1294)

Program	Retrofit Express Program
Measure	High Efficiency Air-Cooled Chiller
Site Description	Community Service

Measure Description

Replace existing chiller with high-efficiency air-cooled chiller.

Summary of Ex Ante Impact Calculations

Demand calculations were estimated based upon the chiller tonnage and the difference between the new unit and a baseline qualifying Title 24 chiller, in conjunction with an assumed 0.75 diversity factor. Energy calculations are based upon all but the latter, in conjunction with standard PG&E EFLH values.

Comments on Calculations

The correct chiller size category and compressor only, full load (under ARI conditions) were used in the application. Fan energy should be included in the KW/Ton rating yielding an ARI efficiency value of 1.25 verses the application value of 1.14.

Evaluation Process

The evaluation process consisted of reviewing the application form and supporting documentation, conducting an on-site survey and then computing impacts using the on-site data. Models were calibrated with actual weather, number of compressor hours as well as an observed operating point, %load @ the outside air temperature. Peak demand was calculated for actual peak temperatures. Energy savings were based on typical weather data. A Title 24 baseline, IPLV at ARI conditions, and typical year bin weather data were used in the analysis.

The on-site survey was conducted on October 15, 1998. Information on the retrofit equipment and operating conditions were collected through an inspection of the chiller and through an interview with the Chief Engineer.

Discussions provided data for development of a relationship between chiller loading and outdoor dry bulb temperatures. The chiller serves a base load 24 hours a day all year. Chiller generally begins to serve additional loads at 72 degrees outside air temperature and reaches 30% loading at 95 Degrees F. In the future more of the building will be added to the chiller load.

To compute the impacts, the following assumptions were used:

- A linear loading strategy was used for the analysis of both the baseline and rebated chillers, which assumed 10% loading at 72 degrees and 30% loading at 95 Degrees F.

- For the baseline chiller case a Title 24 baseline efficiency of 1.302 KW/ton was used, based on an air-cooled chiller less than 150 tons.

- Chiller efficiencies at various temperatures were interpolated from values provided at 25%, 50%, 75%, and 100% loading at ARI conditions. These calculated efficiencies were used to develop a chiller efficiency curve for the Rebate case. The baseline chiller efficiency curve was based on minimum Title 24 full load efficiency requirements, matched to a typical chiller performance curve.

The above assumptions were incorporated into a spreadsheet where energy and demand impacts were calculated. Evaluation- based demand and energy impacts were lower than Ex Ante estimates. Results from these calculations are summarized below and documented in the attached workbook.

Additional Notes The second chiller is a back up only unit.

Impact Results

	KW	KWh	Therm
MDSS	23.81	37,986.1	0
Adjusted Engineering	9.40	3,945.4	0
Engineering Realization Rate	0.39	0.10	N/A

Site # 1294	WYEC Weather		
	kWh	kW	therms
PG&E	37986.10	23.81	-
QC Impact	3945.38	9.4	-
			-
I-Eng. Real. Rat	0.10	0.39	

	New Chiller Efficiency		
	%	Tons	kW/Ton
	25%	24.875	0.984
	50%	49.75	1.000
	75%	74.625	1.177
	100%	99.5	1.250
iplv (kW/Ton	1.09971587		

Operational Parameters	New Chiller (Air Cooled)	
	Minimum	Maximum
Chiller Output (Ton)	9.95	99.5
OSA Temp	65	95
% Of Capacity	10%	30%

Basecase

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	10.00%	10	2.535	25.2	0	-
32	10.00%	10	2.535	25.2	0	-
37	10.00%	10	2.535	25.2	55	1,387
42	10.00%	10	2.535	25.2	211	5,322
47	10.00%	10	2.535	25.2	533	13,444
52	10.00%	10	2.535	25.2	824	20,784
57	10.00%	10	2.535	25.2	1853	46,738
62	10.00%	10	2.535	25.2	2100	52,968
67	10.00%	10	2.535	25.2	**1273**	32,109
72	13.33%	13	2.211	29.3	928	27,218
77	16.67%	17	1.887	31.3	595	18,620
82	20.00%	20	1.563	31.1	278	8,647
87	23.33%	23	1.476	34.3	86	2,947
92	26.67%	27	1.389	36.9	18	663
97	30.00%	30	1.302	38.9	6	233
102	30.00%	30	1.302	38.9	0	-
107	30.00%	30	1.302	38.9	0	-
				38.9	8760	90,436

Rebate Case

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	10.00%	10	2.433	#1	2.433	24.2	0	-
32	10.00%	10	2.433	#1	2.433	24.2	0	-
37	10.00%	10	2.433	#1	2.433	24.2	55	1,331
42	10.00%	10	2.433	#1	2.433	24.2	211	5,108
47	10.00%	10	2.433	#1	2.433	24.2	533	12,903
52	10.00%	10	2.433	#1	2.433	24.2	824	19,948
57	10.00%	10	2.433	#1	2.433	24.2	1853	44,858
62	10.00%	10	2.433	#1	2.433	24.2	2100	50,838
67	10.00%	10	2.433	#1	2.433	24.2	**1273**	30,817
72	13.33%	13	2.122	#1	2.122	28.1	928	26,122
77	16.67%	17	1.811	#1	1.811	30.0	595	17,870
82	20.00%	20	1.500	#1	1.500	29.9	278	8,298
87	23.33%	23	1.329	#1	1.329	30.9	86	2,654
92	26.67%	27	1.158	#1	1.158	30.7	18	553
97	30.00%	30	0.987	#1	0.987	29.5	6	177
102	30.00%	30	0.987	#1	0.987	29.5	0	-
107	30.00%	30	0.987	#1	0.987	29.5	0	-
						29.5	8760	86,491

	Eff base ca	% Loading	Eff rebate case		rebate	% Loading	base
10.000	2.535	10.000	2.309		2.433	10.00%	2.535
20.000	1.563	20.000	1.423		2.122	13.33%	2.211
25.000	1.389	25.000	0.984		1.811	16.67%	1.887
30.000	1.302	30.000			1.500	20.00%	1.563
40.000	1.094	40.000			1.329	23.33%	1.476
50.000	1.076	50.000	1.000		1.158	26.67%	1.389
60.000	1.103	60.000			0.987	30.00%	1.302
70.000	1.137	70.000					
75.000	1.163	75.000	1.177				
80.000	1.189	80.000					
90.000	1.241	90.000					
100.000	1.302	100.000	1.250				

WYEC-clz 5 site 1294 Actual Max Temp =95

Total

	Month												
		1	2	3	4	5	6	7	8	9	10	11	12 Total
Temperature	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	22	6	0	0	0	0	0	0	0	0	3	24	55
	37	70	29	21	11	2	0	0	0	0	0	27	51	211
	42	82	75	67	61	30	10	0	0	0	13	64	131	533
	47	85	105	126	94	52	33	6	5	28	63	118	109	824
	52	165	138	225	157	212	212	137	94	58	154	165	136	1853
	57	167	136	134	168	173	151	250	293	181	181	140	126	2100
	62	101	110	110	93	118	101	78	81	172	100	106	103	1273
	67	38	51	35	71	104	121	99	105	82	119	56	47	928
	72	12	13	16	40	31	48	116	115	112	57	24	11	595
	77	2	9	10	20	11	26	50	44	56	33	11	6	278
	82	0	0	0	5	9	13	6	6	23	18	6	0	86
	87	0	0	0	0	2	5	2	1	4	4	0	0	18
	92	0	0	0	0	0	0	0	0	4	2	0	0	6
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0
								273	271	281	233			

01-08

	Month												
		1	2	3	4	5	6	7	8	9	10	11	12 Total
Temperature	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	20	6	0	0	0	0	0	0	0	0	3	24	53
	37	61	27	21	10	2	0	0	0	0	0	25	36	182
	42	46	58	43	45	26	8	0	0	0	13	44	84	367
	47	32	53	78	55	33	26	6	5	28	57	74	41	488
	52	64	60	86	63	118	128	93	76	44	84	58	40	914
	57	24	13	16	53	49	63	121	151	93	61	28	19	691
	62	1	7	3	9	13	10	15	10	70	23	7	4	172
	67	0	0	1	4	5	4	10	4	3	10	1	0	42
	72	0	0	0	1	1	1	2	1	2	0	0	0	8
	77	0	0	0	0	1	0	1	1	0	0	0	0	3
	82	0	0	0	0	0	0	0	0	0	0	0	0	0
	87	0	0	0	0	0	0	0	0	0	0	0	0	0
	92	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

09-16

	Month												
		1	2	3	4	5	6	7	8	9	10	11	12 Total
Temperature	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	0	0	0	0	0	0	0	0	0	0	0	0	0
	42	3	0	0	0	0	0	0	0	0	0	0	9	12
	47	8	4	0	0	0	0	0	0	0	0	1	12	25
	52	24	23	12	4	1	1	0	0	0	4	13	22	104
	57	76	54	75	44	21	6	0	5	5	13	58	64	421
	62	87	76	102	70	83	46	16	19	10	37	74	77	697
	67	36	46	33	60	94	106	66	68	44	83	54	47	737
	72	12	12	16	37	28	38	110	108	98	54	23	11	547
	77	2	9	10	20	10	25	48	41	53	33	11	6	268
	82	0	0	0	5	9	13	6	6	22	18	6	0	85
	87	0	0	0	0	2	5	2	1	4	4	0	0	18
	92	0	0	0	0	0	0	0	0	4	2	0	0	6
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

17-24

	Month												
		1	2	3	4	5	6	7	8	9	10	11	12 Total
Temperature	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	2	0	0	0	0	0	0	0	0	0	0	0	2
	37	9	2	0	1	0	0	0	0	0	0	2	15	29
	42	33	17	24	16	4	2	0	0	0	0	20	38	154
	47	45	48	48	39	19	7	0	0	0	6	43	56	311
	52	77	55	127	90	93	83	44	18	14	66	94	74	835
	57	67	69	43	71	103	82	129	137	83	107	54	43	988
	62	13	27	5	14	22	45	47	52	92	40	25	22	404
	67	2	5	1	7	5	11	23	33	35	26	1	0	149
	72	0	1	0	2	2	9	4	6	12	3	1	0	40
	77	0	0	0	0	0	1	1	2	3	0	0	0	7
	82	0	0	0	0	0	0	0	0	1	0	0	0	1
	87	0	0	0	0	0	0	0	0	0	0	0	0	0
	92	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

Chiller Replacement (Site 1727)

Program	Retrofit Efficiency Options Program
Measure	High Efficiency Water-Cooled Chiller
Site Description	Personal Service

Measure Description

Replace one of four existing chillers with high-efficiency water-cooled chiller.

Summary of Ex Ante Impact Calculations

Tables of standard values were developed using the HBSSM simulation program based on climate zone, chiller size, building type, chiller efficiency, and condenser water temperature. Values from these tables are used to calculate the rebate and associated impacts.

Comments on PG&E Calculations

The correct climate zone, chiller size category and building were used in the application calculations. However he IPLV, not the APLV was used. According to the REO eligibility requirements, a building served by four chillers does not qualify for a rebate.

Evaluation Process

The evaluation process consisted of reviewing the application form and supporting documentation, conducting an on-site survey and then computing impacts using the on-site data. Models were calibrated with actual weather, number of compressor hours as well as an observed operating point, %load @ the outside air temperature. Peak demand was calculated for actual peak temperatures. Energy savings were based on typical weather data. A Title 24 baseline, IPLV at ARI conditions, and typical year bin weather data for the applicable climate zone was used in the bin analysis.

The on-site survey was conducted on October 12, 1998. Information on the retrofit equipment and operating conditions were collected through an inspection of the chiller and through an interview with the Chief Engineer.

Discussions provided data for development of a relationship between chiller loading and outdoor dry bulb. The chiller is available 24 hours a day, everyday of the year. The chiller runs 8760 serving a consistent 800 ton load. The Chiller generally begins serving additional loads at 60 degrees outside air temperature and reaches 100% loading at 75 Degrees F.

To compute the impacts, the following assumptions were used:

- A linear loading strategy was used for the analysis of both the baseline, and rebated chillers, which assumed a constant 58% load, and additional loading at 60 degrees and 100% loading at 75 Degrees F.

- For the baseline chiller case a Title 24 baseline efficiency of 0.748KW/ton was used, based on a water-cooled chiller greater than

300 tons.

- Chiller efficiencies at various temperatures were interpolated from values provided at 25%, 50%, 75%, and 100% loading at ARI conditions. These calculated efficiencies were used to develop a chiller efficiency curve for the Rebate case. The baseline chiller efficiency curve was based on minimum Title 24 full load efficiency requirements, matched to a typical chiller performance curve.

The above assumptions were incorporated into a spreadsheet where energy and demand impacts were calculated. Evaluation- based demand impacts were lower and energy impacts were higher, than Ex Ante estimates. Results from these calculations are summarized below and documented in the attached workbook.

Additional Notes This site has multiple chillers; the rebated chiller is the primary chiller.

Impact Results

	KW	KWh	Therm
MDSS	418.73	611,030.53	0
Adjusted Engineering	219.42	1,187,535.47	0
Engineering Realization Rate	.52	1.94	N/A

Site # 1727	WYEC Weather		
	kWh	kW	therms
PG&E	611,030.53	418.73	0.00
QC Impact	1,187,535.47	219.42	0.00
I-Eng. Real. Rat	1.94	0.52	

New Chiller Efficiency		
%	Tons	kW/Ton
25%	345	0.708
50%	690	0.568
75%	1035	0.545
100%	1380	0.589

iplv (kW/Ton 0.57452303

Operational Parameters	New Chiller (Centrifugal)	
	Minimum	Maximum
Chiller Output (Ton)	800	1380
OSA Temp	NA	77
% Of Capacity	40%	100%

800 Ton Base load 8760

Basecase

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	57.97%	800	0.709	567.2	0	-
32	57.97%	800	0.709	567.2	7	3,970
37	57.97%	800	0.709	567.2	107	60,689
42	57.97%	800	0.709	567.2	399	226,309
47	57.97%	800	0.709	567.2	941	533,726
52	57.97%	800	0.709	567.2	1944	#######
57	57.97%	800	0.709	567.2	2461	#######
62	68.48%	945	0.703	664.3	1457	967,823
67	78.99%	1,090	0.707	770.5	773	595,562
72	89.49%	1,235	0.724	894.2	409	365,743
77	100.00%	1,380	0.748	1032.2	175	180,642
82	100.00%	1,380	0.748	1032.2	58	59,870
87	100.00%	1,380	0.748	1032.2	28	28,903
92	100.00%	1,380	0.748	1032.2	1	1,032
97	100.00%	1,380	0.748	1032.2	0.00	-
				1032.2	8760	#######

Rebate Case

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Number	Chiller Eff. (kW/Ton)	Total Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	57.97%	800	#1	0.560	447.992	0	-
32	57.97%	800	#1	0.560	447.992	7	3,136
37	57.97%	800	#1	0.560	447.992	107	47,935
42	57.97%	800	#1	0.560	447.992	399	178,749
47	57.97%	800	#1	0.560	447.992	941	421,561
52	57.97%	800	#1	0.560	447.992	1944	870,897
57	57.97%	800	#1	0.560	447.992	2461	1,102,509
62	68.48%	945	#1	0.543	512.865	1457	747,244
67	78.99%	1,090	#1	0.549	598.008	773	462,260
72	89.49%	1,235	#1	0.570	704.052	409	287,957
77	100.00%	1,380	#1	0.589	812.820	175	142,244
82	100.00%	1,380	#1	0.589	812.820	58	47,144
87	100.00%	1,380	#1	0.589	812.820	28	22,759
92	100.00%	1,380	#1	0.589	812.820	1	813
97	100.00%	1,380	#1	0.589	812.820	0.00	-
					812.820	8760.0	4,335,206
	max @94						

% Loading	Eff base case	% Loading	Eff rebate case	rebate	% Loading	base
10.000	1.220	10.000	0.962	0.560	57.97%	0.709
20.000	0.978	20.000	0.772	0.560	57.97%	0.709
25.000	0.898	25.000	0.708	0.560	57.97%	0.709
30.000	0.863	30.000	0.680	0.560	57.97%	0.709
40.000	0.771	40.000	0.624	0.560	57.97%	0.709
50.000	0.713	50.000	0.568	0.560	57.97%	0.709
60.000	0.708	60.000	0.558	0.560	57.97%	0.709
70.000	0.702	70.000	0.540	0.543	68.48%	0.703
75.000	0.702	75.000	0.545	0.549	78.99%	0.707
80.000	0.708	80.000	0.554	0.570	89.49%	0.724
90.000	0.725	90.000	0.571	0.589	100.00%	0.748
100.000	0.748	100.000	0.589	0.589	100.00%	0.748
				0.589	100.00%	0.748
				0.589	100.00%	0.748
				0.589	100.00%	0.748

WYEC-Clz Site 1727

Total

		Month													
		1	2	3	4	5	6	7	8	9	10	11	12	Total	8760
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	
	32	2	0	0	0	0	0	0	0	0	0	0	5	7	
	37	31	6	5	0	0	0	0	0	0	0	10	55	107	
	42	130	44	43	26	4	0	0	0	0	1	33	118	399	
	47	183	157	124	109	55	5	1	0	1	35	121	150	941	
	52	209	194	232	225	244	133	91	61	57	101	171	226	1944	
	57	155	212	185	161	174	230	260	267	194	225	232	166	2461	
	62	29	39	114	121	145	154	144	176	208	200	106	21	1457	
	67	5	17	34	50	69	101	136	122	113	92	31	3	773	
	72	0	3	7	18	27	61	74	79	77	48	15	0	409	
	77	0	0	0	9	14	25	29	33	42	22	1	0	175	
	82	0	0	0	1	6	8	7	5	17	14	0	0	58	
	87	0	0	0	0	6	3	2	1	10	6	0	0	28	
	92	0	0	0	0	0	0	0	0	1	0	0	0	1	
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	
														8760	

01-08

		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	2	0	0	0	0	0	0	0	0	0	0	5	7
	37	30	6	5	0	0	0	0	0	0	0	8	43	92
	42	80	40	40	26	2	0	0	0	0	1	31	74	294
	47	70	107	88	81	46	5	1	0	1	35	86	64	584
	52	46	50	81	120	156	93	72	52	55	81	68	50	924
	57	20	20	27	13	43	104	158	164	126	113	44	12	844
	62	0	1	7	0	1	36	14	32	49	15	3	0	158
	67	0	0	0	0	0	1	3	0	7	3	0	0	14
	72	0	0	0	0	0	1	0	0	2	0	0	0	3
	77	0	0	0	0	0	0	0	0	0	0	0	0	0
	82	0	0	0	0	0	0	0	0	0	0	0	0	0
	87	0	0	0	0	0	0	0	0	0	0	0	0	0
	92	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

09-16

		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	0	0	0	0	0	0	0	0	0	0	0	1	1
	42	10	1	1	0	0	0	0	0	0	0	0	9	21
	47	43	9	14	1	0	0	0	0	0	0	5	35	107
	52	73	60	68	22	10	1	0	0	0	0	19	81	334
	57	97	109	77	66	40	19	7	9	6	29	93	100	652
	62	20	28	59	91	96	57	48	52	53	90	78	19	691
	67	5	14	23	37	57	78	93	81	59	59	30	3	539
	72	0	3	6	14	22	53	65	68	59	35	14	0	339
	77	0	0	0	8	12	22	26	32	36	17	1	0	154
	82	0	0	0	1	5	7	7	5	17	12	0	0	54
	87	0	0	0	0	6	3	2	1	9	6	0	0	27
	92	0	0	0	0	0	0	0	0	1	0	0	0	1
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

17-24

		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	1	0	0	0	0	0	0	0	0	0	2	11	14
	42	40	3	2	0	2	0	0	0	0	0	2	35	84
	47	70	41	22	27	9	0	0	0	0	0	30	51	250
	52	90	84	83	83	78	39	19	9	2	20	84	95	686
	57	38	83	81	82	91	107	95	94	62	83	95	54	965
	62	9	10	48	30	48	61	82	92	106	95	25	2	608
	67	0	3	11	13	12	22	40	41	47	30	1	0	220
	72	0	0	1	4	5	7	9	11	16	13	1	0	67
	77	0	0	0	1	2	3	3	1	6	5	0	0	21
	82	0	0	0	0	1	1	0	0	0	2	0	0	4
	87	0	0	0	0	0	0	0	0	1	0	0	0	1
	92	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

Chiller Replacement (Site 1963)

Program	Advanced Performance Options
Measure	Chiller System Retrofit
Site Description	Personal Service

Measure Description

In two buildings the existing chillers were replaced with high-efficiency centrifugal chillers of reduced capacity, cooling tower fan motors resheaved, downsized and replaced chilled water and condenser water pumps with high efficiency motors. In a third building the existing chiller was replaced with a high-efficiency centrifugal chiller of reduced capacity and a new cooling tower was installed, chilled water and condenser water pumps were downsize and replace with high efficiency motors.

Summary of Ex Ante Impact Calculations

Demand and energy impacts were determined from Visual DOE simulations and the appropriate climate zone weather data. A baseline simulation was developed and then the rebated chiller and new operating set points were substituted for the baseline chiller. Reductions in energy consumption are reflected in space cooling, heat rejection and pumping/fan, all other energy use is constant.

Summary of Ex Ante Impact Calculations

The results from the simulations are reasonable and accurates. The total energy use determined from the baseline simulation was well matched with the historic energy use at the facility. Energy usage associated with the retrofit chiller is computed in a similar fashion, using an identical load line, weather and operating hour assumptions, but with an appropriate approach temperature, chiller efficiency and set points for the retrofit chiller and cooling tower. Savings due to cooling tower effects, and pump/fan motor changes were included in the savings estimate.

Evaluation Process

The evaluation process consisted of reviewing the application form and supporting documentation, conducting an on-site survey and reviewing the results from the Visual DOE Simulations. Models were calibrated with actual weather, number of compressor hours as well as an observed operating point, %load @ the outside air temperature. Peak demand was calculated for actual peak temperatures. Energy saving were based on typical weather data. A Title 24 baseline, IPLV at ARI conditions, and typical year bin weather data was used in the bin analysis. Impacts were also estimated for hi-efficiency motors, using assumed operating hours dictated by the weather bin model, newly installed horsepower and new efficiencies. The baseline used Title 24 minimum motor efficiencies.

The on-site survey was conducted on December 10, 1998 with the Chief Engineer. The retrofit equipment and operating conditions were verified via an inspection of the central plant and through discussions with the Engineer. He confirmed that the chiller and schedule matched the information provided in the application. Discussions provided data for development of a relationship between chiller loading and outdoor dry bulb temperatures. Chiller use generally begins at 52 degrees outside air temperature and reaches 100% loading at 105 Degrees F.

To compute the impacts, the following assumptions were used:

- A linear loading strategy was used for the analysis of both the original, baseline and rebated chillers, which assumed 10% loading at 52 degrees and 100% loading at 105 Degrees F. One building has a constant load of 10% 8760 hour per year.

- For the baseline chiller case a Title 24 baseline efficiency of 0.748KW/ton was used, based on a water-cooled chiller greater than 300 tons. The existing chillers were modeled with a default KW/Ton value of 0.90.

- Chiller efficiencies at various temperatures were interpolated from values provided at 25%, 50%, 75%, and 100% loading at ARI conditions. These calculated efficiencies were used to develop a chiller efficiency curve for the Rebate case. The baseline chiller efficiency curve was based on minimum Title 24 full load efficiency requirements, matched to a typical chiller performance curve.

The above assumptions were incorporated into a spreadsheet where energy and demand impacts were calculated. Evaluation- based demand impacts and energy impacts were lower than Ex Ante estimates. Results from these calculations are summarized below and documented in the attached workbook.

Additional Notes

The facility is 3 connected office buildings.
Saving estimates were calculated in a similar manner using existing equipment performance characteristics. The results from these calculations are documented in the attached workbook.

Impact Results

	KW	KWh	Therm
MDSS	**278.16**	**790,105.43**	0
Adjusted Engineering	**176.51**	**260,130.84**	0
Engineering Realization Rate	0.63	0.33	N/A

Site 1963 **Summary Yac Weather**

	Total kWh	Total kW	Therms
PG&E	790,105.43	278.16	0.00
QC Impact	260,130.84	176.51	0.00

Impact Realization

Rate	0.33	0.63	0.00

Site 1963 Building 30

	Total kWh	Total kW	Therms	Chiller & Tower kWh	Chiller & Tower kW	Fan & Pumping kWh	Fan & Pumping kW
QC Impact	64,567.63	62.21	0.00	64,072.11	62.04	495.52	0.17

Site 1963 Building 31

	Total kWh	Total kW	Therms	Chiller & Tower kWh	Chiller & Tower kW	Fan & Pumping kWh	Fan & Pumping kW
QC Impact	52,612.84	51.40	0.00	51,835.64	51.40	777.20	0.00

Site 1963 Building 32

	Total kWh	Total kW	Therms	Chiller & Tower kWh	Chiller & Tower kW	Fan & Pumping kWh	Fan & Pumping kW
QC Impact	142,950.38	62.91	0.00	135,352.11	62.04	7,598.26	0.87

Site 1963 Building 30

	Total kWh	Total kW	Therms	Chiller & Tower kWh	Chiller & Tower kW	Fan & Pumping kWh	Fan & Pumping kW
PG&E	77,081	51.7	-				
QC Impact	64567.63	62.21	0.00	64072.11	62.04	495.52	0.17

Existing

	hours	Motor Hp	Efficiency	kW	kWh
Fan Cooling tower	2988.20	40	0.87	35.36	105661.83
Pumping Condenser	2988.20	25	0.87	22.10	66038.64
Pumping Evaporator	2988.20	15	0.87	13.26	39623.18
				70.72	211323.65

	Retrofit					base		
	hours	Motor Hp	Efficiency	kW	kWh	Efficiency	kW	kWh
Fan Cooling tower	2988.20	25	0.87	22.10	66038.64	0.89	21.60	64554.63
Pumping Condenser	2988.20	5	0.90	4.26	12739.16	0.88	4.37	13057.64
Pumping Evaporator	2988.20	10	0.92	8.39	25061.56	0.86	8.94	26722.61
				34.75	103839.36		34.92	104334.88

Base Case: Tittle 24 min. eff. Water cool centrifugal

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-		0.0		-
32	0.00%	-		0.0		-
37	0.00%	-		0.0		-
42	0.00%	-		0.0		-
47	0.00%	-		0.0		-
52	10.00%	22	1.365	30.0	500.29	15,023
57	18.18%	40	1.144	45.7	661.12	30,246
62	26.36%	58	0.994	57.6	526.60	30,352
67	34.54%	76	0.919	69.8	395.55	27,623
72	42.73%	94	0.845	79.5	369.91	29,390
77	50.91%	112	0.798	89.4	290.05	25,917
82	59.01%	130	0.793	102.9	164.82	16,958
87	67.27%	148	0.787	116.5	59.50	6,932
92	75.45%	166	0.786	130.5	14.55	1,898
97	83.64%	184	0.799	147.0	5.80	853
102	91.82%	202	0.816	164.8	0.00	-
107	100.00%	220	0.837	184.1	0.00	-
				184.1	0.00	185,193

Operational Parameters	New Chiller		Old Chiller	
Base Case	Minimum	Maximum	Minimum	Maximum
Chiller Output (Ton)	22	220	27.4	274
OSA Temp	50	105	50	105
% Of Capacity	10%	100%	10%	80%

New Chiller Efficiency: @ Application Design of 9 Deg. Approach Temp

%	Tons	kW/Ton
25%	55	0.655
50%	110	0.545
75%	165	0.527
100%	220	0.555

iplv (kW/Ton0.5495146

Note: Based on chiller improvement of .01 kW/ton per Degree of Approach Temperature reduction.

Rebate Case:9 deg Approach Temp

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	#1	0	0.0		-
32	0.00%	-	0.000	#1	0	0.0		-
37	0.00%	-	0.000	#1	0	0.0		-
42	0.00%	-	0.000	#1	0	0.0		-
47	0.00%	-	0.000	#1	0	0.0		-
52	10.00%	22	0.834	#1	0.834	18.35	500.29	9,179
57	18.18%	40	0.710	#1	0.710	28.38	661.12	18,765
62	26.36%	58	0.646	#1	0.646	37.45	526.60	19,720
67	34.54%	76	0.602	#1	0.602	45.77	395.55	18,106
72	42.73%	94	0.570	#1	0.570	53.63	369.91	19,836
77	50.91%	112	0.544	#1	0.544	60.89	290.05	17,661
82	59.01%	130	0.531	#1	0.531	69.00	164.82	11,372
87	67.27%	148	0.527	#1	0.527	78.01	59.50	4,641
92	75.45%	166	0.527	#1	0.527	87.49	14.55	1,273
97	83.64%	184	0.531	#1	0.531	97.63	5.80	566
102	91.82%	202	0.539	#1	0.539	108.81	0.00	-
107	100.00%	220	0.555	#1	0.555	122.10	0.00	-
						122.10	2988.20	121,121

Good estimate Running hrs w/in 6%

	base case		9 deg rebate case	rebate		base	8 deg rebate
10	1.365	10.00%	0.834	0.8340	10.00%	1.3650	
15	1.23	15.00%	0.758	0.7097	18.18%	1.1438	0.698
20	1.095	20.00%	0.682	0.6458	26.36%	0.9939	0.622
25	1.004	25.00%	0.655	0.6024	34.54%	0.9190	0.595
30	0.966	30.00%	0.621	0.5704	42.73%	0.8452	0.561
40	0.863	40.00%	0.580	0.5436	50.91%	0.7978	0.52
50	0.798	50.00%	0.545	0.5315	59.01%	0.7926	0.485
60	0.792	60.00%	0.530	0.5271	67.27%	0.7873	0.47
70	0.785	70.00%	0.526	0.5271	75.45%	0.7861	0.468
75	0.785	75.00%	0.527	0.5305	83.64%	0.7990	0.467
80	0.792	80.00%	0.528	0.5386	91.82%	0.8159	0.468
90	0.811	90.00%	0.535	0.5550	100.00%	0.8370	0.475
100	0.837	100.00%	0.555				0.495

Site 1963 Building 31

	Total kWh	Total kW	Therms	Chiller & Tower kWh	Chiller & Tower kW	Fan & Pumping kWh	Fan & Pumping kW
PG&E	77,081	51.7	-				
QC Impact	52612.84	51.40	0.00	51835.64	51.40	777.20	0.00

Existing

	hours	Motor Hp	Efficiency	kW	kWh
Fan Cooling tower	2988.20	40	0.87	35.36	105661.83
Pumping Condenser	2988.20	20	0.87	17.68	52830.91
Pumping Evaporator	2988.20	15	0.87	13.26	39623.18
				66.30	198115.92

	Retrofit					base		
	hours	Motor Hp	Efficiency	kW	kWh	Efficiency	kW	kWh
Fan Cooling tower	2988.20	25.0	0.87	22.10	66038.64	0.89	21.60	64554.63
Pumping Condenser	2988.20	7.5	0.92	6.29	18796.17	0.87	6.63	19811.59
Pumping Evaporator	2988.20	7.5	0.92	6.29	18796.17	0.86	6.71	20041.96
				34.68	103630.98		-34.68	104408.18

Base Case: Tittle 24 min. eff.cent. Water cooled

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-		0.0		-
32	0.00%	-		0.0		-
37	0.00%	-		0.0		-
42	0.00%	-		0.0		-
47	0.00%	-		0.0		-
52	10.00%	20	1.365	27.3	500.29	13,658
57	18.18%	36	1.144	41.6	661.12	27,496
62	26.36%	53	0.994	52.4	526.60	27,593
67	34.54%	69	0.919	63.5	395.55	25,111
72	42.73%	85	0.845	72.2	369.91	26,718
77	50.91%	102	0.798	81.2	290.05	23,561
82	59.01%	118	0.793	93.5	164.82	15,417
87	67.27%	135	0.787	105.9	59.50	6,302
92	75.45%	151	0.786	118.6	14.55	1,726
97	83.64%	167	0.799	133.7	5.80	776
102	91.82%	184	0.816	149.8	0.00	-
107	100.00%	200	0.837	167.4	0.00	-
				167.4		168,358

Operational Parameters	**New Chiller**		**Old Chiller**	
Base Case	**Minimum**	**Maximum**	**Minimum**	**Maximum**
Chiller Output (Ton)	20	200	2.3	228
OSA Temp	50	105	50	105
% Of Capacity	10%	100%	10%	87%

New Chiller Efficiency: @ Application Design of 9 Deg. Approach Temp

%	Tons	kW/Ton
25%	50	0.685
50%	100	0.570
75%	150	0.551
100%	200	0.58

iplv (kW/To 0.574268

Note: Based on chiller improvement of .01 kW/ton per Degree of Approach Temperature reduction.

Rebate Case:9 deg Approach Temp

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	#1	0	0.0		-
32	0.00%	-	0.000	#1	0	0.0		-
37	0.00%	-	0.000	#1	0	0.0		-
42	0.00%	-	0.000	#1	0	0.0		-
47	0.00%	-	0.000	#1	0	0.0		-
52	10.00%	20	0.946	#1	0.872	18.92	500.29	9,466
57	18.18%	36	0.771	#1	0.742	28.04	661.12	18,535
62	26.36%	53	0.675	#1	0.675	35.58	526.60	18,735
67	34.54%	69	0.630	#1	0.630	43.49	395.55	17,202
72	42.73%	85	0.596	#1	0.596	50.95	369.91	18,845
77	50.91%	102	0.568	#1	0.568	57.85	290.05	16,778
82	59.01%	118	0.555	#1	0.555	65.55	164.82	10,804
87	67.27%	135	0.551	#1	0.551	74.11	59.50	4,409
92	75.45%	151	0.551	#1	0.551	83.12	14.55	1,209
97	83.64%	167	0.554	#1	0.554	92.75	5.80	538
102	91.82%	184	0.563	#1	0.563	103.37	0.00	-
107	100.00%	200	0.580	#1	0.580	116.00	0.00	-
						116.00	2988.20	116,522

Good estimate Running hrs w/in 6%

	base case		9 deg rebate case	rebate		base
10	1.365	10.00%	0.946	0.9460	10.00%	1.3650
15	1.230	15.00%	0.873	0.7710	18.18%	1.1438
20	1.095	20.00%	0.713	0.6748	26.36%	0.9939
25	1.004	25.00%	0.685	0.6295	34.54%	0.9190
30	0.966	30.00%	0.649	0.5961	42.73%	0.8452
40	0.863	40.00%	0.606	0.5681	50.91%	0.7978
50	0.798	50.00%	0.570	0.5554	59.01%	0.7926
60	0.792	60.00%	0.554	0.5508	67.27%	0.7873
70	0.785	70.00%	0.550	0.5508	75.45%	0.7861
75	0.785	75.00%	0.551	0.5544	83.64%	0.7990
80	0.792	80.00%	0.552	0.5629	91.82%	0.8159
90	0.811	90.00%	0.559	0.5800	100.00%	0.8370
100	0.837	100.00%	0.58			

Site 1963 Building 32

	Total kWh	Total kW	Therms	Chiller & Tower kWh	Chiller & Tower kW	Fan & Pumping kWh	Fan & Pumping kW
PG&E	77,081	51.7	-				
QC Impact	142,950.38	62.91	0.00	135,352.11	62.04	7,598.26	0.87

Existing

	hours	Motor Hp	Efficiency	kW	kWh
Fan Cooling tower	8760.00	40	0.87	35.36	309750.44
Pumping Condenser	8760.00	25	0.87	22.10	193594.03
Pumping Evaporator	8760.00	20	0.87	17.68	154875.22
				75.14	658219.69

	Retrofit					base		
	hours	Motor Hp	Efficiency	kW	kWh	Efficiency	kW	kWh
Fan Cooling tower	8760.00	10	0.92	8.39	73468.62	0.89	8.64	75697.44
Pumping Condenser	8760.00	7.5	0.90	6.39	56017.78	0.88	6.55	57418.23
Pumping Evaporator	8760.00	10	0.92	8.39	73468.62	0.87	8.84	77437.61
				23.17	202955.02		24.04	210553.28

Base Case: Tittle 24 min. eff. Water cool centrifugal

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	10.00%	22	1.365	30.0	7	210
32	10.00%	22	1.365	30.0	80	2,402
37	10.00%	22	1.365	30.0	254	7,627
42	10.00%	22	1.365	30.0	571	17,147
47	10.00%	22	1.365	30.0	961	28,858
52	10.00%	22	1.365	30.0	1497.00	44,953
57	18.18%	40	1.144	45.7	1746.00	79,878
62	26.36%	58	0.994	57.6	1240.00	71,471
67	34.54%	76	0.919	69.8	839.00	58,590
72	42.73%	94	0.845	79.5	687.00	54,583
77	50.91%	112	0.798	89.4	493.00	44,051
82	59.01%	130	0.793	102.9	266.00	27,369
87	67.27%	148	0.787	116.5	89.00	10,369
92	75.45%	166	0.786	130.5	21.00	2,740
97	83.64%	184	0.799	147.0	9.00	1,323
102	91.82%	202	0.816	164.8	0.00	-
107	100.00%	220	0.837	184.1	0.00	-
				184.1		395,329

Operational Parameters	New Chiller		Old Chiller	
Base Case	**Minimum**	**Maximum**	**Minimum**	**Maximum**
Chiller Output (Ton)	22	220	2.7	268
OSA Temp	50	105	50	105
% Of Capacity	10%	100%	10%	82%

New Chiller Efficiency: @ Application Design of 9 Deg. Approach Temp

%	Tons	kW/Ton
25%	55	0.655
50%	110	0.545
75%	165	0.527
100%	220	0.555

iplv (kW/To 0.549515

Note: Based on chiller improvement of .01 kW/ton per Degree of Approach Temperature reduction.

Rebate Case:9 deg Approach Temp

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	10.00%	22	0.905	#1	0.834	19.9	7	139
32	10.00%	22	0.905	#1	0.834	19.9	80	1,593
37	10.00%	22	0.905	#1	0.834	19.9	254	5,057
42	10.00%	22	0.905	#1	0.834	19.9	571	11,369
47	10.00%	22	0.905	#1	0.834	19.9	961	19,134
52	10.00%	22	0.905	#1	0.834	19.91	1497.00	29,805
57	18.18%	40	0.723	#1	0.710	28.90	1746.00	50,460
62	26.36%	58	0.646	#1	0.646	37.45	1240.00	46,436
67	34.54%	76	0.602	#1	0.602	45.77	839.00	38,404
72	42.73%	94	0.570	#1	0.570	53.63	687.00	36,841
77	50.91%	112	0.544	#1	0.544	60.89	493.00	30,018
82	59.01%	130	0.531	#1	0.531	69.00	266.00	18,354
87	67.27%	148	0.527	#1	0.527	78.01	89.00	6,943
92	75.45%	166	0.527	#1	0.527	87.49	21.00	1,837
97	83.64%	184	0.531	#1	0.531	97.63	9.00	879
102	91.82%	202	0.539	#1	0.539	108.81	0.00	-
107	100.00%	220	0.555	#1	0.555	122.10	0.00	-
						122.10	8760.00	259,977

Good estimate Running hrs w/in 1%

			9 deg			
	base case		rebate case	rebate		base
10.000	1.365	10.00%	0.905	0.9050	10.00%	1.3650
15.000	1.230	15.00%	0.7935	0.7226	18.18%	1.1438
20.000	1.095	20.00%	0.682	0.6458	26.36%	0.9939
25.000	1.004	25.00%	0.655	0.6024	34.54%	0.9190
30.000	0.966	30.00%	0.621	0.5704	42.73%	0.8452
40.000	0.863	40.00%	0.580	0.5436	50.91%	0.7978
50.000	0.798	50.00%	0.545	0.5315	59.01%	0.7926
60.000	0.792	60.00%	0.530	0.5271	67.27%	0.7873
70.000	0.785	70.00%	0.526	0.5271	75.45%	0.7861
75.000	0.785	75.00%	0.527	0.5305	83.64%	0.7990
80.000	0.792	80.00%	0.528	0.5386	91.82%	0.8159
90.000	0.811	90.00%	0.535	0.5550	100.00%	0.8370
100.000	0.837	100.00%	0.555			

Site 1963 **Savings Summary**

	Total kWh	Total kW	Therms
PG&E	**77,080.72**	**51.69**	**0.00**
QC Savings	**1,051,384.21**	**308.35**	**0.00**
Impact Realization Rate	**13.64**	**5.97**	**0.00**

Site 1963 Building 30

	Total kWh	Total kW	Therms	Chiller & Tower kWh	Chiller & Tower kW	Fan & Pumping kWh	Fan & Pumping kW
QC Savings	209,428.98	100.63	0.00	101,944.68	64.66	107,484.29	35.97

Site 1963 Building 31

	Total kWh	Total kW	Therms	Chiller & Tower kWh	Chiller & Tower kW	Fan & Pumping kWh	Fan & Pumping kW
QC Savings	171,736.65	89.81	0.00	77,251.70	58.19	94,484.95	31.62

Site 1963 Building 32

	Total kWh	Total kW	Therms	Chiller & Tower kWh	Chiller & Tower kW	Fan & Pumping kWh	Fan & Pumping kW
QC Savings	670,218.58	117.92	0.00	214,953.90	65.95	455,264.68	51.97

Site 1963 Building 32

	Total kWh	Total kW	Therms	Chiller & Tower kWh	Chiller & Tower kW	Fan & Pumping kWh	Fan & Pumping kW
PG&E	77,081	51.7	-				
QC Savings	670,218.58	117.92	0.00	214,953.90	65.95	455,264.68	51.97

Existing

	hours	Motor Hp	Efficiency	kW	kWh
Fan Cooling tower	8760.00	40	0.87	35.36	309750.44
Pumping Condenser	8760.00	25	0.87	22.10	193594.03
Pumping Evaporator	8760.00	20	0.87	17.68	154875.22
				75.14	658219.69

	Retrofit					Base		
	hours	Motor Hp	Efficiency	kW	kWh	Efficiency	kW	kWh
Fan Cooling tower	8760.00	10	0.92	8.39	73468.62	0.89	8.64	75697.44
Pumping Condenser	8760.00	7.5	0.90	6.39	56017.78	0.88	6.55	57418.23
Pumping Evaporator	8760.00	10	0.92	8.39	73468.62	0.87	8.84	77437.61
				23.17	202955.02		24.04	210553.28

	9 deg rebate case	rebate		existing case			bld 32
10.00%	0.905	1.1280					
15.00%	0.7935	1.1280		10.00%	1.468	10%	1.468
20.00%	0.682	0.8250		16.55%	1.2772	20%	1.177
25.00%	0.655	0.7440		23.09%	1.1170	25%	1.080
30.00%	0.621	0.7200		29.64%	1.0415	30%	1.038
40.00%	0.580	0.6200		38.18%	0.9700	40%	0.928
50.00%	0.545	0.6200		42.73%	0.9088	50%	0.858
60.00%	0.530	0.5540		49.27%	0.8635	60%	0.852
70.00%	0.526	0.5120		55.81%	0.8544	70%	0.845
75.00%	0.527	0.4720		62.36%	0.8499	75%	0.845
80.00%	0.528	0.3550		68.91%	0.8454	80%	0.852
90.00%	0.535	0.3550				90.00%	0.872
100.00%	0.555					100.00%	0.900

Patterson

Operational Parameters	New Chiller		Old Chiller	
Base Case	Minimum	Maximum	Minimum	Maximum
Chiller Output (Ton)	22	220	2.7	268
OSA Temp	50	105	50	105
% Of Capacity	10%	100%	10%	82%

New Chiller Efficiency: @ Application Design of 9 Deg. Approach Temp

%	Tons	kW/Ton
25%	55	0.655
50%	110	0.545
75%	165	0.527
100%	220	0.555

Note: Based on chiller improvement of .01 kW/ton per Degree of Approach Temperature reduction.

Rebate Case:9 deg Approach Temp

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	10.00%	22	0.905	#1	0.834	19.9	7	139
32	10.00%	22	0.905	#1	0.834	19.9	80	1,593
37	10.00%	22	0.905	#1	0.834	19.9	254	5,057
42	10.00%	22	0.905	#1	0.834	19.9	571	11,369
47	10.00%	22	0.905	#1	0.834	19.9	961	19,134
52	10.00%	22	0.905	#1	0.834	19.91	1497.00	29,805
57	18.18%	40	0.723	#1	0.710	28.90	1746.00	50,460
62	26.36%	58	0.646	#1	0.646	37.45	1240.00	46,436
67	34.54%	76	0.602	#1	0.602	45.77	839.00	38,404
72	42.73%	94	0.570	#1	0.570	53.63	687.00	36,841
77	50.91%	112	0.544	#1	0.544	60.89	493.00	30,018
82	59.01%	130	0.531	#1	0.531	69.00	266.00	18,354
87	67.27%	148	0.527	#1	0.527	78.01	89.00	6,943
92	75.45%	166	0.527	#1	0.527	87.49	21.00	1,837
97	83.64%	184	0.531	#1	0.531	97.63	9.00	879
102	91.82%	202	0.539	#1	0.539	108.81	0.00	-
107	100.00%	220	0.555	#1	0.555	122.10	0.00	-
						122.10	8760.00	259,977

Good estimate Running hrs w/in 1%

Existing Case: 13 deg Approach Temp

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	10.00%	27	1.468	39.3	7	275
32	10.00%	27	1.468	39.3	80	3,147
37	10.00%	27	1.468	39.3	254	9,991
42	10.00%	27	1.468	39.3	571	22,460
47	10.00%	27	1.468	39.3	961	37,800
52	10.00%	27	1.468	39.33	1497.00	58,883
57	16.55%	44	1.2772	56.65	1746.00	98,912
62	23.09%	62	1.1170	69.12	1240.00	85,712
67	29.64%	79	1.0415	82.73	839.00	69,409
72	38.18%	97	0.9700	94.05	687.00	64,615
77	42.73%	115	0.9088	104.07	493.00	51,307
82	49.27%	132	0.8635	114.02	266.00	30,330
87	55.81%	150	0.8544	127.80	89.00	11,374
92	62.36%	167	0.8499	142.04	21.00	2,983
97	68.91%	185	0.8454	156.12	9.00	1,405
102	75.45%	202	0.8452	170.91	0.00	-
107	82.00%	220	0.856	188.05	0.00	-
				188.05	8760.00	474,931

Site 1983 Building 31

	Total kWh	Total kW	Therms	Chiller & Tower kWh	Chiller & Tower kW	Fan & Pumping kWh	Fan & Pumping kW
PG&E	77,081	51.7	-				
QC Savings	171736.65	89.81	0.00	77251.70	58.19	94484.95	31.62

Existing

	hours	Motor Hp	Efficiency	kW	kWh
Fan Cooling tower	2988.20	40	0.87	35.36	105661.83
Pumping Condenser	2988.20	20	0.87	17.68	52830.91
Pumping Evaporator	2988.20	15	0.87	13.26	39623.18
				66.30	198115.92

	Retrofit					base		
	hours	Motor Hp	Efficiency	kW	kWh	Efficiency	kW	kWh
Fan Cooling tower	2988.20	25.0	0.87	22.10	66038.64	0.89	21.60	64554.63
Pumping Condenser	2988.20	7.5	0.92	6.29	18796.17	0.87	6.63	19811.59
Pumping Evaporator	2988.20	7.5	0.92	6.29	18796.17	0.86	6.71	20041.96
				34.68	103630.98		-34.68	104408.18

	9 deg rebate case	rebate	existing case			
10.00%	0.946	1.0921				bld 31
15.00%	0.873	1.3536	10.00%	1.468	10%	1.468
20.00%	0.713	0.8622	17.09%	1.2615	20%	1.177
25.00%	0.685	0.7775	24.14%	1.0967	25%	1.080
30.00%	0.649	0.7524	31.27%	1.0244	30%	1.038
40.00%	0.606	0.6479	38.36%	0.9459	40%	0.928
50.00%	0.570	0.6479	45.45%	0.8900	50%	0.858
60.00%	0.554	0.5790	52.55%	0.8567	60%	0.852
70.00%	0.550	0.5351	59.64%	0.8518	70%	0.845
75.00%	0.551	0.4933	66.73%	0.8469	75%	0.845
80.00%	0.552	0.3710	73.82%	0.8446	80%	0.852
90.00%	0.559	0.3710	80.91%	0.8534	90%	0.872
100.00%	0.58		88.00%	0.8682	100%	0.900

Patterson

Operational Parameters	New Chiller		Old Chiller	
Base Case	Minimum	Maximum	Minimum	Maximum
Chiller Output (Ton)	20	200	2.3	228
OSA Temp	50	105	50	105
% Of Capacity	10%	100%	10%	87%

New Chiller Efficiency: @ Application Design of 9 Deg. Approach Temp

%	Tons	kW/Ton
25%	50	0.685
50%	100	0.570
75%	150	0.551
100%	200	0.58

Note: Based on chiller improvement of .01 kW/ton per Degree of Approach Temperature reduction.

Rebate Case:9 deg Approach Temp

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	#1	0	0.0		-
32	0.00%	-	0.000	#1	0	0.0		-
37	0.00%	-	0.000	#1	0	0.0		-
42	0.00%	-	0.000	#1	0	0.0		-
47	0.00%	-	0.000	#1	0	0.0		-
52	10.00%	20	0.946	#1	0.872	18.92	500.29	9,466
57	18.18%	36	0.771	#1	0.742	28.04	661.12	18,535
62	26.36%	53	0.675	#1	0.675	35.58	526.60	18,735
67	34.54%	69	0.630	#1	0.630	43.49	395.55	17,202
72	42.73%	85	0.596	#1	0.596	50.95	369.91	18,845
77	50.91%	102	0.568	#1	0.568	57.85	290.05	16,778
82	59.01%	118	0.555	#1	0.555	65.55	164.82	10,804
87	67.27%	135	0.551	#1	0.551	74.11	59.50	4,409
92	75.45%	151	0.551	#1	0.551	83.12	14.55	1,209
97	83.64%	167	0.554	#1	0.554	92.75	5.80	538
102	91.82%	184	0.563	#1	0.563	103.37	0.00	-
107	100.00%	200	0.580	#1	0.580	116.00	0.00	-
						116.00	2988.20	116,522

Good estimate Running hrs w/in 6%

Existing Case: 13 deg Approach Temp

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	0.0		-
32	0.00%	-	0.000	0.0		-
37	0.00%	-	0.000	0.0		-
42	0.00%	-	0.000	0.0		-
47	0.00%		0.000	0.0		-
52	10.00%	23	1.468	33.46	500.29	16,742
57	17.09%	39	1.2615	49.16	661.12	32,498
62	24.14%	55	1.0967	60.36	526.60	31,786
67	31.27%	71	1.0244	73.03	395.55	28,889
72	38.36%	87	0.9459	82.73	369.91	30,601
77	45.45%	104	0.8900	92.22	290.05	26,750
82	52.55%	120	0.8567	102.64	164.82	16,917
87	59.64%	136	0.8518	115.83	59.50	6,892
92	66.73%	152	0.8469	128.85	14.55	1,875
97	73.82%	168	0.8446	142.16	5.80	825
102	80.91%	184	0.8534	157.44	0.00	-
107	88.00%	201	0.8682	174.19	0.00	-
				174.19	2988.20	193,774

	9 deg rebate case	rebate	existing case			
10.00%	0.946	1.0921				bld 31
15.00%	0.873	1.3536	10.00%	1.468	10%	1.468
20.00%	0.713	0.8622	17.09%	1.2615	20%	1.177
25.00%	0.685	0.7775	24.14%	1.0967	25%	1.080
30.00%	0.649	0.7524	31.27%	1.0244	30%	1.038
40.00%	0.606	0.6479	38.36%	0.9459	40%	0.928
50.00%	0.570	0.6479	45.45%	0.8900	50%	0.858
60.00%	0.554	0.5790	52.55%	0.8567	60%	0.852
70.00%	0.550	0.5351	59.64%	0.8518	70%	0.845
75.00%	0.551	0.4933	66.73%	0.8469	75%	0.845
80.00%	0.552	0.3710	73.82%	0.8446	80%	0.852
90.00%	0.559	0.3710	80.91%	0.8534	90%	0.872
100.00%	0.58		88.00%	0.8682	100%	0.900

Site 1963 Building 30

	Total kWh	Total kW	Therms	Chiller & Tower kWh	Chiller & Tower kW	Fan & Pumping kWh	Fan & Pumping kW
PG&E	77,081	51.7	-				
QC Savings	209428.98	100.63	0.00	101944.68	64.66	107484.29	35.97

Existing

	hours	Motor Hp	Efficiency	kW	kWh
Fan Cooling tower	2988.20	40	0.87	35.36	105661.83
Pumping Condenser	2988.20	25	0.87	22.10	66038.64
Pumping Evaporator	2988.20	15	0.87	13.26	39623.18
				70.72	211323.65

Retrofit / base

	hours	Motor Hp	Efficiency	kW	kWh	Efficiency (base)	kW (base)	kWh (base)
Fan Cooling tower	2988.20	25	0.87	22.10	66038.64	0.89	21.60	64554.63
Pumping Condenser	2988.20	5	0.90	4.26	12739.16	0.88	4.37	13057.64
Pumping Evaporator	2988.20	10	0.92	8.39	25061.56	0.86	8.94	26722.61
				34.75	103839.38		34.92	104334.88

9 deg

	rebate case	rebate	
10.00%	0.834	0.8340	10.00%
15.00%	0.758	0.7097	18.18%
20.00%	0.682	0.6458	26.36%
25.00%	0.655	0.6024	34.54%
30.00%	0.621	0.5704	42.73%
40.00%	0.580	0.5436	50.91%
50.00%	0.545	0.5315	59.01%
60.00%	0.530	0.5271	67.27%
70.00%	0.526	0.5271	75.45%
75.00%	0.527	0.5305	83.64%
80.00%	0.528	0.5388	91.82%
90.00%	0.535	0.5550	100.00%
100.00%	0.555		

existing case

			bld 30
10.00%	1.468	10%	1.468
16.36%	1.2828	20%	1.177
22.73%	1.1240	25%	1.080
29.09%	1.0460	30%	1.038
35.45%	0.9781	40%	0.928
41.82%	0.9151	50%	0.858
48.18%	0.8711	60%	0.852
54.55%	0.8553	70%	0.845
60.91%	0.8509	75%	0.845
67.27%	0.8465	80%	0.852
73.64%	0.8446	90%	0.872
80.00%	0.8520	100%	0.900

Operational Parameters	New Chiller		Old Chiller	
Base Case	Minimum	Maximum	Minimum	Maximum
Chiller Output (Ton)	22	220	27.4	274
OSA Temp	50	105	50	105
% Of Capacity	10%	100%	10%	80%

New Chiller Efficiency: @ Application Design of 9 Deg. Approach Temp

%	Tons	kW/Ton
25%	55	0.655
50%	110	0.545
75%	165	0.527
100%	220	0.555

Note: Based on chiller improvement of .01 kW/ton per Degree of Approach Temperature reduction.

Rebate Case:9 deg Approach Temp

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	#1	0	0.0		-
32	0.00%	-	0.000	#1	0	0.0		-
37	0.00%	-	0.000	#1	0	0.0		-
42	0.00%	-	0.000	#1	0	0.0		-
47	0.00%	-	0.000	#1	0	0.0		-
52	10.00%	22	0.834	#1	0.834	18.35	500.29	9,179
57	18.18%	40	0.710	#1	0.710	28.38	661.12	18,765
62	26.36%	58	0.646	#1	0.646	37.45	526.60	19,720
67	34.54%	76	0.602	#1	0.602	45.77	395.55	18,106
72	42.73%	94	0.570	#1	0.570	53.63	369.91	19,836
77	50.91%	112	0.544	#1	0.544	60.89	290.05	17,661
82	59.01%	130	0.531	#1	0.531	69.00	164.82	11,372
87	67.27%	148	0.527	#1	0.527	78.01	59.50	4,641
92	75.45%	166	0.527	#1	0.527	87.49	14.55	1,273
97	83.64%	184	0.531	#1	0.531	97.63	5.80	566
102	91.82%	202	0.539	#1	0.539	108.81	0.00	-
107	100.00%	220	0.555	#1	0.555	122.10	0.00	-
						122.10	2988.20	121,121

Good estimate Running hrs w/in 6%

Existing Case: 13 deg Approach Temp

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	0.0		-
32	0.00%	-	0.000	0.0		-
37	0.00%	-	0.000	0.0		-
42	0.00%	-	0.000	0.0		-
47	0.00%		0.000	0.0		-
52	10.00%	27	1.468	40.21	500.29	20,119
57	16.36%	45	1.2828	57.50	661.12	38,016
62	22.73%	62	1.1240	70.00	526.60	36,864
67	29.09%	80	1.0460	83.37	395.55	32,979
72	35.45%	97	0.9781	95.01	369.91	35,143
77	41.82%	115	0.9151	104.86	290.05	30,414
82	48.18%	132	0.8711	114.99	164.82	18,952
87	54.55%	149	0.8553	127.84	59.50	7,606
92	60.91%	167	0.8509	142.01	14.55	2,066
97	67.27%	184	0.8465	156.03	5.80	905
102	73.64%	202	0.8446	170.42	0.00	-
107	80.00%	219	0.852	186.76	0.00	-
				186.76	2988.20	223,066

Total		Month															
		1	2	3	4	5	6	7	8	9	10	11	12	Total	m-f 5amminus holidays	m-f 5am-7pm*0.97	
Temper	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	OSA Temp. lock 50 deg
	27	3	0	0	0	0	0	0	0	0	0	0	4	7	1.875	1.819	
	32	24	14	0	0	0	0	0	0	0	0	5	37	80	22.32	21.66	
	37	61	52	18	13	0	0	0	0	0	1	32	77	254	71.17	69.04	
	42	148	83	72	51	10	2	0	0	0	16	93	96	571	170.8	165.7	
	47	171	120	134	112	58	32	7	1	25	62	128	111	961	303.4	294.3	
	52	183	131	179	149	168	72	57	42	63	99	149	205	1497	515.8	500.3	500.3
	57	108	160	146	132	138	137	168	154	104	169	170	160	1746	681.6	661.1	661.1
	62	42	76	124	120	106	127	115	105	146	150	85	44	1240	542.9	526.6	526.6
	67	4	27	53	64	114	98	104	122	103	107	33	10	839	407.8	395.6	395.6
	72	0	9	14	42	88	108	115	110	115	64	22	0	687	381.3	369.9	369.9
	77	0	0	4	25	40	73	95	114	99	40	3	0	493	299	290.1	290.1
	82	0	0	0	11	14	54	51	73	42	21	0	0	266	169.9	164.8	164.8
	87	0	0	0	1	6	13	23	17	16	13	0	0	89	61.34	59.5	59.5
	92	0	0	0	0	2	3	7	3	4	2	0	0	21	15.00	14.55	14.55
	97	0	0	0	0	0	1	2	3	3	0	0	0	9	5.982	5.803	5.803
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
														8760	3081	2988	2988

01-08		Month													
		1	2	3	4	5	6	7	8	9	10	11	12	Total	m-f *5/7,5am*3/8=.2679
Temper	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	27	3	0	0	0	0	0	0	0	0	0	0	4	7	1.88
	32	22	14	0	0	0	0	0	0	0	0	5	36	77	20.63
	37	48	47	17	13	0	0	0	0	0	1	28	59	213	57.06
	42	92	54	61	43	10	2	0	0	0	16	77	47	402	107.70
	47	58	55	91	84	55	32	7	1	25	56	63	38	565	151.36
	52	19	22	64	61	123	65	49	42	51	81	44	43	664	177.89
	57	6	24	15	33	52	86	131	123	63	77	22	12	644	172.53
	62	0	8	0	6	8	45	40	48	79	14	1	9	258	69.12
	67	0	0	0	0	0	9	19	30	18	3	0	0	79	21.16
	72	0	0	0	0	0	1	2	4	4	0	0	0	11	2.95
	77	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	92	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00

09-16		Month													
		1	2	3	4	5	6	7	8	9	10	11	12	Total	m-f 5/7
Temper	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	32	2	0	0	0	0	0	0	0	0	0	0	0	2	1.43
	37	3	0	1	0	0	0	0	0	0	0	0	3	7	5.00
	42	22	4	2	0	0	0	0	0	0	0	2	10	40	28.57
	47	44	20	3	0	0	0	0	0	0	0	12	24	103	73.57
	52	72	41	34	11	1	0	0	0	0	0	33	65	257	183.57
	57	67	89	66	35	14	1	1	1	0	20	75	110	479	342.14
	62	34	43	82	77	40	21	9	5	7	58	69	27	472	337.14
	67	4	21	44	49	72	40	32	26	26	61	26	9	410	292.86
	72	0	6	13	35	68	69	60	54	65	52	20	0	442	315.71
	77	0	0	3	23	33	49	75	81	82	25	3	0	374	267.14
	82	0	0	0	9	13	44	40	59	38	18	0	0	221	157.86
	87	0	0	0	1	5	12	22	17	15	12	0	0	84	60.00
	92	0	0	0	0	2	3	7	3	4	2	0	0	21	15.00
	97	0	0	0	0	0	1	2	2	3	0	0	0	8	5.71
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00

17-24		Month													
		1	2	3	4	5	6	7	8	9	10	11	12	Total	m-f *5/7,7pm*3/8=.2679
Temper	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	32	0	0	0	0	0	0	0	0	0	0	0	1	1	0.27
	37	10	5	0	0	0	0	0	0	0	0	4	15	34	9.11
	42	34	25	9	8	0	0	0	0	0	0	14	39	129	34.56
	47	69	45	40	28	3	0	0	0	0	6	53	49	293	78.49
	52	92	68	81	77	44	7	8	0	12	18	72	97	576	154.31
	57	35	47	65	64	72	50	36	30	41	72	73	38	623	166.90
	62	8	25	42	37	58	61	66	52	60	78	15	8	510	136.63
	67	0	6	9	15	42	49	53	66	59	43	7	1	350	93.77
	72	0	3	1	7	20	38	53	52	46	12	2	0	234	62.69
	77	0	0	1	2	7	24	20	33	17	15	0	0	119	31.88
	82	0	0	0	2	1	10	11	14	4	3	0	0	45	12.06
	87	0	0	0	0	1	1	1	0	1	1	0	0	5	1.34
	92	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	97	0	0	0	0	0	0	0	1	0	0	0	0	1	0.27
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00

Chiller Replacement (Site 2186)

Program	Retrofit Express Program
Measure	High Efficiency Air-Cooled Chiller
Site Description	Health Care/ Hospital

Measure Description Replace existing chiller with high-efficiency air–cooled chiller.

Summary of Ex Ante Impact Calculations Demand calculations were estimated based upon the chiller tonnage and the difference between the new unit and a baseline qualifying Title 24 chiller, in conjunction with and assumed 0.75 diversity factor. Energy calculations are based upon all but the latter, in conjunction with standard PG&E EFLH values.

Comments on PG&E Calculations The correct chiller size category and compressor only, full load (under ARI conditions) were used in the application. Fan energy should be included in the KW/Ton rating yielding an ARI efficiency value of 1.263 verses the application value of 1.265.

Evaluation Process The evaluation process consisted of reviewing the application form and supporting documentation, conducting an on-site survey and then computing impacts using the on-site data. A Title 24 baseline, typical year bin weather data and actual operating hours were used in bin analysis.

The on-site survey was conducted on October 27, 1998. Information on the retrofit equipment and operating conditions were collected through an inspection of the chiller and through an interview with the Chief Engineer.

Discussions provided data for development of a relationship between chiller loading and outdoor dry bulb temperatures. The chiller is available to operate 24 hours a day April through November. Chiller use generally begins at 62 degrees outside air temperature and reaches 75% loading at 100 Degrees F.

To compute the impacts, the following assumptions were used:

- A linear loading strategy was used for the analysis of both the baseline and rebated chillers, which assumed 15% loading at 62 degrees and 75% loading at 100 Degrees F.

- For the baseline chiller case a Title 24 baseline efficiency of 1.406 KW/ton was used, based on an air-cooled chiller between 150 tons and 300 tons.

The above assumptions were incorporated into a spreadsheet where energy and demand impacts were calculated. Evaluation- based demand and energy impacts were greater than Ex Ante estimates. Results from these calculations are summarized below and documented in the attached workbook.

Additional Notes

Impact Results

	KW	KWh	Therm
MDSS	5.39	13,619.4	0
Adjusted Engineering	27.61	58,685.9	0
Engineering Realization Rate	5.12	4.31	N/A

Site # 2186	WYEC Weather		
	kWh	kW	therms
PG&E	13619.44	5.39	-
QC Impact	58685.90	27.61	-
			-
I-Eng. Real. Rate	4.31	5.12	

New Chiller Efficiency		
%	Tons	kW/Ton
25%	50.3	0.829
50%	100.6	0.953
75%	150.9	1.025
100%	201.2	1.263
iplv (kW/Ton	1.00598271	

Operational Parameters	New Chiller (Air Cooled)	
	Minimum	Maximum
Chiller Output (Ton)	30.18	201.2
OSA Temp	62	100
% Of Capacity	15%	75%

Basecase

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-		0.0	0.00	-
32	0.00%	-		0.0	0.00	-
37	0.00%	-		0.0	0.00	-
42	0.00%	-		0.0	0.00	-
47	0.00%	-		0.0	0.00	-
52	0.00%	-		0.0	0.00	-
57	0.00%	-		0.0	0.00	-
62	15.00%	30	1.148	34.6	1254	43,447
67	18.13%	36	1.884	68.7	714	49,042
72	26.25%	53	1.477	78.0	399	31,115
77	34.38%	69	1.308	90.4	175	15,825
82	42.50%	86	1.186	101.4	58	5,880
87	50.63%	102	1.165	118.6	28	3,322
92	58.75%	118	1.187	140.3	1	140
97	66.88%	135	1.216	163.6	0	-
102	75.00%	151	0.000	0.0	0	-
				140.3	2629	148,770

Rebate Case

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	#1	0.00	0.0	0.00	-
32	0.00%	-	0.000	#1	0.00	0.0	0.00	-
37	0.00%	-	0.000	#1	0.00	0.0	0.00	-
42	0.00%	-	0.000	#1	0.00	0.0	0.00	-
47	0.00%	-	0.000	#1	0.00	0.0	0.00	-
52	0.00%	-	0.000	#1	0.00	0.0	0.00	-
57	0.00%	-	0.000	#1	0.00	0.0	0.00	-
62	15.00%	30	0.829	#1	0.829	25.0	1254	31,374
67	18.13%	36	0.829	#1	0.829	30.2	714	21,585
72	26.25%	53	0.893	#1	0.893	47.2	399	18,818
77	34.38%	69	0.907	#1	0.907	62.7	175	10,978
82	42.50%	86	0.907	#1	0.907	77.6	58	4,498
87	50.63%	102	0.953	#1	0.953	97.1	28	2,718
92	58.75%	118	0.953	#1	0.953	112.6	1	113
97	66.88%	135	1.025	#1	1.025	137.9	0	-
102	75.00%	151	1.025	#1	1.025	154.7	0	-
						112.6	2629	90,085
	max @94							

% Loading	Eff base case
10.000	2.738
20.000	1.687
25.000	1.500
30.000	1.406
40.000	1.181
50.000	1.163
60.000	1.190
70.000	1.228
75.000	1.256
80.000	1.284
90.000	1.341
100.000	1.406

% Loading	Eff rebate case
10.000	1.579
15.100	0.829
25.000	0.893
32.600	0.893
46.600	0.907
50.000	0.953
50.300	0.953
63.000	1.025
75.000	1.025
84.200	1.158
100.000	1.263
100.100	1.263

rebate	% Loading	base
0.829	15.00%	1.148
0.829	18.13%	1.884
0.893	26.25%	1.477
0.907	34.38%	1.308
0.907	42.50%	1.186
0.953	50.63%	1.165
0.953	58.75%	1.187
1.025	66.88%	1.216
1.025	75.00%	1.256

WYEC-Clz 3 Site 2186

Total

		Month														
		1	2	3	4	5	6	7	8	9	10	11	12	Total	in use april thru Nov	
Temperature R	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	32	2	0	0	0	0	0	0	0	0	0	0	5	7	0	
	37	31	6	5	0	0	0	0	0	0	0	10	55	107	10	
	42	130	44	43	26	4	0	0	0	0	1	33	118	399	64	
	47	183	157	124	109	55	5	1	0	1	35	121	150	941	327	
	52	209	194	232	225	244	133	91	61	57	101	171	226	1944	1083	
	57	155	212	185	161	174	230	260	287	194	225	232	166	2461	1743	
	62	29	39	114	121	145	154	144	176	208	200	106	21	1457	1254	1254
	67	5	17	34	50	69	101	136	122	113	92	31	3	773	714	714
	72	0	3	7	18	27	61	74	79	77	48	15	0	409	399	399
	77	0	0	0	9	14	25	29	33	42	22	1	0	175	175	175
	82	0	0	0	1	6	8	7	5	17	14	0	0	58	58	58
	87	0	0	0	0	6	3	2	1	10	6	0	0	28	28	28
	92	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
																2629 at 62 deg < act. Weather hrs

01-08

		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperature R	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	2	0	0	0	0	0	0	0	0	0	0	5	7
	37	30	6	5	0	0	0	0	0	0	0	8	43	92
	42	80	40	40	26	2	0	0	0	0	1	31	74	294
	47	70	107	88	81	46	5	1	0	1	35	86	64	584
	52	46	50	81	120	156	93	72	52	55	81	68	50	924
	57	20	20	27	13	43	104	158	164	126	113	44	12	844
	62	0	1	7	0	1	36	14	32	49	15	3	0	158
	67	0	0	0	0	0	1	3	0	7	3	0	0	14
	72	0	0	0	0	0	1	0	0	2	0	0	0	3
	77	0	0	0	0	0	0	0	0	0	0	0	0	0
	82	0	0	0	0	0	0	0	0	0	0	0	0	0
	87	0	0	0	0	0	0	0	0	0	0	0	0	0
	92	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

09-16

		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperature R	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	0	0	0	0	0	0	0	0	0	0	0	1	1
	42	10	1	1	0	0	0	0	0	0	0	0	9	21
	47	43	9	14	1	0	0	0	0	0	0	5	35	107
	52	73	60	68	22	10	1	0	0	0	0	19	81	334
	57	97	109	77	66	40	19	7	9	6	29	93	100	652
	62	20	28	59	91	96	57	48	52	53	90	78	19	691
	67	5	14	23	37	57	78	93	81	59	59	30	3	539
	72	0	3	6	14	22	53	65	68	59	35	14	0	339
	77	0	0	0	8	12	22	26	32	36	17	1	0	154
	82	0	0	0	1	5	7	7	5	17	12	0	0	54
	87	0	0	0	0	6	3	2	1	9	6	0	0	27
	92	0	0	0	0	0	0	0	0	1	0	0	0	1
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

17-24

		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperature R	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	1	0	0	0	0	0	0	0	0	0	2	11	14
	42	40	3	2	0	2	0	0	0	0	0	2	35	84
	47	70	41	22	27	9	0	0	0	0	0	30	51	250
	52	90	84	83	83	78	39	19	9	2	20	84	95	686
	57	38	83	81	82	91	107	95	94	62	83	95	54	965
	62	9	10	48	30	48	61	82	92	106	95	25	2	608
	67	0	3	11	13	12	22	40	41	47	30	1	0	220
	72	0	0	1	4	5	7	9	11	16	13	1	0	67
	77	0	0	0	1	2	3	3	1	6	5	0	0	21
	82	0	0	0	0	1	1	0	0	0	2	0	0	4
	87	0	0	0	0	0	0	0	0	1	0	0	0	1
	92	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

Chiller Replacement (Site 2043)

Program	Retrofit Express Program
Measure	High Efficiency Air-Cooled Chiller
Site Description	Office Building

Measure Description Replace existing chiller with high-efficiency air–cooled chiller.

Summary of Ex Ante Impact Calculations Demand calculations were estimated based upon the chiller tonnage and the difference between the new unit and a baseline qualifying Title 24 chiller, in conjunction with an assumed 0.75 diversity factor. Energy calculations are based upon all but the latter, in conjunction with standard PG&E EFLH values.

Comments on Calculations The correct chiller size category and the compressor only, full load chiller efficiency and capacity were used in the application. The equipment values submitted were for the manufacturer's D series, while E series units were installed. Fan energy should have been included. At 100% Load D =1.16 (compressor only) vs. E = 1.302 (includes fan energy), and a 45 ton capacity was used in the application, 55.1 tons were installed.

Evaluation Process The evaluation process consisted of reviewing the application form and supporting documentation, conducting an on-site survey and then computing impacts using the on-site data. Models were calibrated with actual weather, number of compressor hours as well as an observed operating point, %load @ the outside air temperature. Peak demand was calculated for actual peak temperatures. Energy savings were based on typical weather data. A Title 24 baseline, IPLV at ARI conditions, and typical year bin weather data were used in the bin analysis.

The on-site survey was conducted on October 16, 1998. Information on the retrofit equipment and operating conditions were collected through an inspection of the chiller and through an interview with the Chief Engineer.

Discussions provided data for development of a relationship between chiller loading and outdoor dry bulb temperatures. The chiller is available to operate from 8am to 6pm Monday to Friday and 9am to 5pm Saturday, year round. Chiller use generally begins at 72 degrees outside air temperature and reaches 100% loading at 94 Degrees F.

To compute the impacts, the following assumptions were used:

- A linear loading strategy was used for the analysis of both the baseline and rebated chillers, which assumed 10% loading at 72 degrees and 100% loading at 94 Degrees F.

- For the baseline chiller case a Title 24 baseline efficiency of 1.302 KW/ton was used, based on an air-cooled chiller less than 150 tons.

- Chiller efficiencies at various temperatures were interpolated from values provided at 25%, 50%, 75%, and 100% loading at ARI conditions. These calculated efficiencies were used to develop a chiller efficiency curve for the Rebate case. The baseline chiller efficiency curve was based on minimum Title 24 full load efficiency requirements, matched to a typical chiller performance curve.

The above assumptions were incorporated into a spreadsheet where energy and demand impacts were calculated. Evaluation- based demand impacts were lower and energy impacts were higher than Ex Ante estimates. Results from these calculations are summarized below and documented in the attached workbook.

Additional Notes

Impact Results

	KW	KWh	Therm
MDSS	1.68	2,236.9	0
Adjusted Engineering	-0.05	3,815.0	0
Engineering Realization Rate	-0.03	1.71	N/A

Site # 2043	WYEC Weather					New Chiller Efficiency		
	kWh	kW	therms			%	Tons	kW/Ton
PG&E	2236.93	1.68	-			25%	12.525	0.909
QC Impact	3814.99	-0.05	-			50%	25.05	0.939
			-			75%	37.575	1.098
I-Eng. Real. Rat	1.71	-0.03				100%	50.1	1.303
					iplv (kW/Ton	1.04373049	act=1.0345	

Operational Parameters	New Chiller (Air Cooled)	
	Minimum	Maximum
Chiller Output (Ton)	5.01	50.1
OSA Temp	72	95
% Of Capacity	10%	100%

Basecase

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-		0.0	0	-
32	0.00%	-		0.0	0	-
37	0.00%	-		0.0	0	-
42	0.00%	-		0.0	0	-
47	0.00%	-		0.0	0	-
52	0.00%	-		0.0	0	-
57	0.00%	-		0.0	0	-
62	0.00%	-		0.0	0	-
67	0.00%	-		0.0	0	-
72	10.00%	5	2.535	12.7	466.95	5,930
77	32.50%	16	1.250	20.4	226.30	4,606
82	55.00%	28	1.090	30.0	71.54	2,148
87	77.50%	39	1.189	46.2	15.11	697
92	100.00%	50	1.302	65.2	5.04	328
97	100.00%	50	1.302	65.2	0.00	-
102	100.00%	50	1.302	65.2	0.00	-
107	100.00%	50	1.302	65.2	0.00	-
				65.2	784.93	13,710

Rebate Case

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	#1	0.000	0.0	0	-
32	0.00%	-	0.000	#1	0.000	0.0	0	-
37	0.00%	-	0.000	#1	0.000	0.0	0	-
42	0.00%	-	0.000	#1	0.000	0.0	0	-
47	0.00%	-	0.000	#1	0.000	0.0	0	-
52	0.00%	-	0.000	#1	0.000	0.0	0	-
57	0.00%	-	0.000	#1	0.000	0.0	0	-
62	0.00%	-	0.000	#1	0.000	0.0	0	-
67	0.00%	-	0.000	#1	0.000	0.0	0	-
72	10.00%	5	1.659	#1	1.659	8.3	466.9464	3,881
77	32.50%	16	0.863	#1	0.863	14.1	226.3036	3,180
82	55.00%	28	0.939	#1	0.939	25.9	71.53571	1,850
87	77.50%	39	1.117	#1	1.117	43.4	15.10714	655
92	100.00%	50	1.303	#1	1.303	65.3	5.035714	329
97	100.00%	50	1.303	#1	1.303	65.3	0	-
102	100.00%	50	1.303	#1	1.303	65.3	0	-
107	100.00%	50	1.303	#1	1.303	65.3	0	-
						65.3	784.9286	9,895

	Eff base ca	% Loading	Eff rebate case	
10.000	2.535	10.000	1.659	
20.000	1.563	20.000	1.022	
25.000	1.389	25.000	0.909	
30.000	1.302	30.000	0.852	
40.000	1.094	40.000	0.8957	
50.000	1.076	50.000	0.9393	
60.000	1.103	60.000	0.983	
70.000	1.137	70.000		
75.000	1.163	75.000	1.0978	
80.000	1.189	80.000	1.136	
90.000	1.241	90.000		
100.000	1.302	100.000	1.303	
iplv (kW/To	1.17			

rebate	% Loading	base
1.659	10.00%	2.535
0.863	32.50%	1.250
0.939	55.00%	1.090
1.117	77.50%	1.189
1.303	100.00%	1.302
1.303	100.00%	1.302
1.303	100.00%	1.302
1.303	100.00%	1.302

WYEC-clz 5 Site 2043 Actual Max Temp =95

Total	Month															
		1	2	3	4	5	6	7	8	9	10	11	12	Total	Act Hrs		Claim economizer load till 72-76 f osa temp
Temperature	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00		
	32	22	6	0	0	0	0	0	0	0	0	3	24	55	0.39		
	37	70	29	21	11	2	0	0	0	0	0	27	51	211	5.70		
	42	82	75	67	61	30	10	0	0	0	13	64	131	533	40.32		
	47	85	105	126	94	52	33	6	5	28	63	118	109	824	82.07		
	52	165	138	225	157	212	212	137	94	58	154	165	136	1853	251.30		
	57	167	136	134	168	173	151	250	293	181	181	140	126	2100	547.41		
	62	101	110	110	93	118	101	78	81	172	100	106	103	1273	664.34		
	67	38	51	35	71	104	121	99	105	82	119	56	47	928	647.82		
	72	12	13	16	40	31	48	116	115	112	57	24	11	595	466.95	466.9464	
	77	2	9	10	20	11	26	50	44	56	33	11	6	278	226.30	226.3036	
	82	0	0	0	5	9	13	6	6	23	18	6	0	86	71.54	71.53571	
	87	0	0	0	0	2	5	2	1	4	4	0	0	18	15.11	15.10714	
	92	0	0	0	0	0	0	0	0	4	2	0	0	6	5.04	5.035714	
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
								273	271	281	233				1432.75	784.9286	hrs @72

01-08	Month													
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperature	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	20	6	0	0	0	0	0	0	0	0	3	24	53
	37	61	27	21	10	2	0	0	0	0	0	25	36	182
	42	46	58	43	45	26	8	0	0	0	13	44	84	367
	47	32	53	78	55	33	26	6	5	28	57	74	41	488
	52	64	60	86	63	118	128	93	76	44	84	58	40	914
	57	24	13	16	53	49	63	121	151	93	61	28	19	691
	62	1	7	3	9	13	10	15	10	70	23	7	4	172
	67	0	0	1	4	5	4	10	4	3	10	1	0	42
	72	0	0	0	1	1	1	2	1	2	0	0	0	8
	77	0	0	0	0	1	0	1	1	0	0	0	0	3
	82	0	0	0	0	0	0	0	0	0	0	0	0	0
	87	0	0	0	0	0	0	0	0	0	0	0	0	0
	92	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

09-16	Month														
		1	2	3	4	5	6	7	8	9	10	11	12	Total	Start m-f 8-6pm, Sat 9am-5
Temperature	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	42	3	0	0	0	0	0	0	0	0	0	0	9	12	10.07143
	47	8	4	0	0	0	0	0	0	0	0	1	12	25	20.98214
	52	24	23	12	4	1	1	0	0	0	4	13	22	104	87.28571
	57	76	54	75	44	21	6	0	5	5	13	58	64	421	353.3393
	62	87	76	102	70	83	46	16	19	10	37	74	77	697	584.9821
	67	36	46	33	60	94	106	66	68	44	83	54	47	737	618.5536
	72	12	12	16	37	28	38	110	108	98	54	23	11	547	459.0893
	77	2	9	10	20	10	25	48	41	53	33	11	6	268	224.9286
	82	0	0	0	5	9	13	6	6	22	18	6	0	85	71.33929
	87	0	0	0	0	2	5	2	1	4	4	0	0	18	15.10714
	92	0	0	0	0	0	0	0	0	4	2	0	0	6	5.035714
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0

17-24	Month														
		1	2	3	4	5	6	7	8	9	10	11	12	Total	
Temperature	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	2	0	0	0	0	0	0	0	0	0	0	0	2	0.392857
	37	9	2	0	1	0	0	0	0	0	0	2	15	29	5.696429
	42	33	17	24	16	4	2	0	0	0	0	20	38	154	30.25
	47	45	48	48	39	19	7	0	0	0	6	43	56	311	61.08929
	52	77	55	127	90	93	83	44	18	14	66	94	74	835	164.0179
	57	67	69	43	71	103	82	129	137	83	107	54	43	988	194.0714
	62	13	27	5	14	22	45	47	52	92	40	25	22	404	79.35714
	67	2	5	1	7	5	11	23	33	35	26	1	0	149	29.26786
	72	0	1	0	2	2	9	4	6	12	3	1	0	40	7.857143
	77	0	0	0	0	0	1	1	2	3	0	0	0	7	1.375
	82	0	0	0	0	0	0	0	0	1	0	0	0	1	0.196429
	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	92	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Roof Insulation (Site 2443)

Program	Advanced Performance Options
Measure	Roof insulation
Site Description	Warehouse

Measure Description

Insulate uninsulated roof of one refrigerated warehouse space and increase existing roof insulation in two others.

Summary of Ex Ante Impact Calculations

Roof cooling loads were calculated in a temperature bin model using ASHRAE Cooling Load Temperature Difference (CLTD) method. A CLTD correction factor was used to account for solar loading. The demand and energy was then calculated based on unit efficiencies that were estimated using manufacturer data.

Comments on Calculations

The CLTD correction factor for solar loading was incorrectly applied. The bin model also assumed the units were equipped with floating head pressure control. It also assumed the refrigerated space was kept at a constant temperature year round. Appropriate weather data, KW/ton ratings and correct existing and proposed u-values were employed.

Evaluation Process

The evaluation process consisted of reviewing the application form and supporting documentation, conducting an on-site survey and reviewing the results from the spreadsheets accompanying the application. The calculations were rerun with the corrected of solar, modified condenser temperatures range and updated space temperature settings.

The on-site survey was conducted on October 13, 1998 with the Chief Engineer. The operating schedule, insulation levels and square footage were verified. The space temperature varies by month; cooling equipment does not have floating head pressure control.

To compute the impacts, the following assumptions were used:

- A bin model was constructed employing the appropriate weather data, ASHRAE CLTD method, monthly solar loading correction factors, monthly space temperatures, square footage and equipment KW/ton based on Condenser water temperatures.

- KW Demand baseline was calculated using the existing roof U- value. The baseline energy use employed the annual typical year temperature bin hours and baseline KW Demand.

- The post retrofit KW Demand was calculated using the upgraded roof U- value. The post retrofit KW hours employed the annual typical year temperature bin hours and post retrofit KW Demand.

The above assumptions were incorporated into a spreadsheet where energy and demand impacts were calculated. Evaluation- based demand and energy impacts were significantly greater than Ex Ante estimates.. Results from these calculations are summarized below and documented in the attached workbook.

Additional Notes

Impact Results

	KW	KWh	Therm
MDSS	42.97	284,345.9	0
Adjusted Engineering	134.68	409,419.3	0
Engineering Realization Rate	3.13	1.44	N/A

Site 2443

Summary

Insulation	Roof SQFT	Existing KW	Existing KWh	Proposed KW	Proposed KWh	KW Saved	KWh Saved	
Keg	5720	6.28	19,724.40	1.36	4,275.67	4.92	15,448.73	
WH B	19040	19.79	60,166.78	4.29	13,032.31	15.50	47,134.47	
WH C	24640	119.80	363,677.10	5.55	16,841.02	114.26	346,836.07	
				11.19	34,149.00	134.68	409,419.28	Total Savings Insulation Project

Impact Results	KW	KWH
MDSS	42.97	284,345.93
Adjusted Engineering	134.68	409,419.28
Engineering Realization Rate	3.13	1.44

Insulation Keg Room	Existing Kwh	19724.4	Proposed Kwh	4275.668
	Existing KW	6 277792	ProposedKw	1.359789

Temp. Bin Data for Bakersfield SCT=30

									Existing				Proposed						
Temp. bin	Jan hours	Suction Temp	kw/ton	Space Temp	Corrected for Solar GainTemp	Uncorrected Temp. Diff	Roof Total Sqft	U Value (1/9.54)	BTUH	Tons	KW	KWh	U Value (1/44.14)	BTUH	Tons	KW	KWh		
27	2.00	85	1.185	32	-5.63	-5	5720	0.1048	0	0	0	0	0.0227	0	0	0	0		
32	23.00	85	1.185	32	-0.63	0	5720	0.1048	0	0	0	0	0.0227	0.00	0.00	0.00	0.00		
37	84.00	85	1.185	32	4.37	5	5720	0.1048	2619.623	0.22	0.26	21.74	0.0227	567.42	0.05	0.06	4.71		
42	180.00	85	1.185	32	9.37	10	5720	0.1048	5616.903	0.47	0.55	99.87	0.0227	1216.64	0.10	0.12	21.63		
47	224.00	85	1.185	32	14.37	15	5720	0.1048	8614.183	0.72	0.85	190.59	0.0227	1865.86	0.16	0.18	41.28		
52	131.00	85	1.185	32	19.37	20	5720	0.1048	11611.46	0.97	1.15	150.25	0.0227	2515.08	0.21	0.25	32.54		
57	56.00	85	1.185	32	24.37	25	5720	0.1048	14608.74	1.22	1.44	80.81	0.0227	3164.30	0.26	0.31	17.50		
62	35.00	85	1.185	32	29.37	30	5720	0.1048	17606.02	1.47	1.74	60.87	0.0227	3813.52	0.32	0.38	13.18		
67	9.00	85	1.185	32	34.37	35	5720	0.1048	20603.3	1.72	2.04	18.32	0.0227	4462.74	0.37	0.44	3.97		
72	0.00	85	1.185	32	39.37	40	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
77	0.00	85	1.185	32	44.37	45	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
82	0.00	85	1.185	32	49.37	50	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
87	0.00	87	1.243	32	54.37	55	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
92	0.00	92	1.307	32	59.37	60	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
97	0.00	102	1.461	32	64.37	65	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
102	0.00	105	1.502	32	69.37	70	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
107	0.00	107	1.528	32	74.37	75	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
112	0.00	112	1.607	32	79.37	80	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00	Exist kWh	Retro kWh
											0.00	622.43				0.00	134.82	622.4306	134.8204

Temp. Bin Data for Bakersfield SCT=30

									Existing				Proposed					
Temp. bin	Feb hours	Suction Temp	kw/ton	Space Temp	Corrected for Solar GainTemp	Uncorrected Temp Diff	Roof Total Sqft	U Value (1/9.54)	BTUH	Tons	KW	KWh	U Value (1/44.14)	BTUH	Tons	KW	KWh	
27	0.00	85	1.185	32	-2.5	-5	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00	
32	19.00	85	1.185	32	2.5	0	5720	0.1048	1498.64	0.12	0.15	2.81	0.0227	324.61	0.03	0.03	0.61	
37	59.00	85	1.185	32	7.5	5	5720	0.1048	4495.92	0.37	0.44	26.20	0.0227	973.83	0.08	0.10	5.68	
42	54.00	85	1.185	32	12.5	10	5720	0.1048	7493.2	0.62	0.74	39.97	0.0227	1623.05	0.14	0.16	8.66	
47	114.00	85	1.185	32	17.5	15	5720	0.1048	10490.48	0.87	1.04	118.13	0.0227	2272.27	0.19	0.22	25.59	
52	173.00	85	1.185	32	22.5	20	5720	0.1048	13487.76	1.12	1.33	230.48	0.0227	2921.49	0.24	0.29	49.92	
57	141.00	85	1.185	32	27.5	25	5720	0.1048	16485.04	1.37	1.63	229.59	0.0227	3570.71	0.30	0.35	49.73	
62	67.00	85	1.185	32	32.5	30	5720	0.1048	19482.32	1.62	1.92	128.93	0.0227	4219.93	0.35	0.42	27.93	
67	31.00	85	1.185	32	37.5	35	5720	0.1048	22479.6	1.87	2.22	68.83	0.0227	4869.15	0.41	0.48	14.91	
72	13.00	85	1.185	32	42.5	40	5720	0.1048	25476.88	2.12	2.52	32.71	0.0227	5518.37	0.46	0.55	7.09	
77	1.00	85	1.185	32	47.5	45	5720	0.1048	28474.16	2.37	2.81	2.81	0.0227	6167.59	0.51	0.61	0.61	
82	0.00	85	1.185	32	52.5	50	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00	
87	0.00	87	1.243	32	57.5	55	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00	
92	0.00	92	1.307	32	62.5	60	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00	
97	0.00	102	1.461	32	67.5	65	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00	
102	0.00	105	1.502	32	72.5	70	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00	
107	0.00	107	1.528	32	77.5	75	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00	
112	0.00	112	1.607	32	82.5	80	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00	
											0.00	880.47				0.00	190.71	880.4715 190.7128

Temp. Bin Data for Bakersfield SCT=30

									Existing				Proposed					
Temp. bin	March hours	Suction Temp	kw/ton	Space Temp	Corrected for Solar GainTemp	Uncorrected Temp. Diff	Roof Total Sqft	U Value (1/9.54)	BTUH	Tons	KW	KWh	U Value (1/44.14)	BTUH	Tons	KW	KWh	
27	0.00	85	1.185	32	2.875	-5	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00	
32	0.00	85	1.185	32	7.875	0	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00	
37	20.00	85	1.185	32	12.875	5	5720	0.1048	7717.996	0.64	0.76	15.25	0.0227	1671.74	0.14	0.17	3.30	
42	77.00	85	1.185	32	17.875	10	5720	0.1048	10715.28	0.89	1.06	81.50	0.0227	2320.96	0.19	0.23	17.65	
47	102.00	85	1.185	32	22.875	15	5720	0.1048	13712.56	1.14	1.35	138.15	0.0227	2970.18	0.25	0.29	29.92	
52	190.00	85	1.185	32	27.875	20	5720	0.1048	16709.84	1.39	1.65	313.60	0.0227	3619.40	0.30	0.36	67.93	
57	137.00	85	1.185	32	32.875	25	5720	0.1048	19707.12	1.64	1.95	266.68	0.0227	4268.62	0.36	0.42	57.76	
62	106.00	85	1.185	32	37.875	30	5720	0.1048	22704.4	1.89	2.24	237.72	0.0227	4917.84	0.41	0.49	51.49	
67	66.00	85	1.185	32	42.875	35	5720	0.1048	25701.68	2.14	2.54	167.55	0.0227	5567.06	0.46	0.55	36.29	
72	31.00	85	1.185	32	47.875	40	5720	0.1048	28698.96	2.39	2.83	87.88	0.0227	6216.28	0.52	0.61	19.03	
77	15.00	85	1.185	32	52.875	45	5720	0.1048	31696.24	2.64	3.13	46.96	0.0227	6865.50	0.57	0.68	10.17	
82	0.00	85	1.185	32	57.875	50	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00	
87	0.00	87	1.243	32	62.875	55	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00	
92	0.00	92	1.307	32	67.875	60	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00	
97	0.00	102	1.461	32	72.875	65	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00	
102	0.00	105	1.502	32	77.875	70	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00	
107	0.00	107	1.528	32	82.875	75	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00	
112	0.00	112	1.607	32	87.875	80	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00	
											0.00	1340.04				0.00	293.56	1340.04 293.5592

Temp. Bin Data for Bakersfield SCT=30

									Existing				Proposed					
Temp. bin	April hours	Suction Temp	kw/ton	Space Temp	Corrected for Solar GainTemp	Uncorrected Temp. Diff	Roof Total Sqft	U Value (1/9.54)	BTUH	Tons	KW	KWh	U Value (1/44.14)	BTUH	Tons	KW	KWh	
27	0.00	85	1.185	32	7.25	-5	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00	
32	0.00	85	1.185	32	12.25	0	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00	
37	4.00	85	1.185	32	17.25	5	5720	0.1048	10340.62	0.86	1.02	4.09	0.0227	2239.81	0.19	0.22	0.88	
42	22.00	85	1.185	32	22.25	10	5720	0.1048	13337.9	1.11	1.32	28.98	0.0227	2889.03	0.24	0.29	6.28	
47	67.00	85	1.185	32	27.25	15	5720	0.1048	16335.18	1.36	1.61	108.10	0.0227	3538.25	0.29	0.35	23.42	
52	115.00	85	1.185	32	32.25	20	5720	0.1048	19332.46	1.61	1.91	219.60	0.0227	4187.47	0.35	0.41	47.57	
57	135.00	85	1.185	32	37.25	25	5720	0.1048	22329.74	1.86	2.21	297.76	0.0227	4836.69	0.40	0.48	64.50	
62	125.00	85	1.185	32	42.25	30	5720	0.1048	25327.02	2.11	2.50	312.71	0.0227	5485.91	0.46	0.54	67.73	
67	90.00	85	1.185	32	47.25	35	5720	0.1048	28324.3	2.36	2.80	251.80	0.0227	6135.13	0.51	0.61	54.54	
72	53.00	85	1.185	32	52.25	40	5720	0.1048	31321.58	2.61	3.09	163.97	0.0227	6784.35	0.57	0.67	35.52	
77	48.00	85	1.185	32	57.25	45	5720	0.1048	34318.86	2.86	3.39	162.71	0.0227	7433.57	0.62	0.73	35.24	
82	48.00	85	1.185	32	62.25	50	5720	0.1048	37316.14	3.11	3.69	176.92	0.0227	8082.79	0.67	0.80	38.32	
87	12.00	87	1.243	32	67.25	55	5720	0.1048	40313.42	3.36	4.17	50.09	0.0227	8732.01	0.73	0.90	10.85	
92	1.00	92	1.307	32	72.25	60	5720	0.1048	43310.7	3.61	4.72	4.72	0.0227	9381.23	0.78	1.02	1.02	
97	0.00	102	1.461	32	77.25	65	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00	
102	0.00	105	1.502	32	82.25	70	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00	
107	0.00	107	1.528	32	87.25	75	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00	
112	0.00	112	1.607	32	92.25	80	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00	
											0.00	1781.46					385.87	1781.455 385.8687

Temp. Bin Data for Bakersfield SCT=30

Temp. bin	May hours	Suction Temp	kw/ton	Space Temp	Corrected for Solar GainTemp	Uncorrected Temp. Diff	Roof Total Sqft	U Value (1/9.54)	Existing BTUH	Tons	KW	KWh	U Value (1/44.14)	Proposed BTUH	Tons	KW	KWh		
27	0	85	1.185	32	9	-5	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	0	85	1.185	32	14	0	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	0	85	1.185	32	19	5	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
42	2	85	1.185	32	24	10	5720	0.1048	14386.94	1.20	1.42	2.84	0.0227	3116.26	0.26	0.31	0.62		
47	23	85	1.185	32	29	15	5720	0.1048	17384.22	1.45	1.72	39.49	0.0227	3765.48	0.31	0.37	8.55		
52	74	85	1.185	32	34	20	5720	0.1048	20381.5	1.70	2.01	148.98	0.0227	4414.70	0.37	0.44	32.27		
57	95	85	1.185	32	39	25	5720	0.1048	23378.78	1.95	2.31	219.38	0.0227	5063.92	0.42	0.50	47.52		
62	96	85	1.185	32	44	30	5720	0.1048	26376.06	2.20	2.61	250.11	0.0227	5713.14	0.48	0.56	54.17		
67	108	85	1.185	32	49	35	5720	0.1048	29373.34	2.45	2.90	313.35	0.0227	6362.36	0.53	0.63	67.87		
72	89	85	1.185	32	54	40	5720	0.1048	32370.62	2.70	3.20	284.57	0.0227	7011.58	0.58	0.69	61.64		
77	89	85	1.185	32	59	45	5720	0.1048	35367.9	2.95	3.49	310.92	0.0227	7660.80	0.64	0.76	67.35		
82	70	85	1.185	32	64	50	5720	0.1048	38365.18	3.20	3.79	265.27	0.0227	8310.02	0.69	0.82	57.46		
87	53	87	1.243	32	69	55	5720	0.1048	41362.46	3.45	4.28	227.00	0.0227	8959.24	0.75	0.93	49.17		
92	32	92	1.307	32	74	60	5720	0.1048	44359.74	3.70	4.83	154.60	0.0227	9608.46	0.80	1.05	33.49		
97	12	102	1.461	32	79	65	5720	0.1048	47357.02	3.95	5.77	69.18	0.0227	10257.68	0.85	1.25	14.99		
102	1	105	1.502	32	84	70	5720	0.1048	50354.3	4.20	6.30	6.30	0.0227	10906.90	0.91	1.36	1.36		
107	0	107	1.528	32	89	75	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
112	0	112	1.607	32	94	80	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
												2291.98					496.45	2291.983	496.4505

Temp. bin	June	Suction Temp	kw/ton	Space Temp	Temp. Diff	Uncorrected Temp Diff	Roof Total Sqft	U Value (1/9.54)	BTUH	Tons	KW	KWh	U Value (1/16.44+27.70)	BTUH	Tons	KW	KWh		
27	0	85	1.185	32	7	-17	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	0	85	1.185	32	12	-12	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	0	85	1.185	32	17	-7	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
42	0	85	1.185	32	22	-2	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
47	0	85	1.185	32	27	3	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
52	6	85	1.185	32	32	8	5720	0.1048	19182.59	1.60	1.89	11.37	0.0227	4155.01	0.35	0.41	2.46		
57	37	85	1.185	32	37	13	5720	0.1048	22179.87	1.85	2.19	81.06	0.0227	4804.23	0.40	0.47	17.56		
62	95	85	1.185	32	42	18	5720	0.1048	25177.15	2.10	2.49	236.25	0.0227	5453.45	0.45	0.54	51.17		
67	90	85	1.185	32	47	23	5720	0.1048	28174.43	2.35	2.78	250.46	0.0227	6102.67	0.51	0.60	54.25		
72	93	85	1.185	32	52	28	5720	0.1048	31171.71	2.60	3.08	286.35	0.0227	6751.89	0.56	0.67	62.02		
77	87	85	1.185	32	57	33	5720	0.1048	34168.99	2.85	3.38	293.63	0.0227	7401.11	0.62	0.73	63.60		
82	95	85	1.185	32	62	38	5720	0.1048	37166.27	3.10	3.67	348.75	0.0227	8050.33	0.67	0.80	75.54		
87	74	87	1.243	32	67	43	5720	0.1048	40163.55	3.35	4.16	307.76	0.0227	8699.55	0.72	0.90	66.66		
92	79	92	1.307	32	72	48	5720	0.1048	43160.83	3.60	4.70	371.35	0.0227	9348.77	0.78	1.02	80.43		
97	43	102	1.461	32	77	53	5720	0.1048	46158.11	3.85	5.62	241.63	0.0227	9997.99	0.83	1.22	52.34		
102	21	105	1.502	32	82	58	5720	0.1048	49155.39	4.10	6.15	129.17	0.0227	10647.21	0.89	1.33	27.98		
107	0	107	1.528	32	87	63	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
112	0	112	1.607	32	92	68	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
											0.00	2557.78				0.00	554.02	2557.784	554.0238

Temp. bin	July	Suction Temp	kw/ton	Space Temp	Temp. Diff	Uncorrected Temp Diff	Roof Total Sqft	U Value (1/9.54)	BTUH	Tons	KW	KWh	U Value (1/16.44+27.70)	BTUH	Tons	KW	KWh		
27	0	85	1.185	32	2	-5	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	0	85	1.185	32	7	0	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	0	85	1.185	32	12	5	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
42	0	85	1.185	32	17	10	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
47	0	85	1.185	32	22	15	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
52	0	85	1.185	32	27	20	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
57	10	85	1.185	32	32	25	5720	0.1048	19182.59	1.60	1.89	18.95	0.0227	4155.01	0.35	0.41	4.10		
62	46	85	1.185	32	37	30	5720	0.1048	22179.87	1.85	2.19	100.78	0.0227	4804.23	0.40	0.47	21.83		
67	67	85	1.185	32	42	35	5720	0.1048	25177.15	2.10	2.49	166.62	0.0227	5453.45	0.45	0.54	36.09		
72	103	85	1.185	32	47	40	5720	0.1048	28174.43	2.35	2.78	286.64	0.0227	6102.67	0.51	0.60	62.09		
77	100	85	1.185	32	52	45	5720	0.1048	31171.71	2.60	3.08	307.90	0.0227	6751.89	0.56	0.67	66.69		
82	103	85	1.185	32	57	50	5720	0.1048	34168.99	2.85	3.38	347.63	0.0227	7401.11	0.62	0.73	75.30		
87	103	87	1.243	32	62	55	5720	0.1048	37166.27	3.10	3.85	396.40	0.0227	8050.33	0.67	0.83	85.86		
92	95	92	1.307	32	67	60	5720	0.1048	40163.55	3.35	4.37	415.54	0.0227	8699.55	0.72	0.95	90.01		
97	84	102	1.461	32	72	65	5720	0.1048	43160.83	3.60	5.25	441.38	0.0227	9348.77	0.78	1.14	95.60		
102	30	105	1.502	32	77	70	5720	0.1048	46158.11	3.85	5.78	173.28	0.0227	9997.99	0.83	1.25	37.53		
107	3	107	1.528	32	82	75	5720	0.1048	49155.39	4.10	6.26	18.78	0.0227	10647.21	0.89	1.36	4.07		
112	0	112	1.607	32	87	80	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
											0.00	2673.89				0.00	579.17	2673.891	579 1729

Temp. bin	Aug'	Suction Temp	kw/ton	Space Temp	Temp. Diff	Uncorrected Temp. Diff	Roof Total Sqft	U Value (1/9.54)	BTUH	Tons	KW	KWh	U Value (1/16.44+27.70)	BTUH	Tons	KW	KWh		
27	0	85	1.185	32	2.25	-5	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	0	85	1.185	32	7.25	0	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	0	85	1.185	32	12.25	5	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
42	0	85	1.185	32	17.25	10	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
47	0	85	1.185	32	22.25	15	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
52	0	85	1.185	32	27.25	20	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
57	11	85	1.185	32	32.25	25	5720	0.1048	19332.46	1.61	1.91	21.01	0.0227	4187.47	0.35	0.41	4.55		
62	59	85	1.185	32	37.25	30	5720	0.1048	22329.74	1.86	2.21	130.13	0.0227	4836.69	0.40	0.48	28.19		
67	106	85	1.185	32	42.25	35	5720	0.1048	25327.02	2.11	2.50	265.18	0.0227	5485.91	0.46	0.54	57.44		
72	113	85	1.185	32	47.25	40	5720	0.1048	28324.3	2.36	2.80	316.14	0.0227	6135.13	0.51	0.61	68.48		
77	97	85	1.185	32	52.25	45	5720	0.1048	31321.58	2.61	3.09	300.10	0.0227	6784.35	0.57	0.67	65.00		
82	100	85	1.185	32	57.25	50	5720	0.1048	34318.86	2.86	3.39	338.98	0.0227	7433.57	0.62	0.73	73.43		
87	81	87	1.243	32	62.25	55	5720	0.1048	37316.14	3.11	3.86	312.99	0.0227	8082.79	0.67	0.84	67.79		
92	78	92	1.307	32	67.25	60	5720	0.1048	40313.42	3.36	4.39	342.46	0.0227	8732.01	0.73	0.95	74.18		
97	56	102	1.461	32	72.25	65	5720	0.1048	43310.7	3.61	5.27	295.27	0.0227	9381.23	0.78	1.14	63.96		
102	41	105	1.502	32	77.25	70	5720	0.1048	46307.98	3.86	5.79	237.58	0.0227	10030.45	0.84	1.26	51.46		
107	2	107	1.528	32	82.25	75	5720	0.1048	49305.26	4.11	6.28	12.56	0.0227	10679.67	0.89	1.38	2.72		
112	0	112	1.607	32	87.25	80	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
											6.28	2572.40				1.36	557.19	2572.397	557.189

Temp. bin	Sept	Suction Temp	kw/ton	Space Temp	Temp. Diff	Uncorrect edTemp. Diff	Roof Total Sqft	U Value (1/9.54)	BTUH	Tons	KW	KWh	U Value (1/16.44+ 27.70)	BTUH	Tons	KW	KWh		
27	0	85	1.185	32	-0.125	-5	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	0	85	1.185	32	4.875	0	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	0	85	1.185	32	9.875	5	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
42	0	85	1.185	32	14.875	10	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
47	0	85	1.185	32	19.875	15	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
52	13	85	1.185	32	24.875	20	5720	0.1048	14911.47	1.24	1.47	19.15	0.0227	3229.87	0.27	0.32	4.15		
57	62	85	1.185	32	29.875	25	5720	0.1048	17908.75	1.49	1.77	109.67	0.0227	3879.09	0.32	0.38	23.76		
62	116	85	1.185	32	34.875	30	5720	0.1048	20906.03	1.74	2.06	239.54	0.0227	4528.31	0.38	0.45	51.88		
67	122	85	1.185	32	39.875	35	5720	0.1048	23903.31	1.99	2.36	288.05	0.0227	5177.53	0.43	0.51	62.39		
72	105	85	1.185	32	44.875	40	5720	0.1048	26900.59	2.24	2.66	279.00	0.0227	5826.75	0.49	0.58	60.43		
77	79	85	1.185	32	49.875	45	5720	0.1048	29897.87	2.49	2.95	233.30	0.0227	6475.97	0.54	0.64	50.53		
82	77	85	1.185	32	54.875	50	5720	0.1048	32895.15	2.74	3.25	250.19	0.0227	7125.19	0.59	0.70	54.19		
87	72	87	1.243	32	59.875	55	5720	0.1048	35892.43	2.99	3.72	267.60	0.0227	7774.41	0.65	0.81	57.96		
92	50	92	1.307	32	64.875	60	5720	0.1048	38889.71	3.24	4.24	211.77	0.0227	8423.63	0.70	0.92	45.87		
97	21	102	1.461	32	69.875	65	5720	0.1048	41886.99	3.49	5.10	107.09	0.0227	9072.85	0.76	1.10	23.20		
102	3	105	1.502	32	74.875	70	5720	0.1048	44884.27	3.74	5.62	16.85	0.0227	9722.07	0.81	1.22	3.65		
107	0	107	1.528	32	79.875	75	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
112	0	112	1.607	32	84.875	80	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
											0.00	2022.20				0.00	438.02	2022.201	438.015

Temp. bin	Oct	Suction Temp	kw/ton	Space Temp	Temp. Diff	Uncorrect edTemp. Diff	Roof Total Sqft	U Value (1/9.54)	BTUH	Tons	KW	KWh	U Value (1/16.44+ 27.70)	BTUH	Tons	KW	KWh		
27	0	85	1.185	32	-2.5	-5	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	0	85	1.185	32	2.5	0	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	0	85	1.185	32	7.5	5	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
42	13	85	1.185	32	12.5	10	5720	0.1048	7493.2	0.62	0.74	9.62	0.0227	1623.05	0.14	0.16	2.08		
47	47	85	1.185	32	17.5	15	5720	0.1048	10490.48	0.87	1.04	48.70	0.0227	2272.27	0.19	0.22	10.55		
52	91	85	1.185	32	22.5	20	5720	0.1048	13487.76	1.12	1.33	121.24	0.0227	2921.49	0.24	0.29	26.26		
57	120	85	1.185	32	27.5	25	5720	0.1048	16485.04	1.37	1.63	195.40	0.0227	3570.71	0.30	0.35	42.32		
62	119	85	1.185	32	32.5	30	5720	0.1048	19482.32	1.62	1.92	228.00	0.0227	4219.93	0.35	0.42	49.60		
67	97	85	1.185	32	37.5	35	5720	0.1048	22479.6	1.87	2.22	215.38	0.0227	4869.15	0.41	0.48	46.65		
72	101	85	1.185	32	42.5	40	5720	0.1048	25476.88	2.12	2.52	254.16	0.0227	5518.37	0.46	0.55	55.05		
77	72	85	1.185	32	47.5	45	5720	0.1048	28474.16	2.37	2.81	202.50	0.0227	6167.59	0.51	0.61	43.86		
82	51	85	1.185	32	52.5	50	5720	0.1048	31471.44	2.62	3.11	158.54	0.0227	6816.81	0.57	0.67	34.34		
87	23	87	1.243	32	57.5	55	5720	0.1048	34468.72	2.87	3.57	82.09	0.0227	7466.03	0.62	0.77	17.78		
92	10	92	1.307	32	62.5	60	5720	0.1048	37466	3.12	4.08	40.80	0.0227	8115.25	0.68	0.88	8.84		
97	0	102	1.461	32	67.5	65	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
102	0	105	1.502	32	72.5	70	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
107	0	107	1.528	32	77.5	75	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
112	0	112	1.607	32	82.5	80	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
											0.00	1557.44				0.00	337.35	1557.437	337.3456

Temp. bin	Nov	Suction Temp	kw/ton	Space Temp	Temp. Diff	Uncorrect edTemp. Diff	Roof Total Sqft	U Value (1/9.54)	BTUH	Tons	KW	KWh	U Value (1/16.44+ 27.70)	BTUH	Tons	KW	KWh		
27	0	85	1.185	32	-5.63	-5	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	14	85	1.185	32	-0.63	0	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	47	85	1.185	32	4.37	5	5720	0.1048	2619.623	0.22	0.26	12.16	0.0227	567.42	0.05	0.06	2.63		
42	71	85	1.185	32	9.37	10	5720	0.1048	5616.903	0.47	0.55	39.39	0.0227	1216.64	0.10	0.12	8.53		
47	144	85	1.185	32	14.37	15	5720	0.1048	8614.183	0.72	0.85	122.52	0.0227	1865.86	0.16	0.18	26.54		
52	146	85	1.185	32	19.37	20	5720	0.1048	11611.46	0.97	1.15	167.45	0.0227	2515.08	0.21	0.25	36.27		
57	136	85	1.185	32	24.37	25	5720	0.1048	14608.74	1.22	1.44	196.25	0.0227	3164.30	0.26	0.31	42.51		
62	81	85	1.185	32	29.37	30	5720	0.1048	17606.02	1.47	1.74	140.86	0.0227	3813.52	0.32	0.38	30.51		
67	42	85	1.185	32	34.37	35	5720	0.1048	20603.3	1.72	2.04	85.47	0.0227	4462.74	0.37	0.44	18.51		
72	21	85	1.185	32	39.37	40	5720	0.1048	23600.58	1.97	2.33	48.95	0.0227	5111.96	0.43	0.50	10.60		
77	18	85	1.185	32	44.37	45	5720	0.1048	26597.86	2.22	2.63	47.29	0.0227	5761.18	0.48	0.57	10.24		
82	0	85	1.185	32	49.37	50	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
87	0	87	1.243	32	54.37	55	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
92	0	92	1.307	32	59.37	60	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
97	0	102	1.461	32	64.37	65	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
102	0	105	1.502	32	69.37	70	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
107	0	107	1.528	32	74.37	75	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
112	0	112	1.607	32	79.37	80	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
											0.00	860.35				0.00	186.36	860.3527	186.355

Temp. bin	dec	Suction Temp	kw/ton	Space Temp	Temp. Diff	Uncorrect edTemp. Diff	Roof Total Sqft	U Value (1/9.54)	BTUH	Tons	KW	KWh	U Value (1/18.44+ 27.70)	BTUH	Tons	KW	KWh		
27	5	85	1.185	32	-8.5	-5	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	52	85	1.185	32	-1.5	0	5720	0.1048	0	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	137	85	1.185	32	3.5	5	5720	0.1048	2098.096	0.17	0.21	28.39	0.0227	454.45	0.04	0.04	6.15		
42	134	85	1.185	32	8.5	10	5720	0.1048	5095.376	0.42	0.50	67.44	0.0227	1103.67	0.09	0.11	14.61		
47	121	85	1.185	32	13.5	15	5720	0.1048	8092.656	0.67	0.80	96.72	0.0227	1752.89	0.15	0.17	20.95		
52	180	85	1.185	32	18.5	20	5720	0.1048	11089.94	0.92	1.10	197.17	0.0227	2402.11	0.20	0.24	42.71		
57	81	85	1.185	32	23.5	25	5720	0.1048	14087.22	1.17	1.39	112.71	0.0227	3051.33	0.25	0.30	24.41		
62	20	85	1.185	32	28.5	30	5720	0.1048	17084.5	1.42	1.69	33.75	0.0227	3700.55	0.31	0.37	7.31		
67	14	85	1.185	32	33.5	35	5720	0.1048	20081.78	1.67	1.98	27.77	0.0227	4349.77	0.36	0.43	6.02		
72	0	85	1.185	32	38.5	40	5720	0.1048	0	0.00	0.00	0.00	0.0227	0	0	0	0		
77	0	85	1.185	32	43.5	45	5720	0.1048	0	0.00	0.00	0.00	0.0227	0	0	0	0		
82	0	85	1.185	32	48.5	50	5720	0.1048	0	0.00	0.00	0.00	0.0227	0	0	0	0		
87	0	87	1.243	32	53.5	55	5720	0.1048	0	0.00	0.00	0.00	0.0227	0	0	0	0		
92	0	92	1.307	32	58.5	60	5720	0.1048	0	0.00	0.00	0.00	0.0227	0	0	0	0		
97	0	102	1.461	32	63.5	65	5720	0.1048	0	0.00	0.00	0.00	0.0227	0	0	0	0		
102	0	105	1.502	32	68.5	70	5720	0.1048	0	0	0	0	0.0227	0	0	0	0		
107	0	107	1.528	32	73.5	75	5720	0.1048	0	0	0	0	0.0227	0	0	0	0		
112	0	112	1.607	32	78.5	80	5720	0.1048	0	0	0	0	0.0227	0	0	0	0		
												563.9577					122.155	563.9577	122.155
																		19724.4	4275.668

Insulation Wharehouse B

Existing Kwh	60166.78	Proposed Kwh	13032.31
Existing KW	19.79162	ProposedKw	4.286926

Temp. Bin Data for Bakersfield SCT=30

Temp. bin	Jan hours	Suction Temp	kw/ton	Space Temp	Corrected for Solar GainTemp	Uncorrected Temp. Diff	Roof Total Sqft	U Value (1/9.54)	Existing BTUH	Tons	KW	KWh	Proposed U Value (1/44.14)	BTUH	Tons	KW	KWh	Exist kWh	Retro kWh
27	2.00	85	1.088	40	-5.63	-13	19040	0.1048	0	0	0	0	0.0227	0.00	0.00	0.00	0.00		
32	23.00	85	1.088	40	-0.63	-8	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	84.00	85	1.088	40	4.37	-3	19040	0.1048	8719.86	0.73	0.79	66.41	0.0227	1888.75	0.16	0.17	14.38		
42	180.00	85	1.088	40	9.37	2	19040	0.1048	18696.82	1.56	1.70	305.13	0.0227	4049.79	0.34	0.37	66.09		
47	224.00	85	1.088	40	14.37	7	19040	0.1048	28673.78	2.39	2.60	582.35	0.0227	6210.83	0.52	0.56	126.14		
52	131.00	85	1.088	40	19.37	12	19040	0.1048	38650.74	3.22	3.50	459.07	0.0227	8371.87	0.70	0.76	99.44		
57	56.00	85	1.088	40	24.37	17	19040	0.1048	48627.70	4.05	4.41	246.90	0.0227	10532.91	0.88	0.95	53.48		
62	35.00	85	1.088	40	29.37	22	19040	0.1048	58604.66	4.88	5.31	185.97	0.0227	12693.95	1.06	1.15	40.28		
67	9.00	85	1.088	40	34.37	27	19040	0.1048	68581.62	5.72	6.22	55.96	0.0227	14854.99	1.24	1.35	12.12		
72	0.00	85	1.088	40	39.37	32	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
77	0.00	85	1.088	40	44.37	37	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
82	0.00	85	1.088	40	49.37	42	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
87	0.00	87	1.1182	40	54.37	47	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
92	0.00	92	1.17256	40	59.37	52	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
97	0.00	102	1.3532	40	64.37	57	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
102	0.00	105	1.4071	40	69.37	62	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
107	0.00	107	1.4471	40	74.37	67	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
112	0.00	112	1.547	40	79.37	72	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
												1901.79					411.93	1901.79	411.9334

Temp. Bin Data for Bakersfield SCT=30

Temp. bin	Feb hours	Suction Temp	kw/ton	Space Temp	Corrected for Solar GainTemp	Uncorrected Temp. Diff	Roof Total Sqft	U Value (1/9.54)	Existing BTUH	Tons	KW	KWh	Proposed U Value (1/44.14)	BTUH	Tons	KW	KWh		
27	0.00	85	1.088	40	-2.5	-13	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	19.00	85	1.088	40	2.5	-8	19040	0.1048	4988.48	0.42	0.45	8.59	0.0227	1080.52	0.09	0.10	1.86		
37	59.00	85	1.088	40	7.5	-3	19040	0.1048	14965.44	1.25	1.36	80.06	0.0227	3241.56	0.27	0.29	17.34		
42	54.00	85	1.088	40	12.5	2	19040	0.1048	24942.40	2.08	2.26	122.12	0.0227	5402.60	0.45	0.49	26.45		
47	114.00	85	1.088	40	17.5	7	19040	0.1048	34919.36	2.91	3.17	360.93	0.0227	7563.64	0.63	0.69	78.18		
52	173.00	85	1.088	40	22.5	12	19040	0.1048	44896.32	3.74	4.07	704.21	0.0227	9724.68	0.81	0.88	152.53		
57	141.00	85	1.088	40	27.5	17	19040	0.1048	54873.28	4.57	4.98	701.50	0.0227	11885.72	0.99	1.08	151.95		
62	67.00	85	1.088	40	32.5	22	19040	0.1048	64850.24	5.40	5.88	393.94	0.0227	14046.76	1.17	1.27	85.33		
67	31.00	85	1.088	40	37.5	27	19040	0.1048	74827.20	6.24	6.78	210.31	0.0227	16207.80	1.35	1.47	45.55		
72	13.00	85	1.088	40	42.5	32	19040	0.1048	84804.16	7.07	7.69	99.96	0.0227	18368.84	1.53	1.67	21.65		
77	1.00	85	1.088	40	47.5	37	19040	0.1048	94781.12	7.90	8.59	8.59	0.0227	20529.88	1.71	1.86	1.86		
82	0.00	85	1.088	40	52.5	42	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
87	0.00	87	1.1182	40	57.5	47	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
92	0.00	92	1.17256	40	62.5	52	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
97	0.00	102	1.3532	40	67.5	57	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
102	0.00	105	1.4071	40	72.5	62	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
107	0.00	107	1.4471	40	77.5	67	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
112	0.00	112	1.547	40	82.5	72	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
												2690.21					582.71	2690.214	582.7086

Temp. Bin Data for Bakersfield SCT=30

Temp. bin	March hours	Suction Temp	kw/ton	Space Temp	Corrected for Solar GainTemp	Uncorrected Temp Diff	Roof Total Sqft	U Value (1/9.54)	Existing BTUH	Tons	KW	KWh	Proposed U Value (1/44.14)	BTUH	Tons	KW	KWh		
27	0.00	85	1.088	40	2.875	-13	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	0.00	85	1.088	40	7.875	-8	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	20.00	85	1.088	40	12.875	-3	19040	0.1048	25690.67	2.14	2.33	46.59	0.0227	5564.68	0.46	0.50	10.09		
42	77.00	85	1.088	40	17.875	2	19040	0.1048	35667.63	2.97	3.23	249.01	0.0227	7725.72	0.64	0.70	53.94		
47	102.00	85	1.088	40	22.875	7	19040	0.1048	45644.59	3.80	4.14	422.12	0.0227	9886.76	0.82	0.90	91.43		
52	190.00	85	1.088	40	27.875	12	19040	0.1048	55621.55	4.64	5.04	958.17	0.0227	12047.80	1.00	1.09	207.54		
57	137.00	85	1.088	40	32.875	17	19040	0.1048	65598.51	5.47	5.95	814.82	0.0227	14208.84	1.18	1.29	176.49		
62	106.00	85	1.088	40	37.875	22	19040	0.1048	75575.47	6.30	6.85	726.33	0.0227	16369.88	1.36	1.48	157.33		
67	66.00	85	1.088	40	42.875	27	19040	0.1048	85552.43	7.13	7.76	511.95	0.0227	18530.92	1.54	1.68	110.89		
72	31.00	85	1.088	40	47.875	32	19040	0.1048	95529.39	7.96	8.66	268.50	0.0227	20691.96	1.72	1.88	58.16		
77	15.00	85	1.088	40	52.875	37	19040	0.1048	105506.35	8.79	9.57	143.49	0.0227	22853.00	1.90	2.07	31.08		
82	0.00	85	1.088	40	57.875	42	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
87	0.00	87	1.1182	40	62.875	47	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
92	0.00	92	1.17256	40	67.875	52	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
97	0.00	102	1.3532	40	72.875	57	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
102	0.00	105	1.4071	40	77.875	62	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
107	0.00	107	1.4471	40	82.875	67	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
112	0.00	112	1.547	40	87.875	72	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
											0.00	4140.98				0.00	896.95	4140.976	896.948

Temp. Bin Data for Bakersfield SCT=30

Temp. bin	April hours	Suction Temp	kw/ton	Space Temp	Corrected for Solar GainTemp	Uncorrected Temp. Diff	Roof Total Sqft	U Value (1/9.54)	Existing BTUH	Tons	KW	KWh	Proposed U Value (1/44.14)	BTUH	Tons	KW	KWh		
27	0.00	85	1.088	40	7.25	-13	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	0.00	85	1.088	40	12.25	-8	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	4.00	85	1.088	40	17.25	-3	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
42	22.00	85	1.088	40	22.25	2	19040	0.1048	44397.47	3.70	4.03	88.56	0.0227	9616.63	0.80	0.87	19.18		
47	67.00	85	1.088	40	27.25	7	19040	0.1048	54374.43	4.53	4.93	330.31	0.0227	11777.67	0.98	1.07	71.55		
52	115.00	85	1.088	40	32.25	12	19040	0.1048	64351.39	5.36	5.83	670.97	0.0227	13938.71	1.16	1.26	145.33		
57	135.00	85	1.088	40	37.25	17	19040	0.1048	74328.35	6.19	6.74	909.78	0.0227	16099.75	1.34	1.46	197.06		
62	125.00	85	1.088	40	42.25	22	19040	0.1048	84305.31	7.03	7.64	955.46	0.0227	18260.79	1.52	1.66	206.96		
67	90.00	85	1.088	40	47.25	27	19040	0.1048	94282.27	7.86	8.55	769.34	0.0227	20421.83	1.70	1.85	166.64		
72	53.00	85	1.088	40	52.25	32	19040	0.1048	104259.23	8.69	9.45	501.00	0.0227	22582.87	1.88	2.05	108.52		
77	48.00	85	1.088	40	57.25	37	19040	0.1048	114236.19	9.52	10.36	497.16	0.0227	24743.91	2.06	2.24	107.69		
82	48.00	85	1.088	40	62.25	42	19040	0.1048	124213.15	10.35	11.26	540.58	0.0227	26904.95	2.24	2.44	117.09		
87	12.00	87	1.1182	40	67.25	47	19040	0.1048	134190.11	11.18	12.50	150.05	0.0227	29065.99	2.42	2.71	32.50		
92	1.00	92	1.17256	40	72.25	52	19040	0.1048	144167.07	12.01	14.09	14.09	0.0227	31227.03	2.60	3.05	3.05		
97	0.00	102	1.3532	40	77.25	57	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
102	0.00	105	1.4071	40	82.25	62	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
107	0.00	107	1.4471	40	87.25	67	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
112	0.00	112	1.547	40	92.25	72	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
												5427.29					1175.57	5427.288	1175.567

Temp. Bin Data for Bakersfield SCT=30

Existing Proposed

Temp. bin	May hours	Suction Temp	kw/ton	Space Temp	Corrected for Solar Gain Temp	Uncorrected Temp. Diff	Roof Total Sqft	U Value (1/9.54)	BTUH	Tons	KW	KWh	U Value (1/44.14)	BTUH	Tons	KW	KWh		
27	0	85	1.088	41	9	-14	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	0	85	1.088	41	14	-9	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	0	85	1.088	41	19	-4	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
42	2	85	1.088	41	24	1	19040	0.1048	47889.41	3.99	4.34	8.68	0.0227	10372.99	0.86	0.94	1.88		
47	23	85	1.088	41	29	6	19040	0.1048	57866.37	4.82	5.25	120.67	0.0227	12534.03	1.04	1.14	26.14		
52	74	85	1.088	41	34	11	19040	0.1048	67843.33	5.65	6.15	455.18	0.0227	14695.07	1.22	1.33	98.59		
57	95	85	1.088	41	39	16	19040	0.1048	77820.29	6.49	7.06	670.29	0.0227	16856.11	1.40	1.53	145.19		
62	96	85	1.088	41	44	21	19040	0.1048	87797.25	7.32	7.96	764.19	0.0227	19017.15	1.58	1.72	165.53		
67	108	85	1.088	41	49	26	19040	0.1048	97774.21	8.15	8.86	957.41	0.0227	21178.19	1.76	1.92	207.38		
72	89	85	1.088	41	54	31	19040	0.1048	107751.17	8.98	9.77	869.48	0.0227	23339.23	1.94	2.12	188.33		
77	89	85	1.088	41	59	36	19040	0.1048	117728.13	9.81	10.67	949.99	0.0227	25500.27	2.13	2.31	205.77		
82	70	85	1.088	41	64	41	19040	0.1048	127705.09	10.64	11.58	810.50	0.0227	27661.31	2.31	2.51	175.56		
87	53	87	1.1182	41	69	46	19040	0.1048	137682.05	11.47	12.83	679.97	0.0227	29822.35	2.49	2.78	147.28		
92	32	92	1.17256	41	74	51	19040	0.1048	147659.01	12.30	14.43	461.70	0.0227	31983.39	2.67	3.13	100.01		
97	12	102	1.3532	41	79	56	19040	0.1048	157635.97	13.14	17.78	213.31	0.0227	34144.43	2.85	3.85	46.20		
102	1	105	1.4071	41	84	61	19040	0.1048	167612.93	13.97	19.65	19.65	0.0227	36305.47	3.03	4.26	4.26		
107	0	107	1.4471	41	89	66	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
112	0	112	1.547	41	94	71	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
									0.00	0.00	0.00	6981.04					1512 11	6981.035	1512.114

Temp. bin	June	Suction Temp	kw/ton	Space Temp	Temp. Diff	Uncorrected Temp. Diff	Roof Total Sqft	U Value (1/9.54)	BTUH	Tons	KW	KWh	U Value (1/16.44+ 27.70)	BTUH	Tons	KW	KWh		
27	0	85	1.088	44	7	-17	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	0	85	1.088	44	12	-12	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	0	85	1.088	44	17	-7	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
42	0	85	1.088	44	22	-2	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
47	0	85	1.088	44	27	3	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
52	6	85	1.088	44	32	8	19040	0.1048	63852.54	5.32	5.79	34.74	0.0227	13830.66	1.15	1.25	7.52		
57	37	85	1.088	44	37	13	19040	0.1048	73829.50	6.15	6.69	247.67	0.0227	15991.70	1.33	1.45	53.65		
62	95	85	1.088	44	42	18	19040	0.1048	83806.46	6.98	7.60	721.85	0.0227	18152.74	1.51	1.65	156.36		
67	90	85	1.088	44	47	23	19040	0.1048	93783.42	7.82	8.50	765.27	0.0227	20313.78	1.69	1.84	165.76		
72	93	85	1.088	44	52	28	19040	0.1048	103760.38	8.65	9.41	874.91	0.0227	22474.82	1.87	2.04	189.51		
77	87	85	1.088	44	57	33	19040	0.1048	113737.34	9.48	10.31	897.16	0.0227	24635.86	2.05	2.23	194.33		
82	95	85	1.088	44	62	38	19040	0.1048	123714.30	10.31	11.22	1065.59	0.0227	26796.90	2.23	2.43	230.81		
87	74	87	1.1182	44	67	43	19040	0.1048	133691.26	11.14	12.46	921.88	0.0227	28957.94	2.41	2.70	199.68		
92	79	92	1.17256	44	72	48	19040	0.1048	143668.22	11.97	14.04	1109.03	0.0227	31118.98	2.59	3.04	240.22		
97	43	102	1.3532	44	77	53	19040	0.1048	153645.18	12.80	17.33	745.02	0.0227	33280.02	2.77	3.75	161.37		
102	21	105	1.4071	44	82	58	19040	0.1048	163622.14	13.64	19 19	402.91	0.0227	35441.06	2.95	4.16	87.27		
107	0	107	1.4471	44	87	63	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
112	0	112	1.547	44	92	68	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
											0.00	7786.03				0.00	1686.48	7786.026	1686.477

Temp. bin	July	Suction Temp	kw/ton	Space Temp	Temp. Diff	Uncorrected Temp. Diff	Roof Total Sqft	U Value (1/9.54)	BTUH	Tons	KW	KWh	U Value (1/16.44+ 27.70)	BTUH	Tons	KW	KWh		
27	0	85	1.088	48	2	-21	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	0	85	1.088	48	7	-16	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	0	85	1.088	48	12	-11	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
42	0	85	1.088	48	17	-6	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
47	0	85	1.088	48	22	-1	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
52	0	85	1.088	48	27	4	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
57	10	85	1.088	48	32	9	19040	0.1048	63852.54	5.32	5.79	57.89	0.0227	13830.66	1.15	1.25	12.54		
62	46	85	1.088	48	37	14	19040	0.1048	73829.50	6.15	6.69	307.92	0.0227	15991.70	1.33	1.45	66.70		
67	67	85	1.088	48	42	19	19040	0.1048	83806.46	6.98	7.60	509.10	0.0227	18152.74	1.51	1.65	110.27		
72	103	85	1.088	48	47	24	19040	0.1048	93783.42	7.82	8.50	875.81	0.0227	20313.78	1.69	1.84	189.70		
77	100	85	1.088	48	52	29	19040	0.1048	103760.38	8.65	9.41	940.76	0.0227	22474.82	1.87	2.04	203.77		
82	103	85	1.088	48	57	34	19040	0.1048	113737.34	9.48	10.31	1062.16	0.0227	24635.86	2.05	2.23	230.07		
87	103	87	1.1182	48	62	39	19040	0.1048	123714.30	10.31	11.53	1187.40	0.0227	26796.90	2.23	2.50	257.19		
92	95	92	1.17256	48	67	44	19040	0.1048	133891.26	11.14	13.06	1241.02	0.0227	28957.94	2.41	2.83	268.81		
97	84	102	1.3532	48	72	49	19040	0.1048	143868.22	11.97	16.20	1360.88	0.0227	31118.98	2.59	3.51	294.77		
102	30	105	1.4071	48	77	54	19040	0.1048	153645.18	12.80	18.02	540.49	0.0227	33280.02	2.77	3.90	117.07		
107	3	107	1.4471	48	82	59	19040	0.1048	163622.14	13.64	19.73	59.19	0.0227	35441.06	2.95	4.27	12.82		
112	0	112	1.547	48	87	64	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
											0.00	8142.62				0.00	1763.72	8142.619	1763.716

Temp. bin	Aug'	Suction Temp	kw/ton	Space Temp	Temp. Diff	Uncorrected Temp. Diff	Roof Total Sqft	U Value (1/9.54)	BTUH	Tons	KW	KWh	U Value (1/16.44+ 27.70)	BTUH	Tons	KW	KWh		
27	0	85	1.088	45	2.25	-18	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	0	85	1.088	45	7.25	-13	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	0	85	1.088	45	12.25	-8	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
42	0	85	1.088	45	17.25	-3	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
47	0	85	1.088	45	22.25	2	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
52	0	85	1.088	45	27.25	7	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
57	11	85	1.088	45	32.25	12	19040	0.1048	64351.39	5.36	5.83	64.18	0.0227	13938.71	1.16	1.26	13.90		
62	59	85	1.088	45	37.25	17	19040	0.1048	74328.35	6.19	6.74	397.61	0.0227	16099.75	1.34	1.46	86.12		
67	106	85	1.088	45	42.25	22	19040	0.1048	84305.31	7.03	7.64	810.23	0.0227	18260.79	1.52	1.66	175.50		
72	113	85	1.088	45	47.25	27	19040	0.1048	94282.27	7.86	8.55	965.95	0.0227	20421.83	1.70	1.85	209.23		
77	97	85	1.088	45	52.25	32	19040	0.1048	104259.23	8.69	9.45	916.93	0.0227	22582.87	1.88	2.05	198.61		
82	100	85	1.088	45	57.25	37	19040	0.1048	114236.19	9.52	10.36	1035.74	0.0227	24743.91	2.06	2.24	224.34		
87	81	87	1.1182	45	62.25	42	19040	0.1048	124213.15	10.35	11.57	937.54	0.0227	26904.95	2.24	2.51	203.07		
92	78	92	1.17256	45	67.25	47	19040	0.1048	134190.11	11.18	13.11	1022.75	0.0227	29065.99	2.42	2.84	221.53		
97	56	102	1.3532	45	72.25	52	19040	0.1048	144167.07	12.01	16.26	910.41	0.0227	31227.03	2.60	3.52	197.20		
102	41	105	1.4071	45	77.25	57	19040	0.1048	154144.03	12.85	18.07	741.06	0.0227	33388.07	2.78	3.92	160.52		
107	2	107	1.4471	45	82.25	62	19040	0.1048	164120.99	13.68	19.79	39.58	0.0227	35549.11	2.96	4.29	8.57		
112	0	112	1.547	45	87.25	67	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
											19.79	7841.98				4.29	1698.60	7841.978	1698.596

Temp. bin	Sept	Suction Temp	kw/ton	Space Temp	Temp. Diff	Uncorrected Temp. Diff	Roof Sqft	Total U Value (1/9.54)	BTUH	Tons	KW	KWh	U Value (1/16.44+ 27.70)	BTUH	Tons	KW	KWh		
27	0	85	1.088	43	-0.125	-16	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	0	85	1.088	43	4.875	-11	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	0	85	1.088	43	9.875	-6	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
42	0	85	1.088	43	14.875	-1	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
47	0	85	1.088	43	19.875	4	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
52	13	85	1.088	43	24.875	9	19040	0.1048	49635.38	4.14	4.50	58.50	0.0227	10751.17	0.90	0.97	12.67		
57	62	85	1.088	43	29.875	14	19040	0.1048	59612.34	4.97	5.40	335.10	0.0227	12912.21	1.08	1.17	72.58		
62	116	85	1.088	43	34.875	19	19040	0.1048	69589.30	5.80	6.31	731.89	0.0227	15073.25	1.26	1.37	158.53		
67	122	85	1.088	43	39.875	24	19040	0.1048	79566.26	6.63	7.21	880.11	0.0227	17234.29	1.44	1.56	190.63		
72	105	85	1.088	43	44.875	29	19040	0.1048	89543.22	7.46	8.12	852.45	0.0227	19395.33	1.62	1.76	184.64		
77	79	85	1.088	43	49.875	34	19040	0.1048	99520.18	8.29	9.02	712.83	0.0227	21556.37	1.80	1.95	154.40		
82	77	85	1.088	43	54.875	39	19040	0.1048	109497.14	9.12	9.93	764.44	0.0227	23717.41	1.98	2.15	165.58		
87	72	87	1.1182	43	59.875	44	19040	0.1048	119474.10	9.96	11.13	801.58	0.0227	25878.45	2.16	2.41	173.62		
92	50	92	1.17256	43	64.875	49	19040	0.1048	129451.06	10.79	12.65	632.45	0.0227	28039.49	2.34	2.74	136.99		
97	21	102	1.3532	43	69.875	54	19040	0.1048	139428.02	11.62	15.72	330.18	0.0227	30200.53	2.52	3.41	71.52		
102	3	105	1.4071	43	74.875	59	19040	0.1048	149404.98	12.45	17.52	52.56	0.0227	32361.57	2.70	3.79	11.38		
107	0	107	1.4471	43	79.875	64	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
112	0	112	1.547	43	84.875	69	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
											0.00	6152.09				0.00	1332.56	6152.091	1332.562

Temp. bin	Oct	Suction Temp	kw/ton	Space Temp	Temp. Diff	Uncorrected Temp. Diff	Roof Sqft	Total U Value (1/9.54)	BTUH	Tons	KW	KWh	U Value (1/16.44+ 27.70)	BTUH	Tons	KW	KWh		
27	0	85	1.088	40	-2.5	-13	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	0	85	1.088	40	2.5	-8	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	0	85	1.088	40	7.5	-3	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
42	13	85	1.088	40	12.5	2	19040	0.1048	24942.40	2.08	2.26	29.40	0.0227	5402.60	0.45	0.49	6.37		
47	47	85	1.088	40	17.5	7	19040	0.1048	34919.36	2.91	3.17	148.80	0.0227	7563.64	0.63	0.69	32.23		
52	91	85	1.088	40	22.5	12	19040	0.1048	44896.32	3.74	4.07	370.42	0.0227	9724.68	0.81	0.88	80.24		
57	120	85	1.088	40	27.5	17	19040	0.1048	54873.28	4.57	4.98	597.02	0.0227	11885.72	0.99	1.08	129.32		
62	119	85	1.088	40	32.5	22	19040	0.1048	64850.24	5.40	5.88	699.69	0.0227	14046.76	1.17	1.27	151.56		
67	97	85	1.088	40	37.5	27	19040	0.1048	74827.20	6.24	6.78	658.08	0.0227	16207.80	1.35	1.47	142.54		
72	101	85	1.088	40	42.5	32	19040	0.1048	84804.16	7.07	7.69	776.58	0.0227	18368.84	1.53	1.67	168.21		
77	72	85	1.088	40	47.5	37	19040	0.1048	94781.12	7.90	8.59	618.73	0.0227	20529.88	1.71	1.86	134.02		
82	51	85	1.088	40	52.5	42	19040	0.1048	104758.08	8.73	9.50	484.40	0.0227	22690.92	1.89	2.06	104.92		
87	23	87	1.1182	40	57.5	47	19040	0.1048	114735.04	9.56	10.69	245.90	0.0227	24851.96	2.07	2.32	53.26		
92	10	92	1.17256	40	62.5	52	19040	0.1048	124712.00	10.39	12.19	121.86	0.0227	27013.00	2.25	2.64	26.40		
97	0	102	1.3532	40	67.5	57	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
102	0	105	1.4071	40	72.5	62	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
107	0	107	1.4471	40	77.5	67	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
112	0	112	1.547	40	82.5	72	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
											0.00	4750.89				0.00	1029.06	4750.894	1029.058

Temp. bin	Nov	Suction Temp	kw/ton	Space Temp	Temp. Diff	Uncorrected Temp. Diff	Roof Sqft	Total U Value (1/9.54)	BTUH	Tons	KW	KWh	U Value (1/16.44+ 27.70)	BTUH	Tons	KW	KWh		
27	0	85	1.088	40	-5.63	-13	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	14	85	1.088	40	-0.63	-8	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	47	85	1.088	40	4.37	-3	19040	0.1048	8719.86	0.73	0.79	37.16	0.0227	1888.75	0.16	0.17	8.05		
42	71	85	1.088	40	9.37	2	19040	0.1048	18696.82	1.56	1.70	120.36	0.0227	4049.79	0.34	0.37	26.07		
47	144	85	1.088	40	14.37	7	19040	0.1048	28673.78	2.39	2.60	374.36	0.0227	6210.83	0.52	0.56	81.09		
52	146	85	1.088	40	19.37	12	19040	0.1048	38650.74	3.22	3.50	511.63	0.0227	8371.87	0.70	0.76	110.82		
57	136	85	1.088	40	24.37	17	19040	0.1048	48627.70	4.05	4.41	599.61	0.0227	10532.91	0.88	0.95	129.88		
62	81	85	1.088	40	29.37	22	19040	0.1048	58604.66	4.88	5.31	430.39	0.0227	12693.95	1.06	1.15	93.22		
67	42	85	1.088	40	34.37	27	19040	0.1048	68581.62	5.72	6.22	261.16	0.0227	14854.99	1.24	1.35	56.57		
72	21	85	1.088	40	39.37	32	19040	0.1048	78558.58	6.55	7.12	149.58	0.0227	17016.03	1.42	1.54	32.40		
77	18	85	1.088	40	44.37	37	19040	0.1048	88535.54	7.38	8.03	144.49	0.0227	19177.07	1.60	1.74	31.30		
82	0	85	1.088	40	49.37	42	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
87	0	87	1.1182	40	54.37	47	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
92	0	92	1.17256	40	59.37	52	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
97	0	102	1.3532	40	64.37	57	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
102	0	105	1.4071	40	69.37	62	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
107	0	107	1.4471	40	74.37	67	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
112	0	112	1.547	40	79.37	72	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
											0.00	2628.74				0.00	569.39	2628.743	569.3937

Temp. bin	dec	Suction Temp	kw/ton	Space Temp	Temp. Diff	Uncorrected Temp. Diff	Roof Sqft	Total U Value (1/9.54)	BTUH	Tons	KW	KWh	U Value (1/16.44+ 27.70)	BTUH	Tons	KW	KWh		
27	5	85	1.088	40	-6.5	-13	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	52	85	1.088	40	-1.5	-8	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	137	85	1.088	40	3.5	-3	19040	0.1048	6983.87	0.58	0.63	86.75	0.0227	1512.73	0.13	0.14	18.79		
42	134	85	1.088	40	8.5	2	19040	0.1048	16960.83	1.41	1.54	206.06	0.0227	3673.77	0.31	0.33	44.63		
47	121	85	1.088	40	13.5	7	19040	0.1048	26937.79	2.24	2.44	295.53	0.0227	5834.81	0.49	0.53	64.01		
52	180	85	1.088	40	18.5	12	19040	0.1048	36914.75	3.08	3.35	602.45	0.0227	7995.85	0.67	0.72	130.49		
57	81	85	1.088	40	23.5	17	19040	0.1048	46891.71	3.91	4.25	344.37	0.0227	10156.89	0.85	0.92	74.59		
62	20	85	1.088	40	28.5	22	19040	0.1048	56868.67	4.74	5.16	103.12	0.0227	12317.83	1.03	1.12	22.34		
67	14	85	1.088	40	33.5	27	19040	0.1048	66845.63	5.57	6.06	84.85	0.0227	14478.97	1.21	1.31	18.38		
72	0	85	1.088	40	38.5	32	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
77	0	85	1.088	40	43.5	37	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
82	0	85	1.088	40	48.5	42	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
87	0	87	1.1182	40	53.5	47	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
92	0	92	1.17256	40	58.5	52	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
97	0	102	1.3532	40	63.5	57	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
102	0	105	1.4071	40	68.5	62	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
107	0	107	1.4471	40	73.5	67	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
112	0	112	1.547	40	78.5	72	19040	0.1048	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
												1723.13					373.24	1723.13	373.2352
																		60166.78	13032.31

Insulation Wharehouse C

Existing Kwh	363677.1	Proposed Kwh	16841.02
Existing KW	119.8029	ProposedKw	5.547787

Temp. Bin Data for Bakersfield SCT=30

									Existing					Proposed					
Temp. bin	Jan hours	Suction Temp	kw/ton	Space Temp	Corrected for Solar GainTemp	Uncorrect edTemp. Diff	Roof Total Sqft	U Value (1/2.04)	BTUH	Tons	KW	KWh	U Value (1/44.14)	BTUH	Tons	KW	KWh		
27	2.00	85	1.088	40	-5.63	-13	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	23.00	85	1.088	40	-0.63	-8	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	84.00	85	1.088	40	4.37	-3	24640	0.4902	52783.17	4.40	4.79	402.00	0.0227	2444.26	0.20	0.22	18.62		
42	180.00	85	1.088	40	9.37	2	24640	0.4902	113175.81	9.43	10.26	1847.03	0.0227	5240.90	0.44	0.48	85.53		
47	224.00	85	1.088	40	14.37	7	24640	0.4902	173568.45	14.46	15.74	3525.06	0.0227	8037.54	0.67	0.73	163.24		
52	131.00	85	1.088	40	19.37	12	24640	0.4902	233961.09	19.50	21.21	2778.83	0.0227	10834.18	0.90	0.98	128.88		
57	56.00	85	1.088	40	24.37	17	24640	0.4902	294353.73	24.53	26.69	1494.53	0.0227	13630.82	1.14	1.24	69.21		
62	35.00	85	1.088	40	29.37	22	24640	0.4902	354746.37	29.56	32.16	1125.73	0.0227	16427.46	1.37	1.49	52.13		
67	9.00	85	1.088	40	34.37	27	24640	0.4902	415139.01	34.59	37.64	338.75	0.0227	19224.10	1.60	1.74	15.89		
72	0.00	85	1.088	40	39.37	32	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
77	0.00	85	1.088	40	44.37	37	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
82	0.00	85	1.088	40	49.37	42	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
87	0.00	87	1.1182	40	54.37	47	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
92	0.00	92	1.17256	40	59.37	52	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
97	0.00	102	1.3532	40	64.37	57	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
102	0.00	105	1.4071	40	69.37	62	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
107	0.00	107	1.4471	40	74.37	67	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
112	0.00	112	1.547	40	79.37	72	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00	Exist kWh	Retro kWh
												11511.93					533.09	11511.9329	533.090326

Temp. Bin Data for Bakersfield SCT=30

									Existing					Proposed					
Temp. bin	Feb hours	Suction Temp	kw/ton	Space Temp	Corrected for Solar GainTemp	Uncorrect edTemp. Diff	Roof Total Sqft	U Value (1/2.04)	BTUH	Tons	KW	KWh	U Value (1/44.14)	BTUH	Tons	KW	KWh		
27	0.00	85	1.088	40	-2.5	-13	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	19.00	85	1.088	40	2.5	-8	24640	0.4902	30196.32	2.52	2.74	52.02	0.0227	1398.32	0.12	0.13	2.41		
37	59.00	85	1.088	40	7.5	-3	24640	0.4902	90588.96	7.55	8.21	484.59	0.0227	4194.96	0.35	0.38	22.44		
42	54.00	85	1.088	40	12.5	2	24640	0.4902	150981.60	12.58	13.69	739.21	0.0227	6991.60	0.58	0.63	34.23		
47	114.00	85	1.088	40	17.5	7	24640	0.4902	211374.24	17.61	19.16	2184.76	0.0227	9788.24	0.82	0.89	101.17		
52	173.00	85	1.088	40	22.5	12	24640	0.4902	271766.88	22.65	24.64	4262.75	0.0227	12584.88	1.05	1.14	197.40		
57	141.00	85	1.088	40	27.5	17	24640	0.4902	332159.52	27.68	30.12	4246.33	0.0227	15381.52	1.28	1.39	196.64		
62	67.00	85	1.088	40	32.5	22	24640	0.4902	392552.16	32.71	35.59	2384.62	0.0227	18178.16	1.51	1.65	110.43		
67	31.00	85	1.088	40	37.5	27	24640	0.4902	452944.80	37.75	41.07	1273.08	0.0227	20974.80	1.75	1.90	58.95		
72	13.00	85	1.088	40	42.5	32	24640	0.4902	513337.44	42.78	46.54	605.05	0.0227	23771.44	1.98	2.16	28.02		
77	1.00	85	1.088	40	47.5	37	24640	0.4902	573730.08	47.81	52.02	52.02	0.0227	26568.08	2.21	2.41	2.41		
82	0.00	85	1.088	40	52.5	42	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
87	0.00	87	1.1182	40	57.5	47	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
92	0.00	92	1.17256	40	62.5	52	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
97	0.00	102	1.3532	40	67.5	57	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
102	0.00	105	1.4071	40	72.5	62	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
107	0.00	107	1.4471	40	77.5	67	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
112	0.00	112	1.547	40	82.5	72	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
											0.00	16284.43				0.00	754.09	16284.4325	754.093467

Temp. Bin Data for Bakersfield SCT=30

									Existing					Proposed					
Temp. bin	March hours	Suction Temp	kw/ton	Space Temp	Corrected for Solar GainTemp	Uncorrect edTemp Diff	Roof Total Sqft	U Value (1/2.04)	BTUH	Tons	KW	KWh	U Value (1/44.14)	BTUH	Tons	KW	KWh		
27	0.00	85	1.088	40	2.875	-13	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	0.00	85	1.088	40	7.875	-8	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	20.00	85	1.088	40	12.875	-3	24640	0.4902	155511.05	12.96	14.10	281.99	0.0227	7201.35	0.60	0.65	13.06		
42	77.00	85	1.088	40	17.875	2	24640	0.4902	215903.69	17.99	19.58	1507.30	0.0227	9997.99	0.83	0.91	69.80		
47	102.00	85	1.088	40	22.875	7	24640	0.4902	276296.33	23.02	25.05	2555.19	0.0227	12794.63	1.07	1.16	118.32		
52	190.00	85	1.088	40	27.875	12	24640	0.4902	336688.97	28.06	30.53	5800.03	0.0227	15591.27	1.30	1.41	268.59		
57	137.00	85	1.088	40	32.875	17	24640	0.4902	397081.61	33.09	36.00	4932.28	0.0227	18387.91	1.53	1.67	228.40		
62	106.00	85	1.088	40	37.875	22	24640	0.4902	457474.25	38.12	41.48	4396.63	0.0227	21184.55	1.77	1.92	203.60		
67	66.00	85	1.088	40	42.875	27	24640	0.4902	517866.89	43.16	46.95	3098.92	0.0227	23981.19	2.00	2.17	143.50		
72	31.00	85	1.088	40	47.875	32	24640	0.4902	578259.53	48.19	52.43	1625.29	0.0227	26777.83	2.23	2.43	75.26		
77	15.00	85	1.088	40	52.875	37	24640	0.4902	638652.17	53.22	57.90	868.57	0.0227	29574.47	2.46	2.68	40.22		
82	0.00	85	1.088	40	57.875	42	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
87	0.00	87	1.1182	40	62.875	47	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
92	0.00	92	1.17256	40	67.875	52	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
97	0.00	102	1.3532	40	72.875	57	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
102	0.00	105	1.4071	40	77.875	62	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
107	0.00	107	1.4471	40	82.875	67	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
112	0.00	112	1.547	40	87.875	72	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
											0.00	25066.20				0.00	1160.76	25066.1988	1160.75625

Temp. Bin Data for Bakersfield SCT=30

									Existing					Proposed					
Temp. bin	April hours	Suction Temp	kw/ton	Space Temp	Corrected for Solar GainTemp	Uncorrect edTemp. Diff	Roof Total Sqft	U Value (1/2.04)	BTUH	Tons	KW	KWh	U Value (1/44.14)	BTUH	Tons	KW	KWh		
27	0.00	85	1.088	40	7.25	-13	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	0.00	85	1.088	40	12.25	-8	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	4.00	85	1.088	40	17.25	-3	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
42	22.00	85	1.088	40	22.25	2	24640	0.4902	268747.25	22.40	24.37	536.06	0.0227	12445.05	1.04	1.13	24.82		
47	67.00	85	1.088	40	27.25	7	24640	0.4902	329139.89	27.43	29.84	1999.42	0.0227	15241.69	1.27	1.38	92.59		
52	115.00	85	1.088	40	32.25	12	24640	0.4902	389532.53	32.46	35.32	4061.53	0.0227	18038.33	1.50	1.64	188.08		
57	135.00	85	1.088	40	37.25	17	24640	0.4902	449925.17	37.49	40.79	5507.08	0.0227	20834.97	1.74	1.89	255.02		
62	125.00	85	1.088	40	42.25	22	24640	0.4902	510317.81	42.53	46.27	5783.60	0.0227	23631.61	1.97	2.14	267.82		
67	90.00	85	1.088	40	47.25	27	24640	0.4902	570710.45	47.56	51.74	4657.00	0.0227	26428.25	2.20	2.40	215.65		
72	53.00	85	1.088	40	52.25	32	24640	0.4902	631103.09	52.59	57.22	3032.66	0.0227	29224.89	2.44	2.65	140.44		
77	48.00	85	1.088	40	57.25	37	24640	0.4902	691495.73	57.62	62.70	3009.39	0.0227	32021.53	2.67	2.90	139.36		
82	48.00	85	1.088	40	62.25	42	24640	0.4902	751888.37	62.66	68.17	3272.22	0.0227	34818.17	2.90	3.16	151.53		
87	12.00	87	1.1182	40	67.25	47	24640	0.4902	812281.01	67.69	75.69	908.28	0.0227	37614.81	3.13	3.51	42.06		
92	1.00	92	1.17256	40	72.25	52	24640	0.4902	872673.65	72.72	85.27	85.27	0.0227	40411.45	3.37	3.95	3.95		
97	0.00	102	1.3532	40	77.25	57	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
102	0.00	105	1.4071	40	82.25	62	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
107	0.00	107	1.4471	40	87.25	67	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
112	0.00	112	1.547	40	92.25	72	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
												32852.52					1521.32	32852.518	1521.32223

Temp. Bin Data for Bakersfield

SCT=30

Temp. bin	May hours	Suction Temp	kw/ton	Space Temp	Corrected for Solar GainTemp	Uncorrected Temp. Diff	Roof Total Sqft	U Value (1/2.04)	Existing BTUH	Tons	KW	KWh	Proposed U Value (1/44.14)	BTUH	Tons	KW	KWh		
27	0	85	1.088	41	9	-14	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	0	85	1.088	41	14	-9	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	0	85	1.088	41	19	-4	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
42	2	85	1.088	41	24	1	24640	0.4902	289884.67	24.16	26.28	52.57	0.0227	13423.87	1.12	1.22	2.43		
47	23	85	1.088	41	29	6	24640	0.4902	350277.31	29.19	31.76	730.44	0.0227	16220.51	1.35	1.47	33.83		
52	74	85	1.088	41	34	11	24640	0.4902	410669.95	34.22	37.23	2755.32	0.0227	19017.15	1.58	1.72	127.59		
57	95	85	1.088	41	39	16	24640	0.4902	471062.59	39.26	42.71	4057.42	0.0227	21813.79	1.82	1.98	187.89		
62	96	85	1.088	41	44	21	24640	0.4902	531455.23	44.29	48.19	4625.79	0.0227	24610.43	2.05	2.23	214.21		
67	108	85	1.088	41	49	26	24640	0.4902	591847.87	49.32	53.66	5795.37	0.0227	27407.07	2.28	2.48	268.37		
72	89	85	1.088	41	54	31	24640	0.4902	652240.51	54.35	59.14	5263.15	0.0227	30203.71	2.52	2.74	243.72		
77	89	85	1.088	41	59	36	24640	0.4902	712633.15	59.39	64.61	5750.47	0.0227	33000.35	2.75	2.99	266.29		
82	70	85	1.088	41	64	41	24640	0.4902	773025.79	64.42	70.09	4906.14	0.0227	35796.99	2.98	3.25	227.19		
87	53	87	1.1182	41	69	46	24640	0.4902	833418.43	69.45	77.68	4116.02	0.0227	38593.63	3.22	3.60	190.60		
92	32	92	1.17256	41	74	51	24640	0.4902	893811.07	74.48	87.34	2794.79	0.0227	41390.27	3.45	4.04	129.42		
97	12	102	1.3532	41	79	56	24640	0.4902	954203.71	79.52	107.60	1291.23	0.0227	44186.91	3.68	4.98	59.79		
102	1	105	1.4071	41	84	61	24640	0.4902	1014596.35	84.55	118.97	118.97	0.0227	46983.55	3.92	5.51	5.51		
107	0	107	1.4471	41	89	66	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
112	0	112	1.547	41	94	71	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
												42257.68					1956.85	42257.6778	1956.85289

Temp. bin	June	Suction Temp	kw/ton	Space Temp	Temp. Diff	Uncorrected Temp. Diff	Roof Total Sqft	U Value (1/2.04)	BTUH	Tons	KW	KWh	U Value (1/16.44+ 27.70)	BTUH	Tons	KW	KWh		
27	0	85	1.088	44	7	-17	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	0	85	1.088	44	12	-12	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	0	85	1.088	44	17	-7	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
42	0	85	1.088	44	22	-2	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
47	0	85	1.088	44	27	3	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
52	6	85	1.088	44	32	8	24640	0.4902	386512.90	32.21	35.04	210.26	0.0227	17898.50	1.49	1.62	9.74		
57	37	85	1.088	44	37	13	24640	0.4902	446905.54	37.24	40.52	1499.22	0.0227	20695.14	1.72	1.88	69.43		
62	95	85	1.088	44	42	18	24640	0.4902	507298.18	42.27	46.00	4369.53	0.0227	23491.78	1.96	2.13	202.34		
67	90	85	1.088	44	47	23	24640	0.4902	567690.82	47.31	51.47	4632.36	0.0227	26288.42	2.19	2.38	214.51		
72	93	85	1.088	44	52	28	24640	0.4902	628083.46	52.34	56.95	5296.00	0.0227	29085.06	2.42	2.64	245.25		
77	87	85	1.088	44	57	33	24640	0.4902	688476.10	57.37	62.42	5430.70	0.0227	31881.70	2.66	2.89	251.48		
82	95	85	1.088	44	62	38	24640	0.4902	748868.74	62.41	67.90	6450.26	0.0227	34678.34	2.89	3.14	298.70		
87	74	87	1.1182	44	67	43	24640	0.4902	809261.38	67.44	75.41	5580.32	0.0227	37474.98	3.12	3.49	258.41		
92	79	92	1.17256	44	72	48	24640	0.4902	869654.02	72.47	84.98	6713.17	0.0227	40271.62	3.36	3.94	310.87		
97	43	102	1.3532	44	77	53	24640	0.4902	930046.66	77.50	104.88	4509.77	0.0227	43068.26	3.59	4.86	208.84		
102	21	105	1.4071	44	82	58	24640	0.4902	990439.30	82.54	116.14	2438.88	0.0227	45864.90	3.82	5.38	112.94		
107	0	107	1.4471	44	87	63	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
112	0	112	1.547	44	92	68	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
											0.00	47130.45				0.00	2182.50	47130.4528	2182.49955

Temp. bin	July	Suction Temp	kw/ton	Space Temp	Temp. Diff	Uncorrected Temp. Diff	Roof Total Sqft	U Value (1/2.04)	BTUH	Tons	KW	KWh	U Value (1/16.44+ 27.70)	BTUH	Tons	KW	KWh		
27	0	85	1.088	48	2	-21	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	0	85	1.088	48	7	-16	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	0	85	1.088	48	12	-11	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
42	0	85	1.088	48	17	-6	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
47	0	85	1.088	48	22	-1	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
52	0	85	1.088	48	27	4	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
57	10	85	1.088	48	32	9	24640	0.4902	386512.90	32.21	35.04	350.44	0.0227	17898.50	1.49	1.62	16.23		
62	46	85	1.088	48	37	14	24640	0.4902	446905.54	37.24	40.52	1863.89	0.0227	20695.14	1.72	1.88	86.31		
67	67	85	1.088	48	42	19	24640	0.4902	507298.18	42.27	46.00	3081.67	0.0227	23491.78	1.96	2.13	142.70		
72	103	85	1.088	48	47	24	24640	0.4902	567690.82	47.31	51.47	5301.48	0.0227	26288.42	2.19	2.38	245.50		
77	100	85	1.088	48	52	29	24640	0.4902	628083.46	52.34	56.95	5694.62	0.0227	29085.06	2.42	2.64	263.70		
82	103	85	1.088	48	57	34	24640	0.4902	688476.10	57.37	62.42	6429.45	0.0227	31881.70	2.66	2.89	297.73		
87	103	87	1.1182	48	62	39	24640	0.4902	748868.74	62.41	69.78	7187.55	0.0227	34678.34	2.89	3.23	332.84		
92	95	92	1.17256	48	67	44	24640	0.4902	809261.38	67.44	79.08	7512.18	0.0227	37474.98	3.12	3.66	347.87		
97	84	102	1.3532	48	72	49	24640	0.4902	869654.02	72.47	98.07	8237.71	0.0227	40271.62	3.36	4.54	381.47		
102	30	105	1.4071	48	77	54	24640	0.4902	930046.66	77.50	109.06	3271.67	0.0227	43068.26	3.59	5.05	151.50		
107	3	107	1.4471	48	82	59	24640	0.4902	990439.30	82.54	119.44	358.32	0.0227	45864.90	3.82	5.53	16.59		
112	0	112	1.547	48	87	64	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
											0.00	49288.98				0.00	2282.46	49288.9849	2282.45605

Temp. bin	Aug'	Suction Temp	kw/ton	Space Temp	Temp. Diff	Uncorrected Temp. Diff	Roof Total Sqft	U Value (1/2.04)	BTUH	Tons	KW	KWh	U Value (1/16.44+ 27.70)	BTUH	Tons	KW	KWh		
27	0	85	1.088	45	2.25	-18	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	0	85	1.088	45	7.25	-13	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	0	85	1.088	45	12.25	-8	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
42	0	85	1.088	45	17.25	-3	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
47	0	85	1.088	45	22.25	2	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
52	0	85	1.088	45	27.25	7	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
57	11	85	1.088	45	32.25	12	24640	0.4902	389532.53	32.46	35.32	388.49	0.0227	18038.33	1.50	1.64	17.99		
62	59	85	1.088	45	37.25	17	24640	0.4902	449925.17	37.49	40.79	2406.80	0.0227	20834.97	1.74	1.89	111.45		
67	106	85	1.088	45	42.25	22	24640	0.4902	510317.81	42.53	46.27	4904.49	0.0227	23631.61	1.97	2.14	227.12		
72	113	85	1.088	45	47.25	27	24640	0.4902	570710.45	47.56	51.74	5847.12	0.0227	26428.25	2.20	2.40	270.77		
77	97	85	1.088	45	52.25	32	24640	0.4902	631103.09	52.59	57.22	5550.34	0.0227	29224.89	2.44	2.65	257.02		
82	100	85	1.088	45	57.25	37	24640	0.4902	691495.73	57.62	62.70	6269.56	0.0227	32021.53	2.67	2.90	290.33		
87	81	87	1.1182	45	62.25	42	24640	0.4902	751888.37	62.66	70.06	5675.14	0.0227	34818.17	2.90	3.24	262.80		
92	78	92	1.17256	45	67.25	47	24640	0.4902	812281.01	67.69	79.37	6190.91	0.0227	37614.81	3.13	3.68	286.69		
97	56	102	1.3532	45	72.25	52	24640	0.4902	872673.65	72.72	98.41	5510.88	0.0227	40411.45	3.37	4.56	255.20		
102	41	105	1.4071	45	77.25	57	24640	0.4902	933066.29	77.76	109.41	4485.80	0.0227	43208.09	3.60	5.07	207.73		
107	2	107	1.4471	45	82.25	62	24640	0.4902	993458.93	82.79	119.80	239.61	0.0227	46004.73	3.83	5.55	11.10		
112	0	112	1.547	45	87.25	67	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
											119.80	47469.15				5.55	2198.18	47469.1466	2198.18365

Temp bin	Sept	Suction Temp	kw/ton	Space Temp	Temp. Diff	Uncorrect edTemp. Diff	Roof Total Sqft	U Value (1/2.04)	BTUH	Tons	KW	KWh	U Value (1/16.44+ 27.70)	BTUH	Tons	KW	KWh		
27	0	85	1.088	43	-0.125	-16	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	0	85	1.088	43	4.875	-11	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	0	85	1.088	43	9.875	-6	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
42	0	85	1.088	43	14.875	-1	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
47	0	85	1.088	43	19.875	4	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
52	13	85	1.088	43	24.875	9	24640	0.4902	300453.38	25.04	27.24	354.13	0.0227	13913.28	1.16	1.26	16.40		
57	62	85	1.088	43	29.875	14	24640	0.4902	360846.02	30.07	32.72	2028.44	0.0227	16709.92	1.39	1.52	93.93		
62	116	85	1.088	43	34.875	19	24640	0.4902	421238.66	35.10	38.19	4430.31	0.0227	19506.56	1.63	1.77	205.16		
67	122	85	1.088	43	39.875	24	24640	0.4902	481631.30	40.14	43.67	5327.48	0.0227	22303.20	1.86	2.02	246.70		
72	105	85	1.088	43	44.875	29	24640	0.4902	542023.94	45.17	49.14	5160.07	0.0227	25099.84	2.09	2.28	238.95		
77	79	85	1.088	43	49.875	34	24640	0.4902	602416.58	50.20	54.62	4314.91	0.0227	27896.48	2.32	2.53	199.81		
82	77	85	1.088	43	54.875	39	24640	0.4902	662809.22	55.23	60.09	4627.29	0.0227	30693.12	2.56	2.78	214.28		
87	72	87	1.1182	43	59.875	44	24640	0.4902	723201.86	60.27	67.39	4852.11	0.0227	33489.76	2.79	3.12	224.69		
92	50	92	1.17256	43	64.875	49	24640	0.4902	783594.50	65.30	76.57	3828.38	0.0227	36286.40	3.02	3.55	177.28		
97	21	102	1.3532	43	69.875	54	24640	0.4902	843987.14	70.33	95.17	1998.65	0.0227	39083.04	3.26	4.41	92.55		
102	3	105	1.4071	43	74.875	59	24640	0.4902	904379.78	75.36	106.05	318.14	0.0227	41879.68	3.49	4.91	14.73		
107	0	107	1.4471	43	79.875	64	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
112	0	112	1.547	43	84.875	69	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
											0.00	37239.90				0.00	1724.49	37239.9029	1724.49163

Temp. bin	Oct	Suction Temp	kw/ton	Space Temp	Temp. Diff	Uncorrect edTemp. Diff	Roof Total Sqft	U Value (1/2.04)	BTUH	Tons	KW	KWh	U Value (1/16.44+ 27.70)	BTUH	Tons	KW	KWh		
27	0	85	1.088	40	-2.5	-13	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	0	85	1.088	40	2.5	-8	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	0	85	1.088	40	7.5	-3	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
42	13	85	1.088	40	12.5	2	24640	0.4902	150981.60	12.58	13.69	177.96	0.0227	6991.60	0.58	0.63	8.24		
47	47	85	1.088	40	17.5	7	24640	0.4902	211374.24	17.61	19.16	900.74	0.0227	9788.24	0.82	0.89	41.71		
52	91	85	1.088	40	22.5	12	24640	0.4902	271766.88	22.65	24.64	2242.26	0.0227	12584.88	1.05	1.14	103.83		
57	120	85	1.088	40	27.5	17	24640	0.4902	332159.52	27.68	30.12	3613.90	0.0227	15381.52	1.28	1.39	167.35		
62	119	85	1.088	40	32.5	22	24640	0.4902	392552.16	32.71	35.59	4235.38	0.0227	18178.16	1.51	1.65	196.13		
67	97	85	1.088	40	37.5	27	24640	0.4902	452944.80	37.75	41.07	3983.50	0.0227	20974.80	1.75	1.90	184.47		
72	101	85	1.088	40	42.5	32	24640	0.4902	513337.44	42.78	46.54	4700.80	0.0227	23771.44	1.98	2.16	217.68		
77	72	85	1.088	40	47.5	37	24640	0.4902	573730.08	47.81	52.02	3745.31	0.0227	26568.08	2.21	2.41	173.44		
82	51	85	1.088	40	52.5	42	24640	0.4902	634122.72	52.84	57.49	2932.18	0.0227	29364.72	2.45	2.66	135.78		
87	23	87	1.1182	40	57.5	47	24640	0.4902	694515.36	57.88	64.72	1488.50	0.0227	32161.36	2.68	3.00	68.93		
92	10	92	1.17256	40	62.5	52	24640	0.4902	754908.00	62.91	73.76	737.65	0.0227	34958.00	2.91	3.42	34.16		
97	0	102	1.3532	40	67.5	57	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
102	0	105	1.4071	40	72.5	62	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
107	0	107	1.4471	40	77.5	67	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
112	0	112	1.547	40	82.5	72	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
											0.00	28758.16				0.00	1331.72	28758.1594	1331.72219

Temp. bin	Nov	Suction Temp	kw/ton	Space Temp	Temp. Diff	Uncorrect edTemp. Diff	Roof Total Sqft	U Value (1/2.04)	BTUH	Tons	KW	KWh	U Value (1/16.44+ 27.70)	BTUH	Tons	KW	KWh		
27	0	85	1.088	40	-5.63	-13	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	14	85	1.088	40	-0.63	-8	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	47	85	1.088	40	4.37	-3	24640	0.4902	52783.17	4.40	4.79	224.93	0.0227	2444.26	0.20	0.22	10.42		
42	71	85	1.088	40	9.37	2	24640	0.4902	113175.81	9.43	10.26	728.55	0.0227	5240.90	0.44	0.48	33.74		
47	144	85	1.088	40	14.37	7	24640	0.4902	173568.45	14.46	15.74	2266.11	0.0227	8037.54	0.67	0.73	104.94		
52	146	85	1.088	40	19.37	12	24640	0.4902	233961.09	19.50	21.21	3097.02	0.0227	10834.18	0.90	0.98	143.42		
57	136	85	1.088	40	24.37	17	24640	0.4902	294353.73	24.53	26.69	3629.58	0.0227	13630.82	1.14	1.24	168.08		
62	81	85	1.088	40	29.37	22	24640	0.4902	354746.37	29.56	32.16	2605.26	0.0227	16427.46	1.37	1.49	120.64		
67	42	85	1.088	40	34.37	27	24640	0.4902	415139.01	34.59	37.64	1580.85	0.0227	19224.10	1.60	1.74	73.21		
72	21	85	1.088	40	39.37	32	24640	0.4902	475531.65	39.63	43.11	905.41	0.0227	22020.74	1.84	2.00	41.93		
77	18	85	1.088	40	44.37	37	24640	0.4902	535924.29	44.66	48.59	874.63	0.0227	24817.38	2.07	2.25	40.50		
82	0	85	1.088	40	49.37	42	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	27614.02	2.30	0.00	0.00		
87	0	87	1.1182	40	54.37	47	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	30410.66	2.53	0.00	0.00		
92	0	92	1.17256	40	59.37	52	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	33207.30	2.77	0.00	0.00		
97	0	102	1.3532	40	64.37	57	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	36003.94	3.00	0.00	0.00		
102	0	105	1.4071	40	69.37	62	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	38800.58	3.23	0.00	0.00		
107	0	107	1.4471	40	74.37	67	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	41597.22	3.47	0.00	0.00		
112	0	112	1.547	40	79.37	72	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	44393.86	3.70	0.00	0.00		
											0.00	15912.33				0.00	736.86	15912.3327	736.862406

Temp. bin	dec	Suction Temp	kw/ton	Space Temp	Temp. Diff	Uncorrect edTemp. Diff	Roof Total Sqft	U Value (1/2.04)	BTUH	Tons	KW	KWh	U Value (1/16.44+ 27.70)	BTUH	Tons	KW	KWh		
27	5	85	1.088	40	-6.5	-13	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
32	52	85	1.088	40	-1.5	-8	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
37	137	85	1.088	40	3.5	-3	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
42	134	85	1.088	40	8.5	2	24640	0.4902	102667.49	8.56	9.31	1247.34	0.0227	4754.29	0.40	0.43	57.76		
47	121	85	1.088	40	13.5	7	24640	0.4902	163060.13	13.59	14.78	1788.88	0.0227	7550.93	0.63	0.68	82.84		
52	180	85	1.088	40	18.5	12	24640	0.4902	223452.77	18.62	20.26	3646.75	0.0227	10347.57	0.86	0.94	168.87		
57	81	85	1.088	40	23.5	17	24640	0.4902	283845.41	23.65	25.74	2084.56	0.0227	13144.21	1.10	1.19	96.53		
62	20	85	1.088	40	28.5	22	24640	0.4902	344238.05	28.69	31.21	624.22	0.0227	15940.85	1.33	1.45	28.91		
67	14	85	1.088	40	33.5	27	24640	0.4902	404630.69	33.72	36.69	513.61	0.0227	18737.49	1.56	1.70	23.78		
72	0	85	1.088	40	38.5	32	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
77	0	85	1.088	40	43.5	37	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
82	0	85	1.088	40	48.5	42	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
87	0	87	1.1182	40	53.5	47	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
92	0	92	1.17256	40	58.5	52	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
97	0	102	1.3532	40	63.5	57	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
102	0	105	1.4071	40	68.5	62	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
107	0	107	1.4471	40	73.5	67	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
112	0	112	1.547	40	78.5	72	24640	0.4902	0.00	0.00	0.00	0.00	0.0227	0.00	0.00	0.00	0.00		
												9905.36					458.69	9905.35924	458.693706
																		363677.098	16841.0243

clz 3 Yac Site 2443

Total

		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	2	0	0	0	0	0	0	0	0	0	0	5	7
	32	23	19	0	0	0	0	0	0	0	0	14	52	108
	37	84	59	20	4	0	0	0	0	0	0	47	137	351
	42	180	54	77	22	2	0	0	0	0	13	71	134	553
	47	224	114	102	67	23	0	0	0	0	47	144	121	842
	52	131	173	190	115	74	6	0	0	13	91	146	180	1119
	57	56	141	137	135	95	37	10	11	62	120	136	81	1021
	62	35	67	106	125	96	95	46	59	116	119	81	20	965
	67	9	31	66	90	108	90	67	106	122	97	42	14	842
	72	0	13	31	53	89	93	103	113	105	101	21	0	722
	77	0	1	15	48	89	87	100	97	79	72	18	0	606
	82	0	0	0	48	70	95	103	100	77	51	0	0	544
	87	0	0	0	12	53	74	103	81	72	23	0	0	418
	92	0	0	0	1	32	79	95	78	50	10	0	0	345
	97	0	0	0	0	12	43	84	56	21	0	0	0	216
	102	0	0	0	0	1	21	30	41	3	0	0	0	96
	107	0	0	0	0	0	0	3	2	0	0	0	0	5
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

01-08

		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	2	0	0	0	0	0	0	0	0	0	0	5	7
	32	19	19	0	0	0	0	0	0	0	0	14	42	94
	37	55	53	20	4	0	0	0	0	0	0	37	84	253
	42	88	31	68	21	2	0	0	0	0	13	47	44	314
	47	73	66	66	54	23	0	0	0	0	43	89	32	446
	52	10	46	83	81	62	6	0	0	13	71	43	33	448
	57	0	9	11	57	60	34	10	11	55	73	10	7	337
	62	1	0	0	18	48	72	45	56	87	42	0	1	370
	67	0	0	0	3	39	68	62	86	69	6	0	0	333
	72	0	0	0	2	12	41	74	65	15	0	0	0	209
	77	0	0	0	0	2	14	45	27	1	0	0	0	89
	82	0	0	0	0	0	5	10	3	0	0	0	0	18
	87	0	0	0	0	0	0	2	0	0	0	0	0	2
	92	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

09-16

		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	8	1	0	0	0	0	0	0	0	0	3	14	26
	42	34	4	0	0	0	0	0	0	0	0	5	33	76
	47	61	14	6	0	0	0	0	0	0	0	12	41	134
	52	69	49	33	5	1	0	0	0	0	0	30	80	267
	57	43	75	58	16	10	0	0	0	0	8	68	52	330
	62	26	43	65	53	14	9	0	0	4	20	54	14	302
	67	7	25	47	53	27	4	0	4	10	37	35	14	263
	72	0	12	25	31	34	18	3	9	36	62	16	0	246
	77	0	1	14	33	50	28	11	26	34	53	17	0	267
	82	0	0	0	38	43	51	37	49	45	39	0	0	302
	87	0	0	0	10	35	39	53	43	50	19	0	0	249
	92	0	0	0	1	22	50	62	45	39	10	0	0	229
	97	0	0	0	0	11	28	56	38	19	0	0	0	152
	102	0	0	0	0	1	13	23	32	3	0	0	0	72
	107	0	0	0	0	0	0	3	2	0	0	0	0	5
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

17-24

		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	4	0	0	0	0	0	0	0	0	0	0	10	14
	37	21	5	0	0	0	0	0	0	0	0	7	39	72
	42	58	19	9	1	0	0	0	0	0	0	19	57	163
	47	90	34	30	13	0	0	0	0	0	4	43	48	262
	52	52	78	74	29	11	0	0	0	0	20	73	67	404
	57	13	57	68	62	25	3	0	0	7	39	58	22	354
	62	8	24	41	54	34	14	1	3	25	57	27	5	293
	67	2	6	19	34	42	18	5	16	43	54	7	0	246
	72	0	1	6	20	43	34	26	39	54	39	5	0	267
	77	0	0	1	15	37	45	44	44	44	19	1	0	250
	82	0	0	0	10	27	39	56	48	32	12	0	0	224
	87	0	0	0	2	18	35	48	38	22	4	0	0	167
	92	0	0	0	0	10	29	33	33	11	0	0	0	116
	97	0	0	0	0	1	15	28	18	2	0	0	0	64
	102	0	0	0	0	0	8	7	9	0	0	0	0	24
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

Chiller Replacement (Site 2514)

Program	Retrofit Efficiency Options Program
Measure	High Efficiency Water-Cooled Chiller
Site Description	Retail

Measure Description

Replace existing chiller with high-efficiency water-cooled chiller.

Summary of Ex Ante Impact Calculations

Tables of standard values were developed using the HBSSM simulation program based on climate zone, chiller size, building type, chiller efficiency, and condenser water temperature. Values from these tables are used to calculate the rebate and associated impacts.

Comments on PG&E Calculations

The correct climate zone, chiller size category, building type and chiller efficiency used in the application calculations.

Evaluation Process

The evaluation process consisted of reviewing the application form and supporting documentation, conducting an on-site survey and then computing impacts using the on-site data. Models were calibrated with actual weather, number of compressor hours as well as an observed operating point, %load @ the outside air temperature. Peak demand was calculated for actual peak temperatures. Energy savings were based on typical weather data. A Title 24 baseline, IPLV at ARI conditions, and typical year bin weather data were used in the bin analysis.

The on-site survey was conducted on October 21, 1998. Information on the retrofit equipment and operating conditions were collected through an inspection of the chiller and through an interview with the Chief Engineer.

Discussions provided data for development of a relationship between chiller loading and outdoor dry bulb temperatures. The chiller is available 10 am until 9:30pm, everyday of the year. Chiller use generally begins at 70 degrees outside air temperature and reaches 100% loading at 95 Degrees F.

To compute the impacts, the following assumptions were used:

- A linear loading strategy was used for the analysis of both the baseline, and rebated chillers, which assumed 10% loading at 70 degrees and 100% loading at 95 Degrees F.
- For the baseline chiller case a Title 24 baseline efficiency of 0.837 KW/ton was used, based on a water-cooled chiller between 150 and 300 tons.
- Chiller efficiencies at various temperatures were interpolated from values provided at 25%, 50%, 75%, and 100% loading at ARI conditions. These calculated efficiencies were used to develop a

chiller efficiency curve for the Rebate case. The baseline chiller efficiency curve was based on minimum Title 24 full load efficiency requirements, matched to a typical chiller performance curve.

The above assumptions were incorporated into a spreadsheet where energy and demand impacts were calculated. Evaluation- based demand impacts were higher and energy impacts were lower, than Ex Ante estimates. Results from these calculations are summarized below and documented in the attached workbook.

Additional Notes

Impact Results

	KW	KWh	Therm
MDSS	73.53	105,384.4	0
Adjusted Engineering	81.80	20,799.3	0
Engineering Realization Rate	1.11	0.20	N/A

Site # 2514	WYEC Weather		
	kWh	kW	therms
PG&E	105,384.37	73.53	-
QC Impact	20,799.28	81.80	-
			-
I-Eng. Real. Rate	0.20	1.11	

New Chiller Efficiency		
%	Tons	kW/Ton
25%	71.25	0.710
50%	142.5	0.480
75%	213.75	0.500
100%	285	0.550
iplv (kW/Ton	0.51772684	

Operational Parameters	New Chiller (Centrifugal)	
	Minimum	Maximum
Chiller Output (Ton)	28.5	285
OSA Temp	72	99
% Of Capacity	10%	100%

Basecase

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-		0.0	0.00	-
32	0.00%	-		0.0	0.00	-
37	0.00%	-		0.0	0.00	-
42	0.00%	-		0.0	0.00	-
47	0.00%	-		0.0	0.00	-
52	0.00%	-		0.0	0.00	-
57	0.00%	-		0.0	0.00	-
62	0.00%	-		0.0	0.00	-
67	0.00%	-		0.0	0.00	-
72	10.00%	29	1.365	38.9	459.88	17,890
77	28.00%	80	0.981	78.3	364.44	28,535
82	46.00%	131	0.824	108.0	207.44	22,409
87	64.00%	182	0.789	144.0	75.06	10,805
92	82.00%	234	0.796	186.0	18.38	3,417
97	100.00%	285	0.837	238.5	7.31	1,744
102	100.00%	285	0.837	238.5	0.00	-
				238.5	1132.50	84,801

Rebate Case

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000		0.00	0.0	0.00	-
32	0.00%	-	0.000		0.00	0.0	0.00	-
37	0.00%	-	0.000		0.00	0.0	0.00	-
42	0.00%	-	0.000		0.00	0.0	0.00	-
47	0.00%	-	0.000		0.00	0.0	0.00	-
52	0.00%	-	0.000		0.00	0.0	0.00	-
57	0.00%	-	0.000		0.00	0.0	0.00	-
62	0.00%	-	0.000		0.00	0.0	0.00	-
67	0.00%	-	0.000		0.00	0.0	0.00	-
72	10.00%	29	1.508	#1	1.508	43.0	459.88	19,765
77	28.00%	80	0.691	#1	0.691	55.2	364.44	20,104
82	46.00%	131	0.517	#1	0.517	67.8	207.44	14,054
87	64.00%	182	0.491	#1	0.491	89.6	75.06	6,725
92	82.00%	234	0.514	#1	0.514	120.1	18.38	2,207
97	100.00%	285	0.550	#1	0.550	156.8	7.31	1,146
102	100.00%	285	0.550	#1	0.550	156.8	0.00	-
						156.8	1132.50	64,002
	max @102							

% Loading	Eff base case	% Loading	Eff rebate case	rebate	% Loading	base
10.000	1.365	10.000	1.508	1.508	10.00%	1.365
20.000	1.095	20.000	0.774	0.691	28.00%	0.981
25.000	1.004	25.000	0.710	0.517	46.00%	0.824
30.000	0.966	30.000		0.491	64.00%	0.789
40.000	0.863	40.000		0.514	82.00%	0.796
50.000	0.798	50.000	0.480	0.550	100.00%	0.837
60.000	0.792	60.000		0.550	100.00%	0.837
70.000	0.785	70.000				
75.000	0.785	75.000	0.500			
80.000	0.792	80.000				
90.000	0.811	90.000				
100.000	0.837	100.000	0.550			

clz 4 Site 2514

Total		Month													10 am-9:30 pm 364 day/yr	
		1	2	3	4	5	6	7	8	9	10	11	12	Total		
Tempe	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	27	3	0	0	0	0	0	0	0	0	0	0	4	7	0	
	32	24	14	0	0	0	0	0	0	0	0	5	37	80	2.063	
	37	61	52	18	13	0	0	0	0	0	1	32	77	254	16.75	
	42	148	83	72	51	10	2	0	0	0	16	93	96	571	75.31	
	47	171	120	134	112	58	32	7	1	25	62	128	111	961	181.7	
	52	183	131	179	149	168	72	57	42	63	99	149	205	1497	404.9	
	57	108	160	146	132	138	137	168	154	104	169	170	160	1746	613.8	
	62	42	76	124	120	106	127	115	105	146	150	85	44	1240	572.4	
	67	4	27	53	64	114	98	104	122	103	107	33	10	839	468.1	
	72	0	9	14	42	88	108	115	110	115	64	22	0	687	459.9	459.9
	77	0	0	4	25	40	73	95	114	99	40	3	0	493	364.4	364.4
	82	0	0	0	11	14	54	51	73	42	21	0	0	266	207.4	207.4
	87	0	0	0	1	6	13	23	17	16	13	0	0	89	75.06	75.06
	92	0	0	0	0	2	3	7	3	4	2	0	0	21	18.38	18.38
	97	0	0	0	0	0	1	2	3	3	0	0	0	9	7.313	7.313
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
																1133 at 72 deg

01-08		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Tempe	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	3	0	0	0	0	0	0	0	0	0	0	4	7
	32	22	14	0	0	0	0	0	0	0	0	5	36	77
	37	48	47	17	13	0	0	0	0	0	1	28	59	213
	42	92	54	61	43	10	2	0	0	0	16	77	47	402
	47	58	55	91	84	55	32	7	1	25	56	63	38	565
	52	19	22	64	61	123	65	49	42	51	81	44	43	664
	57	6	24	15	33	52	86	131	123	63	77	22	12	644
	62	0	8	0	6	8	45	40	48	79	14	1	9	258
	67	0	0	0	0	0	9	19	30	18	3	0	0	79
	72	0	0	0	0	0	1	2	4	4	0	0	0	11
	77	0	0	0	0	0	0	0	0	0	0	0	0	0
	82	0	0	0	0	0	0	0	0	0	0	0	0	0
	87	0	0	0	0	0	0	0	0	0	0	0	0	0
	92	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

09-16		Month													
		1	2	3	4	5	6	7	8	9	10	11	12	Total	10 am start
Tempe	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	2	0	0	0	0	0	0	0	0	0	0	0	2	1.75
	37	3	0	1	0	0	0	0	0	0	0	0	3	7	6.125
	42	22	4	2	0	0	0	0	0	0	0	2	10	40	35
	47	44	20	3	0	0	0	0	0	0	0	12	24	103	90.13
	52	72	41	34	11	1	0	0	0	0	0	33	65	257	224.9
	57	67	89	66	35	14	1	1	1	0	20	75	110	479	419.1
	62	34	43	82	77	40	21	9	5	7	58	69	27	472	413
	67	4	21	44	49	72	40	32	26	26	61	26	9	410	358.8
	72	0	6	13	35	68	69	60	54	65	52	20	0	442	386.8
	77	0	0	3	23	33	49	75	81	82	25	3	0	374	327.3
	82	0	0	0	9	13	44	40	59	38	18	0	0	221	193.4
	87	0	0	0	1	5	12	22	17	15	12	0	0	84	73.5
	92	0	0	0	0	2	3	7	3	4	2	0	0	21	18.38
	97	0	0	0	0	0	1	2	2	3	0	0	0	8	7
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0
								206	216	207	109	23	0		
									761						

17-24		Month													
		1	2	3	4	5	6	7	8	9	10	11	12	Total	9:30 shut down
Tempe	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	1	1	0.313
	37	10	5	0	0	0	0	0	0	0	0	4	15	34	10.63
	42	34	25	9	8	0	0	0	0	0	0	14	39	129	40.31
	47	69	45	40	28	3	0	0	0	0	6	53	49	293	91.56
	52	92	68	81	77	44	7	8	0	12	18	72	97	576	180
	57	35	47	65	64	72	50	36	30	41	72	73	38	623	194.7
	62	8	25	42	37	58	61	66	52	60	78	15	8	510	159.4
	67	0	6	9	15	42	49	53	66	59	43	7	1	350	109.4
	72	0	3	1	7	20	38	53	52	46	12	2	0	234	73.13
	77	0	0	1	2	7	24	20	33	17	15	0	0	119	37.19
	82	0	0	0	2	1	10	11	14	4	3	0	0	45	14.06
	87	0	0	0	0	1	1	1	0	1	1	0	0	5	1.563
	92	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	1	0	0	0	0	1	0.313
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0
								85	100	68	31	2	0		

Chiller Replacement (Site 2515)

Program	Retrofit Efficiency Options Program
Measure	High Efficiency Water-Cooled Chiller
Site Description	Retail

Measure Description Replace existing chiller with high-efficiency water-cooled chiller.

Summary of Ex Ante Impact Calculations Tables of standard values were developed using the HBSSM simulation program based on climate zone, chiller size, building type, chiller efficiency, and condenser water temperature. Values from these tables are used to calculate the rebate and associated impacts.

Comments on PG&E Calculations The correct climate zone, chiller size category, and building type were used in the application. The chiller efficiency at 100% load and not the APLV was used. In this case the APLV would have been less KW/ton than the value used. The approach temperature was also underestimated by one degree.

Evaluation Process The evaluation process consisted of reviewing the application form and supporting documentation, conducting an on-site survey and then computing impacts using the on-site data. Models were calibrated with actual weather, number of compressor hours as well as an observed operating point, %load @ the outside air temperature. Peak demand was calculated for actual peak temperatures. Energy savings were based on typical weather data. A Title 24 baseline, IPLV at ARI conditions, and typical year bin weather were used in the bin analysis.

The on-site survey was conducted on October 19, 1998. Information on the retrofit equipment and operating conditions were collected through an inspection of the chiller and through an interview with the Chief Engineer.

Discussions provided data for development of a relationship between chiller loading and outdoor dry bulb temperatures. The chiller is available form 10am to 9pm everyday of the year. Chiller use generally begins at 70 degrees outside air temperature and reaches 100% loading at 102 Degrees F.

To compute the impacts, the following assumptions were used:

- A linear loading strategy was used for the analysis of the baseline and rebated chillers, which assumed 10% loading at 70 degrees and 100% loading at 102 Degrees F.
- For the baseline chiller case a Title 24 baseline efficiency of 0.837 KW/ton was used, based on a water-cooled chiller between 150 and 300 tons.

- Chiller efficiencies at various temperatures were interpolated from values provided at 25%, 50%, 75%, and 100% loading at ARI conditions. These calculated efficiencies were used to develop a chiller efficiency curve for the Rebate case. The baseline chiller efficiency curve was based on minimum Title 24 full load efficiency requirements, matched to a typical chiller performance curve.

The above assumptions were incorporated into a spreadsheet where energy and demand impacts were calculated. Evaluation- based demand and energy impacts were lower than Ex Ante estimates. Results from these calculations are summarized below and documented in the attached workbook.

Additional Notes

Savings were calculated in a similar manner. Results from these calculations are documented in the attached workbooks.

Impact Results

	KW	KWh	Therm
MDSS	100.18	140,947.6	0
Adjusted Engineering	61.40	22,502.2	0
Engineering Realization Rate	0.61	0.16	N/A

	kWh	kW	therms
PG&E	140,947.62	100.18	-
QC Baseline	22,502.23	61.40	-
			-
Eng. Realization	0.16	0.61	

New Chiller Efficiency

%	Tons	kW/Ton
25%	50	0.550
50%	100	0.427
75%	150	0.461
100%	200	0.516

iplv (kW/Ton 0.46533199

Operational Parameters	**New Chiller**		**Old Chiller**	
Base Case	**Minimum**	**Maximum**	**Minimum**	**Maximum**
Chiller Output (Ton)	20	200	16	161
OSA Temp	70	99	70	92.86
% Of Capacity	10%	100%	10%	100%

Basecase

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-		0.0		-
32	0.00%	-		0.0		-
37	0.00%	-		0.0		-
42	0.00%	-		0.0		-
47	0.00%	-		0.0		-
52	0.00%	-		0.0		-
57	0.00%	-		0.0		-
62	0.00%	-		0.0		-
67	0.00%	-		0.0		-
72	10.00%	20	1.163	23.3	342.8	7,973
77	26.90%	54	0.872	46.9	294	13,788
82	43.80%	88	0.699	61.2	213	13,039
87	60.70%	121	0.711	86.3	162	13,973
92	77.60%	155	0.756	117.4	83.3	9,778
97	94.50%	189	0.811	153.2	34.5	5,286
102	100.00%	200	0.823	164.6	0	-
107	100.00%	200	0.823	164.6	0	-
				164.6	1129.6	63,836

Rebate Case

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	#1	0	0.0	0	-
32	0.00%	-	0.000	#1	0	0.0		-
37	0.00%	-	0.000	#1	0	0.0		-
42	0.00%	-	0.000	#1	0	0.0		-
47	0.00%	-	0.000	#1	0	0.0		-
52	0.00%	-	0.000	#1	0	0.0		-
57	0.00%	-	0.000	#1	0.000	0.0		-
62	0.00%	-	0.000	#1	0.000	0.0		-
67	0.00%	-	0.000	#1	0.000	0.0		-
72	10.0%	20.0	1.004	#1	1.004	20.1	342.8	6,883
77	26.9%	53.8	0.5371	#1	0.5371	28.9	294	8,495
82	43.8%	87.6	0.431	#1	0.431	37.7	213	8,036
87	60.7%	121.4	0.438	#1	0.438	53.2	162	8,614
92	77.6%	155.2	0.466	#1	0.466	72.3	83.3	6,025
97	94.5%	189.0	0.503	#1	0.503	95.1	34.5	3,280
102	100.0%	200.0	0.516	#1	0.516	103.2	0	-
107	100.0%	200.0	0.516	#1	0.516	103.2	0	-
						103.2	1129.6	41,334

	base case		rebate case	rebate		base
10	1.629	10	1.004	1.00	10.000	116.29%
20	1.004	20	0.619	53.71%	26.900	87.17%
25	0.893	30	0.516	43.07%	43.800	69.88%
30	0.837	40	0.433	0.44	60.700	71.05%
40	0.703	50	0.427	46.60%	77.600	75.63%
50	0.692	60	0.437	50.30%	94.500	81.06%
60	0.709	70	0.451	0.516	100.000	0.823
70	0.731	80	0.471			
75	0.748	90	0.492			
80	0.764	100	0.516			
90	0.789	25	0.55			
100	0.837	75	0.461			

Estimated number of hrs w/in 7% of Actual

WYEC-clz 2 Site 2515
Total Month

		1	2	3	4	5	6	7	8	9	10	11	12	Total	Total 10am -9 pm		
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
	27	14	0	0	0	0	0	0	0	0	0	0	10	24	0.0	0	
	32	99	25	3	1	0	0	0	0	0	0	19	87	234	30.0	30	
	37	107	67	59	32	11	0	0	0	0	4	81	97	458	108.8	108.8	
	42	179	76	71	96	37	3	0	0	6	59	109	85	721	252.0	252	
	47	127	163	133	152	81	42	32	13	45	85	121	172	1166	447.0	447	
	52	99	160	191	127	144	110	108	107	141	144	165	194	1690	672.8	672.8	
	57	77	109	153	83	134	129	115	161	139	141	113	70	1424	707.3	707.3	
	62	35	51	68	77	94	85	93	108	92	105	65	21	894	577.5	577.5	
	67	7	18	45	44	85	91	88	88	69	62	28	8	633	454.5	454.5	
	72	0	3	15	57	66	76	72	59	54	47	14	0	463	342.8	342.8	342.8
	77	0	0	6	37	42	74	72	57	68	34	5	0	395	294.0	294	294
	82	0	0	0	14	25	62	71	57	38	18	0	0	285	213.8	213	213
	87	0	0	0	0	19	28	51	43	42	33	0	0	216	162.0	162	162
	92	0	0	0	0	6	17	27	30	19	12	0	0	111	83.3	83.3	83.3
	97	0	0	0	0	0	3	15	21	7	0	0	0	46	34.5	34.5	34.5
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0
														8760			1129.6

01-08 Month

		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	14	0	0	0	0	0	0	0	0	0	0	10	24
	32	74	24	3	1	0	0	0	0	0	0	18	74	194
	37	51	53	57	22	11	0	0	0	0	4	68	47	313
	42	67	35	41	72	33	3	0	0	6	57	55	16	385
	47	18	67	69	94	59	41	32	13	40	53	32	52	570
	52	8	37	72	44	88	89	83	104	96	78	51	43	793
	57	8	8	6	7	51	73	66	104	82	55	15	6	481
	62	8	0	0	0	5	27	44	22	16	1	1	0	124
	67	0	0	0	0	1	5	16	5	0	0	0	0	27
	72	0	0	0	0	0	2	4	0	0	0	0	0	6
	77	0	0	0	0	0	0	3	0	0	0	0	0	3
	82	0	0	0	0	0	0	0	0	0	0	0	0	0
	87	0	0	0	0	0	0	0	0	0	0	0	0	0
	92	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

09-16 Month

		1	2	3	4	5	6	7	8	9	10	11	12	Total	10am start * 6/8
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	15	0	0	0	0	0	0	0	0	0	0	7	22	16.5
	37	20	0	0	0	0	0	0	0	0	0	2	17	39	29.25
	42	38	12	1	3	0	0	0	0	0	0	13	20	87	65.25
	47	46	31	5	20	1	0	0	0	4	3	24	42	176	132
	52	51	48	40	25	5	0	0	0	12	18	44	80	323	242.25
	57	56	66	85	28	25	4	4	6	11	29	60	53	427	320.25
	62	15	46	56	45	45	13	10	27	24	53	51	21	406	304.5
	67	7	18	40	31	53	43	25	34	27	41	27	8	354	265.5
	72	0	3	15	44	44	47	41	37	33	29	14	0	307	230.25
	77	0	0	6	31	35	48	40	32	45	21	5	0	263	197.25
	82	0	0	0	13	21	47	50	39	26	13	0	0	209	156.75
	87	0	0	0	0	13	22	40	32	34	29	0	0	170	127.5
	92	0	0	0	0	6	13	23	21	17	12	0	0	92	69
	97	0	0	0	0	0	3	15	20	7	0	0	0	45	33.75
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0

17-24 Month

		1	2	3	4	5	6	7	8	9	10	11	12	Total	stop 9 pm * 6/8
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	10	1	0	0	0	0	0	0	0	0	1	6	18	13.5
	37	36	14	2	10	0	0	0	0	0	0	11	33	106	79.5
	42	74	29	29	21	4	0	0	0	0	2	41	49	249	186.75
	47	63	65	59	38	21	1	0	0	1	29	65	78	420	315
	52	40	75	79	58	51	21	25	3	33	48	70	71	574	430.5
	57	13	35	62	48	58	52	45	51	46	57	38	11	516	387
	62	12	5	12	32	44	45	39	59	52	51	13	0	364	273
	67	0	0	5	13	31	43	47	49	42	21	1	0	252	189
	72	0	0	0	13	22	27	27	22	21	18	0	0	150	112.5
	77	0	0	0	6	7	26	29	25	23	13	0	0	129	96.75
	82	0	0	0	1	4	15	21	18	12	5	0	0	76	57
	87	0	0	0	0	6	6	11	11	8	4	0	0	46	34.5
	92	0	0	0	0	0	4	4	9	2	0	0	0	19	14.25
	97	0	0	0	0	0	0	0	1	0	0	0	0	1	0.75
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site 2515						New Chiller Efficiency					rebate case					existing case			
	kWh	kW	therms			%	Tons	kW/Ton		% Load			% Load		% Load			% Load	
PG&E	140,948	100.2	-			25%	50	0.550		10	1.004	1.004	10.00		10.00%	1.582	0.970	100	
QC Savings	101,134	269.6				50%	100	0.427		20	0.619	0.577	24.10%		28.00%	1.137	0.940	90	0.922
			-			75%	150	0.461		30	0.516	0.448	38.20%		46.00%	0.955	0.918	80	
						100%	200	0.516		40	0.433				64.00%	0.909	0.910	75	
QC Realization	0.72	2.69								50	0.427	0.429	52.30%		82.00%	0.922	0.910	70	0.909
Rate										60	0.437	0.446	66.40%		100.00%	0.97	0.908	60	0.917
										70	0.451						0.925	50	
Operational Parameters		**New Chiller**			**Old Chiller**					80	0.471	0.472	80.50				1.000	40	0.955
Base Case		**Minimum**	**Maximum**		**Minimum**	**Maximum**				90	0.492						1.119	30	1.137
Chiller Output (Ton)		20	200		16	161				100	0.516						1.164	25	
OSA Temp		67	99		67	99											1.268	20	
% Of Capacity		10%	80%		10%	100%											1.582	10	

Rebate Case										**Existing Case**									
Outside Air (F)	**Total Chiller Load (%)**	**Chiller Output (Ton)**	**Chiller Eff. (kW/Ton)**	**Chiller Number**	**Chiller Eff. Equation**	**Chiller Input (kW)**	**Annual Operation (Hrs/Yr)**	**Total (kWh/Yr)**		**Outside Air (F)**	**Chiller Load (%)**	**Chiller Output (Ton)**	**Chiller Eff. (kW/Ton)**	**Chiller Input (kW)**	**Annual Operation (Hrs/Yr)**	**Total (kWh/Yr)**			
27	0.00%	-	0.000	#1	0	0.0	0	-		27		-		0.0		-			
32	0.00%	-	0.000	#1	0	0.0		-		32	0.00%	-		0.0		-			
37	0.00%	-	0.000	#1	0	0.0		-		37	0.00%	-		0.0		-			
42	0.00%	-	0.000	#1	0	0.0		-		42	0.00%	-		0.0		-			
47	0.00%	-	0.000	#1	0	0.0		-		47	0.00%	-		0.0		-			
52	0.00%	-	0.000	#1	0	0.0		-		52	0.00%	-		0.0		-			
57	0.00%	-	0.000	#1	0.000	0.0		-		57	0.00%	-		0.0		-			
62	0.00%	-	0.000	#1	0.000	0.0		-		62	0.00%			0.0		-			
67	0.00%	-	1.004	#1	0.000	0.0		-		67	0.00%	-		0.0		-			
72	10.00%	20	0.601	#1	1.004	12.0	342.8	4,120		72	10.00%	16	1.582	25.5	342.8	8,731			
77	24.10%	48	0.487	#1	0.577	23.5	294	6,901		77	28.00%	45	1.137	51.3	294	15,069			
82	38.20%	76	0.430	#1	0.448	32.9	213	6,997		82	46.00%	74	0.955	70.7	213	15,065			
87	52.30%	105	0.434	#1	0.429	45.4	162	7,354		87	64.00%	103	0.909	93.7	162	15,173			
92	66.40%	133	0.449	#1	0.446	59.6	83.3	4,967		92	82.00%	132	0.922	121.7	83.3	13,009			
97	80.50%	161	0.472	#1	0.472	76.0	34.5	2,622		97	100.00%	161	0.97	156.2	34.5	67,048			
						249.4	1129.6	32,962						519.0	1129.6	134,096			
						Estimated number of hrs w/in 10% of Actual													

clz 2 Site 2515

Total

		Month															
		1	2	3	4	5	6	7	8	9	10	11	12	Total	Total 10am -9 pm		
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
	27	14	0	0	0	0	0	0	0	0	0	0	10	24	0.0	0	
	32	99	25	3	1	0	0	0	0	0	0	19	87	234	30.0	30	
	37	107	67	59	32	11	0	0	0	0	4	81	97	458	108.8	108.8	
	42	179	76	71	96	37	3	0	0	6	59	109	85	721	252.0	252	
	47	127	163	133	152	81	42	32	13	45	85	121	172	1166	447.0	447	
	52	99	160	191	127	144	110	108	107	141	144	165	194	1690	672.8	672.8	
	57	77	109	153	83	134	129	115	161	139	141	113	70	1424	707.3	707.3	
	62	35	51	68	77	94	85	93	108	92	105	65	21	894	577.5	577.5	
	67	7	18	45	44	85	91	88	88	69	62	28	8	633	454.5	454.5	
	72	0	3	15	57	66	76	72	59	54	47	14	0	463	342.8	342.8	342.8
	77	0	0	6	37	42	74	72	57	68	34	5	0	395	294.0	294	294
	82	0	0	0	14	25	62	71	57	38	18	0	0	285	213.8	213	213
	87	0	0	0	0	19	28	51	43	42	33	0	0	216	162.0	162	162
	92	0	0	0	0	6	17	27	30	19	12	0	0	111	83.3	83.3	83.3
	97	0	0	0	0	0	3	15	21	7	0	0	0	46	34.5	34.5	34.5
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0
														8760			1129.6

01-08

		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	14	0	0	0	0	0	0	0	0	0	0	10	24
	32	74	24	3	1	0	0	0	0	0	0	18	74	194
	37	51	53	57	22	11	0	0	0	0	4	68	47	313
	42	67	35	41	72	33	3	0	0	6	57	55	16	385
	47	18	67	69	94	59	41	32	13	40	53	32	52	570
	52	8	37	72	44	88	89	83	104	96	78	51	43	793
	57	8	8	6	7	51	73	66	104	82	55	15	6	481
	62	8	0	0	0	5	27	44	22	16	1	1	0	124
	67	0	0	0	0	1	5	16	5	0	0	0	0	27
	72	0	0	0	0	0	2	4	0	0	0	0	0	6
	77	0	0	0	0	0	0	3	0	0	0	0	0	3
	82	0	0	0	0	0	0	0	0	0	0	0	0	0
	87	0	0	0	0	0	0	0	0	0	0	0	0	0
	92	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

09-16

		Month													
		1	2	3	4	5	6	7	8	9	10	11	12	Total	10am start * 6/8
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	15	0	0	0	0	0	0	0	0	0	0	7	22	16.5
	37	20	0	0	0	0	0	0	0	0	0	2	17	39	29.25
	42	38	12	1	3	0	0	0	0	0	0	13	20	87	65.25
	47	46	31	5	20	1	0	0	0	4	3	24	42	176	132
	52	51	48	40	25	5	0	0	0	12	18	44	80	323	242.25
	57	56	66	85	28	25	4	4	6	11	29	60	53	427	320.25
	62	15	46	56	45	45	13	10	27	24	53	51	21	406	304.5
	67	7	18	40	31	53	43	25	34	27	41	27	8	354	265.5
	72	0	3	15	44	44	47	41	37	33	29	14	0	307	230.25
	77	0	0	6	31	35	48	40	32	45	21	5	0	263	197.25
	82	0	0	0	13	21	47	50	39	26	13	0	0	209	156.75
	87	0	0	0	0	13	22	40	32	34	29	0	0	170	127.5
	92	0	0	0	0	6	13	23	21	17	12	0	0	92	69
	97	0	0	0	0	0	3	15	20	7	0	0	0	45	33.75
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0

17-24

		Month													
		1	2	3	4	5	6	7	8	9	10	11	12	Total	stop 9 pm * 6/8
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	10	1	0	0	0	0	0	0	0	0	1	6	18	13.5
	37	36	14	2	10	0	0	0	0	0	0	11	33	106	79.5
	42	74	29	29	21	4	0	0	0	0	2	41	49	249	186.75
	47	63	65	59	38	21	1	0	0	1	29	65	78	420	315
	52	40	75	79	58	51	21	25	3	33	48	70	71	574	430.5
	57	13	35	62	48	58	52	45	51	46	57	38	11	516	387
	62	12	5	12	32	44	45	39	59	52	51	13	0	364	273
	67	0	0	5	13	31	43	47	49	42	21	1	0	252	189
	72	0	0	0	13	22	27	27	22	21	18	0	0	150	112.5
	77	0	0	0	6	7	26	29	25	23	13	0	0	129	96.75
	82	0	0	0	1	4	15	21	18	12	5	0	0	76	57
	87	0	0	0	0	6	6	11	11	8	4	0	0	46	34.5
	92	0	0	0	0	0	4	4	9	2	0	0	0	19	14.25
	97	0	0	0	0	0	0	0	1	0	0	0	0	1	0.75
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Chiller Replacement (Site 2733)

Program	Retrofit Express Program
Measure	High Efficiency Air-Cooled Chiller
Site Description	Hotel/Motel

Measure Description

Replace existing chiller with high-efficiency air-cooled chiller.

Summary of Ex Ante Impact Calculations

Demand calculations were estimated based upon the chiller tonnage and the difference between the new unit and a baseline qualifying Title 24 chiller, in conjunction with an assumed 0.75 diversity factor. Energy calculations are based upon all but the latter, in conjunction with standard PG&E EFLH values.

Comments on Calculations

The correct chiller size category and full load, compressor only, chiller efficiency were used for the application. Fan energy should be included in the chiller efficiency rating, yielding an ARI rating of 1.18 KW/Ton instead of the 1.055 value used in the application. Also actual chiller capacity of 68.4 tons should have been used to calculate the impacts, not the 70-Ton capacity found in the application.

Evaluation Process

The evaluation process consisted of reviewing the application form and supporting documentation, conducting an on-site survey and then computing impacts using the on-site data. Models were calibrated with actual weather, number of compressor hours as well as an observed operating point, %load @ the outside air temperature. Peak demand was calculated for actual peak temperatures. Energy savings were based on typical weather data. A Title 24 baseline, IPLV at ARI conditions, and typical year bin weather were used in the bin analysis.

The on-site survey was conducted on October 24, 1998. Information on the retrofit equipment and operating conditions were collected through an inspection of the chiller and through an interview with the Chief Engineer.

Discussions provided data for development of a relationship between chiller loading and outdoor dry bulb temperatures. The chiller is available to operate 24 hours a day year round. Chiller use generally begins at 62 degrees outside air temperature and reaches 100% loading at 94 Degrees F.

To compute the impacts, the following assumptions were used:

- A linear loading strategy was used for the analysis of both the baseline and rebated chillers, which assumed 10% loading at 62 degrees and 100% loading at 94 Degrees F.

- For the baseline chiller case a Title 24 baseline efficiency of 1.302 KW/Ton was used based on an air-cooled chiller of less than 150tons.

- Chiller efficiencies at various temperatures were interpolated from values provided at 25%, 50%, 75%, and 100% loading at ARI conditions. These calculated efficiencies were used to develop a chiller efficiency curve for the Rebate case. The baseline chiller efficiency curve was based on minimum Title 24 full load efficiency requirements, matched to a typical chiller performance curve.

The above assumptions were incorporated into a spreadsheet where energy and demand impacts were calculated. Evaluation- based demand impacts were lower than Ex Ante estimates. Evaluation- based energy impacts were higher than Ex Ante estimates Results from these calculations are summarized below and documented in the attached workbook.

Additional Notes

Impact Results

	KW	KWh	Therm
MDSS	8.37	7,794.5	0
Adjusted Engineering	7.80	13,595.2	0
Engineering Realization Rate	0.93	1.74	N/A

Site # 2733	WYEC Weather					New Chiller Efficiency		
	kWh	kW	therms			%	Tons	kW/Ton
PG&E	7794.47	8.37	-			25%	17.1	0.916
QC Impact	13595.22	7.80	-			50%	34.2	0.938
			-			75%	51.3	1.081
I-Eng. Real. Rate	1.74	0.93				100%	68.4	1.188
					iplv (kW/Ton	1.0246777		

Operational Parameters		New Chiller (Air Cooled)	
		Minimum	Maximum
Chiller Output (Ton)		6.84	68.4
OSA Temp		63	94
% Of Capacity		10%	100%

Basecase

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-		0.0	0.00	-
32	0.00%	-		0.0	0.00	-
37	0.00%	-		0.0	0.00	-
42	0.00%	-		0.0	0.00	-
47	0.00%	-		0.0	0.00	-
52	0.00%	-		0.0	0.00	-
57	0.00%	-		0.0	0.00	-
62	10.00%	7	2.535	17.3	728.5	12,632
67	25.00%	17	1.389	23.8	773	18,360
72	40.00%	27	1.094	29.9	409	12,240
77	55.00%	38	1.090	41.0	175	7,173
82	70.00%	48	1.137	54.4	58	3,157
87	85.00%	58	1.215	70.6	28	1,978
92	100.00%	68	1.302	89.1	1	89
97	100.00%	68	1.302	89.1	0	-
102	100.00%	68	1.302	89.1	0	-
107	100.00%	68	1.302	89.1	0	-
				89.1	2172.50	55,630

Rebate Case

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	#1	0.00	0.0	0.00	-
32	0.00%	-	0.000	#1	0.00	0.0	0.00	-
37	0.00%	-	0.000	#1	0.00	0.0	0.00	-
42	0.00%	-	0.000	#1	0.00	0.0	0.00	-
47	0.00%	-	0.000	#1	0.00	0.0	0.00	-
52	0.00%	-	0.000	#1	0.000	0.0	0.00	-
57	0.00%	-	0.000	#1	0.000	0.0	0.00	-
62	10.00%	7	1.672	#1	1.672	11.4	728.5	8,331
67	25.00%	17	0.916	#1	0.916	15.7	773	12,108
72	40.00%	27	0.929	#1	0.929	25.4	409	10,398
77	55.00%	38	0.967	#1	0.967	36.4	175	6,364
82	70.00%	48	1.052	#1	1.052	50.4	58	2,923
87	85.00%	58	1.124	#1	1.124	65.3	28	1,829
92	100.00%	68	1.188	#1	1.188	81.3	1	81
97	100.00%	68	1.188	#1	1.188	81.3	0	-
102	100.00%	68	1.188	#1	1.188	81.3	0	-
107	100.00%	68	1.188	#1	1.188	81.3	0	-
						81.3	2172.50	42,034
	max Temp= 94deg							

		Eff base ca	% Loading	Eff rebate case		rebate	% Loading	base
1.302	10.000	2.535	10.000	1.672		1.672	10.00%	2.535
1.241	20.000	1.563	20.000	1.031		0.916	25.00%	1.389
1.189	25.000	1.389	25.000	0.916		0.929	40.00%	1.094
1.163	30.000	1.302	30.000			0.967	55.00%	1.090
1.137	40.000	1.094	40.000			1.052	70.00%	1.137
1.103	50.000	1.076	50.000	0.938		1.124	85.00%	1.215
1.076	60.000	1.103	60.000			1.188	100.00%	1.302
1.094	70.000	1.137	70.000					
1.302	75.000	1.163	75.000	1.081				
1.389	80.000	1.189	80.000					
1.563	90.000	1.241	90.000					
2.535	100.000	1.302	100.000	1.188				

WYEC-Clz Site 2733

Total		Month															
		1	2	3	4	5	6	7	8	9	10	11	12	Total	8760 hrs/yr		
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	32	2	0	0	0	0	0	0	0	0	0	0	5	7	7		
	37	31	6	5	0	0	0	0	0	0	0	10	55	107	107		
	42	130	44	43	26	4	0	0	0	0	1	33	118	399	399		
	47	183	157	124	109	55	5	1	0	1	35	121	150	941	941		
	52	209	194	232	225	244	133	91	61	57	101	171	226	1944	1944		
	57	155	212	185	161	174	230	260	267	194	225	232	166	2461	2461		
	62	29	39	114	121	145	154	144	176	208	200	106	21	1457	1457		728.5
	67	5	17	34	50	69	101	136	122	113	92	31	3	773	773	773	773
	72	0	3	7	18	27	61	74	79	77	48	15	0	409	409	409	409
	77	0	0	0	9	14	25	29	33	42	22	1	0	175	175	175	175
	82	0	0	0	1	6	8	7	5	17	14	0	0	58	58	58	58
	87	0	0	0	0	6	3	2	1	10	6	0	0	28	28	28	28
	92	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	1
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
															2901	1444	2172.5

01-08		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	2	0	0	0	0	0	0	0	0	0	0	5	7
	37	30	6	5	0	0	0	0	0	0	0	8	43	92
	42	80	40	40	26	2	0	0	0	0	1	31	74	294
	47	70	107	88	81	46	5	1	0	1	35	86	64	584
	52	46	50	81	120	156	93	72	52	55	81	68	50	924
	57	20	20	27	13	43	104	158	164	126	113	44	12	844
	62	0	1	7	0	1	36	14	32	49	15	3	0	158
	67	0	0	0	0	0	1	3	0	7	3	0	0	14
	72	0	0	0	0	0	1	0	0	2	0	0	0	3
	77	0	0	0	0	0	0	0	0	0	0	0	0	0
	82	0	0	0	0	0	0	0	0	0	0	0	0	0
	87	0	0	0	0	0	0	0	0	0	0	0	0	0
	92	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

09-16		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	0	0	0	0	0	0	0	0	0	0	0	1	1
	42	10	1	1	0	0	0	0	0	0	0	0	9	21
	47	43	9	14	1	0	0	0	0	0	0	5	35	107
	52	73	60	68	22	10	1	0	0	0	0	19	81	334
	57	97	109	77	66	40	19	7	9	6	29	93	100	652
	62	20	28	59	91	96	57	48	52	53	90	78	19	691
	67	5	14	23	37	57	78	93	81	59	59	30	3	539
	72	0	3	6	14	22	53	65	68	59	35	14	0	339
	77	0	0	0	8	12	22	26	32	36	17	1	0	154
	82	0	0	0	1	5	7	7	5	17	12	0	0	54
	87	0	0	0	0	6	3	2	1	9	6	0	0	27
	92	0	0	0	0	0	0	0	0	1	0	0	0	1
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

17-24		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	1	0	0	0	0	0	0	0	0	0	2	11	14
	42	40	3	2	0	2	0	0	0	0	0	2	35	84
	47	70	41	22	27	9	0	0	0	0	0	30	51	250
	52	90	84	83	83	78	39	19	9	2	20	84	95	686
	57	38	83	81	82	91	107	95	94	62	83	95	54	965
	62	9	10	48	30	48	61	82	92	106	95	25	2	608
	67	0	3	11	13	12	22	40	41	47	30	1	0	220
	72	0	0	1	4	5	7	9	11	16	13	1	0	67
	77	0	0	0	1	2	3	3	1	6	5	0	0	21
	82	0	0	0	0	1	1	0	0	0	2	0	0	4
	87	0	0	0	0	0	0	0	0	1	0	0	0	1
	92	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

Chiller Replacement (Site 2757)

Program	Retrofit Express Program
Measure	High Efficiency Air-Cooled Chiller
Site Description	Office Building

Measure Description Replace existing chiller with high-efficiency air-cooled chiller.

Summary of Ex Ante Impact Calculations Demand calculations were estimated based upon the chiller tonnage and the difference between the new unit and a baseline qualifying Title 24 chiller, in conjunction with and assumed 0.75 diversity factor. Energy calculations are based upon all but the latter, in conjunction with standard PG&E EFLH values.

Comments on Calculations The correct chiller size category and compressor only, full load (under ARI conditions) were used in the application. Fan energy should be included in the KW/Ton rating yielding an ARI efficiency value of 1.277 verses the application value of 1.09. A 54.6 ton capacity was used in the application, 50.8 tons were installed.

Evaluation Process The evaluation process consisted of reviewing the application form and supporting documentation, conducting an on-site survey and then computing impacts using the on-site data. Models were calibrated with actual weather, number of compressor hours as well as an observed operating point, %load @ the outside air temperature. Peak demand was calculated for actual peak temperatures. Energy savings were based on typical weather data. A Title 24 baseline, IPLV at ARI conditions, and typical year bin weather data were used in the bin analysis.

The on-site survey was conducted on October 16, 1998. Information on the retrofit equipment and operating conditions were collected through an inspection of the chiller and through an interview with the Chief Engineer.

Discussions provided data for development of a relationship between chiller loading and outdoor dry bulb temperatures. The chiller is available to operate Monday through Friday 7am to 6 pm all year. Chiller use generally begins at 62 degrees outside air temperature and reaches 85% loading at 95 Degrees F.

To compute the impacts, the following assumptions were used:

- A linear loading strategy was used for the analysis of both the baseline and rebated chillers, which assumed 10% loading at 62 degrees and 85% loading at 95 Degrees F.
- For the baseline chiller case a Title 24 baseline efficiency of 1.302 was used, based on an air-cooled chiller less than 150 tons.

- Chiller efficiencies at various temperatures were interpolated from values provided at 25%, 50%, 75%, and 100% loading at ARI conditions. These calculated efficiencies were used to develop a chiller efficiency curve for the Rebate case. The baseline chiller efficiency curve was based on minimum Title 24 full load efficiency requirements, matched to a typical chiller performance curve.

The above assumptions were incorporated into a spreadsheet where energy and demand impacts were calculated. Evaluation- based demand and energy impacts were than Ex Ante estimates. Results from these calculations are summarized below and documented in the attached workbook.

Additional Notes

Impact Results

	KW	KWh	Therm
MDSS	8.57	11,399.4	0
Adjusted Engineering	1.51	5,990.5	0
Engineering Realization Rate	0.18	0.53	N/A

Site # 2757	WYEC Weather		
	kWh	kW	therms
PG&E	11,399.41	8.57	-
QC Impact	5,990.54	1.51	-
			-
I-Eng. Real. Rat	0.53	0.18	

New Chiller Efficiency		
%	Tons	kW/Ton
25%	12.7	0.961
50%	25.4	1.091
75%	38.1	1.117
100%	50.8	1.277

iplv (kW/Ton 1.10192843

Operational Parameters	New Chiller (Air Cooled)	
	Minimum	Maximum
Chiller Output (Ton)	5.08	50.8
OSA Temp	64	94
% Of Capacity	10%	85%

Basecase

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-		0.0	0	-
32	0.00%	-		0.0	0	-
37	0.00%	-		0.0	0	-
42	0.00%	-		0.0	0	-
47	0.00%	-		0.0	0	-
52	0.00%	-		0.0	0	-
57	0.00%	-		0.0	0	-
62	10.00%	5	2.535	12.9	585.36	7,539
67	22.50%	11	1.485	17.0	556.79	9,449
72	35.00%	18	1.198	21.3	398.57	8,490
77	47.50%	24	1.081	26.1	192.95	5,034
82	60.00%	30	1.102	33.6	60.89	2,046
87	72.50%	37	1.140	42.0	12.86	540
92	85.00%	43	1.216	52.5	4.29	225
97	85.00%	43	1.216	52.5	0.00	-
102	85.00%	43	1.216	52.5	0.00	-
107	85.00%	43	1.216	52.5	0.00	-
112	85.00%	43	1.216	52.5	0.00	-
				52.5	1811.70	33,323

Rebate Case

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	#1	0	0.0	0	-
32	0.00%	-	0.000	#1	0	0.0	0	-
37	0.00%	-	0.000	#1	0	0.0	0	-
42	0.00%	-	0.000	#1	0	0.0	0	-
47	0.00%	-	0.000	#1	0	0.0	0	-
52	0.00%	-	0.000	#1	0	0.0	0	-
57	0.00%	-	0.000	#1	0.000	0.0	0	-
62	10.00%	5	1.754	#1	1.754	8.9	585.36	5,216
67	22.50%	11	1.021	#1	1.021	11.7	556.79	6,498
72	35.00%	18	1.101	#1	1.101	19.6	398.57	7,804
77	47.50%	24	1.078	#1	1.078	26.0	192.95	5,019
82	60.00%	30	1.104	#1	1.104	33.7	60.89	2,049
87	72.50%	37	1.114	#1	1.114	41.0	12.86	528
92	85.00%	43	1.181	#1	1.181	51.0	4.29	219
97	85.00%	43	1.181	#1	1.181	51.0	0.00	-
102	85.00%	43	1.181	#1	1.181	51.0	0.00	-
107	85.00%	43	1.181	#1	1.181	51.0	0.00	-
112	85.00%	43	1.181	#1	1.181	51.0	0.00	-
						51.0	1811.70	27,332

	Eff base ca	% Loading	Eff rebate case		rebate	% Loading	base
10.000	2.535	10.000	1.754		1.754	10.00%	2.535
20.000	1.563	20.000	1.081		1.021	22.50%	1.485
25.000	1.389	25.000	0.961		1.101	35.00%	1.198
30.000	1.302	30.000			1.078	47.50%	1.081
40.000	1.094	40.000			1.104	60.00%	1.102
50.000	1.077	50.000	1.091		1.114	72.50%	1.140
60.000	1.102	60.000			1.181	85.00%	1.216
70.000	1.137	70.000					
75.000	1.163	75.000	1.117				
80.000	1.190	80.000					
90.000	1.242	90.000					
100.000	1.302	100.000	1.277				

WYEC-clz Site 2757 Actual Max Temp =95

Total

		Month														
		1	2	3	4	5	6	7	8	9	10	11	12	Total	Operation Hours	
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	
	32	22	6	0	0	0	0	0	0	0	0	3	24	55	5.09	
	37	70	29	21	11	2	0	0	0	0	0	27	51	211	21.43	
	42	82	75	67	61	30	10	0	0	0	13	64	131	533	68.84	
	47	85	105	126	94	52	33	6	5	28	63	118	109	824	116.96	
	52	165	138	225	157	212	212	137	94	58	154	165	136	1853	305.00	
	57	167	136	134	168	173	151	250	293	181	181	140	126	2100	538.84	
	62	101	110	110	93	118	101	78	81	172	100	106	103	1273	585.36	585.3571
	67	38	51	35	71	104	121	99	105	82	119	56	47	928	556.79	556.7857
	72	12	13	16	40	31	48	116	115	112	57	24	11	595	398.57	398.5714
	77	2	9	10	20	11	26	50	44	56	33	11	6	278	192.95	192.9464
	82	0	0	0	5	9	13	6	6	23	18	6	0	86	60.89	60.89286
	87	0	0	0	0	2	5	2	1	4	4	0	0	18	12.86	12.85714
	92	0	0	0	0	0	0	0	0	4	2	0	0	6	4.29	4.285714
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0
														3184		1811.696

01-08

		Month													
		1	2	3	4	5	6	7	8	9	10	11	12	Total	m-f 6am
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	20	6	0	0	0	0	0	0	0	0	3	24	53	4.732143
	37	61	27	21	10	2	0	0	0	0	0	25	36	182	16.25
	42	46	58	43	45	26	8	0	0	0	13	44	84	367	32.76786
	47	32	53	78	55	33	26	6	5	28	57	74	41	488	43.57143
	52	64	60	86	63	118	128	93	76	44	84	58	40	914	81.60714
	57	24	13	16	53	49	63	121	151	93	61	28	19	691	61.69643
	62	1	7	3	9	13	10	15	10	70	23	7	4	172	15.35714
	67	0	0	1	4	5	4	10	4	3	10	1	0	42	3.75
	72	0	0	0	1	1	1	2	1	2	0	0	0	8	0.714286
	77	0	0	0	0	1	0	1	1	0	0	0	0	3	0.267857
	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	92	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0

09-16

		Month													
		1	2	3	4	5	6	7	8	9	10	11	12	Total	m-f
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	42	3	0	0	0	0	0	0	0	0	0	0	9	12	8.571429
	47	8	4	0	0	0	0	0	0	0	0	1	12	25	17.85714
	52	24	23	12	4	1	1	0	0	0	4	13	22	104	74.28571
	57	76	54	75	44	21	6	0	5	5	13	58	64	421	300.7143
	62	87	76	102	70	83	46	16	19	10	37	74	77	697	497.8571
	67	36	46	33	60	94	106	66	68	44	83	54	47	737	526.4286
	72	12	12	16	37	28	38	110	108	98	54	23	11	547	390.7143
	77	2	9	10	20	10	25	48	41	53	33	11	6	268	191.4286
	82	0	0	0	5	9	13	6	6	22	18	6	0	85	60.71429
	87	0	0	0	0	2	5	2	1	4	4	0	0	18	12.85714
	92	0	0	0	0	0	0	0	0	4	2	0	0	6	4.285714
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0

17-24

		Month													
		1	2	3	4	5	6	7	8	9	10	11	12	Total	stop 6pm
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	2	0	0	0	0	0	0	0	0	0	0	0	2	0.357143
	37	9	2	0	1	0	0	0	0	0	0	2	15	29	5.178571
	42	33	17	24	16	4	2	0	0	0	0	20	38	154	27.5
	47	45	48	48	39	19	7	0	0	0	6	43	56	311	55.53571
	52	77	55	127	90	93	83	44	18	14	66	94	74	835	149.1071
	57	67	69	43	71	103	82	129	137	83	107	54	43	988	176.4286
	62	13	27	5	14	22	45	47	52	92	40	25	22	404	72.14286
	67	2	5	1	7	5	11	23	33	35	26	1	0	149	26.60714
	72	0	1	0	2	2	9	4	6	12	3	1	0	40	7.142857
	77	0	0	0	0	0	1	1	2	3	0	0	0	7	1.25
	82	0	0	0	0	0	0	0	0	1	0	0	0	1	0.178571
	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	92	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Chiller Replacement (Site 2817)

Program	Retrofit Efficiency Options Program
Measure	High Efficiency Water-Cooled Chiller
Site Description	Community Service

Measure Description

Replace existing chiller with high-efficiency water-cooled chiller.

Summary of Ex Ante Impact Calculations

Tables of standard values were developed using the HBSSM simulation program based on climate zone, chiller size, building type, chiller efficiency, and condenser water temperature. Values from these tables are used to calculate the rebate and associated impacts.

Comments on PG&E Calculations

The correct climate zone, chiller size category, chiller efficiency and building type were used in the application calculations.

Evaluation Process

The evaluation process consisted of reviewing the application form and supporting documentation, conducting an on-site survey and then computing impacts using the on-site data. Models were calibrated with actual weather, number of compressor hours as well as an observed operating point, %load @ the outside air temperature. Peak demand was calculated for actual peak temperatures. Energy saving were based on typical weather data. A Title 24 baseline, IPLV at ARI conditions, and typical year bin weather data was used in the bin analysis.

The on-site survey was conducted on October 19, 1998. Information on the retrofit equipment and operating conditions were collected through an inspection of the chiller and through an interview with the Chief Engineer.

Discussions provided data for development of a relationship between chiller loading and outdoor dry bulb temperatures. The chiller is available from 10am to 9pm, everyday of the year. Chiller use generally begins at 65 degrees outside air temperature and reaches 75% loading at 99 Degrees F.

To compute the impacts, the following assumptions were used:

- A linear loading strategy was used for the analysis of the original, baseline and rebated chillers, which assumed 10% loading at 65 degrees and 75% loading at 99 Degrees F.
- For the baseline chiller case a Title 24 baseline efficiency of 0.837 KW/ton was used, based on a water-cooled chiller between 150 and 300 tons. The existing chiller had a KW/Ton of 0.97.
- Chiller efficiencies at various temperatures were interpolated from values provided at 25%, 50%, 75%, and 100% loading at ARI conditions. These calculated efficiencies were used to develop a

chiller efficiency curve for the Rebate case. The baseline chiller efficiency curve was based on minimum Title 24 full load efficiency requirements, matched to a typical chiller performance curve.

The above assumptions were incorporated into a spreadsheet where energy and demand impacts were calculated. Evaluation- based demand impacts were higher and energy impacts were lower, than Ex Ante estimates. Results from these calculations are summarized below and documented in the attached workbook

Additional Notes Savings were also calculated.

Impact Results

	KW	KWh	Therm
MDSS	16.85	35,930.1	0
Adjusted Engineering	27.40	23,277.6	0
Engineering Realization Rate	1.63	0.65	N/A

Site 2817	kWh	kW	therms
PG&E	35,930.11	16.85	-
QC Impact	23,277.56	27.40	-
QC Savings	33212.75	41.30	-
QC Realization	0.65	1.63	
Rate			

New Chiller Efficiency		
%	Tons	kW/Ton
25%	31.825	0.550
50%	63.65	0.427
75%	95.475	0.461
100%	127.3	0.516
iplv (kW/Ton) =	0.465331994	

Operational Parameters	New Chiller		Old Chiller	
Base Case	Minimum	Maximum	Minimum	Maximum
Chiller Output (Ton)	12.73	127.3	13	125
OSA Temp	67	99	67	99
% Of Capacity	10%	75%	10%	75%

Basecase

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-		0.0		-
32	0.00%	-		0.0		-
37	0.00%	-		0.0		-
42	0.00%	-		0.0		-
47	0.00%	-		0.0		-
52	0.00%	-		0.0		-
57	0.00%	-		0.0		-
62	0.00%	-		0.0		-
67	10.00%	13	1.629	20.7	454.5	9,425
72	18.13%	23	1.121	25.9	342.8	8,866
77	26.25%	33	0.879	29.4	294	8,636
82	34.38%	44	0.778	34.1	213	7,254
87	42.50%	54	0.700	37.9	162	6,138
92	50.63%	64	0.693	44.7	83.3	3,721
97	58.75%	75	0.707	52.9	34.5	1,824
102	66.88%	85	0.724	61.6	0	-
107	75.00%	95	0.748	71.4	0	-
				71.4	1584.1	45,863

Rebate Case

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	#1	0	0.0	0	-
32	0.00%	-	0.000	#1	0	0.0		-
37	0.00%	-	0.000	#1	0	0.0		-
42	0.00%	-	0.000	#1	0	0.0		-
47	0.00%	-	0.000	#1	0	0.0		-
52	0.00%	-	0.000	#1	0	0.0		-
57	0.00%	-	0.000	#1	0.000	0.0		-
62	0.00%	-	0.000	#1	0.000	0.0		-
67	10.00%	13	1.004	#1	1.004	12.8	454.5	5,809
72	18.13%	23	0.691	#1	0.691	15.9	342.8	5,465
77	26.25%	33	0.555	#1	0.555	18.5	294	5,448
82	34.38%	44	0.480	#1	0.480	21.0	213	4,470
87	42.50%	54	0.432	#1	0.432	23.3	162	3,782
92	50.63%	64	0.428	#1	0.428	27.6	83.3	2,295
97	58.75%	75	0.438	#1	0.436	32.6	34.5	1.124
102	66.88%	85	0.447	#1	0.447	38.0	0	-
105	75.00%	95	0.46	#1	0.46	44.0	0	-
						44.0	1584.1	22,586

Actual temp Max 105 DegF

Existing Case

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27		-		0.0		-
32	0.00%	-		0.0		-
37	0.00%	-		0.0		-
42	0.00%	-		0.0		-
47	0.00%	-		0.0		-
52	0.00%	-		0.0		-
57	0.00%	-		0.0		-
62	0.00%			0.0		-
67	10.00%	13	1.582	19.8	454.5	8,988
72	18.13%	23	1.327	30.1	342.8	10,304
77	26.25%	33	1.153	37.8	294	11,121
82	34.38%	43	1.067	45.8	213	9,765
87	42.50%	53	0.981	52.1	162	8,445
92	50.63%	63	0.924	58.5	83.3	4,870
97	58.75%	73	0.910	66.8	34.5	2,306
102	66.88%	84	0.909	76.0	0	-
105	75.00%	94	0.910	85.3	0	-
				85.3	1584.1	55,799

Estimated number of hrs w/in 10% of Actual

	base case		rebate case	rebate		base			existing case		
10	1.629	10	1.004	1.004	10.000%	1.629	18.13%	1.327	1.3267	0.970	100
20	1.004	20	0.619	0.691	18.13%	1.121	26.25%	1.153	1.1528	0.940	90
25	0.893	30	0.516	0.555	26.25%	0.879	34.38%	1.067	1.0669	0.918	80
30	0.837	40	0.433	0.480	34.38%	0.778	42.50%	0.981		0.910	75
40	0.703	50	0.427	0.432	42.50%	0.700	50.63%	0.924		0.910	70
50	0.692	60	0.437	0.428	50.63%	0.693	58.75%	0.910		0.908	60
60	0.709	70	0.451	0.436	58.75%	0.707	66.88%	0.909		0.925	50
70	0.731	80	0.471	0.447	66.88%	0.724	75.00%	0.910		1.000	40
75	0.748	90	0.492	0.46	75.00%	0.748				1.119	30
80	0.764	100	0.516							1.184	25
90	0.789									1.268	20
100	0.837									1.582	10
iplv (kW/Ton) =	0.754970189										

clz 2 Site 2817

Total

	Month															
		1	2	3	4	5	6	7	8	9	10	11	12	Total	Total 10am -9 pm		
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
	27	14	0	0	0	0	0	0	0	0	0	0	10	24	0.0	0	
	32	99	25	3	1	0	0	0	0	0	0	19	87	234	30.0	30	
	37	107	67	59	32	11	0	0	0	0	4	81	97	458	108.8	108.8	
	42	179	76	71	96	37	3	0	0	6	59	109	85	721	252.0	252	
	47	127	163	133	152	81	42	32	13	45	85	121	172	1166	447.0	447	
	52	99	160	191	127	144	110	108	107	141	144	165	194	1690	672.8	672.8	
	57	77	109	153	83	134	129	115	161	139	141	113	70	1424	707.3	707.3	
	62	35	51	68	77	94	85	93	108	92	105	65	21	894	577.5	577.5	
	67	7	18	45	44	85	91	88	88	69	62	28	8	633	454.5	454.5	454.5
	72	0	3	15	57	66	76	72	59	54	47	14	0	463	342.8	342.8	342.8
	77	0	0	6	37	42	74	72	57	68	34	5	0	395	294.0	294	294
	82	0	0	0	14	25	62	71	57	38	18	0	0	285	213.8	213	213
	87	0	0	0	0	19	28	51	43	42	33	0	0	216	162.0	162	162
	92	0	0	0	0	6	17	27	30	19	12	0	0	111	83.3	83.3	83.3
	97	0	0	0	0	0	3	15	21	7	0	0	0	46	34.5	34.5	34.5
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0
														8760		1584.1	1584.1

01-08

	Month													
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	14	0	0	0	0	0	0	0	0	0	0	10	24
	32	74	24	3	1	0	0	0	0	0	0	18	74	194
	37	51	53	57	22	11	0	0	0	0	4	68	47	313
	42	67	35	41	72	33	3	0	0	6	57	55	16	385
	47	18	67	69	94	59	41	32	13	40	53	32	52	570
	52	8	37	72	44	88	89	83	104	96	78	51	43	793
	57	8	8	6	7	51	73	66	104	82	55	15	6	481
	62	8	0	0	0	5	27	44	22	16	1	1	0	124
	67	0	0	0	0	1	5	16	5	0	0	0	0	27
	72	0	0	0	0	0	2	4	0	0	0	0	0	6
	77	0	0	0	0	0	0	3	0	0	0	0	0	3
	82	0	0	0	0	0	0	0	0	0	0	0	0	0
	87	0	0	0	0	0	0	0	0	0	0	0	0	0
	92	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

09-16

	Month														
		1	2	3	4	5	6	7	8	9	10	11	12	Total	10am start * 6/8
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	15	0	0	0	0	0	0	0	0	0	0	7	22	16.5
	37	20	0	0	0	0	0	0	0	0	0	2	17	39	29.25
	42	38	12	1	3	0	0	0	0	0	0	13	20	87	65.25
	47	46	31	5	20	1	0	0	0	4	3	24	42	176	132
	52	51	48	40	25	5	0	0	0	12	18	44	80	323	242.25
	57	56	66	85	28	25	4	4	6	11	29	60	53	427	320.25
	62	15	46	56	45	45	13	10	27	24	53	51	21	406	304.5
	67	7	18	40	31	53	43	25	34	27	41	27	8	354	265.5
	72	0	3	15	44	44	47	41	37	33	29	14	0	307	230.25
	77	0	0	6	31	35	48	40	32	45	21	5	0	263	197.25
	82	0	0	0	13	21	47	50	39	26	13	0	0	209	156.75
	87	0	0	0	0	13	22	40	32	34	29	0	0	170	127.5
	92	0	0	0	0	6	13	23	21	17	12	0	0	92	69
	97	0	0	0	0	0	3	15	20	7	0	0	0	45	33.75
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0

17-24

	Month														
		1	2	3	4	5	6	7	8	9	10	11	12	Total	stop 9 pm * 6/8
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	10	1	0	0	0	0	0	0	0	0	1	6	18	13.5
	37	36	14	2	10	0	0	0	0	0	0	11	33	106	79.5
	42	74	29	29	21	4	0	0	0	0	2	41	49	249	186.75
	47	63	65	59	38	21	1	0	0	1	29	65	78	420	315
	52	40	75	79	58	51	21	25	3	33	48	70	71	574	430.5
	57	13	35	62	48	58	52	45	51	46	57	38	11	516	387
	62	12	5	12	32	44	45	39	59	52	51	13	0	364	273
	67	0	0	5	13	31	43	47	49	42	21	1	0	252	189
	72	0	0	0	13	22	27	27	22	21	18	0	0	150	112.5
	77	0	0	0	6	7	26	29	25	23	13	0	0	129	96.75
	82	0	0	0	1	4	15	21	18	12	5	0	0	76	57
	87	0	0	0	0	6	6	11	11	8	4	0	0	46	34.5
	92	0	0	0	0	0	4	4	9	2	0	0	0	19	14.25
	97	0	0	0	0	0	0	0	1	0	0	0	0	1	0.75
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Chiller Replacement (Site 2904)

Program	Retrofit Efficiency Options Program
Measure	Oversized Evaporative Cooling Tower
Site Description	Community Service

Measure Description Replace Cooling tower with an oversized cooling tower.

Summary of Ex Ante Impact Calculations Tables of standard values were developed using the HBSSM simulation program based on climate zone, chiller size, building type, chiller efficiency, and condenser water temperature. Values from these tables are used to calculate the rebate and associated impacts.

Comments on PG&E Calculations The correct climate zone and building were used in the application. The correct approach temperature design and incorrect fan horsepower per evaporator ton was used in the application. The actual hp/ton rating is 0.04 not 0.06.

Evaluation Process The evaluation process consisted of reviewing the application form and supporting documentation, conducting an on-site survey and then computing impacts using the on-site data. Models were calibrated with actual weather, number of compressor hours as well as an observed operating point, %load @ the outside air temperature. Peak demand was calculated for actual peak temperatures. Energy saving were based on typical weather data. A Title 24 baseline, IPLV at ARI conditions, and typical year bin weather data were used in the bin analysis.

The on-site survey was conducted on December 15, 1998. Information on the retrofit equipment and operating conditions were collected through an inspection of the chiller, cooling tower and through an interview with the Chief Engineer.

Discussions provided data for development of a relationship between chiller loading and outdoor dry bulb temperatures. The chiller is available 24 hours a day, 52 weeks a year. Chiller use generally begins at 65 degrees outside air temperature and reaches 100% loading at 97 Degrees F.

To compute the impacts, the following assumptions were used:

- A linear loading strategy was used for the analysis of the chiller, for both the baseline and rebated cooling tower, which assumed 10% loading at 65 degrees and 100% loading at 97 Degrees F.
- For the baseline chiller/tower case a Title 24 baseline efficiency of 1.046 KW/ton was used, based on an air-cooled chiller greater than 150 tons and an assumed chiller improvement of 0.01 KW/ton per degree reduction in approach temperature.

- Chiller efficiencies at various temperatures were interpolated from values provided at 25%, 50%, 75%, and 100% loading at ARI conditions. These calculated efficiencies were used to develop a chiller efficiency curve for the Rebate case. The baseline chiller efficiency curve was based on minimum Title 24 full load efficiency requirements, matched to a typical chiller performance curve.

The above assumptions were incorporated into a spreadsheet where energy and demand impacts were calculated. Evaluation- based demand impacts were higher and energy impacts were lower, than Ex Ante estimates. Results from these calculations are summarized below and documented in the attached workbook.

Additional Notes

Impact Results

	KW	KWh	Therm
MDSS	6.23	27,401.2	0
Adjusted Engineering	7.00	13,261.3	0
Engineering Realization Rate	1.12	.48	N/A

Site # 2904	WYEC Weather		
	kWh	kW	therms
PG&E	27,401.23	6.23	-
QC Impact	13,261.28	7.00	-
			-
I-Eng. Real. Rat	0.48	1.12	

Existing Chiller Efficiency w/ new Oversized CoolingTower

%	Tons	kW/Ton
25%	43.75	0.964
50%	87.5	0.758
75%	131.25	0.745
100%	175	1.366

iplv (kW/Ton 0.83556151

Note: Based on chillerdecrease of .01 kW/ton per Degree of Approach Temperature increase.

Operational Parameters	Existing Chiller	
	Minimum	Maximum
Chiller Output (Ton)	17.5	175
OSA Temp	64	95
% Of Capacity	10%	100%

Base Case 14 Deg Approach Temp.

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-		0.0	0	-
32	0.00%	-		0.0	0	-
37	0.00%	-		0.0	0	-
42	0.00%	-		0.0	0	-
47	0.00%	-		0.0	0	-
52	0.00%	-		0.0	0	-
57	0.00%	-		0.0	0	-
62	0.00%	-		0.0	0	-
67	10.00%	18	1.365	23.9	707	16,888
72	25.00%	44	1.004	43.9	545	23,949
77	40.00%	70	0.863	60.4	428	25,848
82	55.00%	96	0.950	91.4	407	37,215
87	70.00%	123	0.785	96.2	254	24,441
92	85.00%	149	0.802	119.2	165	19,672
97	100.00%	175	1.406	246.1	81	19,930
102	100.00%	175	1.406	246.1	26	6,397
107	100.00%	175	1.406	246.1	0	-
				246.1	2613	174,339

Rebate Case **10 Deg Approach**

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	#1	0	0.0	0	-
32	0.00%	-	0.000	#1	0	0.0	0	-
37	0.00%	-	0.000	#1	0	0.0	0	-
42	0.00%	-	0.000	#1	0	0.0	0	-
47	0.00%	-	0.000	#1	0	0.0	0	-
52	0.00%	-	0.000	#1	0	0.0	0	-
57	0.00%	-	0.000	#1	0	0.0	0	-
62	0.00%	-	0.000	#1	0	0.0	0	-
67	10.00%	18	1.325	#1	1.325	23.2	707	16,393
72	25.00%	44	0.964	#1	0.964	42.2	545	22,995
77	40.00%	70	0.823	#1	0.823	57.6	428	24,650
82	55.00%	96	0.755	#1	0.755	72.7	407	29,576
87	70.00%	123	0.745	#1	0.745	91.3	254	23,196
92	85.00%	149	0.762	#1	0.762	113.3	165	18,690
97	100.00%	175	1.366	#1	1.366	239.1	81	19,363
102	100.00%	175	1.366	#1	1.366	239.1	26	6,215
107	100.00%	175	1.366	#1	1.366	239.1	0	-
						239.1	2613	161,078
	Act. Max Temp = 107							

	Eff base ca	% Loading	Eff rebate case	rebate	% Loading	base
10.000	1.365	10.000	1.325	1.325	10.00%	1.365
20.000	1.095	20.000	1.055	0.964	25.00%	1.004
25.000	1.004	25.000	0.964	0.823	40.00%	0.863
30.000	0.966	30.000	0.926	0.755	55.00%	0.950
40.000	0.863	40.000	0.823	0.745	70.00%	0.785
50.000	0.798	50.000	0.758	0.762	85.00%	0.802
60.000	0.792	60.000	0.752	1.366	100.00%	1.406
70.000	0.785	70.000	0.745	1.366	100.00%	1.406
75.000	0.785	75.000	0.745	1.366	100.00%	1.406
80.000	0.792	80.000	0.752			
90.000	0.811	90.000	0.771			
100.000	1.406	100.000	1.366			

Clz 12 Site 2094

Total		Month													
		1	2	3	4	5	6	7	8	9	10	11	12	Total	
Temper	22	0	0	0	0	0	0	0	0	0	0	0	0	0	
	27	10	0	0	0	0	0	0	0	0	0	0	5	15	
	32	48	22	1	0	0	0	0	0	0	0	5	35	111	
	37	90	47	21	22	0	0	0	0	0	1	44	100	325	
	42	219	94	103	42	9	0	0	0	0	12	98	219	796	
	47	205	180	138	126	39	12	0	0	12	82	139	182	1115	
	52	123	138	175	153	145	60	40	50	70	125	164	138	1381	
	57	36	103	136	109	133	138	106	140	144	150	143	46	1384	
	62	13	71	107	83	103	106	115	109	118	107	70	18	1020	
	67	0	16	42	78	77	92	100	91	80	100	30	1	707	707
	72	0	1	19	55	73	71	76	76	77	77	20	0	545	545
	77	0	0	2	39	73	67	68	57	78	37	7	0	428	428
	82	0	0	0	12	65	73	77	77	70	33	0	0	407	407
	87	0	0	0	1	14	56	72	60	35	16	0	0	254	254
	92	0	0	0	0	11	24	51	48	27	4	0	0	165	165
	97	0	0	0	0	2	18	30	22	9	0	0	0	81	81
	102	0	0	0	0	0	3	9	14	0	0	0	0	26	26
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0
															2613

01-08		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temper	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	10	0	0	0	0	0	0	0	0	0	0	5	15
	32	40	22	1	0	0	0	0	0	0	0	5	30	98
	37	54	41	21	22	0	0	0	0	0	1	41	63	243
	42	88	67	91	34	9	0	0	0	0	12	64	102	467
	47	52	76	84	87	34	11	0	0	12	77	62	37	532
	52	4	11	45	76	113	49	34	45	64	87	56	11	595
	57	0	7	6	16	58	94	87	102	100	61	12	0	543
	62	0	0	0	4	28	54	64	53	57	8	0	0	268
	67	0	0	0	1	5	23	44	35	5	2	0	0	115
	72	0	0	0	0	1	5	17	11	2	0	0	0	36
	77	0	0	0	0	0	4	2	2	0	0	0	0	8
	82	0	0	0	0	0	0	0	0	0	0	0	0	0
	87	0	0	0	0	0	0	0	0	0	0	0	0	0
	92	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

09-16		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temper	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	13	3	0	0	0	0	0	0	0	0	0	7	23
	42	53	10	0	0	0	0	0	0	0	0	10	41	114
	47	77	27	10	0	0	0	0	0	0	0	19	74	207
	52	68	59	47	20	2	0	0	0	0	2	44	69	311
	57	26	61	66	41	14	2	2	6	1	19	73	38	349
	62	11	52	73	44	26	7	4	5	12	36	47	18	335
	67	0	11	35	52	36	29	15	17	25	57	23	1	301
	72	0	1	15	40	52	31	23	30	39	60	17	0	308
	77	0	0	2	31	50	38	36	28	52	27	7	0	271
	82	0	0	0	11	47	51	50	55	53	28	0	0	295
	87	0	0	0	1	11	47	49	44	26	15	0	0	193
	92	0	0	0	0	8	17	40	37	23	4	0	0	129
	97	0	0	0	0	2	15	23	16	9	0	0	0	65
	102	0	0	0	0	0	3	6	10	0	0	0	0	19
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

17-24		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temper	22	0	0	0	0	0	0	0	0	0	0	0	0	22
	27	0	0	0	0	0	0	0	0	0	0	0	0	27
	32	8	0	0	0	0	0	0	0	0	0	0	5	45
	37	23	3	0	0	0	0	0	0	0	0	3	30	96
	42	78	17	12	8	0	0	0	0	0	0	24	76	257
	47	76	77	44	39	5	1	0	0	0	5	58	71	423
	52	51	68	83	57	30	11	6	5	6	36	64	58	527
	57	10	35	64	52	61	42	17	32	43	70	58	8	549
	62	2	19	34	35	49	45	47	51	49	63	23	0	479
	67	0	5	7	25	36	40	41	39	50	41	7	0	358
	72	0	0	4	15	20	35	36	35	36	17	3	0	273
	77	0	0	0	8	23	25	30	27	26	10	0	0	226
	82	0	0	0	1	18	22	27	22	17	5	0	0	194
	87	0	0	0	0	3	9	23	16	9	1	0	0	148
	92	0	0	0	0	3	7	11	11	4	0	0	0	128
	97	0	0	0	0	0	3	7	6	0	0	0	0	113
	102	0	0	0	0	0	0	3	4	0	0	0	0	109
	107	0	0	0	0	0	0	0	0	0	0	0	0	107
	112	0	0	0	0	0	0	0	0	0	0	0	0	112

Chiller Replacement (Site 2935)

Program	Retrofit Efficiency Options Program
Measure	High Efficiency Water-Cooled Chiller Oversized Evaporative Cooling Tower
Site Description	Office

Measure Description

Replace existing chiller with high-efficiency water-cooled chiller. Replace Cooling tower with an oversized cooling tower.

Summary of Ex Ante Impact Calculations

Tables of standard values were developed using the HBSSM simulation program based on climate zone, chiller size, building type, chiller efficiency, and condenser water and approach temperature. Values from these tables are used to calculate the rebate and associated impacts.

Comments on Calculations

The correct climate zone, chiller size category and chiller was used in the application. The plant operations staff claimed nothing was done to the cooling tower, but the approach temperature design and fan horsepower agrees with the application. A paid invoice for the work was also included.

Evaluation Process

The evaluation process consisted of reviewing the application form and supporting documentation, conducting an on-site survey and then computing impacts using the on-site data. Models were calibrated with actual weather, number of compressor hours as well as an observed operating point, %load @ the outside air temperature. Peak demand and energy savings were based on actual weather. A Title 24 baseline, IPLV at ARI conditions, and a chiller efficiency improvement of 0.01 KW/Ton per degree of approach temperature reduction.

The on-site survey was conducted on October 2, 1998. Information on the retrofit equipment and operating conditions were collected through an inspection of the chiller, cooling tower and through an interview with the Chief Engineer.

Discussions provided data for development of a relationship between chiller loading and outdoor dry bulb temperatures. The chiller is available Monday through Friday 6am to 6pm, 52 weeks a year. Chiller use generally begins at 62 degrees outside air temperature and reaches 100% loading at 90 Degrees F.

To compute the impacts, the following assumptions were used:

- A linear loading strategy was used for the analysis of both the original, baseline and rebated chillers, which assumed 10% loading at 62 degrees and 100% loading at 90 Degrees F.
- For the baseline chiller case a Title 24 baseline efficiency of 0.837 KW/ton was used, based on a water-cooled chiller between 150 and

300 tons. Existing chillers modeled with default efficiency of 0.90 KW/Ton. An assumed chiller improvement of 0.01 KW/ton per degree reduction of approach temperature.

- Chiller efficiencies at various temperatures were interpolated from values provided at 25%, 50%, 75%, and 100% loading at ARI conditions. These calculated efficiencies were used to develop a chiller efficiency curve for the Rebate case. The baseline chiller efficiency curve was based on minimum Title 24 full load efficiency requirements, matched to a typical chiller performance curve.

The above assumptions were incorporated into a spreadsheet where energy and demand impacts were calculated. Evaluation- based demand and energy impacts were lower than Ex Ante estimates. Results from these calculations are summarized below and documented in the attached workbook

Additional Notes Saving estimates were calculated in a similar manner, employing 1998 actual weather from the closest weather station. The combined measure total results from these calculations are summarized below and documented in the attached workbook.

Impact Results

	KW	KWh	Therm
MDSS	72.07	104,659.6	0
Adjusted Engineering	43.96	27,190.5	0
Engineering Realization Rate	0.61	0.26	N/A

Site 2935	Change Due to Chiller Measure kWh	Change Due to Chiller Measure kW	Change Due to Chiller Measure therms	Change Due to Cooling Tower Measure kWh	Change Due to Cooling Tower Measure kW	Change Due to Cooling Tower Measure therms	Combined Total kWh	Combined Total kW
PG&E	77,081	51.7	-	27578.89	20.38	-	104659.61	72.07
QC Impact	24291.70	37.68	-	2,899	6.28	-	27190.53	43.96
QC Savings	49022.01	47.57	-	2665.02	6.28	-	51687.03	53.85
Eng. Realization Rate	0.32	0.73		0.11	0.31			

Base Case: 14 deg Approach Temp

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-		0.0	0	-
32	0.00%	-		0.0	0	-
37	0.00%	-		0.0	0	-
42	0.00%	-		0.0	0	-
47	0.00%	-		0.0	0	-
52	0.00%	-		0.0	0	-
57	0.00%	-		0.0	0	-
62	10.00%	16	1.629	25.6	485.71	12,422
67	25.00%	39	0.893	35.1	335.00	11,742
72	40.00%	63	0.703	44.1	223.04	9,847
77	55.00%	86	0.701	60.5	148.04	8,954
82	70.00%	110	0.731	80.3	97.14	7,804
87	85.00%	133	0.777	103.6	52.86	5,477
92	100.00%	157	0.837	131.4	32.68	4,294
97	100.00%	157	0.837	131.4	7.14	939
102	100.00%	157	0.837	131.4	5.89	774
				131.4	1387.50	62,254

Operational Parameters	New Chiller		Old Chiller	
Base Case	Minimum	Maximum	Minimum	Maximum
Chiller Output (Ton)	15.7	157	15.7	157
OSA Temp	65	90	65	90
% Of Capacity	10%	100%	10%	100%

New Chiller Efficiency: @ Application Design of 10 Deg. Approach Temp

%	Tons	kW/Ton
25%	50	0.581
50%	100	0.524
75%	150	0.523
100%	200	0.557

iplv (kW/Ton) = 0.534758187

Note: Based on chillerdecrease of .01 kW/ton per Degree of Approach Temperature increase.

Rebate Case:14 deg Approach Temp

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	#1	0	0.0	0	-
32	0.00%	-	0.000	#1	0	0.0	0	-
37	0.00%	-	0.000	#1	0	0.0	0	-
42	0.00%	-	0.000	#1	0	0.0	0	-
47	0.00%	-	0.000	#1	0	0.0	0	-
52	0.00%	-	0.000	#1	0	0.0	0	-
57	0.00%	-	0.000	#1	0.000	0.0	0	-
62	10.00%	16	1.124	#1	1.124	17.6	485.71	8,571
67	25.00%	39	0.621	#1	0.621	24.4	335.00	8,165
72	40.00%	63	0.587	#1	0.587	36.9	223.04	8,222
77	55.00%	86	0.564	#1	0.564	48.7	148.04	7,210
82	70.00%	110	0.563	#1	0.563	61.9	97.14	6,011
87	85.00%	133	0.577	#1	0.577	77.0	52.86	4,070
92	100.00%	157	0.597	#1	0.597	93.7	32.68	3,063
97	100.00%	157	0.597	#1	0.597	93.7	7.14	669
102	100.00%	157	0.597	#1	0.597	93.7	5.89	552
						93.7	1387.50	37,962

Existing Case: 14 deg Approach Temp

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	0.0	0	-
32	0.00%	-	0.000	0.0	0	-
37	0.00%	-	0.000	0.0	0	-
42	0.00%	-	0.000	0.0	0	-
47	0.00%	-	0.000	0.0	0	-
52	0.00%	-	0.000	0.0	0	-
57	0.00%	-	0.000	0.0	0	-
62	10.00%	16	1.468	57.6	485.71	27,986
67	25.00%	39	1.08	42.4	335.00	14,201
72	40.00%	63	0.928	58.3	223.04	12,998
77	55.00%	86	0.855	73.8	148.04	10,929
82	70.00%	110	0.845	92.9	97.14	9,021
87	85.00%	133	0.862	115.0	52.86	6,080
92	100.00%	157	0.900	141.3	32.68	4,617
97	100.00%	157	0.900	141.3	7.14	1,009
102	100.00%	157	0.900	141.3	5.89	141.3
				141.3	1387.50	86,984

Good estimate Running hrs for 2 yrs is 2888 vs 2886 estimate w/in 1%

				rebate		14 deg	10 deg					
base case	base case	rebate case	rebate	10deg		base case	base case		existing case			
10	1.629	10	1.084	1.084	10.00	1.629	1.589	1.589	10.00%	1.488	0.900	100
20	1.004	20	0.592	0.581	25.00	0.893	0.853	0.853	25.00%	1.080	0.872	90
25	0.893	25	0.581	0.547	40.00	0.703	0.663	0.663	40.00%	0.928	0.852	80
30	0.837	30	0.570	0.524	55	0.701	0.6605	0.661	55.00%	0.855	0.845	75
40	0.703	40	0.547	0.523	70.00	0.731	0.691	0.691	70.00%	0.845	0.845	70
50	0.692	50	0.524	0.537	85.00	0.777	0.737	0.737	85.00%	0.862	0.852	60
60	0.709	60	0.524	0.557	100.00	0.837	0.797	0.797	100.00%	0.900	0.858	50
70	0.731	70	0.523								0.928	40
75	0.748	75	0.523								1.038	30
80	0.764	80	0.530								1.080	25
90	0.789	90	0.543								1.177	20
100	0.837	100	0.557								1.468	10

Site 2935: Cooling Tower

New Chiller Efficiency		
%	Tons	kW/Ton
25%	50	0.581
50%	100	0.524
75%	150	0.523
100%	200	0.557

Note: Based on chiller improvement of .01 kW/ton per Degree of Approach Temperature reduction.

Patterson

Operational Parameters	New Chiller		Old Chiller	
Base Case	Minimum	Maximum	Minimum	Maximum
Chiller Output (Ton)	15.7	157	15.7	157
OSA Temp	65	90	65	90
% Of Capacity	10%	100%	10%	100%

Base Case: 10 deg Approach Temp

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.0	0.0	0	-
32	0.00%	-	0.0	0.0	0	-
37	0.00%	-	0.0	0.0	0	-
42	0.00%	-	0.0	0.0	0	-
47	0.00%	-	0.0	0.0	0	-
52	0.00%	-	0.0	0.0	0	-
57	0.00%	-	0.0	0.0	0	-
62	10.00%	16	1.589	24.9	485.71	12,117
67	25.00%	39	0.853	33.5	335.00	11,216
72	40.00%	63	0.663	41.8	223.04	9,286
77	55.00%	86	0.661	57.0	148.04	8,443
82	70.00%	110	0.691	75.9	97.14	7,377
87	85.00%	133	0.737	98.3	52.86	5,195
92	100.00%	157	0.797	125.1	32.68	4,089
97	100.00%	157	0.797	125.1	7.14	894
102	100.00%	157	0.797	125.1	5.89	737
				125.1	1387.50	59,355

Rebate Case:10 deg Approach Temp

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	#1	0	0.0	0	-
32	0.00%	-	0.000	#1	0	0.0	0	-
37	0.00%	-	0.000	#1	0	0.0	0	-
42	0.00%	-	0.000	#1	0	0.0	0	-
47	0.00%	-	0.000	#1	0	0.0	0	-
52	0.00%	-	0.000	#1	0	0.00	0	-
57	0.00%	-	0.000	#1	0.000	0.00	0	-
62	10.00%	16	1.084	#1	1.084	17.02	485.71	8,286
67	25.00%	39	0.581	#1	0.581	22.80	335.00	7,639
72	40.00%	63	0.547	#1	0.547	34.34	223.04	7,659
77	55.00%	86	0.524	#1	0.524	45.28	148.04	6,703
82	70.00%	110	0.523	#1	0.523	57.50	97.14	5,586
87	85.00%	133	0.537	#1	0.537	71.60	52.86	3,784
92	100.00%	157	0.557	#1	0.557	87.45	32.68	2,858
97	100.00%	157	0.557	#1	0.557	87.45	7.14	625
102	100.00%	157	0.557	#1	0.557	87.45	5.89	515
						87.4	1387.50	43,636

Good estimate Running hrs for 2 yrs is 2888 vs 2969 estimate w/in 3%

Existing Case: 10 deg Approach Temp

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	0.0	0	-
32	0.00%	-	0.000	0.0	0	-
37	0.00%	-	0.000	0.0	0	-
42	0.00%	-	0.000	0.0	0	-
47	0.00%	-	0.000	0.0	0	-
52	0.00%	-	0.000	0.0	0	-
57	0.00%	-	0.000	0.0	0	-
62	10.00%	16	1.428	56.0	485.71	27,224
67	25.00%	39	1.04	40.8	335.00	13,675
72	40.00%	63	0.888	55.8	223.04	12,438
77	55.00%	86	0.815	70.4	148.04	10,418
82	70.00%	110	0.805	88.5	97.14	8,594
87	85.00%	133	0.822	109.7	52.86	5,798
92	100.00%	157	0.860	135.0	32.68	4,412
97	100.00%	157	0.860	135.0	7.14	964
102	100.00%	157	0.860	135.0	5.89	796
				135.0	1387.50	84,319

				rebate		14 deg	10 deg
base case	base case	rebate case	rebate	10deg		base case	base case
10.000	1.629	10.000	1.084	1.084	10.000	1.629	1.589
20.000	1.004	20.000	0.592	0.581	25.000	0.893	0.853
25.000	0.893	25.000	0.581	0.547	40.000	0.703	0.663
30.000	0.837	30.000	0.570	0.524	55.000	0.701	0.661
40.000	0.703	40.000	0.547	0.523	70.000	0.731	0.691
50.000	0.692	50.000	0.524	0.537	85.000	0.777	0.737
60.000	0.709	60.000	0.524	0.557	100.000	0.837	0.797
70.000	0.731	70.000	0.523				
75.000	0.748	75.000	0.523				
80.000	0.764	80.000	0.530				
90.000	0.789	90.000	0.543				
100.000	0.837	100.000	0.557				

existing case @14 deg		existing case @10deg	existing case @14 deg	
0.100	1.468	1.428	0.900	100.000
0.250	1.080	1.040	0.872	90.000
0.400	0.928	0.888	0.852	80.000
0.550	0.855	0.815	0.845	75.000
0.700	0.845	0.805	0.845	70.000
0.850	0.862	0.822	0.852	60.000
1.000	0.900	0.860	0.858	50.000
			0.928	40.000
			1.038	30.000
			1.080	25.000
			1.177	20.000
			1.468	10.000

clz3 Site 2935

Total		Month														
		1	2	3	4	5	6	7	8	9	10	11	12	Total	ACTUAL TOTAL	
Temper	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	
	32	6	0	0	0	0	0	0	0	0	0	0	23	29	6.25	
	37	22	17	25	9	0	0	0	0	0	0	0	85	158	30.36	
	42	85	72	80	45	5	0	0	0	0	8	26	154	475	100.36	
	47	220	159	152	158	56	5	0	0	0	61	106	193	1110	299.46	
	52	235	309	158	206	237	101	48	66	49	157	239	184	1989	583.39	
	57	148	110	205	157	254	255	218	178	228	148	219	95	2215	721.25	
	62	26	5	77	59	140	167	145	123	139	145	85	10	1121	485.71	485.7
	67	2	0	40	40	42	94	104	102	100	107	18	0	649	335.00	335
	72	0	0	7	20	10	45	94	73	80	68	9	0	406	223.04	223
	77	0	0	0	23	0	19	62	67	45	30	16	0	262	148.04	148
	82	0	0	0	3	0	26	37	57	34	16	2	0	175	97.14	97.14
	87	0	0	0	0	0	7	15	36	33	4	0	0	95	52.86	52.86
	92	0	0	0	0	0	1	17	24	12	0	0	0	54	32.68	32.68
	97	0	0	0	0	0	0	3	10	0	0	0	0	13	7.14	7.143
	102	0	0	0	0	0	0	1	8	0	0	0	0	9	5.89	5.893
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0
															1387.50	1388

01-08		Month														
		1	2	3	4	5	6	7	8	9	10	11	12	Total	6am St	5 of 7 days
Temper	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
	32	5	0	0	0	0	0	0	0	0	0	0	22	27	6.75	4.82
	37	11	17	25	9	0	0	0	0	0	0	0	63	125	31.25	22.32
	42	57	46	54	37	5	0	0	0	0	8	25	61	293	73.25	52.32
	47	68	65	76	107	47	5	0	0	0	57	69	67	561	140.25	100.18
	52	82	87	59	64	117	82	45	62	40	94	106	30	868	217.00	155.00
	57	25	8	31	21	75	128	146	120	139	63	39	5	800	200.00	142.86
	62	0	1	3	2	4	19	46	43	38	20	1	0	177	44.25	31.61
	67	0	0	0	0	0	4	7	17	19	6	0	0	53	13.25	9.46
	72	0	0	0	0	0	2	3	5	4	0	0	0	14	3.50	2.50
	77	0	0	0	0	0	0	1	1	0	0	0	0	2	0.50	0.36
	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
	92	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00

09-16		Month													
		1	2	3	4	5	6	7	8	9	10	11	12	Total	5 of 7 days
Temper	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	32	1	0	0	0	0	0	0	0	0	0	0	1	2	1.43
	37	2	0	0	0	0	0	0	0	0	0	0	2	4	2.86
	42	7	2	1	0	0	0	0	0	0	0	0	19	29	20.71
	47	70	35	23	6	1	0	0	0	0	0	4	50	189	135.00
	52	68	116	34	49	25	0	0	0	0	1	46	87	426	304.29
	57	80	67	92	83	70	15	5	4	11	11	91	79	608	434.29
	62	18	4	59	34	107	87	32	25	41	53	63	10	533	380.71
	67	2	0	32	34	35	67	59	45	44	78	13	0	409	292.14
	72	0	0	7	13	10	34	59	40	53	60	5	0	281	200.71
	77	0	0	0	20	0	12	40	42	32	27	16	0	189	135.00
	82	0	0	0	1	0	19	25	38	24	14	2	0	123	87.86
	87	0	0	0	0	0	5	10	25	23	4	0	0	67	47.86
	92	0	0	0	0	0	1	14	16	12	0	0	0	43	30.71
	97	0	0	0	0	0	0	3	6	0	0	0	0	9	6.43
	102	0	0	0	0	0	0	1	7	0	0	0	0	8	5.71
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00

17-24		Month														
		1	2	3	4	5	6	7	8	9	10	11	12	Total	6pm off	5 of 7 days
Temper	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
	37	9	0	0	0	0	0	0	0	0	0	0	20	29	7.25	5.18
	42	21	24	25	8	0	0	0	0	0	0	1	74	153	38.25	27.32
	47	82	59	53	45	8	0	0	0	0	4	33	76	360	90.00	64.29
	52	85	106	65	93	95	19	3	4	9	62	87	67	695	173.75	124.11
	57	43	35	82	53	109	112	67	54	78	74	89	11	807	201.75	144.11
	62	8	0	15	23	29	61	67	55	60	72	21	0	411	102.75	73.39
	67	0	0	8	6	7	23	38	40	37	23	5	0	187	46.75	33.39
	72	0	0	0	7	0	9	32	28	23	8	4	0	111	27.75	19.82
	77	0	0	0	3	0	7	21	24	13	3	0	0	71	17.75	12.68
	82	0	0	0	2	0	7	12	19	10	2	0	0	52	13.00	9.29
	87	0	0	0	0	0	2	5	11	10	0	0	0	28	7.00	5.00
	92	0	0	0	0	0	0	3	8	0	0	0	0	11	2.75	1.96
	97	0	0	0	0	0	0	0	4	0	0	0	0	4	1.00	0.71
	102	0	0	0	0	0	0	0	1	0	0	0	0	1	0.25	0.18
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00

Chiller Replacement (Site 2936)

Program	Retrofit Efficiency Options Program
Measure	High Efficiency Water-Cooled Chiller Oversized Evaporative Cooling Tower
Site Description	Office

Measure Description

Replace existing chiller with high-efficiency water-cooled chiller. Replace Cooling tower with an oversized cooling tower.

Summary of Ex Ante Impact Calculations

Tables of standard values were developed using the HBSSM simulation program based on climate zone, chiller size, building type, chiller efficiency, condenser water and approach temperature. Values from these tables are used to calculate the rebate and associated impacts.

Comments on Calculations

The correct climate zone, chiller size category, building type and correct chiller efficiency was used in the application. The only discrepancy is that the cooling tower was upgraded not replaced. Project cost reflects this. The correct approach temperature design and fan horsepower was used in the application. A paid invoice for the cooling tower work was also included.

Evaluation Process

The evaluation process consisted of reviewing the application form and supporting documentation, conducting an on-site survey and then computing impacts using the on-site data. Models were calibrated with actual weather, number of compressor hours as well as an observed operating point, %load @ the outside air temperature. Peak demand was calculated for actual peak temperatures. Energy saving were based on typical weather data. A Title 24 baseline, IPLV at ARI conditions, and typical year bin weather data were used in the bin analysis.

The on-site survey was conducted on October 2, 1998. Information on the retrofit equipment and operating conditions were collected through an inspection of the chiller, cooling tower and through an interview with the Chief Engineer.

Discussions provided data for development of a relationship between chiller loading and outdoor dry bulb temperatures. The chiller is available Monday through Friday 7am to 7:30pm, 52 weeks a year. Chiller use generally begins at 61 degrees outside air temperature and reaches 100% loading at 100 Degrees F.

To compute the impacts, the following assumptions were used:

- A linear loading strategy was used for the analysis of the original, baseline and rebated chillers, which assumed 10% loading at 61 degrees and 100% loading at 100 Degrees F.

- For the baseline chiller case a Title 24 baseline efficiency of 0.837

KW/ton was used, based on a water-cooled chiller between 150 and 300 tons. The existing chiller had a default KW/Ton of 0.90. An assumed chiller improvement of 0.01 KW/ton per degree reduction of approach temperature.

- Chiller efficiencies at various temperatures were interpolated from values provided at 25%, 50%, 75%, and 100% loading at ARI conditions. These calculated efficiencies were used to develop a chiller efficiency curve for the Rebate case. The baseline chiller efficiency curve was based on minimum Title 24 full load efficiency requirements, matched to a typical chiller performance curve.

The above assumptions were incorporated into a spreadsheet where energy and demand impacts were calculated. Evaluation- based demand higher and energy impacts were lower than Ex Ante estimates. Results from these calculations are summarized below and documented in the attached workbook

Additional Notes

Saving estimates were calculated in a similar manner. The combined measure total results are documented in the attached workbook.

Impact Results

	KW	KWh	Therm
MDSS	47.53	64,089.6	0
Adjusted Engineering	27.28	30,392.2	0
Engineering Realization Rate	0.57	.47	N/A

Site 2936	Change Due to Chiller Measure kWh	Change Due to Chiller Measure kW *	Change Due to Chiller Measure therms	Change Due to Cooling Tower Measure kWh	Change Due to Cooling Tower Measure kW*	Change Due to Cooling Tower Measure therms		
PG&E	51,312.25	37.84	0.00	12,777.36	9.69	-	64,089.61	47.53
QC Impact	27,990.67	19.88	0.00	2,401.49	7.40	-	30,392.16	27.28
QC Savings	52,840.65	57.35	0.00	3032.64	7.40	-	55,873.29	64.75
Eng. Impact	0.55	0.53		0.19	0.76			
Realization Rate								

Base Case: 14 deg Approach Temp

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-		0.0	0	-
32	0.00%	-		0.0	0	-
37	0.00%	-		0.0	0	-
42	0.00%	-		0.0	0	-
47	0.00%	-		0.0	0	-
52	0.00%	-		0.0	0	-
57	0.00%	-		0.0	0	-
62	10.00%	19	1.629	30.1	558.14	16,820
67	21.25%	39	0.976	38.4	455.00	17,462
72	32.50%	60	0.804	48.3	263.35	12,722
77	43.75%	81	0.699	56.6	116.56	6,593
82	55.00%	102	0.701	71.3	39.82	2,838
87	66.25%	123	0.720	88.2	19.60	1,729
92	77.50%	143	0.756	108.4	0.71	77
97	88.75%	164	0.786	129.0	0.00	-
102	100.00%	185	0.837	129.0	0.00	-
				129.0	1453.19	58,243

New Chiller Efficiency: @ Application Design of 10 Deg. Approach Temp

%	Tons	kW/Ton
25%	50	0.565
50%	100	0.510
75%	150	0.507
100%	200	0.550

Operational Parameters	New Chiller Minimum	New Chiller Maximum	Old Chiller Minimum	Old Chiller Maximum
Base Case	Minimum	Maximum	Minimum	Maximum
Chiller Output (Ton)	18.5	185	18.5	185
OSA Temp	61	100	61	100
% Of Capacity	10%	100%	10%	100%

Note: Based on chillerdecrease of .01 kW/ton per Degree of Approach Temperature increase.

Rebate Case:14 deg Approach Temp

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	#1	0	0.0	0	-
32	0.00%	-	0.000	#1	0	0.0	0	-
37	0.00%	-	0.000	#1	0	0.0	0	-
42	0.00%	-	0.000	#1	0	0.0	0	-
47	0.00%	-	0.000	#1	0	0.0	0	-
52	0.00%	-	0.000	#1	0	0.0	0	-
57	0.00%	-	0.000	#1	0.000	0.0	0	-
62	10.00%	19	1.111	#1	1.111	20.6	558.14	11,472
67	21.25%	39	0.679	#1	0.679	26.7	455.00	12,147
72	32.50%	60	0.580	#1	0.580	34.9	263.35	9,188
77	43.75%	81	0.564	#1	0.564	45.6	116.56	5,319
82	55.00%	102	0.549	#1	0.549	55.9	39.82	2,226
87	66.25%	123	0.548	#1	0.548	67.2	19.60	1,316
92	77.50%	143	0.551	#1	0.551	79.0	0.71	56
97	88.75%	164	0.571	#1	0.571	93.7	0.00	-
102	100.00%	185	0.590	#1	0.590	109.2	0.00	-
						109.2	1453.19	30,252

Existing Case: 14 deg Approach Temp

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	0.0	0	-
32	0.00%	-	0.000	0.0	0	-
37	0.00%	-	0.000	0.0	0	-
42	0.00%	-	0.000	0.0	0	-
47	0.00%	-	0.000	0.0	0	-
52	0.00%	-	0.000	0.0	0	-
57	0.00%	-	0.000	0.0	0	-
62	10.00%	19	1.468	57.7	558.14	32,211
67	21.25%	39	1.153	45.3	455.00	20,619
72	32.50%	60	1.011	60.8	263.35	16,000
77	43.75%	81	0.902	73.0	116.56	8,507
82	55.00%	102	0.855	87.0	39.82	3,464
87	66.25%	123	0.848	104.0	19.60	2,038
92	77.50%	143	0.849	121.7	0.71	87
97	88.75%	164	0.870	142.8	0.00	-
102	100.00%	185	0.900	166.5	0.00	166.5
				166.5	1453.19	83,093

Good estimate Running hrs for 2 yrs is 2888 vs 2886 estimate w/in 1%

											rebate			
% load	base case	% load	14deg	rebate case	rebate	rebate case	rebate	14deg	% load			Existing		
10	1.629	10.00	1.6290	10	1.071	10	1.111	1.1110	10.00	% load		14deg		% load
20	1.004	21.25	0.9763	20	0.664	20	0.704	0.6791	21.25	10		1.468	1.4680	10.00
25	0.893	32.50	0.8035	25	0.565	25	0.605	0.5803	32.50	20		1.177	1.1528	21.25
30	0.837	43.75	0.6989	30	0.543	30	0.583	0.5638	43.75	25		1.080	1.0105	32.50
40	0.703	55.00	0.7005	40	0.532	40	0.572	0.5494	55.00	30		1.038	0.9018	43.75
50	0.692	66.25	0.7196	50	0.510	50	0.550	0.5481	66.25	40		0.928	0.8550	55.00
60	0.709	77.50	0.7560	60	0.509	60	0.549	0.5513	77.50	50		0.858	0.8483	66.25
70	0.731	88.75	0.7859	70	0.508	70	0.548	0.5707	88.75	60		0.852	0.8485	77.50
75	0.748	100.00	0.8370	75	0.507	75	0.547	0.5900	100.00	70		0.845	0.8695	88.75
80	0.764			80	0.516	80	0.556			75		0.845	0.9000	100.00
90	0.789			90	0.533	90	0.573			80		0.852		
100	0.837			100	0.55	100	0.590			90		0.872		
										100		0.900		

Site 2936: Cooling Tower

New Chiller Efficiency

%	Tons	kW/Ton
25%	50	0.565
50%	100	0.510
75%	150	0.507
100%	200	0.550

Note: Based on chiller improvement of .01 kW/ton per Degree of Approach Temperature reduction.

Operational Parameters	New Chiller		Old Chiller	
Base Case	**Minimum**	**Maximum**	**Minimum**	**Maximum**
Chiller Output (Ton)	18.5	185	18.5	185
OSA Temp	61	100	61	100
% Of Capacity	10%	100%	10%	100%

Base Case: 10 deg Approach Temp

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.0	0.0	0.00	-
32	0.00%	-	0.0	0.0	0.00	-
37	0.00%	-	0.0	0.0	0.00	-
42	0.00%	-	0.0	0.0	0.00	-
47	0.00%	-	0.0	0.0	0.00	-
52	0.00%	-	0.0	0.0	0.00	-
57	0.00%	-	0.0	0.0	0.00	-
62	10.00%	19	1.589	29.4	558.14	16,407
67	21.25%	39	0.936	36.8	455.00	16,747
72	32.50%	60	0.764	45.9	263.35	12,089
77	43.75%	81	0.659	53.3	116.56	6,216
82	55.00%	102	0.661	67.2	39.82	2,676
87	66.25%	123	0.680	83.3	19.60	1,632
92	77.50%	143	0.716	102.7	0.71	73
97	88.75%	164	0.746	122.5	0.00	-
102	100.00%	185	0.797	147.4	0.00	-
				147.4	1453.19	55,841

Rebate Case:10 deg Approach Temp

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	#1	0	0.0	0	-
32	0.00%	-	0.000	#1	0	0.0	0	-
37	0.00%	-	0.000	#1	0	0.0	0	-
42	0.00%	-	0.000	#1	0	0.0	0	-
47	0.00%	-	0.000	#1	0	0.0	0	-
52	0.00%	-	0.000	#1	0	0.00	0	-
57	0.00%	-	0.000	#1	0.000	0.00	0	-
62	10.00%	19	1.071	#1	1.084	19.81	558.14	11,059
67	21.25%	39	0.639	#1	0.581	25.12	455.00	11,432
72	32.50%	60	0.540	#1	0.547	32.48	263.35	8,554
77	43.75%	81	0.524	#1	0.524	42.39	116.56	4,941
82	55.00%	102	0.509	#1	0.523	51.83	39.82	2,064
87	66.25%	123	0.508	#1	0.537	62.27	19.60	1,220
92	77.50%	143	0.511	#1	0.557	73.31	0.71	52
97	88.75%	164	0.531	#1	0.557	87.13	0.00	-
102	100.00%	185	0.550	#1	0.557	101.75	0.00	-
						101.8	1453.19	39,323

Good estimate Running hrs for 2 yrs is 2888 vs 2969 estimate w/in 3%

Existing Case: 10 deg Approach Temp

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	0.0	0	-
32	0.00%	-	0.000	0.0	0	-
37	0.00%	-	0.000	0.0	0	-
42	0.00%	-	0.000	0.0	0	-
47	0.00%	-	0.000	0.0	0	-
52	0.00%	-	0.000	0.0	0	-
57	0.00%	-	0.000	0.0	0	-
62	10.00%	19	1.428	56.1	558.14	31,333
67	21.25%	39	1.11275	43.7	455.00	19,904
72	32.50%	60	0.9705	58.4	263.35	15,367
77	43.75%	81	0.86175	69.7	116.56	8,130
82	55.00%	102	0.815	82.9	39.82	3,302
87	66.25%	123	0.80825	99.1	19.60	1,941
92	77.50%	143	0.809	115.9	0.71	83
97	88.75%	164	0.830	136.2	0.00	-
102	100.00%	185	0.860	159.1	0.00	-
				159.1	1453.19	80,060

% load	base case	% load	10deg	rebate case	rebate	10deg	% load		Existing	
10.000	1.629	10.000	1.589	10.000	1.071	1.071	10.000	10deg	10deg	% load
20.000	1.004	21.250	0.936	20.000	0.664	0.639	21.250	1.428	1.428	10.000
25.000	0.893	32.500	0.764	25.000	0.565	0.540	32.500	1.137	1.113	21.250
30.000	0.837	43.750	0.659	30.000	0.543	0.524	43.750	1.040	0.971	32.500
40.000	0.703	55.000	0.661	40.000	0.532	0.509	55.000	0.998	0.862	43.750
50.000	0.692	66.250	0.680	50.000	0.510	0.508	66.250	0.888	0.815	55.000
60.000	0.709	77.500	0.716	60.000	0.509	0.511	77.500	0.818	0.808	66.250
70.000	0.731	88.750	0.746	70.000	0.508	0.531	88.750	0.812	0.809	77.500
75.000	0.748	100.000	0.797	75.000	0.507	0.550	100.000	0.805	0.830	88.750
80.000	0.764			80.000	0.516			0.805	0.860	100.000
90.000	0.789			90.000	0.533			0.812		
100.000	0.837			100.000	0.550			0.832		
								0.860		

clz3 Site 2636

Total		Month														
		1	2	3	4	5	6	7	8	9	10	11	12	Total	ACTUAL TOTAL	
Temper	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	
	32	6	0	0	0	0	0	0	0	0	0	0	23	29	3.84	
	37	22	17	25	9	0	0	0	0	0	0	0	85	158	23.08	
	42	85	72	80	45	5	0	0	0	0	8	26	154	475	94.69	
	47	220	159	152	158	56	5	0	0	0	61	106	193	1110	297.59	
	52	235	309	158	206	237	101	48	66	49	157	239	184	1989	598.97	
	57	148	110	205	157	254	255	218	178	228	148	219	95	2215	757.90	
	62	26	5	77	59	140	167	145	123	139	145	85	10	1121	524.96	525
	67	2	0	40	40	42	94	104	102	100	107	18	0	649	355.31	355.3
	72	0	0	7	20	10	45	94	73	80	68	9	0	406	236.65	236.7
	77	0	0	0	23	0	19	62	67	45	30	16	0	262	157.37	157.4
	82	0	0	0	3	0	26	37	57	34	16	2	0	175	104.11	104.1
	87	0	0	0	0	0	7	15	36	33	4	0	0	95	56.61	56.61
	92	0	0	0	0	0	1	17	24	12	0	0	0	54	34.15	34.15
	97	0	0	0	0	0	0	3	10	0	0	0	0	13	7.68	7.679
	102	0	0	0	0	0	0	1	8	0	0	0	0	9	6.03	6.027
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0
															1482.86	1483

01-08		Month														
		1	2	3	4	5	6	7	8	9	10	11	12	Total	7am St	5 of 7 days
Temper	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	5	0	0	0	0	0	0	0	0	0	0	22	27	3.375	2.41071
	37	11	17	25	9	0	0	0	0	0	0	0	63	125	15.63	11.1607
	42	57	46	54	37	5	0	0	0	0	8	25	61	293	36.63	26.1607
	47	68	65	76	107	47	5	0	0	0	57	69	67	561	70.13	50.0893
	52	82	87	59	64	117	82	45	62	40	94	106	30	868	108.5	77.5
	57	25	8	31	21	75	128	146	120	139	63	39	5	800	100	71.4286
	62	0	1	3	2	4	19	46	43	38	20	1	0	177	22.13	15.8036
	67	0	0	0	0	0	4	7	17	19	6	0	0	53	6.625	4.73214
	72	0	0	0	0	0	2	3	5	4	0	0	0	14	1.75	1.25
	77	0	0	0	0	0	0	1	1	0	0	0	0	2	0.25	0.17857
	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

09-16		Month													
		1	2	3	4	5	6	7	8	9	10	11	12	Total	5 of 7 days
Temper	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	32	1	0	0	0	0	0	0	0	0	0	0	1	2	1.43
	37	2	0	0	0	0	0	0	0	0	0	0	2	4	2.86
	42	7	2	1	0	0	0	0	0	0	0	0	19	29	20.71
	47	70	35	23	6	1	0	0	0	0	0	4	50	189	135.00
	52	68	116	34	49	25	0	0	0	0	1	46	87	426	304.29
	57	80	67	92	83	70	15	5	4	11	11	91	79	608	434.29
	62	18	4	59	34	107	87	32	25	41	53	63	10	533	380.71
	67	2	0	32	34	35	67	59	45	44	78	13	0	409	292.14
	72	0	0	7	13	10	34	59	40	53	60	5	0	281	200.71
	77	0	0	0	20	0	12	40	42	32	27	16	0	189	135.00
	82	0	0	0	1	0	19	25	38	24	14	2	0	123	87.86
	87	0	0	0	0	0	5	10	25	23	4	0	0	67	47.86
	92	0	0	0	0	0	1	14	16	12	0	0	0	43	30.71
	97	0	0	0	0	0	0	3	6	0	0	0	0	9	6.43
	102	0	0	0	0	0	0	1	7	0	0	0	0	8	5.71
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00

17-24		Month														
		1	2	3	4	5	6	7	8	9	10	11	12	Total	7:30pm	5 of 7 days
Temper	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
	37	9	0	0	0	0	0	0	0	0	0	0	20	29	12.69	9.06
	42	21	24	25	8	0	0	0	0	0	0	1	74	153	66.94	47.81
	47	82	59	53	45	8	0	0	0	0	4	33	76	360	157.50	112.50
	52	85	106	65	93	95	19	3	4	9	62	87	67	695	304.06	217.19
	57	43	35	82	53	109	112	67	54	78	74	89	11	807	353.06	252.19
	62	8	0	15	23	29	61	67	55	60	72	21	0	411	179.81	128.44
	67	0	0	8	6	7	23	38	40	37	23	5	0	187	81.81	58.44
	72	0	0	0	7	0	9	32	28	23	8	4	0	111	48.56	34.69
	77	0	0	0	3	0	7	21	24	13	3	0	0	71	31.06	22.19
	82	0	0	0	2	0	7	12	19	10	2	0	0	52	22.75	16.25
	87	0	0	0	0	0	2	5	11	10	0	0	0	28	12.25	8.75
	92	0	0	0	0	0	0	3	8	0	0	0	0	11	4.81	3.44
	97	0	0	0	0	0	0	0	4	0	0	0	0	4	1.75	1.25
	102	0	0	0	0	0	0	0	1	0	0	0	0	1	0.44	0.31
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00

Chiller Replacement (Site 2974)

Program	Advanced Performance Options
Measure	High Efficiency Chiller
Site Description	College / University

Measure Description Replace 2 existing chillers with 2 high-efficiency centrifugal chillers.

Summary of Ex Ante Impact Calculations Demand and energy impacts were determined from Visual DOE simulations and weather data from California climate zone 3. A baseline simulation was developed and then the rebated chiller was substituted for the baseline chiller. Reduction in energy consumption are reflected in space cooling and heat rejection, all other energy use is constant. No input file or documentation of inputs, accompanied the application.

Comments on Calculations The results from the simulations are reasonable and accurate. The proper weather data was used for the simulations. The total energy use determined from the baseline simulation was not well matched with the historic energy use at the facility, due to the large number of buildings on a single meter. Energy usage associated with the retrofit chiller is computed in a similar fashion, using an identical load line, weather and operating hour assumptions, but with a chiller efficiency appropriate for the retrofit chiller. Savings due to cooling tower effects were included in the savings estimate.

Evaluation Process The evaluation process consisted of reviewing the application form and supporting documentation, conducting an on-site survey and reviewing the results from the Visual DOE Simulations. Impacts were calculated using the on-site data. Models were calibrated with actual weather, number of compressor hours as well as an observed operating point, %load @ the outside air temperature. Peak demand was calculated for actual peak temperatures. Energy saving were based on typical weather data. A Title 24 baseline, IPLV at ARI conditions, and typical year bin weather data for the applicable climate zone was used in the bin analysis. Our bin model does not capture the cooling tower effects. The cooling tower effects contribute less than 6% of the impact.

The on-site survey was conducted on October 6, 1998 with the Chief Engineer. The retrofit equipment and operating conditions were verified via an inspection of the central plant and through discussions with the Engineer. He confirmed that the chiller and schedule matched the information provided in the application. Discussions provided data for development of a relationship between chiller loading and outdoor dry bulb temperature. Chiller use generally begins at 62 degrees outside air temperature. The Lead chiller reaches 100% loading at 82 Degrees F, bringing the second chiller on line. The second chiller reaches 100% loading at 97degrees F.

To compute the impacts, the following assumptions were used:

- A linear loading strategy was used for the analysis of both the baseline and rebated chillers, which assumed 10% loading at 62 degrees and 100% loading at 82Degrees F. The second chiller reaches 100% loading at 97degrees F.
- For the baseline chiller case a Title 24 baseline efficiency of 0.748KW/ton, based on a water-cooled chiller greater than 300 tons, was used.
- Chiller efficiencies at various temperatures were interpolated from values provided at 25%, 50%, 75%, and 100% loading at ARI conditions. These calculated efficiencies were used to develop a chiller efficiency curve for the Rebate case. The baseline chiller efficiency curve was based on minimum Tittle 24 full load efficiency requirements, matched to a typical chiller performance curve.

The above assumptions were incorporated into a spreadsheet where energy and demand impacts were calculated. Evaluation- based demand and energy impacts were significantly lower than Ex Ante estimates. Results from these calculations are summarized below and documented in the attached workbook.

Additional Notes

Impact Results

	KW	KWh	Therm
MDSS	222.33	315,951.3	0
Adjusted Engineering	129.50	110,488.7	0
Engineering Realization Rate	0.58	0.35	N/A

Site # 2974	WYEC Weather		
	kWh	kW	therms
PG&E	315,951.30	222.33	-
QC Impact	110,488.70	129.50	-
			-
I-Eng. Real. Rat	0.35	0.58	

New Chiller Efficiency Qty 2 identical		
%	Tons	kW/Ton
25%	87.5	0.750
50%	175	0.563
75%	262.5	0.532
100%	350	0.563

iplv (kW/To 0.565659

Operational Parameters	# 1 & 2 New Chiller (Centrifugal)	
	Minimum	Maximum
Chiller Output (Ton)	35	700
OSA Temp	60	102
% Of Capacity	5%	100%

Basecase Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-		0.0	0.00	-
32	0.00%	-		0.0	0.00	-
37	0.00%	-		0.0	0.00	-
42	0.00%	-		0.0	0.00	-
47	0.00%	-		0.0	0.00	-
52	0.00%	-		0.0	0.00	-
57	0.00%	-		0.0	0.00	-
62	10.00%	70	1.220	85.4	1013.26	86,533
67	16.25%	114	1.068	121.5	591.69	71,881
72	27.50%	193	0.881	169.5	331.39	56,169
77	38.75%	271	0.783	212.3	145.79	30,945
82	55.00%	385	0.711	273.5	50.35	13,772
87	83.34%	583	0.714	416.3	25.04	10,425
92	91.67%	642	0.729	467.6	0.93	434
97	100.00%	700	0.748	523.6	0.00	-
102	100.00%	700	0.748	523.6	0.00	-
				523.6	2158.45	270,159

Rebate Case

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Number	Chiller #1 Load (%)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller #2 Load (%)	Chiller Eff. (kW/Ton)	Total Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	#1	0.00%	0.000	#2	0.00%	0.000	0.00	0.00	-
32	0.00%	-	#1	0.00%	0.000	#2	0.00%	0.000	0.00	0.00	-
37	0.00%	-	#1	0.00%	0.000	#2	0.00%	0.000	0.00	0.00	-
42	0.00%	-	#1	0.00%	0.000	#2	0.00%	0.000	0.00	0.00	-
47	0.00%	-	#1	0.00%	0.000	#2	0.00%	0.000	0.00	0.00	-
52	0.00%	-	#1	0.00%	0.000	#2	0.00%	0.000	0.00	0.00	-
57	0.00%	-	#1	0.00%	0.000	#2	0.00%	0.000	0.00	0.00	-
62	5.00%	35	#1	10.00%	1.019	#2	0.00%	0.000	35.665	1013.26	36,138
67	16.25%	114	#1	32.50%	0.694	#2	0.00%	0.000	78.931	591.69	46,703
72	27.50%	193	#1	55.00%	0.557	#2	0.00%	0.000	107.184	331.39	35,520
77	38.75%	271	#1	77.50%	0.535	#2	0.00%	0.000	145.146	145.79	21,161
82	55.00%	385	#1	100.00%	0.563	#2	10.00%	1.019	232.715	50.35	11,716
87	83.34%	583	#1	100.00%	0.563	#2	66.67%	0.542	323.593	25.04	8,103
92	91.67%	642	#1	100.00%	0.563	#2	83.33%	0.542	355.215	0.93	330
97	100.00%	700	#1	100.00%	0.563	#2	100.00%	0.563	394.100	0.00	-
102	100.00%	700	#1	100.00%	0.563	#2	100.00%	0.563	394.100	0.00	-
									394.10	2158.45	159,670
	max @102										

% Loading	Eff base ca	Eff rebate case
10.000	1.220	1.019
20.000	0.978	0.817
25.000	0.898	0.750
30.000	0.863	
40.000	0.771	
50.000	0.713	0.563
60.000	0.708	
70.000	0.702	
75.000	0.702	0.532
80.000	0.708	
90.000	0.725	
100.000	0.748	0.563

iplv (kW/To 0.731034

Eff rebate case % Loading ch1		ch2		Eff base case % Loading	
10.00%	1.019	0.00%	0.000	10.00%	1.220
32.50%	0.694	0.00%	0.000	16.25%	1.068
55.00%	0.557	0.00%	0.000	27.50%	0.881
77.50%	0.535	0.00%	0.000	38.75%	0.783
100.00%	0.563	10.00%	1.019	55.00%	0.711
100.00%	0.563	66.67%	0.542	83.34%	0.714
100.00%	0.563	83.33%	0.542	91.67%	0.729
100.00%	0.563	100.00%	0.563	100.00%	0.748
100.00%	0.563	100.00%	0.563	100.00%	0.748

ch1	ch2	
10.00%	0.00%	5.00%
32.50%	0.00%	16.25%
55.00%	0.00%	27.50%
77.50%	0.00%	38.75%
100.00%	10.00%	55.00%
100.00%	66.67%	83.34%
100.00%	83.33%	91.67%
100.00%	100.00%	100.00%
100.00%	100.00%	100.00%

Yac-Clz 3
Total

		Month														
		1	2	3	4	5	6	7	8	9	10	11	12	Total	Total hours scheduled	
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	
	32	2	0	0	0	0	0	0	0	0	0	0	5	7	3.13	
	37	31	6	5	0	0	0	0	0	0	0	10	55	107	50.38	
	42	130	44	43	26	4	0	0	0	0	1	33	118	399	201.00	
	47	183	157	124	109	55	5	1	0	1	35	121	150	941	509.63	
	52	209	194	232	225	244	133	91	61	57	101	171	226	1944	1119.75	
	57	155	212	185	161	174	230	260	267	194	225	232	166	2461	1497.68	
	62	29	39	114	121	145	154	144	176	208	200	106	21	1457	1013.26	1013.26
	67	5	17	34	50	69	101	136	122	113	92	31	3	773	591.69	591.69
	72	0	3	7	18	27	61	74	79	77	48	15	0	409	331.39	331.39
	77	0	0	0	9	14	25	29	33	42	22	1	0	175	145.79	145.79
	82	0	0	0	1	6	8	7	5	17	14	0	0	58	50.35	50.35
	87	0	0	0	0	6	3	2	1	10	6	0	0	28	25.04	25.04
	92	0	0	0	0	0	0	0	0	1	0	0	0	1	0.93	0.93
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
																2158.45

01-08

		Month													
		1	2	3	4	5	6	7	8	9	10	11	12	Total	5am start up year round m-f
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	2	0	0	0	0	0	0	0	0	0	0	5	7	3.125
	37	30	6	5	0	0	0	0	0	0	0	8	43	92	41.07143
	42	80	40	40	26	2	0	0	0	0	1	31	74	294	131.25
	47	70	107	88	81	46	5	1	0	1	35	86	64	584	260.7143
	52	46	50	81	120	156	93	72	52	55	81	68	50	924	412.5
	57	20	20	27	13	43	104	158	164	126	113	44	12	844	376.7857
	62	0	1	7	0	1	36	14	32	49	15	3	0	158	70.53571
	67	0	0	0	0	0	1	3	0	7	3	0	0	14	6.25
	72	0	0	0	0	0	1	0	0	2	0	0	0	3	1.339286
	77	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	92	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0

09-16
9am-4pm

		Month													
															m-f 9-4 + wntr sat start 9:30 am & sun 1:30 am
		1	2	3	4	5	6	7	8	9	10	11	12	Total	summer Sat & Sun start at 12:30
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	0	0	0	0	0	0	0	0	0	0	0	1	1	0.928571
	42	10	1	1	0	0	0	0	0	0	0	0	9	21	19.5
	47	43	9	14	1	0	0	0	0	0	0	5	35	107	99.35714
	52	73	60	68	22	10	1	0	0	0	0	19	81	334	310.0379
	57	97	109	77	66	40	19	7	9	6	29	93	100	652	601.7567
	62	20	28	59	91	96	57	48	52	53	90	78	19	691	625.1719
	67	5	14	23	37	57	78	93	81	59	59	30	3	539	474.0625
	72	0	3	6	14	22	53	65	68	59	35	14	0	339	295.2723
	77	0	0	0	8	12	22	26	32	36	17	1	0	154	134.6071
	82	0	0	0	1	5	7	7	5	17	12	0	0	54	48.14955
	87	0	0	0	0	6	3	2	1	9	6	0	0	27	24.44196
	92	0	0	0	0	0	0	0	0	1	0	0	0	1	0.928571
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0

17-24

		Month													
															wntr stop at 10:30 4 days/wk,stop 5:30 2 day/wk,8:30 1 day/wk
		1	2	3	4	5	6	7	8	9	10	11	12	Total	summer stop at 8:30 4 day/s wk, stop at 5:50 3 days/wk
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	1	0	0	0	0	0	0	0	0	0	2	11	14	8.375
	42	40	3	2	0	2	0	0	0	0	0	2	35	84	50.25
	47	70	41	22	27	9	0	0	0	0	0	30	51	250	149.5536
	52	90	84	83	83	78	39	19	9	2	20	84	95	686	397.2143
	57	38	83	81	82	91	107	95	94	62	83	95	54	965	519.1339
	62	9	10	48	30	48	61	82	92	106	95	25	2	608	317.5536
	67	0	3	11	13	12	22	40	41	47	30	1	0	220	111.375
	72	0	0	1	4	5	7	9	11	16	13	1	0	67	34.77679
	77	0	0	0	1	2	3	3	1	6	5	0	0	21	11.1875
	82	0	0	0	0	1	1	0	0	0	2	0	0	4	2.196429
	87	0	0	0	0	0	0	0	0	1	0	0	0	1	0.598214
	92	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Chiller Replacement (Site 3303)

Program	Retrofit Efficiency Options Program
Measure	High Efficiency Water-Cooled Chiller
Site Description	Health Care /Hospital

Measure Description Replace existing chiller with high-efficiency water-cooled chiller.

Summary of Ex Ante Impact Calculations Tables of standard values were developed using the HBSSM simulation program based on climate zone, chiller size, building type, chiller efficiency, and condenser water temperature. Values from these tables are used to calculate the rebate and associated impacts.

Comments on PG&E Calculations The correct climate zone, chiller size category, chiller efficiency and building type were used for the application. The application assumed a 9-degree approach temperature, 15 degrees is the actual approach temperature. Another discrepancy between the application requirements and the site installation is that there is no condenser water reset.

Evaluation Process The evaluation process consisted of reviewing the application form and supporting documentation, conducting an on-site survey and then computing impacts using the on-site data. Models were calibrated with actual weather, number of compressor hours as well as an observed operating point, %load @ the outside air temperature. Peak demand was calculated for actual peak temperatures. Energy savings were based on typical weather data. A Title 24 baseline, IPLV at ARI conditions, and typical year bin weather data was used in the bin analysis.

The on-site survey was conducted on October 12, 1998. Information on the retrofit equipment and operating conditions were collected through an inspection of the chiller and through an interview with the Chief Engineer.

Discussions provided data for development of a relationship between chiller loading and outdoor dry bulb temperatures. The chiller is available 24 hours a day, everyday of the year. Chiller use generally begins at 77 degrees outside air temperature and reaches 100% loading at 102Degrees F.

To compute the impacts, the following assumptions were used:

- A linear loading strategy was used for the analysis of both the baseline, and rebated chillers, which assumed 10% loading at 77 degrees and 100% loading at 102 Degrees F.

- For the baseline chiller case a Title 24 baseline efficiency of 0.925 KW/ton was used, based on a water-cooled chiller less than 150 tons.

- Chiller efficiencies at various temperatures were interpolated from values provided at 25%, 50%, 75%, and 100% loading at ARI conditions. These calculated efficiencies were used to develop a chiller efficiency curve for the Rebate case. The baseline chiller efficiency curve was based on minimum Title 24 full load efficiency requirements, matched to a typical chiller performance curve.

The above assumptions were incorporated into a spreadsheet where energy and demand impacts were calculated. Evaluation- based demand and energy impacts were lower than Ex Ante estimates. Results from these calculations are summarized below and documented in the attached workbook.

Additional Notes

Impact Results

	KW	KWh	Therm
MDSS	25.46	108,944.4	0
Adjusted Engineering	14.90	23,997.8	0
Engineering Realization Rate	0.59	0.22	N/A

Site # 3303	WYEC Weather					New Chiller Efficiency		
	kWh	kW	therms			%	Tons	kW/Ton
PG&E	108,944.38	25.46	-			25%	19	0.463
QC Impact	23,997.78	14.90	-			50%	38	0.559
						75%	57	0.679
I-Eng. Real. Rat	0.22	0.59				100%	76	0.729
					Aplv (kW/To	0.61143713		

Operational Parameters	New Chiller	
	Minimum	Maximum
Chiller Output (Ton)	15.2	76
OSA Temp	75	105
% Of Capacity	20%	100%

Basecase

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-		0.0	0	-
32	0.00%	-		0.0	0	-
37	0.00%	-		0.0	0	-
42	0.00%	-		0.0	0	-
47	0.00%	-		0.0	0	-
52	0.00%	-		0.0	0	-
57	0.00%	-		0.0	0	-
62	0.00%	-		0.0	0	-
67	0.00%	-		0.0	0	-
72	0.00%	-		0.0	0	-
77	20.00%	15	1.110	16.9	606	10,224
82	33.33%	25	0.881	22.3	544	12,135
87	46.67%	35	0.876	31.1	418	12,983
92	60.00%	46	0.783	35.7	345	12,318
97	73.33%	56	0.820	45.7	216	9,871
102	100.00%	76	0.870	66.1	96	6,345
107	100.00%	76	0.925	70.3	5	352
112	100.00%	76	0.925	70.3	0	-
				70.3	2230	64,228

Rebate Case

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	#1	0	0.0	0	-
32	0.00%	-	0.000	#1	0	0.0	0	-
37	0.00%	-	0.000	#1	0	0.0	0	-
42	0.00%	-	0.000	#1	0	0.0	0	-
47	0.00%	-	0.000	#1	0	0.0	0	-
52	0.00%	-	0.000	#1	0	0.0	0	-
57	0.00%	-	0.000	#1	0	0.0	0	-
62	0.00%	-	0.000	#1	0	0.0	0	-
67	0.00%	-	0.000	#1	0	0.0	0	-
72	0.00%	-	0.000	#1	0	0.0	0	-
77	20.00%	15	0.45	#1	0.446	6.8	606	4,105
82	33.33%	25	0.46	#1	0.463	11.7	544	6,380
87	46.67%	35	0.54	#1	0.540	19.2	418	8,009
92	60.00%	46	0.59	#1	0.595	27.1	345	9,354
97	73.33%	56	0.64	#1	0.643	35.8	216	7,743
102	86.67%	66	0.69	#1	0.690	45.4	96	4,362
107	100.00%	76	0.73	#1	0.729	55.4	5	277
112	100.00%	76	0.73	#1	0.729	55.4	0	-
						55.4	2230	40,231

	Eff base ca	% Loading	Eff rebate case		rebate	% Loading	base
10.000	1.801	10.000	0.72		0.4457	20.00%	1.110
		18.000	0.443		0.463	33.33%	0.881
20.000	1.110	20.000	0.4457		0.540	46.67%	0.876
25.000	0.987	25.000	0.463		0.595	60.00%	0.783
30.000	0.925	30.000	0.463		0.643	73.33%	0.820
		33.000	0.463		0.690	86.67%	0.870
40.000	0.777	40.000	0.5025		0.729	100.00%	0.925
50.000	0.765	50.000	0.559				
60.000	0.783	60.000	0.5946				
		66.000	0.616				
70.000	0.808	70.000	0.6308				
75.000	0.826	75.000	0.679				
80.000	0.845	80.000	0.679				
		83.000	0.679				
90.000	0.882	90.000	0.6996				
100.000	0.925	100.000	0.729				

WYEC-clz13 Site 3303

Total Month

		1	2	3	4	5	6	7	8	9	10	11	12	Total	Chiller runs 24/7	
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	27	2	0	0	0	0	0	0	0	0	0	0	5	7	7	
	32	23	19	0	0	0	0	0	0	0	0	14	52	108	108	
	37	84	59	20	4	0	0	0	0	0	0	47	137	351	351	
	42	180	54	77	22	2	0	0	0	0	13	71	134	553	553	
	47	224	114	102	67	23	0	0	0	0	47	144	121	842	842	
	52	131	173	190	115	74	6	0	0	13	91	146	180	1119	1119	
	57	56	141	137	135	95	37	10	11	62	120	136	81	1021	1021	
	62	35	67	106	125	96	95	46	59	116	119	81	20	965	965	
	67	9	31	66	90	108	90	67	106	122	97	42	14	842	842	
	72	0	13	31	53	89	93	103	113	105	101	21	0	722	722	
	77	0	1	15	48	89	87	100	97	79	72	18	0	606	606	606
	82	0	0	0	48	70	95	103	100	77	51	0	0	544	544	544
	87	0	0	0	12	53	74	103	81	72	23	0	0	418	418	418
	92	0	0	0	1	32	79	95	78	50	10	0	0	345	345	345
	97	0	0	0	0	12	43	84	56	21	0	0	0	216	216	216
	102	0	0	0	0	1	21	30	41	3	0	0	0	96	96	96
	107	0	0	0	0	0	0	3	2	0	0	0	0	5	5	5
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
								744	744	720	731				7741	2230

01-08 Month

		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	2	0	0	0	0	0	0	0	0	0	0	5	7
	32	19	19	0	0	0	0	0	0	0	0	14	42	94
	37	55	53	20	4	0	0	0	0	0	0	37	84	253
	42	88	31	68	21	2	0	0	0	0	13	47	44	314
	47	73	66	66	54	23	0	0	0	0	43	89	32	446
	52	10	46	83	81	62	6	0	0	13	71	43	33	448
	57	0	9	11	57	60	34	10	11	55	73	10	7	337
	62	1	0	0	18	48	72	45	56	87	42	0	1	370
	67	0	0	0	3	39	68	62	86	69	6	0	0	333
	72	0	0	0	2	12	41	74	65	15	0	0	0	209
	77	0	0	0	0	2	14	45	27	1	0	0	0	89
	82	0	0	0	0	0	5	10	3	0	0	0	0	18
	87	0	0	0	0	0	0	2	0	0	0	0	0	2
	92	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

09-16 Month

		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	8	1	0	0	0	0	0	0	0	0	3	14	26
	42	34	4	0	0	0	0	0	0	0	0	5	33	76
	47	61	14	6	0	0	0	0	0	0	0	12	41	134
	52	69	49	33	5	1	0	0	0	0	0	30	80	267
	57	43	75	58	16	10	0	0	0	0	8	68	52	330
	62	26	43	65	53	14	9	0	0	4	20	54	14	302
	67	7	25	47	53	27	4	0	4	10	37	35	14	263
	72	0	12	25	31	34	18	3	9	36	62	16	0	246
	77	0	1	14	33	50	28	11	26	34	53	17	0	267
	82	0	0	0	38	43	51	37	49	45	39	0	0	302
	87	0	0	0	10	35	39	53	43	50	19	0	0	249
	92	0	0	0	1	22	50	62	45	39	10	0	0	229
	97	0	0	0	0	11	28	56	38	19	0	0	0	152
	102	0	0	0	0	1	13	23	32	3	0	0	0	72
	107	0	0	0	0	0	0	3	2	0	0	0	0	5
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

17-24 Month

		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	4	0	0	0	0	0	0	0	0	0	0	10	14
	37	21	5	0	0	0	0	0	0	0	0	7	39	72
	42	58	19	9	1	0	0	0	0	0	0	19	57	163
	47	90	34	30	13	0	0	0	0	0	4	43	48	262
	52	52	78	74	29	11	0	0	0	0	20	73	67	404
	57	13	57	68	62	25	3	0	0	7	39	58	22	354
	62	8	24	41	54	34	14	1	3	25	57	27	5	293
	67	2	6	19	34	42	18	5	16	43	54	7	0	246
	72	0	1	6	20	43	34	26	39	54	39	5	0	267
	77	0	0	1	15	37	45	44	44	44	19	1	0	250
	82	0	0	0	10	27	39	56	48	32	12	0	0	224
	87	0	0	0	2	18	35	48	38	22	4	0	0	167
	92	0	0	0	0	10	29	33	33	11	0	0	0	116
	97	0	0	0	0	1	15	28	18	2	0	0	0	64
	102	0	0	0	0	0	8	7	9	0	0	0	0	24
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

Chiller Replacement (Site 3606)

Program	Retrofit Express Program
Measure	High Efficiency Air-Cooled Chiller
Site Description	Health Care/ Hospital

Measure Description

Replace existing chiller with high-efficiency air-cooled chiller.

Summary of Ex Ante Impact Calculations

Demand calculations were estimated based upon the chiller tonnage and the difference between the new unit and a baseline qualifying Title 24 chiller, in conjunction with an assumed 0.75 diversity factor. Energy calculations are based upon all but the latter, in conjunction with standard PG&E EFLH values.

Comments on Calculations

The correct chiller size category and compressor only chiller efficiency rating (at 100% Load under ARI conditions) was used in the application. Fan energy should be included in the KW/Ton rating. An ARI efficiency value of 1.349 vs. 1.23 should have been used.

Evaluation Process

The evaluation process consisted of reviewing the application form and supporting documentation, conducting an on-site survey and then computing impacts using the on-site data. Models were calibrated with actual weather, number of compressor hours as well as an observed operating point, %load @ the outside air temperature. Peak demand was calculated for actual peak temperatures. Energy saving were based on typical weather data. A Title 24 baseline, IPLV at ARI conditions, and typical year bin weather data were used in the bin analysis.

The on-site survey was conducted on October 16, 1998. Information on the retrofit equipment and operating conditions were collected through an inspection of the chiller and through an interview with the Chief Engineer.

Discussions provided data for development of a relationship between chiller loading and outdoor dry bulb temperatures. The chiller is available to operate 8760 hrs a year. Chiller use generally begins at 72 degrees outside air temperature and reaches 50% loading at 95 Degrees F.

To compute the impacts, the following assumptions were used:

- A linear loading strategy was used for the analysis of both the baseline and rebated chillers, which assumed 10% loading at 72 degrees and 50% loading at 95 Degrees F.
- For the baseline chiller case a Title 24 baseline efficiency of 1.406 KW/ton, based on an air-cooled chiller between 150 and 300 Tons, was used.
- Chiller efficiencies at various temperatures were interpolated from

values provided at 25%, 50%, 75%, and 100% loading at ARI conditions. These calculated efficiencies were used to develop a chiller efficiency curve for the Rebate case. The baseline chiller efficiency curve was based on minimum Title 24 full load efficiency requirements, matched to a typical chiller performance curve.

The above assumptions were incorporated into a spreadsheet where energy and demand impacts were calculated. Evaluation- based demand and energy impacts were lower than Ex Ante estimates. Results from these calculations are summarized below and documented in the attached workbook.

Additional Notes

Impact Results

	KW	KWh	Therm
MDSS	23.86	60,284.4	0
Adjusted Engineering	18.69	22,223.2	0
Engineering Realization Rate	0.78	0.37	N/A

Site #3606	WYEC Weather		
	kWh	kW	therms
PG&E	60,284.44	23.86	-
QC Impact	22,223.16	18.69	-
			-
I-Eng. Real. Rate	0.37	0.78	

New Chiller Efficiency		
%	Tons	kW/Ton
25%	44.325	0.869
50%	88.65	0.952
75%	132.975	1.153
100%	177.3	1.349
iplv (kW/Ton	1.0665803	

Operational Parameters	New Chiller (Recip. Air Cooled)	
	Minimum	Maximum
Chiller Output (Ton)	17.73	177.3
OSA Temp	70	97
% Of Capacity	10%	50%

Basecase

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-		0.0	0	-
32	0.00%	-		0.0	0	-
37	0.00%	-		0.0	0	-
42	0.00%	-		0.0	0	-
47	0.00%	-		0.0	0	-
52	0.00%	-		0.0	0	-
57	0.00%	-		0.0	0	-
62	0.00%	-		0.0	0	-
67	0.00%	-		0.0	0	-
72	10.00%	18	2.738	48.5	595	28,879
77	18.00%	32	1.897	60.5	278	16,832
82	26.00%	46	1.481	68.3	86	5,872
87	34.00%	60	1.316	79.3	18	1,428
92	42.00%	74	1.177	87.7	6	526
97	50.00%	89	1.163	103.1	0	-
102	50.00%	89	1.163	103.1	0	-
107	50.00%	89	1.163	103.1	0	-
				103.1	983.00	53,537

Rebate Case

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	#1	0	0.0	0	-
32	0.00%	-	0.000	#1	0	0.0	0	-
37	0.00%	-	0.000	#1	0	0.0	0	-
42	0.00%	-	0.000	#1	0	0.0	0	-
47	0.00%	-	0.000	#1	0	0.0	0	-
52	0.00%	-	0.000	#1	0	0.0	0	-
57	0.00%	-	0.000	#1	0	0.0	0	-
62	0.00%	-	0.000	#1	0	0.0	0	-
67	0.00%	-	0.000	#1	0	0.0	0	-
72	10.00%	18	1.585	#1	1.585	28.1	595	16,719
77	18.00%	32	1.099	#1	1.099	35.1	278	9,747
82	26.00%	46	0.872	#1	0.872	40.2	86	3,459
87	34.00%	60	0.899	#1	0.899	54.2	18	976
92	42.00%	74	0.926	#1	0.926	68.9	6	414
97	50.00%	89	0.952	#1	0.952	84.4	0	-
102	50.00%	89	0.952	#1	0.952	84.4	0	-
107	50.00%	89	0.952	#1	0.952	84.4	0	-
						84.4	983.00	31,314

	Eff base ca	% Loading	Eff rebate case		rebate	% Loading	base
10.000	2.738	10.000	1.585		1.585	10.00%	2.738
20.000	1.687	20.000	0.977		1.099	18.00%	1.897
25.000	1.500	25.000	0.869		0.872	26.00%	1.481
30.000	1.406	30.000	0.886		0.899	34.00%	1.316
40.000	1.181	40.000	0.919		0.926	42.00%	1.177
50.000	1.163	50.000	0.952		0.952	50.00%	1.163
60.000	1.190	60.000			0.952	50.00%	1.163
70.000	1.228	70.000			0.952	50.00%	1.163
75.000	1.256	75.000	1.153				
80.000	1.284	80.000					
90.000	1.341	90.000					
100.000	1.406	100.000	1.349				
iplv (kW/To	1.267977						

WYEC-clz Site 3606 Actual Max Temp =95

Operation Hours 8760 > 70 deg f

Total

	Month	1	2	3	4	5	6	7	8	9	10	11	12	Total	
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	
	32	22	6	0	0	0	0	0	0	0	0	3	24	55	
	37	70	29	21	11	2	0	0	0	0	0	27	51	211	
	42	82	75	67	61	30	10	0	0	0	13	64	131	533	
	47	85	105	126	94	52	33	6	5	28	63	118	109	824	
	52	165	138	225	157	212	212	137	94	58	154	165	136	1853	
	57	167	136	134	168	173	151	250	293	181	181	140	126	2100	
	62	101	110	110	93	118	101	78	81	172	100	106	103	1273	
	67	38	51	35	71	104	121	99	105	82	119	56	47	928	
	72	12	13	16	40	31	48	116	115	112	57	24	11	595	595
	77	2	9	10	20	11	26	50	44	56	33	11	6	278	278
	82	0	0	0	5	9	13	6	6	23	18	6	0	86	86
	87	0	0	0	0	2	5	2	1	4	4	0	0	18	18
	92	0	0	0	0	0	0	0	0	4	2	0	0	6	6
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0
							92	174	166	199	114			7137	983.00
											745				

01-08

	Month	1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	20	6	0	0	0	0	0	0	0	0	3	24	53
	37	61	27	21	10	2	0	0	0	0	0	25	36	182
	42	46	58	43	45	26	8	0	0	0	13	44	84	367
	47	32	53	78	55	33	26	6	5	28	57	74	41	488
	52	64	60	86	63	118	128	93	76	44	84	58	40	914
	57	24	13	16	53	49	63	121	151	93	61	28	19	691
	62	1	7	3	9	13	10	15	10	70	23	7	4	172
	67	0	0	1	4	5	4	10	4	3	10	1	0	42
	72	0	0	0	1	1	1	2	1	2	0	0	0	8
	77	0	0	0	0	1	0	1	1	0	0	0	0	3
	82	0	0	0	0	0	0	0	0	0	0	0	0	0
	87	0	0	0	0	0	0	0	0	0	0	0	0	0
	92	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

09-16

	Month	1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	0	0	0	0	0	0	0	0	0	0	0	0	0
	42	3	0	0	0	0	0	0	0	0	0	0	9	12
	47	8	4	0	0	0	0	0	0	0	0	1	12	25
	52	24	23	12	4	1	1	0	0	0	4	13	22	104
	57	76	54	75	44	21	6	0	5	5	13	58	64	421
	62	87	76	102	70	83	46	16	19	10	37	74	77	697
	67	36	46	33	60	94	106	66	68	44	83	54	47	737
	72	12	12	16	37	28	38	110	108	98	54	23	11	547
	77	2	9	10	20	10	25	48	41	53	33	11	6	268
	82	0	0	0	5	9	13	6	6	22	18	6	0	85
	87	0	0	0	0	2	5	2	1	4	4	0	0	18
	92	0	0	0	0	0	0	0	0	4	2	0	0	6
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

17-24

	Month	1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	2	0	0	0	0	0	0	0	0	0	0	0	2
	37	9	2	0	1	0	0	0	0	0	0	2	15	29
	42	33	17	24	16	4	2	0	0	0	0	20	38	154
	47	45	48	48	39	19	7	0	0	0	6	43	56	311
	52	77	55	127	90	93	83	44	18	14	66	94	74	835
	57	67	69	43	71	103	82	129	137	83	107	54	43	988
	62	13	27	5	14	22	45	47	52	92	40	25	22	404
	67	2	5	1	7	5	11	23	33	35	26	1	0	149
	72	0	1	0	2	2	9	4	6	12	3	1	0	40
	77	0	0	0	0	0	1	1	2	3	0	0	0	7
	82	0	0	0	0	0	0	0	0	1	0	0	0	1
	87	0	0	0	0	0	0	0	0	0	0	0	0	0
	92	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

Chiller Replacement (Site 3883)

Program	Retrofit Efficiency Options Program
Measure	High Efficiency Water-Cooled Chiller
Site Description	Community Service

Measure Description Replace existing chiller with high-efficiency water-cooled chiller.

Summary of Ex Ante Impact Calculations Tables of standard values were developed using the HBSSM simulation program based on climate zone, chiller size, building type, chiller efficiency, and condenser water temperature. Values from these tables are used to calculate the rebate and associated impacts.

Comments on PG&E Calculations The correct climate zone, chiller size category, chiller efficiency and building type were used in the application calculations.

Evaluation Process The evaluation process consisted of reviewing the application form and supporting documentation, conducting an on-site survey and then computing impacts using the on-site data. Models were calibrated with actual weather, number of compressor hours as well as an observed operating point, %load @ the outside air temperature. Peak demand was calculated for actual peak temperatures. Energy savings were based on typical weather data. A Title 24 baseline, IPLV at ARI conditions, and typical year bin weather data were used in the bin analysis.

The on-site survey was conducted on October 13, 1998. Information on the retrofit equipment and operating conditions were collected through an inspection of the chiller and through an interview with the Chief Engineer.

Discussions provided data for development of a relationship between chiller loading and outdoor dry bulb temperatures. The chiller is available Monday through Friday 8am to 5pm, and from 7am to 1:30pm on Sundays, everyday of the year. Chiller use generally begins at 70 degrees outside air temperature and reaches 63% loading at 112Degrees F.

To compute the impacts, the following assumptions were used:

- A linear loading strategy was used for the analysis of both the original, baseline and rebated chillers, which assumed 10% loading at 70 degrees and 63% loading at 112 Degrees F.
- For the baseline chiller case a Title 24 baseline efficiency of 0.925 KW/ton was used, based on a water-cooled chiller less than 150 tons.
- Chiller efficiencies at various temperatures were interpolated from values provided at 25%, 50%, 75%, and 100% loading at ARI conditions. These calculated efficiencies were used to develop a chiller efficiency curve for the Rebate case. The baseline chiller

efficiency curve was based on minimum Title 24 full load efficiency requirements, matched to a typical chiller performance curve.

The above assumptions were incorporated into a spreadsheet where energy and demand impacts were calculated. Evaluation- based demand and energy impacts were lower than Ex Ante estimates. Results from these calculations are summarized below and documented in the attached workbook

Additional Notes

Saving estimates were calculated in a similar manner, employing 1998 actual weather from the closest weather station results from these calculations are documented in the attached workbook.

Impact Results

	KW	KWh	Therm
MDSS	26.32	72,011.33	0
Adjusted Engineering	0.35	5,214.96	0
Engineering Realization Rate	0.01	0.07	N/A

Site # 3883	Average Weather		
	kWh	kW	therms
PG&E	72,011.33	26.32	-
QC Impact	5,214.96	0.35	-
			-
Impact Realization			
Rate	0.07	0.01	

New Chiller Efficiency		
%	Tons	kW/Ton
25%	9.375	0.638
50%	18.75	0.755
75%	28.125	0.833
100%	37.5	0.928
iplv (kW/Ton	0.79315296	

Operational Parameters	New Chiller		Old Chiller 40 Tons	
Base Case	Minimum	Maximum	Minimum	Maximum
Chiller Output (Ton)	3.75	37.5	4	40
OSA Temp	70	112	70	112
% Of Capacity	10%	63%	10%	63%

Basecase

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-		0.0	0	-
32	0.00%	-		0.0	0	-
37	0.00%	-		0.0	0	-
42	0.00%	-		0.0	0	-
47	0.00%	-		0.0	0	-
52	0.00%	-		0.0	0	-
57	0.00%	-		0.0	0	-
62	0.00%	-		0.0	0	-
67	0.00%	-		0.0	0	-
72	10.00%	4	1.509	5.7	224.43	1,270
77	16.67%	6	1.310	8.2	237.57	1,945
82	23.33%	9	1.067	9.3	261.99	2,445
87	30.00%	11	1.068	12.0	214.20	2,574
92	36.67%	14	0.992	13.6	193.61	2,641
97	43.33%	16	0.930	15.1	127.35	1,925
102	50.00%	19	0.883	16.6	59.76	989
107	56.67%	21	0.878	18.7	4.00	75
112	63.33%	24	0.873	20.7	0.00	-
				20.7	1322.90	13,863

Rebate Case

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	#1	0	0.0	0	-
32	0.00%	-	0.000	#1	0	0.0	0	-
37	0.00%	-	0.000	#1	0	0.0	0	-
42	0.00%	-	0.000	#1	0	0.0	0	-
47	0.00%	-	0.000	#1	0	0.0	0	-
52	0.00%	-	0.000	#1	0	0.0	0	-
57	0.00%	-	0.000	#1	0	0.0	0	-
62	0.00%	-	0.000	#1	0	0.0	0	-
67	0.00%	-	0.000	#1	0	0.0	0	-
72	10.00%	4	0.568	#1	0.568	2.1	224.43	478
77	16.67%	6	0.599	#1	0.599	3.7	237.57	890
82	23.33%	9	0.630	#1	0.630	5.5	261.99	1,445
87	30.00%	11	0.661	#1	0.661	7.4	214.20	1,593
92	36.67%	14	0.692	#1	0.692	9.5	193.61	1,843
97	43.33%	16	0.719	#1	0.719	11.7	127.35	1,488
102	50.00%	19	0.755	#1	0.755	14.2	59.76	846
107	56.67%	21	0.776	#1	0.776	16.5	4.00	66
112	63.33%	24	0.858	#1	0.858	20.4	0.00	-
						20.4	1,322.9	8,648

	Typical Cent.					
	Eff base ca	% Loading	Eff rebate case	rebate	% Loading	base
10	1.509	10	0.568	0.568	10.00%	1.509
20	1.210	20	0.615	0.599	16.67%	1.310
25	1.110	25	0.638	0.630	23.33%	1.067
30	1.068	30	0.661	0.661	30.00%	1.068
40	0.954	40	0.708	0.692	36.67%	0.992
50	0.883	50	0.755	0.719	43.33%	0.930
60	0.875	60	0.786	0.755	50.00%	0.883
70	0.868	70	0.817	0.776	56.67%	0.878
75	0.868	75	0.833	0.858	63.34%	0.873
80	0.875	80	0.852			
90	0.897	90	0.89			
100	0.925	100	0.928			
iplv (kW/To	0.904219					

WYEC-clz Site 3883

Total		Month																	
		1	2	3	4	5	6	7	8	9	10	11	12	Total	Sun 7-8am	sun till 1:30	m-f 5/7	Site total	Site total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
	27	2	0	0	0	0	0	0	0	0	0	0	5	7					
	32	23	19	0	0	0	0	0	0	0	0	14	52	108					
	37	84	59	20	4	0	0	0	0	0	0	47	137	351					
	42	180	54	77	22	2	0	0	0	0	13	71	134	553					
	47	224	114	102	67	23	0	0	0	0	47	144	121	842					
	52	131	173	190	115	74	6	0	0	13	91	146	180	1119					
	57	56	141	137	135	95	37	10	11	62	120	136	81	1021					
	62	35	67	106	125	96	95	46	59	116	119	81	20	965					
	67	9	31	66	90	108	90	67	106	122	97	42	14	842			m-f 5/7 9-4	m-f *5/74-5pm	
	72	0	13	31	53	89	93	103	113	105	101	21	0	722	3.73	21.14	175.71	23.84	224.43
	77	0	1	15	48	89	87	100	97	79	72	18	0	606	1.59	22.95	190.71	22.32	237.57
	82	0	0	0	48	70	95	103	100	77	51	0	0	544	0.32	25.95	215.71	20.00	261.99
	87	0	0	0	12	53	74	103	81	72	23	0	0	418	0.04	21.40	177.86	14.91	214.20
	92	0	0	0	1	32	79	95	78	50	10	0	0	345	0.00	19.68	163.57	10.36	193.61
	97	0	0	0	0	12	43	84	56	21	0	0	0	216	0.00	13.06	108.57	5.71	127.35
	102	0	0	0	0	1	21	30	41	3	0	0	0	96	0.00	6.19	51.43	2.14	59.76
	107	0	0	0	0	0	0	3	2	0	0	0	0	5	0.00	0.43	3.57	0.00	4.00
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00
								744	744	720	731								1322.90

01-08		Month													
		1	2	3	4	5	6	7	8	9	10	11	12	Total	Sun 7-8am
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	27	2	0	0	0	0	0	0	0	0	0	0	5	7	
	32	19	19	0	0	0	0	0	0	0	0	14	42	94	
	37	55	53	20	4	0	0	0	0	0	0	37	84	253	
	42	88	31	68	21	2	0	0	0	0	13	47	44	314	
	47	73	66	66	54	23	0	0	0	0	43	89	32	446	
	52	10	46	83	81	62	6	0	0	13	71	43	33	448	
	57	0	9	11	57	60	34	10	11	55	73	10	7	337	
	62	1	0	0	18	48	72	45	56	87	42	0	1	370	
	67	0	0	0	3	39	68	62	86	69	6	0	0	333	
	72	0	0	0	2	12	41	74	65	15	0	0	0	209	3.73
	77	0	0	0	0	2	14	45	27	1	0	0	0	89	1.59
	82	0	0	0	0	0	5	10	3	0	0	0	0	18	0.32
	87	0	0	0	0	0	0	2	0	0	0	0	0	2	0.04
	92	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00

09-16		Month															
		1	2	3	4	5	6	7	8	9	10	11	12	Total		m-f 5/7	sun till 1:30
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0			
	27	0	0	0	0	0	0	0	0	0	0	0	0	0			
	32	0	0	0	0	0	0	0	0	0	0	0	0	0			
	37	8	1	0	0	0	0	0	0	0	0	3	14	26			
	42	34	4	0	0	0	0	0	0	0	0	5	33	76			
	47	61	14	6	0	0	0	0	0	0	0	12	41	134			
	52	69	49	33	5	1	0	0	0	0	0	30	80	267			
	57	43	75	58	16	10	0	0	0	0	8	68	52	330			
	62	26	43	65	53	14	9	0	0	4	20	54	14	302			
	67	7	25	47	53	27	4	0	4	10	37	35	14	263		m-f 5/7 9-4	sun till 1:30
	72	0	12	25	31	34	18	3	9	36	62	16	0	246	246.00	175.71	21.14
	77	0	1	14	33	50	28	11	26	34	53	17	0	267	267.00	190.71	22.95
	82	0	0	0	38	43	51	37	49	45	39	0	0	302	302.00	215.71	25.95
	87	0	0	0	10	35	39	53	43	50	19	0	0	249	249.00	177.86	21.40
	92	0	0	0	1	22	50	62	45	39	10	0	0	229	229.00	163.57	19.68
	97	0	0	0	0	11	28	56	38	19	0	0	0	152	152.00	108.57	13.06
	102	0	0	0	0	1	13	23	32	3	0	0	0	72	72.00	51.43	6.19
	107	0	0	0	0	0	0	3	2	0	0	0	0	5	5.00	3.57	0.43
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00
																0.00	

17-24		Month															
		1	2	3	4	5	6	7	8	9	10	11	12	Total			
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0			
	27	0	0	0	0	0	0	0	0	0	0	0	0	0			
	32	4	0	0	0	0	0	0	0	0	0	.0	10	14			
	37	21	5	0	0	0	0	0	0	0	0	7	39	72			
	42	58	19	9	1	0	0	0	0	0	0	19	57	163			
	47	90	34	30	13	0	0	0	0	0	4	43	48	262			
	52	52	78	74	29	11	0	0	0	0	20	73	67	404			
	57	13	57	68	62	25	3	0	0	7	39	58	22	354			
	62	8	24	41	54	34	14	1	3	25	57	27	5	293			
	67	2	6	19	34	42	18	5	16	43	54	7	0	246		1 of 8 hrs	m-f *5/74-5pm
	72	0	1	6	20	43	34	26	39	54	39	5	0	267	267.00	33.38	23.84
	77	0	0	1	15	37	45	44	44	44	19	1	0	250	250.00	31.25	22.32
	82	0	0	0	10	27	39	56	48	32	12	0	0	224	224.00	28.00	20.00
	87	0	0	0	2	18	35	48	38	22	4	0	0	167	167.00	20.88	14.91
	92	0	0	0	0	10	29	33	33	11	0	0	0	116	116.00	14.50	10.36
	97	0	0	0	0	1	15	28	18	2	0	0	0	64	64.00	8.00	5.71
	102	0	0	0	0	0	8	7	9	0	0	0	0	24	24.00	3.00	2.14
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00

Site # 3883	Average Weather					New Chiller Efficiency		
	kWh	kW	therms			%	Tons	kW/Ton
PG&E	72,011	28.3	-			25%	9.375	0.638
			-			50%	18.75	0.756
QC Savings	5,586	1.3	-			75%	28.125	0.833
Impact Realization						100%	37.5	0.928
Rate	0.08	0.05						
					iplv (kW/Ton) =	0.793152964		
Operational Parameters		New Chiller			Old Chiller 40 Tons			
Base Case		Minimum	Maximum		Minimum	Maximum		
Chiller Output (Ton)		3.75	37.5		4	40		
OSA Temp		70	112		70	112		
% Of Capacity		10%	63%		10%	63%		

Basecase

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-		0.0	0	-
32	0.00%	-		0.0	0	-
37	0.00%	-		0.0	0	-
42	0.00%	-		0.0	0	-
47	0.00%	-		0.0	0	-
52	0.00%	-		0.0	0	-
57	0.00%	-		0.0	0	-
62	0.00%	-		0.0	0	-
67	0.00%	-		0.0	0	-
72	10.00%	4	1.509	5.7	226.86	1,284
77	16.67%	6	1.310	8.2	217.64	1,782
82	23.33%	9	1.087	9.3	181.90	1,697
87	30.00%	11	1.068	12.0	179.70	2,159
92	36.67%	14	0.992	13.8	163.81	2,235
97	43.33%	16	0.930	15.1	137.85	2,084
102	50.00%	19	0.883	16.6	87.60	1,450
107	56.67%	21	0.878	18.7	47.49	886
112	63.33%	24	0.873	20.7	5.80	116
				20.7	1248.46	13,693

Rebate Case

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	#1	0	0.0	0	-
32	0.00%	-	0.000	#1	0	0.0	0	-
37	0.00%	-	0.000	#1	0	0.0	0	-
42	0.00%	-	0.000	#1	0	0.0	0	-
47	0.00%	-	0.000	#1	0	0.0	0	-
52	0.00%	-	0.000	#1	0	0.0	0	-
57	0.00%	-	0.000	#1	0	0.0	0	-
62	0.00%	-	0.000	#1	0	0.0	0	-
67	0.00%	-	0.000	#1	0	0.0	0	-
72	10.00%	4	0.568	#1	0.568	2.1	226.86	483
77	16.67%	6	0.589	#1	0.589	3.7	217.64	815
82	23.33%	9	0.630	#1	0.630	5.5	181.90	1,003
87	30.00%	11	0.661	#1	0.661	7.4	179.70	1,334
92	36.67%	14	0.692	#1	0.692	9.5	163.81	1,559
97	43.33%	16	0.719	#1	0.719	11.7	137.85	1,611
102	50.00%	19	0.756	#1	0.756	14.2	87.60	1,240
107	56.67%	21	0.778	#1	0.778	16.5	47.49	783
112	63.33%	24	0.858	#1	0.858	20.4	5.80	114
						20.4	1248.46	8,945

Existing Case

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-		0.0	0	-
32	0.00%	-		0.0	0	-
37	0.00%	-		0.0	0	-
42	0.00%	-		0.0	0	-
47	0.00%	-		0.0	0	-
52	0.00%	-		0.0	0	-
57	0.00%	-		0.0	0	-
62	0.00%	-		0.0	0	-
67	0.00%	-		0.0	0	-
72	10.00%	4	1.947027027	7.8	226.86	1,767
77	16.67%	7	1.449	9.7	217.64	2,103
82	23.33%	9	1.1114	10.4	181.90	1,887
87	30.00%	12	1	12.0	179.70	2,156
92	36.67%	15	0.8933	13.1	163.81	2,146
97	43.33%	17	0.8357	14.5	137.85	1,997
102	50.00%	20	0.827	16.5	87.60	1,449
107	56.67%	23	0.8397	19.0	47.49	904
112	63.34%	25	0.8564	21.7	5.80	121
				21.7	1248.46	14,530

	Typical Cent.											
	Eff base case	% Loading	Eff rebate case		rebate	% Loading	base			existing case		
10	1.509	10	0.568		0.568	10.00%	1.509		10.00%	1.947	10	1.947
20	1.210	20	0.615		0.589	16.67%	1.310		16.67%	1.449	20	1.200
25	1.110	25	0.638		0.630	23.33%	1.087		23.33%	1.1114	25	1.067
30	1.068	30	0.661		0.661	30.00%	1.068		30.00%	1	30	1.000
40	0.954	40	0.706		0.692	36.67%	0.992		36.67%	0.8933	40	0.840
50	0.883	50	0.756		0.719	43.33%	0.930		43.33%	0.8357	50	0.827
60	0.878	60	0.796		0.756	50.00%	0.883		50.00%	0.827	60	0.846
70	0.868	70	0.817		0.778	56.67%	0.878		56.67%	0.8397	70	0.874
75	0.866	75	0.833		0.858	63.34%	0.873		63.34%	0.8564	75	0.893
80	0.875	80	0.852								80	0.914
90	0.897	90	0.88								90	0.954
100	0.925	100	0.928								100	1.000
iplv (kW/Ton) =	0.90421873											

act 13

Total	Month																		
		1	2	3	4	5	6	7	8	9	10	11	12	Total		Sun 7-8	sun till 1	m-f 5/7	Site total
Temper	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	27	0	0	0	0	0	0	0	0	0	0	0	2	2	2				
	32	2	0	0	0	0	0	0	0	0	0	0	56	58	58				
	37	25	1	8	0	0	0	0	0	0	0	1	98	133	133				
	42	108	55	33	28	0	0	0	0	0	7	33	155	419	419				
	47	172	159	108	90	6	0	0	0	0	46	93	174	848	848				
	52	169	208	149	136	78	0	0	0	0	87	161	138	1126	1126				
	57	150	172	164	126	171	23	0	0	18	122	181	58	1185	1185				
	62	82	64	132	134	185	104	4	5	88	106	117	42	1061	1061				
	67	29	13	63	65	140	130	41	45	101	113	67	20	827	827			m-f 5/7-m-f *5/7 4-5pm	
	72	6	0	49	51	84	124	74	67	101	99	25	1	681	681	3.63	21.83	181.43	20	226.88
	77	1	0	25	32	47	94	116	87	147	83	14	0	646	646	3.55	21.05	175.00	18.04	217.64
	82	0	0	13	20	27	92	108	119	92	41	16	0	528	528	2.21	17.36	144.29	18.04	181.90
	87	0	0	0	24	6	85	107	96	70	26	11	0	425	425	0.64	17.45	145.00	16.61	179.70
	92	0	0	0	14	0	51	104	102	39	10	1	0	321	321	0.16	16.41	136.43	10.8	163.81
	97	0	0	0	0	0	17	106	97	38	4	0	0	262	262	0.00	13.84	115.00	9.018	137.85
	102	0	0	0	0	0	0	67	67	19	0	0	0	153	153	0.00	8.94	74.29	4.375	87.60
	107	0	0	0	0	0	0	17	52	9	0	0	0	78	78	0.00	4.90	40.71	1.875	47.49
	112	0	0	0	0	0	0	0	7	0	0	0	0	7	7	0.00	0.60	5.00	0	5.60
															3101					1248.46

01-08	Month														
		1	2	3	4	5	6	7	8	9	10	11	12	Total	Sun 7-8am
Temper	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	2	2	
	32	2	0	0	0	0	0	0	0	0	0	0	49	51	
	37	19	1	8	0	0	0	0	0	0	0	1	54	83	
	42	76	54	22	27	0	0	0	0	0	7	30	70	286	
	47	67	96	71	66	6	0	0	0	0	46	74	41	467	
	52	51	52	70	69	68	0	0	0	0	62	67	19	458	
	57	33	9	70	41	109	20	0	0	18	75	54	10	439	
	62	0	9	7	24	55	78	4	5	74	35	10	3	304	
	67	0	3	0	10	10	87	40	44	44	17	4	0	259	
	72	0	0	0	2	0	44	63	57	32	5	0	0	203	3.63
	77	0	0	0	1	0	9	86	60	42	1	0	0	199	3.55
	82	0	0	0	0	0	2	41	59	22	0	0	0	124	2.21
	87	0	0	0	0	0	0	12	17	7	0	0	0	36	0.64
	92	0	0	0	0	0	0	2	6	1	0	0	0	9	0.16
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00

09-16	Month																
		1	2	3	4	5	6	7	8	9	10	11	12	Total		m-f 5/7	sun till 1:30
Temper	22	0	0	0	0	0	0	0	0	0	0	0	0	0			
	27	0	0	0	0	0	0	0	0	0	0	0	0	0			
	32	0	0	0	0	0	0	0	0	0	0	0	1	1			
	37	3	0	0	0	0	0	0	0	0	0	0	15	18			
	42	13	0	2	0	0	0	0	0	0	0	2	22	39			
	47	36	14	8	0	0	0	0	0	0	0	4	56	118			
	52	47	62	34	23	1	0	0	0	0	0	18	79	264			
	57	57	102	41	44	18	0	0	0	0	7	60	30	359			
	62	62	38	67	60	45	10	0	0	1	24	62	25	394			
	67	24	8	34	31	77	10	0	0	14	40	46	19	303		m-f 5/7-sun till 1:30	
	72	5	0	32	25	55	32	2	2	33	53	14	1	254	254	181.4	21.83
	77	1	0	20	16	29	42	9	7	51	62	8	0	245	245	175.00	21.05
	82	0	0	10	12	19	48	18	19	33	29	14	0	202	202	144.29	17.36
	87	0	0	0	15	4	51	42	30	29	21	11	0	203	203	145.00	17.45
	92	0	0	0	14	0	36	57	46	28	9	1	0	191	191	136.43	16.41
	97	0	0	0	0	0	11	64	55	28	3	0	0	161	161	115.00	13.84
	102	0	0	0	0	0	0	44	45	15	0	0	0	104	104	74.29	8.94
	107	0	0	0	0	0	0	12	37	8	0	0	0	57	57	40.71	4.90
	112	0	0	0	0	0	0	0	7	0	0	0	0	7	7	5.00	0.60
															1424	#####	

17-24	Month																
		1	2	3	4	5	6	7	8	9	10	11	12	Total			
Temper	22	0	0	0	0	0	0	0	0	0	0	0	0	0			
	27	0	0	0	0	0	0	0	0	0	0	0	0	0			
	32	0	0	0	0	0	0	0	0	0	0	0	6	6			
	37	3	0	0	0	0	0	0	0	0	0	0	29	32			
	42	19	1	9	1	0	0	0	0	0	0	1	63	94			
	47	69	49	29	24	0	0	0	0	0	0	15	77	263			
	52	71	94	45	44	9	0	0	0	0	25	76	40	404			
	57	60	61	53	41	44	3	0	0	0	40	67	18	387			
	62	20	17	58	50	85	16	0	0	11	47	45	14	363			
	67	5	2	29	24	53	33	1	1	43	56	17	1	265		1 of 8 h m-f *5/7 4-5pm	
	72	1	0	17	24	29	48	9	8	36	41	11	0	224	224	28	20.00
	77	0	0	5	15	18	43	21	20	54	20	6	0	202	202	25.25	18.04
	82	0	0	3	8	8	42	49	41	37	12	2	0	202	202	25.25	18.04
	87	0	0	0	9	2	34	53	49	34	5	0	0	186	186	23.25	16.61
	92	0	0	0	0	0	15	45	50	10	1	0	0	121	121	15.13	10.80
	97	0	0	0	0	0	6	42	42	10	1	0	0	101	101	12.63	9.02
	102	0	0	0	0	0	0	23	22	4	0	0	0	49	49	6.13	4.38
	107	0	0	0	0	0	0	5	15	1	0	0	0	21	21	2.63	1.88
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00

Chiller Replacement (Site 4254)

Program	Retrofit Efficiency Options Program
Measure	High Efficiency Water-Cooled Chiller
Site Description	Health Care/ Hospital

Measure Description

Replace existing chiller with high-efficiency water-cooled chiller.

Summary of Ex Ante Impact Calculations

Tables of standard values were developed using the HBSSM simulation program based on climate zone, chiller size, building type, chiller efficiency, and condenser water temperature. Values from these tables are used to calculate the rebate and associated impacts.

Comments on PG&E Calculations

The correct climate zone, chiller size category, chiller efficiency and building type were used in the application calculatons.

Evaluation Process

The evaluation process consisted of reviewing the application form and supporting documentation, conducting an on-site survey and then computing impacts using the on-site data. Models were calibrated with actual weather, number of compressor hours as well as an observed operating point, %load @ the outside air temperature. Peak demand was calculated for actual peak temperatures. Energy savings were based on typical weather data. A Title 24 baseline, IPLV at ARI conditions, and typical year bin weather data were used in the bin analysis.

The on-site survey was conducted on October 14, 1998. Information on the retrofit equipment and operating conditions were collected through an inspection of the chiller and through an interview with the Chief Engineer.

Discussions provided data for development of a relationship between chiller loading and outdoor dry bulb temperatures. The chiller is available 24 hours a day, everyday of the year. Chiller use generally begins at 52 degrees outside air temperature and reaches 25% loading at 107 Degrees F.

To compute the impacts, the following assumptions were used:

- A linear loading strategy was used for the analysis of both the original, baseline and rebated chillers, which assumed 10% loading at 52 degrees and 25% loading at 107 Degrees F.

- For the baseline chiller case a Title 24 baseline efficiency of 0.925 KW/ton was used, based on a water-cooled chiller less than 150 tons. The existing chiller had a KW/Ton of 0.97.

- Chiller efficiencies at various temperatures were interpolated from values provided at 25%, 50%, 75%, and 100% loading at ARI conditions. These calculated efficiencies were used to develop a

chiller efficiency curve for the Rebate case. The baseline chiller efficiency curve was based on minimum Title 24 full load efficiency requirements, matched to a typical chiller performance curve.

The above assumptions were incorporated into a spreadsheet where energy and demand impacts were calculated. Evaluation- based demand and energy impacts were lower, than Ex Ante estimates. Results from these calculations

Additional Notes

Saving estimates were calculated in a similar manner. The results from these calculations are documented in the attached workbook.

Impact Results

	KW	KWh	Therm
MDSS	10.62	46,557.72	0
Adjusted Engineering	3.9	10,411.7	0
Engineering Realization Rate	0.37	0.22	N/A

Site # 4254	kWh	kW	therms
PG&E	46,558	10.6	-
QC Impact	10,412	3.9	-
QC Savings	11,856	7.7	-
I-Eng. Real. Rate	0.22	0.37	

New Chiller Efficiency

%	Tons	kW/Ton
25%	20	0.766
50%	40	0.665
75%	60	0.747
100%	80	0.838

Operational Parameters	New Chiller Minimum	New Chiller Maximum	Old Chillers (2 @ 40 Tons) Minimum	Old Chillers (2 @ 40 Tons) Maximum
Chiller Output (Ton)	8	80	4	80
OSA Temp	53	112	67	112
% Of Capacity	10%	25%	10%	25%

Basecase

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-		0.0	0	-
32	0.00%	-		0.0	0	-
37	0.00%	-		0.0	0	-
42	0.00%	-		0.0	0	-
47	0.00%	-		0.0	0	-
52	0.00%	-		0.0	0	-
53	10.00%	8	1.801	14.4	395	5,691
57	11.36%	9	1.707	15.5	1021	15,839
62	12.72%	10	1.613	16.4	965	15,839
67	14.09%	11	1.518	17.1	842	14,407
72	15.45%	12	1.424	17.6	722	12,708
77	16.82%	13	1.330	17.9	606	10,845
82	18.18%	15	1.236	18.0	544	9,779
87	19.55%	16	1.141	17.8	418	7,459
92	20.91%	17	1.088	18.2	345	6,279
97	22.27%	18	1.054	18.8	216	4,056
102	23.64%	19	1.021	19.3	96	1,854
107	25.00%	20	0.987	19.7	5	99
112	26.36%	21	0.970	20.5	0	-
				20.5	6175.007	104,856

Rebate Case

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	#1	0	0.0	0	-
32	0.00%	-	0.000	#1	0	0.0	0	-
37	0.00%	-	0.000	#1	0	0.0	0	-
42	0.00%	-	0.000	#1	0	0.0	0	-
47	0.00%	-	0.000	#1	0	0.0	0	-
52	0.00%	-	0.000	#1	0	0.0	0	-
53	10.00%	8	1.631	#1	1.631	13.0	395	5,154
57	11.36%	9	1.546	#1	1.546	14.1	1021	14,345
62	12.72%	10	1.461	#1	1.461	14.9	965	14,347
67	14.09%	11	1.375	#1	1.375	15.5	842	13,050
72	15.45%	12	1.290	#1	1.290	15.9	722	11,512
77	16.82%	13	1.205	#1	1.205	16.2	606	9,826
82	18.18%	15	1.120	#1	1.120	16.3	544	8,861
87	19.55%	16	1.034	#1	1.034	16.2	418	6,760
92	20.91%	17	0.962	#1	0.962	16.1	345	5,552
97	22.27%	18	0.897	#1	0.897	16.0	216	3,452
102	23.64%	19	0.831	#1	0.831	15.7	96	1,509
107	25.00%	20	0.766	#1	0.766	15.3	5	77
112	26.36%	21	0.786	#1	0.786	16.6	0	-
						16.6	6175.007	94,444

Existing Case

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27		-		0.0	0	-
32	0.00%	-		0.0	0	-
37	0.00%	-		0.0	0	-
42	0.00%	-		0.0	0	-
47	0.00%	-		0.0	0	-
52	0.00%	-		0.0	0	-
53	10.00%	8	1.582	12.7	395	4,999
57	11.36%	9	1.539	15.7	1021	15,990
62	12.72%	10	1.497	15.2	965	14,700
67	14.09%	11	1.454	16.4	842	13,800
72	15.45%	12	1.411	17.4	722	12,592
77	16.82%	13	1.37	18.4	606	11,171
82	18.18%	15	1.325	19.3	544	10,483
87	19.55%	16	1.282	20.1	418	8,381
92	20.91%	17	1.249	20.9	345	7,208
97	22.27%	18	1.22	21.7	216	4,695
102	23.64%	19	1.192	22.5	96	2,164
107	25.00%	20	1.164	23.3	5	116
112	26.36%	21	1.152	24.3	0	-
				24.3	6175.007	106,300

	Eff base case	% Loading	Eff rebate case
10.000	1.801	10.000	1.631
20.000	1.110	20.000	1.008
25.000	0.987	25.000	0.766
30.000	0.925	30.000	0.838
40.000	0.777	40.000	0.704
50.000	0.765	50.000	0.665
60.000	0.783	60.000	0.710
70.000	0.808	70.000	0.732
75.000	0.826	75.000	0.747
80.000	0.845	80.000	0.765
90.000	0.882	90.000	0.799
100.000	0.925	100.000	0.838

rebate	% Loading	base
1.631	0.100	1.801
1.546	0.114	1.707
1.461	0.127	1.613
1.375	0.141	1.518
1.290	0.155	1.424
1.205	0.168	1.330
1.120	0.182	1.236
1.034	0.196	1.141
0.962	0.209	1.088
0.897	0.223	1.054
0.831	0.236	1.021
0.766	0.250	0.987
0.786	0.264	0.970

	existing case			
0.100	1.582		0.970	100.000
0.114	1.539		0.940	90.000
0.127	1.497		0.918	80.000
0.141	1.454		0.910	75.000
0.155	1.411		0.910	70.000
0.168	1.370		0.918	60.000
0.182	1.325		0.925	50.000
0.196	1.282		1.000	40.000
0.209	1.249		1.119	30.000
0.223	1.220		1.164	25.000
0.236	1.192		1.288	20.000
0.250	1.164		1.582	10.000
0.264	1.152			

clz 13 Site 4254
Total Month

		1	2	3	4	5	6	7	8	9	10	11	12	Total	Chiller runs 24/7		@53.23
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	27	2	0	0	0	0	0	0	0	0	0	0	5	7	7		
	32	23	19	0	0	0	0	0	0	0	0	14	52	108	108		
	37	84	59	20	4	0	0	0	0	0	0	47	137	351	351		
	42	180	54	77	22	2	0	0	0	0	13	71	134	553	553		
	47	224	114	102	67	23	0	0	0	0	47	144	121	842	842	842	
	52	131	173	190	115	74	6	0	0	13	91	146	180	1119	1119	1119	395
	57	56	141	137	135	95	37	10	11	62	120	136	81	1021	1021	1021	1021
	62	35	67	106	125	96	95	46	59	116	119	81	20	965	965	965	965
	67	9	31	66	90	108	90	67	106	122	97	42	14	842	842	842	842
	72	0	13	31	53	89	93	103	113	105	101	21	0	722	722	722	722
	77	0	1	15	48	89	87	100	97	79	72	18	0	606	606	606	606
	82	0	0	0	48	70	95	103	100	77	51	0	0	544	544	544	544
	87	0	0	0	12	53	74	103	81	72	23	0	0	418	418	418	418
	92	0	0	0	1	32	79	95	78	50	10	0	0	345	345	345	345
	97	0	0	0	0	12	43	84	56	21	0	0	0	216	216	216	216
	102	0	0	0	0	1	21	30	41	3	0	0	0	96	96	96	96
	107	0	0	0	0	0	0	3	2	0	0	0	0	5	5	5	5
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
								744	744	720	731				7741	7741	6175.007

01-08 Month

		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	2	0	0	0	0	0	0	0	0	0	0	5	7
	32	19	19	0	0	0	0	0	0	0	0	14	42	94
	37	55	53	20	4	0	0	0	0	0	0	37	84	253
	42	88	31	68	21	2	0	0	0	0	13	47	44	314
	47	73	66	66	54	23	0	0	0	0	43	89	32	446
	52	10	46	83	81	62	6	0	0	13	71	43	33	448
	57	0	9	11	57	60	34	10	11	55	73	10	7	337
	62	1	0	0	18	48	72	45	56	87	42	0	1	370
	67	0	0	0	3	39	68	62	86	69	6	0	0	333
	72	0	0	0	2	12	41	74	65	15	0	0	0	209
	77	0	0	0	0	2	14	45	27	1	0	0	0	89
	82	0	0	0	0	0	5	10	3	0	0	0	0	18
	87	0	0	0	0	0	0	2	0	0	0	0	0	2
	92	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

09-16 Month

		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	8	1	0	0	0	0	0	0	0	0	3	14	26
	42	34	4	0	0	0	0	0	0	0	0	5	33	76
	47	61	14	6	0	0	0	0	0	0	0	12	41	134
	52	69	49	33	5	1	0	0	0	0	0	30	80	267
	57	43	75	58	16	10	0	0	0	0	8	68	52	330
	62	26	43	65	53	14	9	0	0	4	20	54	14	302
	67	7	25	47	53	27	4	0	4	10	37	35	14	263
	72	0	12	25	31	34	18	3	9	36	62	16	0	246
	77	0	1	14	33	50	28	11	26	34	53	17	0	267
	82	0	0	0	38	43	51	37	49	45	39	0	0	302
	87	0	0	0	10	35	39	53	43	50	19	0	0	249
	92	0	0	0	1	22	50	62	45	39	10	0	0	229
	97	0	0	0	0	11	28	56	38	19	0	0	0	152
	102	0	0	0	0	1	13	23	32	3	0	0	0	72
	107	0	0	0	0	0	0	3	2	0	0	0	0	5
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

17-24 Month

		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	4	0	0	0	0	0	0	0	0	0	0	10	14
	37	21	5	0	0	0	0	0	0	0	0	7	39	72
	42	58	19	9	1	0	0	0	0	0	0	19	57	163
	47	90	34	30	13	0	0	0	0	0	4	43	48	262
	52	52	78	74	29	11	0	0	0	0	20	73	67	404
	57	13	57	68	62	25	3	0	0	7	39	58	22	354
	62	8	24	41	54	34	14	1	3	25	57	27	5	293
	67	2	6	19	34	42	18	5	16	43	54	7	0	246
	72	0	1	6	20	43	34	26	39	54	39	5	0	267
	77	0	0	1	15	37	45	44	44	44	19	1	0	250
	82	0	0	0	10	27	39	56	48	32	12	0	0	224
	87	0	0	0	2	18	35	48	38	22	4	0	0	167
	92	0	0	0	0	10	29	33	33	11	0	0	0	116
	97	0	0	0	0	1	15	28	18	2	0	0	0	64
	102	0	0	0	0	0	8	7	9	0	0	0	0	24
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

Chiller Replacement (Site 4342)

Program	Retrofit Efficiency Options Program
Measure	High Efficiency Water-Cooled Chiller
Site Description	Office Building

Measure Description Replace existing chiller with high-efficiency water-cooled chiller.

Summary of Ex Ante Impact Calculations Tables of standard values were developed using the HBSSM simulation program based on climate zone, chiller size, building type, chiller efficiency, and condenser water temperature. Values from these tables are used to calculate the rebate and associated impacts.

Comments on PG&E Calculations The correct climate zone, chiller size category, chiller efficiency and building type were used in the application calculations.

Evaluation Process The evaluation process consisted of reviewing the application form and supporting documentation, conducting an on-site survey and then computing impacts using the on-site data. Models were calibrated with actual weather, number of compressor hours as well as an observed operating point, %load @ the outside air temperature. Peak demand was calculated for actual peak temperatures. Energy savings were based on typical weather data. A Title 24 baseline, IPLV at ARI conditions, and typical year bin weather data for the applicable climate zone was used in the bin analysis.

The on-site survey was conducted on October 12, 1998. Information on the retrofit equipment and operating conditions were collected through an inspection of the chiller and through an interview with the Chief Engineer.

Discussions provided data for development of a relationship between chiller loading and outdoor dry bulb temperatures. The chiller is available 24 hours a day, everyday of the year. Chiller use generally begins at 55 degrees outside air temperature and reaches 75% loading at 105Degrees F.

To compute the impacts, the following assumptions were used:

- A linear loading strategy was used for the analysis of both the baseline, and rebated chillers, which assumed 10% loading at 55 degrees and 75% loading at 105 Degrees F.
- For the baseline chiller case a Title 24 baseline efficiency of 0.837KW/ton was used, based on a water-cooled chiller between 150 and 300 tons.
- Chiller efficiencies at various temperatures were interpolated from values provided at 25%, 50%, 75%, and 100% loading at ARI conditions. These calculated efficiencies were used to develop a

chiller efficiency curve for the Rebate case. The baseline chiller efficiency curve was based on minimum Title 24 full load efficiency requirements, matched to a typical chiller performance curve.

The above assumptions were incorporated into a spreadsheet where energy and demand impacts were calculated. Evaluation- based demand and energy impacts were higher than Ex Ante estimates. Results from these calculations are summarized below and documented in the attached workbook

Additional Notes

Impact Results

	KW	KWh	Therm
MDSS	21.75	67,365.9	0
Adjusted Engineering	58.72	237,337.1	0
Engineering Realization Rate	2.70	3.52	N/A

Site # 4342	WYEC Weather		
	kWh	kW	therms
PG&E	67,365.94	21.75	-
QC Impact	237,337.05	58.72	-
			-
I-Eng. Real. Rat	3.52	2.70	

New Chiller Efficiency		
%	Tons	kW/Ton
25%	40.95	0.502
50%	81.9	0.481
75%	122.85	0.525
100%	163.8	0.540
iplv (kW/Ton	0.50945909	

Operational Parameters	New Chiller	
	Minimum	Maximum
Chiller Output (Ton)	20.475	163.8
OSA Temp	55	105
% Of Capacity	13%	75%

Basecase

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-		0.0	0	-
32	0.00%	-		0.0	0	-
37	0.00%	-		0.0	0	-
42	0.00%	-		0.0	0	-
47	0.00%	-		0.0	0	-
52	0.00%	-		0.0	0	-
57	12.50%	20	1.707	35.0	1021	35,685
62	18.75%	31	1.613	49.5	965	47,805
67	25.00%	41	1.518	62.2	842	52,340
72	31.25%	51	1.424	72.9	722	52,627
77	37.50%	61	1.330	81.7	606	49,507
82	43.75%	72	1.236	88.6	544	48,185
87	50.00%	82	1.141	93.4	418	39,061
92	56.25%	92	1.088	100.2	345	34,585
97	62.50%	102	1.054	107.9	216	23,307
102	68.75%	113	1.021	115.0	96	11,038
107	75.00%	123	0.987	121.3	5	606
112	81.25%	133	0.970	129.1	0	-
				129.1	5780	394,747

Rebate Case

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller Eff. Equation	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	0.000	#1	0	0.0	0	-
32	0.00%	-	0.000	#1	0	0.0	0	-
37	0.00%	-	0.000	#1	0	0.0	0	-
42	0.00%	-	0.000	#1	0	0.0	0	-
47	0.00%	-	0.000	#1	0	0.0	0	-
52	0.00%	-	0.000	#1	0	0.0	0	-
57	12.50%	20	0.829	#1	0.829	17.0	1021	17,330
62	18.75%	31	0.609	#1	0.609	18.7	965	18,049
67	25.00%	41	0.502	#1	0.502	20.6	842	17,309
72	31.25%	51	0.497	#1	0.497	25.4	722	18,364
77	37.50%	61	0.491	#1	0.491	30.2	606	18,288
82	43.75%	72	0.486	#1	0.486	34.8	544	18,946
87	50.00%	82	0.481	#1	0.481	39.4	418	16,467
92	56.25%	92	0.492	#1	0.492	45.4	345	15,649
97	62.50%	102	0.503	#1	0.503	51.5	216	11,129
102	68.75%	113	0.514	#1	0.514	57.9	96	5,556
107	75.00%	123	0.525	#1	0.525	64.5	5	322
112	81.25%	133	0.529	#1	0.529	70.4	0	-
						70.4	5780	157,410

	Eff base ca	% Loading	Eff rebate case		rebate	% Loading	base
10.000	1.629	10.000	0.917		0.829	12.50%	1.801
20.000	1.004	20.000	0.565		0.609	18.75%	1.707
25.000	0.766	25.000	0.502		0.502	25.00%	1.613
30.000	0.837	30.000	0.498		0.497	31.25%	1.518
40.000	0.703	40.000	0.489		0.491	37.50%	1.424
50.000	0.665	50.000	0.481		0.486	43.75%	1.330
60.000	0.709	60.000	0.499		0.481	50.00%	1.236
70.000	0.731	70.000	0.516		0.492	56.25%	1.141
75.000	0.747	75.000	0.525		0.503	62.50%	1.088
80.000	0.764	80.000	0.528		0.514	68.75%	1.054
90.000	0.798	90.000	0.534		0.525	75.00%	1.021
100.000	0.837	100.000	0.540		0.529	81.25%	0.987
iplv (kW/To	0.73258						

WYEC Clz 13 Site 4342

Total		Month 1	2	3	4	5	6	7	8	9	10	11	12	Total	Chiller runs 24/7	@55	
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	27	2	0	0	0	0	0	0	0	0	0	0	5	7	7		
	32	23	19	0	0	0	0	0	0	0	0	14	52	108	108		
	37	84	59	20	4	0	0	0	0	0	0	47	137	351	351		
	42	180	54	77	22	2	0	0	0	0	13	71	134	553	553		
	47	224	114	102	67	23	0	0	0	0	47	144	121	842	842	842	
	52	131	173	190	115	74	6	0	0	13	91	146	180	1119	1119	1119	
	57	56	141	137	135	95	37	10	11	62	120	136	81	1021	1021	1021	1021 at 55 deg
	62	35	67	106	125	96	95	46	59	116	119	81	20	965	965	965	965
	67	9	31	66	90	108	90	67	106	122	97	42	14	842	842	842	842
	72	0	13	31	53	89	93	103	113	105	101	21	0	722	722	722	722
	77	0	1	15	48	89	87	100	97	79	72	18	0	606	606	606	606
	82	0	0	0	48	70	95	103	100	77	51	0	0	544	544	544	544
	87	0	0	0	12	53	74	103	81	72	23	0	0	418	418	418	418
	92	0	0	0	1	32	79	95	78	50	10	0	0	345	345	345	345
	97	0	0	0	0	12	43	84	56	21	0	0	0	216	216	216	216
	102	0	0	0	0	1	21	30	41	3	0	0	0	96	96	96	96
	107	0	0	0	0	0	0	3	2	0	0	0	0	5	5	5	5
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
																	5780

01-08		Month 1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	2	0	0	0	0	0	0	0	0	0	0	5	7
	32	19	19	0	0	0	0	0	0	0	0	14	42	94
	37	55	53	20	4	0	0	0	0	0	0	37	84	253
	42	88	31	68	21	2	0	0	0	0	13	47	44	314
	47	73	66	66	54	23	0	0	0	0	43	89	32	446
	52	10	46	83	81	62	6	0	0	13	71	43	33	448
	57	0	9	11	57	60	34	10	11	55	73	10	7	337
	62	1	0	0	18	48	72	45	56	87	42	0	1	370
	67	0	0	0	3	39	68	62	86	69	6	0	0	333
	72	0	0	0	2	12	41	74	65	15	0	0	0	209
	77	0	0	0	0	2	14	45	27	1	0	0	0	89
	82	0	0	0	0	0	5	10	3	0	0	0	0	18
	87	0	0	0	0	0	0	2	0	0	0	0	0	2
	92	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

09-16		Month 1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	8	1	0	0	0	0	0	0	0	0	3	14	26
	42	34	4	0	0	0	0	0	0	0	0	5	33	76
	47	61	14	6	0	0	0	0	0	0	0	12	41	134
	52	69	49	33	5	1	0	0	0	0	0	30	80	267
	57	43	75	58	16	10	0	0	0	0	8	68	52	330
	62	26	43	65	53	14	9	0	0	4	20	54	14	302
	67	7	25	47	53	27	4	0	4	10	37	35	14	263
	72	0	12	25	31	34	18	3	9	36	62	16	0	246
	77	0	1	14	33	50	28	11	26	34	53	17	0	267
	82	0	0	0	38	43	51	37	49	45	39	0	0	302
	87	0	0	0	10	35	39	53	43	50	19	0	0	249
	92	0	0	0	1	22	50	62	45	39	10	0	0	229
	97	0	0	0	0	11	28	56	38	19	0	0	0	152
	102	0	0	0	0	1	13	23	32	3	0	0	0	72
	107	0	0	0	0	0	0	3	2	0	0	0	0	5
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

17-24		Month 1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	4	0	0	0	0	0	0	0	0	0	0	10	14
	37	21	5	0	0	0	0	0	0	0	0	7	39	72
	42	58	19	9	1	0	0	0	0	0	0	19	57	163
	47	90	34	30	13	0	0	0	0	0	4	43	48	262
	52	52	78	74	29	11	0	0	0	0	20	73	67	404
	57	13	57	68	62	25	3	0	0	7	39	58	22	354
	62	8	24	41	54	34	14	1	3	25	57	27	5	293
	67	2	6	19	34	42	18	5	16	43	54	7	0	246
	72	0	1	6	20	43	34	26	39	54	39	5	0	267
	77	0	0	1	15	37	45	44	44	44	19	1	0	250
	82	0	0	0	10	27	39	56	48	32	12	0	0	224
	87	0	0	0	2	18	35	48	38	22	4	0	0	167
	92	0	0	0	0	10	29	33	33	11	0	0	0	116
	97	0	0	0	0	1	15	28	18	2	0	0	0	64
	102	0	0	0	0	0	8	7	9	0	0	0	0	24
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

Chiller Replacement (Site 4963)

Program	Retrofit Express Program
Measure	High Efficiency Air-Cooled Chiller
Site Description	College / University

Measure Description	Replace existing chiller with high-efficiency with two air–cooled chillers. Note there was no pre-existing chiller or any other cooling equipment.
Summary of Ex Ante Impact Calculations	Demand calculations were estimated based upon the chiller tonnage and the difference between the new unit and a baseline qualifying Title 24 chillers, in conjunction with and assumed 0.75 diversity factor. Energy calculations are based upon all but the latter, in conjunction with standard PG&E EFLH values.
Comments on Calculations	The correct chiller size category, chiller efficiency (100% Load) and nominal tonage were used in the application. The chiller tonnage at 100% Load at ARI conditions is 72.5 tons, not the 83 tons used in the application. The two chillers are in a lead/lag configuration the lagging chiller's full capacity is never called for.
Evaluation Process	The evaluation process consisted of reviewing the application form and supporting documentation, conducting an on-site survey and then computing impacts using the on-site data. Models were calibrated with actual weather, number of compressor hours as well as an observed operating point, %load @ the outside air temperature. Peak demand was calculated for actual peak temperatures. Energy saving were based on typical weather data. A Title 24 baseline, IPLV at ARI conditions, and typical year bin weather were used in the bin analysis.

The on-site survey was conducted on October 20, 1998. Information on the retrofit equipment and operating conditions were collected through an inspection of the chiller and through an interview with the Chief Engineer.

Discussions provided data for development of a relationship between chiller loading and outdoor dry bulb temperature. The chiller is available to operate Monday through Friday 7am till 11pm, Saturday and Sunday 9am till 6pm all year. Chiller use generally begins at 62 degrees outside air temperature. When outside air temperatures reach 85 degrees (and the first chiller reached 100% capacity) the lag chiller comes on. The second chiller reaches 46% capacity at peak temperature of 94 degrees F.

To compute the impacts, the following assumptions were used:

- A linear loading strategy was used for the analysis of both the baseline and rebated chillers, which assumed 10% loading at 62 degrees and 73% combined loading at 94 Degrees F.

- For the baseline chiller case a Title 24 baseline efficiency of 1.302 KW/ton was used , based on an air-cooled chiller less than 150 Tons.

- Chiller efficiencies at various temperatures were interpolated from values provided at 25%, 50%, 75%, and 100% loading at ARI conditions. These calculated efficiencies were used to develop a chiller efficiency curve for the Rebate case. The baseline chiller efficiency curve was based on minimum Title 24 full load efficiency requirements, matched to a typical chiller performance curve.

The above assumptions were incorporated into a spreadsheet where energy and demand impacts were calculated. Evaluation- based demand was lower than Ex Ante estimates. Evaluation- based energy was greater than Ex Ante estimates Results from these calculations are summarized below and documented in the attached workbook.

Additional Notes

Note there was no pre-existing chiller or any other cooling equipment for this building.

Impact Results

	KW	KWh	Therm
MDSS	16.14	25,745.6	0
Adjusted Engineering	2.99	33,956.8	0
Engineering Realization Rate	0.19	1.32	N/A

Site # 4963	WYEC Weather		
	kWh	kW	therms
PG&E	25,745.60	16.14	-
QC Impact	33,956.77	2.99	-
			-
I-Eng. Real. Ra	1.32	0.19	

New Chiller Efficiency Qty 2 Identical		
%	Tons	kW/Ton
25%	18.125	1.265
50%	36.25	1.172
75%	54.375	1.099
100%	72.5	1.037
iplv (kW/To 1.126978		

Operational Parameters	# 1 & 2 New Chiller (Air cooled)	
	Minimum	Maximum
Chiller Output (Ton)	7.25	145
OSA Temp	65	94
% Of Capacity	5%	73%

Basecase

Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-		0.0	0.00	-
32	0.00%	-		0.0	0.00	-
37	0.00%	-		0.0	0.00	-
42	0.00%	-		0.0	0.00	-
47	0.00%	-		0.0	0.00	-
52	0.00%	-		0.0	0.00	-
57	0.00%	-		0.0	0.00	-
62	10.00%	15	2.535	36.8	1128.54	41,482
67	14.00%	20	1.757	35.7	693.46	24,739
72	23.00%	33	1.436	47.9	385.93	18,480
77	32.00%	46	1.281	59.4	168.63	10,024
82	41.00%	59	1.092	64.9	56.79	3,687
87	55.00%	80	1.090	86.9	27.70	2,406
92	64.00%	93	1.117	103.6	1.00	104
97	73.00%	106	1.145	121.2	0.00	-
				103.6	2462.04	100,923

Rebate Case

Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Number	Chiller #1 Load (%)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller #2 Load (%)	Chiller Eff. (kW/Ton)	Total Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	#1	0.00%	0.000	#2	0.00%	0.000	0.00	0.00	-
32	0.00%	-	#1	0.00%	0.000	#2	0.00%	0.000	0.00	0.00	-
37	0.00%	-	#1	0.00%	0.000	#2	0.00%	0.000	0.00	0.00	-
42	0.00%	-	#1	0.00%	0.000	#2	0.00%	0.000	0.00	0.00	-
47	0.00%	-	#1	0.00%	0.000	#2	0.00%	0.000	0.00	0.00	-
52	0.00%	-	#1	0.00%	0.000	#2	0.00%	0.000	0.00	0.00	-
57	0.00%	-	#1	0.00%	0.000	#2	0.00%	0.000	0.00	0.00	-
62	5.00%	7	#1	10.00%	2.309	#2	0.00%	0.000	16.740	1128.54	18,892
67	14.00%	20	#1	28.00%	1.254	#2	0.00%	0.000	25.452	693.46	17,650
72	23.00%	33	#1	46.00%	1.187	#2	0.00%	0.000	39.583	385.93	15,276
77	32.00%	46	#1	64.00%	1.131	#2	0.00%	0.000	52.483	168.63	8,850
82	41.00%	59	#1	82.00%	1.082	#2	0.00%	0.000	64.301	56.79	3,651
87	55.00%	80	#1	100.00%	1.037	#2	10.00%	2.309	91.923	27.70	2,546
92	64.00%	93	#1	100.00%	1.037	#2	28.00%	1.254	100.635	1.00	101
97	73.00%	106	#1	100.00%	1.037	#2	46.00%	1.187	114.766	0.00	-
									100.63	2462.04	66,966
	max @92										

% Loading	Eff base ca	Eff rebate case
10.000	2.535	2.309
20.000	1.563	1.423
25.000	1.389	1.265
30.000	1.302	
40.000	1.094	
50.000	1.076	1.172
60.000	1.103	
70.000	1.137	
75.000	1.163	1.099
80.000	1.189	
90.000	1.241	
100.000	1.302	1.037

Eff rebate case				Eff base case	
% Loading				% Loading	
ch1		ch2			
10.00%	2.309	0.00%		10.00%	2.535
28.00%	1.254	0.00%		14.00%	1.757
46.00%	1.187	0.00%		23.00%	1.436
64.00%	1.131	0.00%		32.00%	1.281
82.00%	1.082	0.00%		41.00%	1.092
100.00%	1.037	10.00%	2.309	55.00%	1.090
100.00%	1.037	28.00%	1.254	64.00%	1.117
100.00%	1.037	46.00%	1.187	73.00%	1.145

ch1	ch2	
10.00%	0.00%	5.00%
28.00%	0.00%	14.00%
46.00%	0.00%	23.00%
64.00%	0.00%	32.00%
82.00%	0.00%	41.00%
100.00%	10.00%	55.00%
100.00%	28.00%	64.00%
100.00%	46.00%	73.00%

WYEC-Clz Site 4963

Total — Month

		1	2	3	4	5	6	7	8	9	10	11	12	Total	Actual Schedule	
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	32	2	0	0	0	0	0	0	0	0	0	0	5	7	0.625	
	37	31	6	5	0	0	0	0	0	0	0	10	55	107	18.96429	
	42	130	44	43	26	4	0	0	0	0	1	33	118	399	105.75	
	47	183	157	124	109	55	5	1	0	1	35	121	150	941	333.25	
	52	209	194	232	225	244	133	91	61	57	101	171	226	1944	894.25	
	57	155	212	185	161	174	230	260	267	194	225	232	166	2461	1399.411	
	62	29	39	114	121	145	154	144	176	208	200	106	21	1457	1128.536	1128.536
	67	5	17	34	50	69	101	136	122	113	92	31	3	773	693.4643	693.4643
	72	0	3	7	18	27	61	74	79	77	48	15	0	409	385.9286	385.9286
	77	0	0	0	9	14	25	29	33	42	22	1	0	175	168.625	168.625
	82	0	0	0	1	6	8	7	5	17	14	0	0	58	56.78571	56.78571
	87	0	0	0	0	6	3	2	1	10	6	0	0	28	27.69643	27.69643
	92	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
															2462.036	2462.036

01-08 — Month

		1	2	3	4	5	6	7	8	9	10	11	12	Total	Mon -Fri&7am Start, sat & sun 9am
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	2	0	0	0	0	0	0	0	0	0	0	5	7	0.625
	37	30	6	5	0	0	0	0	0	0	0	8	43	92	8.214286
	42	80	40	40	26	2	0	0	0	0	1	31	74	294	26.25
	47	70	107	88	81	46	5	1	0	1	35	86	64	584	52.14286
	52	46	50	81	120	156	93	72	52	55	81	68	50	924	82.5
	57	20	20	27	13	43	104	158	164	126	113	44	12	844	75.35714
	62	0	1	7	0	1	36	14	32	49	15	3	0	158	14.10714
	67	0	0	0	0	0	1	3	0	7	3	0	0	14	1.25
	72	0	0	0	0	0	1	0	0	2	0	0	0	3	0.267857
	77	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	92	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0

09-16 — Month

		1	2	3	4	5	6	7	8	9	10	11	12	Total	all
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	0	0	0	0	0	0	0	0	0	0	0	1	1	1
	42	10	1	1	0	0	0	0	0	0	0	0	9	21	21
	47	43	9	14	1	0	0	0	0	0	0	5	35	107	107
	52	73	60	68	22	10	1	0	0	0	0	19	81	334	334
	57	97	109	77	66	40	19	7	9	6	29	93	100	652	652
	62	20	28	59	91	96	57	48	52	53	90	78	19	691	691
	67	5	14	23	37	57	78	93	81	59	59	30	3	539	539
	72	0	3	6	14	22	53	65	68	59	35	14	0	339	339
	77	0	0	0	8	12	22	26	32	36	17	1	0	154	154
	82	0	0	0	1	5	7	7	5	17	12	0	0	54	54
	87	0	0	0	0	6	3	2	1	9	6	0	0	27	27
	92	0	0	0	0	0	0	0	0	1	0	0	0	1	1
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0

17-24 — Month

		1	2	3	4	5	6	7	8	9	10	11	12	Total	M-F Stop 11pm, sat&sun 6pm
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	1	0	0	0	0	0	0	0	0	0	2	11	14	9.75
	42	40	3	2	0	2	0	0	0	0	0	2	35	84	58.5
	47	70	41	22	27	9	0	0	0	0	0	30	51	250	174.1071
	52	90	84	83	83	78	39	19	9	2	20	84	95	686	477.75
	57	38	83	81	82	91	107	95	94	62	83	95	54	965	672.0536
	62	9	10	48	30	48	61	82	92	106	95	25	2	608	423.4286
	67	0	3	11	13	12	22	40	41	47	30	1	0	220	153.2143
	72	0	0	1	4	5	7	9	11	16	13	1	0	67	46.66071
	77	0	0	0	1	2	3	3	1	6	5	0	0	21	14.625
	82	0	0	0	0	1	1	0	0	0	2	0	0	4	2.785714
	87	0	0	0	0	0	0	0	0	1	0	0	0	1	0.696429
	92	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0

EMS System Upgrade (Site 4946)

Program	Advance Performance Options
Measure	EMS And HVAC System Control
Site Description	College/University

Measure Description

Install a DDC energy management system to reduce the number of operating hours. The current EMS is limited to stop and start control of selected systems.

Summary of Ex Ante Impact Calculations

Savings were determined using engineering calculations and bin models, which represent the loading of the cooling and ventilation systems. Savings were based on the reduced number of operating hours of selected systems to correspond to occupancy schedules. Electricity is saved by reducing the number of operating hours of the compressors, fans and pumps; as well as reducing the number of hours the buildings are conditioned by reset thermostats during unoccupied periods. Connected loads were based on detailed audits of the facility.

Comments on Calculations

Savings calculations were based on the reduction of operating hours and a temperature set back for unoccupied hours. The model was not able to match billing data due to the large number of buildings on one meter. Fan saving were included in non-air conditioned spaces. Calculations did not include latent heat loads. Therm savings were not included in the application. Appropriate equipment efficiencies, size, cfm and climate zone weather data were used.

Evaluation Process

The evaluation process consisted of reviewing the application form and supporting documentation, conducting an on-site survey and reviewing the results from the spreadsheets accompanying the application. Pre and post retrofit schedules were reconfirmed through interviews with the chief engineer. Outside air requirements of some zones have changed since the project was completed.

The on-site survey was conducted on December 9, 1998 with the Chief Engineer. The cfm ratings used in the application calculations were verified during the on site inspection.

The engineering calculation and bin methods used for the analyses were accepted as an accurate representation of pre- and post-retrofit conditions and were adopted as the evaluation-based savings estimates..

Additional Notes

Impact Results

	KW	KWh	Therm
MDSS	0.0	375,348.32	0
Adjusted Engineering	0.0	375,348.32	0

Engineering Realization Rate	1.0	1.0	0

Chiller Replacement (Site 4954)

Program	Advanced Performance Options
Measure	High Efficiency Chiller
Site Description	Health Care / Hospital

Measure Description Replace 2 existing chillers with 2 high-efficiency centrifugal chillers.

Summary of Ex Ante Impact Calculations Demand and energy impacts were determined from Visual DOE simulations and weather data from California climate zone 3. A baseline simulation was developed and then the rebated chiller was substituted for the baseline chiller. Reduction in energy consumption is, reflected in space cooling, heat rejection, Pumps and fan. No input file or documentation of inputs accompanied the application.

Comments on Calculations The results from the simulations are reasonable and accurate. The proper weather data was used for the simulations. The total energy use determined from the existing simulation matched well with the historic energy use at the site. Energy usage associated with the retrofit chiller is computed in a similar fashion, using an identical load line, weather and operating hour assumptions, but with a chiller efficiency appropriate for the retrofit chiller. Savings due to cooling tower effects as well as pump and fan energy were included in the saving estimate.

Evaluation Process The evaluation process consisted of reviewing the application form and supporting documentation, conducting an on-site survey and reviewing the results from the Visual DOE Simulations. Impacts were calculated using the on-site data. Models were calibrated with actual weather, number of compressor hours as well as an observed operating point, %load @ the outside air temperature. Peak demand was calculated for actual peak temperatures. Energy savings were based on typical weather data. A Title 24 baseline, IPLV at ARI conditions, and typical year bin weather data for the applicable climate zone was used in the bin analysis. Our bin model does not capture the pumping; fan or cooling tower effects. These effects contribute more than 50% of the impact.

The on-site survey was conducted on December 30, 1998 with the Chief Engineer. The retrofit equipment and operating conditions were verified via an inspection of the central plant and through discussions with the Engineer. He confirmed that the chiller and schedule matched the information provided in the application. . Discussions provided data for development of a relationship between chiller loading and outdoor dry bulb temperature.. Chiller use generally begins at 57 degrees outside air temperature. The Lead chiller reaches 100% loading at 82 Degrees F, bringing the second chiller on line. The second chiller reaches 26% loading at 92degrees F.

To compute the impacts, the following assumptions were used:

- A linear loading strategy was used for the analysis of both the baseline and rebated chillers, which assumed 10% loading at 57 degrees and 100% loading at 82Degrees F. The second chiller reaches 26% loading at 92degrees F.

- For the baseline chiller case a Title 24 baseline efficiency of 0.748KW/ton, based on a water-cooled chiller greater than 300 tons, was used. Baseline chiller capacity was assumed to be equal to the sum of the new chillers.

- Chiller efficiencies at various temperatures were interpolated from values provided at 25%, 50%, 75%, and 100% loading at ARI conditions. These calculated efficiencies were used to develop a chiller efficiency curve for the Rebate case. The baseline chiller efficiency curve was based on Tittle 24 100% load minimum efficiencies matched to a typical chiller performance curve.

The above assumptions were incorporated into a spreadsheet where energy and demand impacts were calculated. Evaluation- based demand and energy impacts were significantly lower than Ex Ante estimates. Results from these calculations are summarized below and documented in the attached workbook.

Additional Notes

Impact Results

	KW	KWh	Therm
MDSS	81.75	642,461.92	0
Adjusted Engineering	-0.04	96,231.85	0
Engineering Realization Rate	- 0.00	0.15	N/A

Site # 4954	WYEC Weather		
	kWh	kW	therms
PG&E	642,461.92	81.75	-
QC Impact	*96,231.85*	*-0.04*	-
			-
I-Eng. Real. Rat	0.15	0.00	

Basecase						
Outside Air (F)	Chiller Load (%)	Chiller Output (Ton)	Chiller Eff. (kW/Ton)	Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-		0.0	0.00	-
32	0.00%	-		0.0	0.00	-
37	0.00%	-		0.0	0.00	-
42	0.00%	-		0.0	0.00	-
47	0.00%	-		0.0	0.00	-
52	0.00%	-		0.0	0.00	-
57	10.00%	20	1.456	29.1	1743.00	50,760
62	10.18%	56	1.446	81.0	1254	101,544
67	16.73%	92	1.081	99.4	714	70,976
72	23.27%	128	0.833	106.6	399	42,523
77	29.82%	164	0.750	123.0	175	21,519
82	42.73%	235	0.625	146.9	58	8,523
87	46.55%	256	0.622	159.1	28	4,455
92	52.91%	291	0.622	181.1	1	181
				181.1	4372.00	300,480

Operational Parameters		New Chiller #1				New Chiller #2	
		Minimum	Maximum			Minimum	Maximum
Chiller Output (Ton)		80	200			35	350
OSA Temp		8760 hrs					
% Of Capacity		40%	100%			10%	

New Chiller #1 Efficiency			New Chiller #2 Efficiency		
%	Tons	kW/Ton	%	Tons	kW/Ton
25%	50	0.740	25%	87.5	0.667
50%	100	0.510	50%	175	0.520
75%	150	0.527	75%	262.5	0.508
100%	200	0.605	100%	350	0.540

iplv (kW/Ton) = 0.5504374

Rebate Case												
Outside Air (F)	Total Chiller Load (%)	Chiller Output (Ton)	Chiller Number	Chiller #1 Load (%)	Chiller Eff. (kW/Ton)	Chiller Number	Chiller #2 Load (%)	Chiller Eff. (kW/Ton)	Total Chiller Input (kW)	Annual Operation (Hrs/Yr)	Total (kWh/Yr)
27	0.00%	-	#1	0.00%	0.000	#2	0.00%	0.000	0.00	0.00	-
32	0.00%	-	#1	0.00%	0.000	#2	0.00%	0.000	0.00	0.00	-
37	0.00%	-	#1	0.00%	0.000	#2	0.00%	0.000	0.00	0.00	-
42	0.00%	-	#1	0.00%	0.000	#2	0.00%	0.000	0.00	0.00	-
47	0.00%	-	#1	0.00%	0.000	#2	0.00%	0.000	0.00	0.00	-
52	0.00%	-	#1	0.00%	0.000	#2	0.00%	0.000	0.00	0.00	-
57	10.00%	20	#1	10.00%	1.351	#2	0.00%	0.000	27.020	1743	47,096
62	10.18%	56	#1	28.00%	0.822	#2	0.00%	0.000	46.021	1254	57,710
67	16.73%	92	#1	46.00%	0.662	#2	0.00%	0.000	60.895	714	43,479
72	23.27%	128	#1	64.00%	0.520	#2	0.00%	0.000	66.496	399	26,532
77	29.82%	164	#1	82.00%	0.549	#2	0.00%	0.000	90.003	175	15,751
82	42.73%	235	#1	100.00%	0.605	#2	10.00%	0.907	152.745	58	8,859
87	46.55%	256	#1	100.00%	0.605	#2	16.00%	0.799	165.744	28	4,641
92	52.91%	291	#1	100.00%	0.605	#2	26.00%	0.661	181.160	1	181
									181.160	4372	204,248

max temp. =92

				Eff rebate case							
% Loading	Eff base case		% Loading	ch1	ch2	rebate	% Loading			base	
10.000	1.456		10.000	1.351	0.907	ch1		ch2			
20.000	0.898		20.000	0.833	0.727	10.00%	1.351	0.00%		10.00%	1.456
25.000	0.798		25.000	0.740	0.667	28.00%	0.822	0.00%		10.18%	1.446
30.000	0.748		30.000			46.00%	0.662	0.00%		16.73%	1.081
40.000	0.628		40.000			64.00%	0.520	0.00%		23.27%	0.833
50.000	0.618		50.000	0.510	0.520	82.00%	0.549	0.00%		29.82%	0.750
60.000	0.633		60.000			100.00%	0.605	10.00%	0.907	42.73%	0.625
70.000	0.653		70.000			100.00%	0.605	16.00%	0.799	46.55%	0.622
75.000	0.668		75.000	0.527	0.508	100.00%	0.605	26.00%	0.661	52.91%	0.622
80.000	0.683		80.000								
90.000	0.713		90.000					ch1	ch2		
100.000	0.748		100.000	0.605	0.540						
							57	10.00%	0.00%	3.64%	
							62	28.00%	0.00%	10.18%	
							67	46.00%	0.00%	16.73%	
							72	64.00%	0.00%	23.27%	
							77	82.00%	0.00%	29.82%	
							82	100.00%	10.00%	42.73%	
							87	100.00%	16.00%	46.55%	
							92	100.00%	26.00%	52.91%	

WYEC-Clz Site 4954

Total		Month														
		1	2	3	4	5	6	7	8	9	10	11	12	Total	In use april thru Nov	
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	32	2	0	0	0	0	0	0	0	0	0	0	5	7	0	
	37	31	6	5	0	0	0	0	0	0	0	10	55	107	10	
	42	130	44	43	26	4	0	0	0	0	1	33	118	399	64	
	47	183	157	124	109	55	5	1	0	1	35	121	150	941	327	
	52	209	194	232	225	244	133	91	61	57	101	171	226	1944	1083	
	57	155	212	185	161	174	230	260	267	194	225	232	166	2461	1743	
	62	29	39	114	121	145	154	144	176	208	200	106	21	1457	1254	1254
	67	5	17	34	50	69	101	136	122	113	92	31	3	773	714	714
	72	0	3	7	18	27	61	74	79	77	48	15	0	409	399	399
	77	0	0	0	9	14	25	29	33	42	22	1	0	175	175	175
	82	0	0	0	1	6	8	7	5	17	14	0	0	58	58	58
	87	0	0	0	0	6	3	2	1	10	6	0	0	28	28	28
	92	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1
	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

2629 at 62 deg < act. Weather hrs

01-08		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	2	0	0	0	0	0	0	0	0	0	0	5	7
	37	30	6	5	0	0	0	0	0	0	0	8	43	92
	42	80	40	40	26	2	0	0	0	0	1	31	74	294
	47	70	107	88	81	46	5	1	0	1	35	86	64	584
	52	46	50	81	120	156	93	72	52	55	81	68	50	924
	57	20	20	27	13	43	104	158	164	126	113	44	12	844
	62	0	1	7	0	1	36	14	32	49	15	3	0	158
	67	0	0	0	0	0	1	3	0	7	3	0	0	14
	72	0	0	0	0	0	1	0	0	2	0	0	0	3
	77	0	0	0	0	0	0	0	0	0	0	0	0	0
	82	0	0	0	0	0	0	0	0	0	0	0	0	0
	87	0	0	0	0	0	0	0	0	0	0	0	0	0
	92	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

09-16		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	0	0	0	0	0	0	0	0	0	0	0	1	1
	42	10	1	1	0	0	0	0	0	0	0	0	9	21
	47	43	9	14	1	0	0	0	0	0	0	5	35	107
	52	73	60	68	22	10	1	0	0	0	0	19	81	334
	57	97	109	77	66	40	19	7	9	6	29	93	100	652
	62	20	28	59	91	96	57	48	52	53	90	78	19	691
	67	5	14	23	37	57	78	93	81	59	59	30	3	539
	72	0	3	6	14	22	53	65	68	59	35	14	0	339
	77	0	0	0	8	12	22	26	32	36	17	1	0	154
	82	0	0	0	1	5	7	7	5	17	12	0	0	54
	87	0	0	0	0	6	3	2	1	9	6	0	0	27
	92	0	0	0	0	0	0	0	0	1	0	0	0	1
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

17-24		Month												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Temperatu	22	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	1	0	0	0	0	0	0	0	0	0	2	11	14
	42	40	3	2	0	2	0	0	0	0	0	2	35	84
	47	70	41	22	27	9	0	0	0	0	0	30	51	250
	52	90	84	83	83	78	39	19	9	2	20	84	95	686
	57	38	83	81	82	91	107	95	94	62	83	95	54	965
	62	9	10	48	30	48	61	82	92	106	95	25	2	608
	67	0	3	11	13	12	22	40	41	47	30	1	0	220
	72	0	0	1	4	5	7	9	11	16	13	1	0	67
	77	0	0	0	1	2	3	3	1	6	5	0	0	21
	82	0	0	0	0	1	1	0	0	0	2	0	0	4
	87	0	0	0	0	0	0	0	0	1	0	0	0	1
	92	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment 2

Standard HVAC Algorithm Review

Setback Programmable Thermostats

Measure Description:	Installation of setback programmable thermostats in spaces with regular occupied and unoccupied periods.
Summary of Advice Filing Calculations:	A bin analysis method was employed to create per thermostat energy and therm impacts. Demand impacts were not calculated, as setback thermostats do not affect peak demand.
Comments on Advice Filing Calculations:	Program review has shown that the per-unit impacts were applied to each participant with the assumption that each thermostat controlled the conditioning of 5,000 sq ft of office space, regardless of building size or type. These impacts were not adjusted to account for different climate zones.
Comments on Advice Filing Inputs:	Incorrect return air values were used to determine the heating and cooling loads during setback hours. Weather data was for San Jose, and thus only represented one climate zone.
Evaluation Process:	Energy and therm impacts were developed using modified return air values during setback hours and binned weather data from all 16 California climate zones. A conditioned square footage value was developed for each participant using MDSS, survey, and audit data. Climate zone-specific impacts (leveraged by square footage) were then applied.
Additional Notes:	If the ex ante assumptions for a given premise indicated only energy impacts, then no therm impact was developed.

Setback Programmable Thermostat:

1) Installs setback programmable thermostats in spaces with regular occupied and unoccupied periods.

2) Assumptions used in Advice Filing:

Office hours = 07:00-18:00 M-F
Occupied Hours = 11 hr/day x 5 day/week x 52.14 week/yr
= 2,868
= Listed as 2,870 hr/year
AC size = 10 tons (120,000 Btu)
AC Efficiency = 1.3 kW/ton with out fans
EER = 9.23 Btu/Watt (calculated in spreadsheet "Window Film AF")
Area serviced/ton = 500 sqft/ton
Heating size = 250 kBtu/hr
Heating efficiency = 70%
Area served = 50 Btu/hr-sqft
Total cfm = 5,000
Fan hp = 3
Outside Supply Air = 20%
Location = San Jose, ASHRAE bin weather data

A bin analysis method is used, where:
OSA = outside air temp (F)
Bin = hours per year that temp is in a given range (hr/yr)
% OSA = percent outside air (fixed at 20%)
Ret Air = return air temp (F)
Mix Air = mixed air temperature
= (% OSA x OSA) + [(1 - % OSA) x Ret Air]
67 F = temp at which system switches from cooling to heating
SAT = supply air temp (F)
SAT (cooling) = 67 F + {[67 F - OSA)/5] x 2}
SAT (heating) = 67 F + {[67 F - OSA)/5] x 3}
Heating Loads (kBtu/yr) = [SAT - Mix Air (F)] x Bin (hr/yr) x (1.085 Btu/hr-F-CFM) x Air Flow (CFM)
Cooling Loads (kBtu/yr) = [Mix Air - SAT (F)] x Bin (hr/yr) x (1.085 Btu/hr-F-CFM) x Air Flow (CFM)

Sample Heating and Cooling Load Calculations for San Jose

Outside Air (F)	Total Bin (hr/yr)	% OSA	Return Air (F)	Mixed Air (F)	Supply Air (F)	Cooling (kBtu/yr)	Heating (kBtu/yr)
92	6	20%	74	77.6	57	671	0
87	24	20%	74	76.6	59	2,292	0
82	84	20%	74	75.6	61	6,653	0
77	207	20%	74	74.6	63	13,027	0
72	535	20%	74	73.6	65	24,960	0
67	1,077	20%	74	72.6	67	32,719	0
62	1,756	20%	74	71.6	70	15,242	0
57	1,977	20%	74	70.6	73	0	25,741
52	1,545	20%	74	69.6	76	0	53,642
47	935	20%	74	68.6	79	0	52,753
42	451	20%	74	67.6	82	0	35,232
37	138	20%	74	66.6	85	0	13,775
32	24	20%	74	65.6	88	0	2,916
27	1	20%	74	64.6	91	0	143
Total	8,760				Total	95,564	184,203

Recreated from Advice Filing p.AC-32 (Thermostat Set-back)

Baseline Energy Usage:

Cooing = Cooling Loads (kBtu/yr) x (1 ton-hr/12 kBtu) x 1.3 kW/ton
= 95,564 kBtu/yr x (1 ton-hr/12 kBtu) x 1.3 kW/ton
= 10,353
= 10,353 kWh/yr for San Jose

Heating = Heating Loads (kBtu/yr) x (1 therm/100 kBtu) x 1/Efficiency
= 184,203 kBtu/yr x (1 therm/100 kBtu) x 1/70%
= 2,631
= 2,631 therm/yr for San Jose

Revised Energy Use 7:00AM - 6:00PM

Sample Heating and Cooling Load Calculations for San Jose

Outside Air (F)	Total Bin (hr/yr)	% OSA	Return Air (F)	Mixed Air (F)	Supply Air (F)	Cooling (kBtu/yr)	Heating (kBtu/yr)
92	4	20%	74	77.6	57	447	0
87	16	20%	74	76.6	59	1,528	0
82	53	20%	74	75.6	61	4,198	0
77	122	20%	74	74.6	63	7,677	0
72	293	20%	74	73.6	65	13,670	0
67	516	20%	74	72.6	67	15,676	0
62	608	20%	74	71.6	70	5,277	0
57	563	20%	74	70.6	73	0	7,330
52	395	20%	74	69.6	76	0	13,714
47	200	20%	74	68.6	79	0	11,284
42	78	20%	74	67.6	82	0	6,093
37	19	20%	74	66.6	85	0	1,897
32	3	20%	74	65.6	88	0	365
27	0	20%	74	64.6	91	0	0
Total	2,870				Total	48,473	40,683

Recreated from Advice Filing p.AC-32 (Thermostat Set-back)
Advice Filing lists total bin as 2,879 hours, but calculations do not support this.

Business Hours Energy Usage:

Cooling = Cooling Loads (kBtu/yr) x (1 ton-hr/12 kBtu) x 1.3 kW/ton

= 48,473 kBtu/yr x (1 ton-hr/12 kBtu) x 1.3 kW/ton
= 5,251
= 5,251 kWh/yr for San Jose

Heating = Heating Loads (kBtu/yr) x (1 therm/100 kBtu) x 1/Efficiency
= 40,683 kBtu/yr x (1 therm/100 kBtu) x 1/70%
= 581
= 581 therm/yr for San Jose

Revised Energy Use 7:00PM - 6:00AM

Sample Heating and Cooling Load Calculations for San Jose							
Outside Air (F)	Total Bin (hr/yr)	% OSA	Return Air (F)	Mixed Air (F)	Supply Air (F)	Cooling (kBtu/yr)	Heating (kBtu/yr)
92	2	20%	74	77.6	62.0	169	0
87	8	20%	74	76.6	64.0	547	0
82	31	20%	74	75.6	66.0	1,614	0
77	85	20%	74	74.6	68.0	3,043	0
72	242	20%	74	73.6	73.6	0	0
67	561	20%	74	72.6	72.6	0	0
62	1,148	20%	74	71.6	71.6	0	0
57	1,414	20%	74	70.6	70.6	0	0
52	1,150	20%	74	69.6	71.0	0	8,734
47	735	20%	74	68.6	74.0	0	21,532
42	373	20%	74	67.6	77.0	0	19,021
37	119	20%	74	66.6	80.0	0	8,651
32	21	20%	74	65.6	83.0	0	1,982
27	1	20%	74	64.6	86.0	0	116
Total	5,890				Total	5,374	60,036

Recreated from Advice Filing p.AC-33 (Thermostat Set-back)

Setback Energy Usage:

Cooling = Cooling Loads (kBtu/yr) x (1 ton-hr/12 kBtu) x 1.3 kW/ton
= 5,374 kBtu/yr x (1 ton-hr/12 kBtu) x 1.3 kW/ton
= 582
= 582 kWh/yr for San Jose

Heating = Heating Loads (kBtu/yr) x (1 therm/100 kBtu) x 1/Efficiency
= 60,036 kBtu/yr x (1 therm/100 kBtu) x 1/70%
= 858
= 858 therm/yr for San Jose

Additional warm-up/cool-down loads:

Cooling = 19 F x (1hr/day x 3 mo/yr x 22 day/mo) x 1.085 Btu/cfm-deg-hr x 5,000 cfm
= 6,802,950
= 6,803 kBtu/yr

Heating = 11 F x (1hr/day x 3 mo/yr x 22 day/mo) x 1.085 Btu/cfm-deg-hr x 5,000 cfm
= 3,938,550
= 3,939 kBtu/yr

Total Retrofit Energy Use:

Cooling = 48,473 kBtu/yr + 5,373 kBtu/yr +3,939 kBtu/yr
= 57,785
Adjust to kWh = 57,785 kBtu/yr x (1 ton/12,000 Btu) x (1,000 Btu/kBtu)
= 4,815
= 4,815 ton/yr x 1.3 kW/ton
= 6,260
= 6,260 kWh/yr

Heating = 40,683 kBtu/yr + 60,036 kBtu/yr + 6,803 kBtu/yr
= 107,522
Adjust to Therm = 107,522 kBtu/yr x (1 therm/100,000 Btu) x (1,000 Btu/kBtu)
= 1,075
= 1,075 therm/yr x (1/70%)
= 1,536
= 1,536 therm/yr

Energy Savings:

Cooling = 10,353 kWh/yr - 6,260 kWh/yr
= 4,093
= 4,093 kWh/yr for a 10 ton unit — According to Advice Filing p. AC-33

Heating = 2,631 therms/yr - 1,536 therms/yr
= 1,095
= 1,095 therms/yr for a 250 kBtuh unit — According to Advice Filing p. AC-33

4) Evaluation Estimates:

For Baseline and Business Hours energy usage, see advice filing.

Revised Energy Use 7:00PM - 6:00AM

Sample Heating and Cooling Load Calculations for San Jose							
Outside Air (F)	Total Bin (hr/yr)	% OSA	Return Air (F)	Mixed Air (F)	Supply Air (F)	Cooling (kBtu/yr)	Heating (kBtu/yr)
92	2	20%	85	86.4	82.2	46	0
87	8	20%	85	85.4	84.2	52	0
82	31	20%	85	84.4	86.2	0	0
77	85	20%	85	83.4	88.2	0	0
72	242	20%	85	82.4	90.2	0	0
67	561	20%	85	81.4	92.2	0	0
62	1,148	20%	85	80.4	94.2	0	0
57	1,414	20%	85	79.4	101.8	0	0

52	1,150	20%	55	54.4	56.8	0	14,973
47	735	20%	55	53.4	59.8	0	25,519
42	373	20%	55	52.4	62.8	0	21,045
37	119	20%	55	51.4	65.8	0	9,296
32	21	20%	55	50.4	68.8	0	2,096
27	1	20%	55	49.4	71.8	0	122
Total	5,890				Total	98	73,051

Recreated from Advice Filing p.AC-33 (Thermostat Set-back)

Setback Energy Usage:
Cooling = Cooling Loads (kBtu/yr) x (1 ton-hr/12 kBtu) x 1.3 kW/ton
= 5,374 kBtu/yr x (1 ton-hr/12 kBtu) x 1.3 kW/ton
= 11
= 11 kWh/yr

Heating = Heating Loads (kBtu/yr) x (1 ton-hr/100 kBtu) x 1/Efficiency
= 60,036 kBtu/yr x (1 therm/100 kBtu) x 1/70%
= 1,044
= 1,044 therms/yr

Total Retrofit Energy Use:
Assume same "ramping" used in the Advice Filing.
Cooling = 48,473 kBtu/yr + 98 kBtu/yr +3,939 kBtu/yr
= 52,510
Adjust to kWh = 52510 kBtu/yr x (1 ton/12,000 Btu) x (1,000 Btu/kBtu)
= 4,376
= 4,376 ton/yr x 1.3 kW/ton
= 5,689
= 5,689 kWh/yr

Heating = 40,683 kBtu/yr + 73,051 kBtu/yr + 6,803 kBtu/yr
= 120,537
Adjust to Therm = 120,573 kBtu/yr x (1 therm/100,000 Btu) x (1,000 Btu/kBtu)
= 1,205
= 1,205 therm/yr x (1/70%)
= 1,722
= 1,722 therm/yr

Energy Savings:
Cooling = 10,353 kWh/yr - 5,689 kWh/yr
= 4,664
= 4,664 kWh/yr for a 10 ton unit

Heating = 2,631 therms/yr - 1,722 therms/yr
= 909
= 909 therms/yr for a 250 kBtuh unit

5) Summary of Results:

Impact Type (per 10-ton unit)	Impact		Recommended Source
	Advice Filing	Evaluation	
NC Demand (kW)	-	-	
Coinc. Demand (kW)	-	-	
Annual Energy (kWh)	4,093	4,664	Evaluation

Climate Zone Specific Impacts:

Climate Zone	kWh/ton
CZ_1	73.4
CZ_2	546.9
CZ_3	253.3
CZ_4	559.6
CZ_5	305.9
CZ_6	597.9
CZ_7	764.2
CZ_8	844.2
CZ_9	942.2
CZ_10	1059.4
CZ_11	1043.7
CZ_12	736.6
CZ_13	1366.5
CZ_14	1307.2
CZ_15	2435.2
CZ_16	489.2

6) Adjust Energy Impacts by Conditioned Area:

Advice Filing Assumptions:
Cooling Energy Savings = 4,664 kWh/yr for a 10 ton unit
= 466.4 kWh/yr-ton
Heating Energy Savings = 909 therms/yr for a 250 kBtuh unit
= 3.636 therms/yr-kBtuh

AC Sizing = 1 ton/500 sqft — According to Advice Filing p. AC-31

Furnace Sizing = 50 Btuh/sqft — According to Advice Filing p. AC-31

Evaluation Energy Estimate:
Cooling = (Conditioned Area) x (1 ton/500 sqft) x 466.4 kWh/yr-ton

Heating = (Conditioned Area) x (50 Btuh/sqft) x (3.636 therms/yr-kBtuh) x (1 kBtuh/1,000 Btuh)

Package Terminal AC Units

Measure Description:	Installation of high efficiency packaged terminal air-conditioners and heat-pumps. This measure provides an incentive to install PTAC and PTHP units that exceed Title20 standards.
Summary of Advice Filing Calculations:	Demand and energy impacts were developed using equivalent full load hours (ELFHs), coincident demand factors (CDFs), and system efficiency.
Comments on Advice Filing Calculations:	Calculation methods cited in the Advice Filing do not accurately model participant specific retrofits. This is due to a generalized assumption regarding typical efficiency and capacity upgrades.
Comments on Advice Filing Inputs:	Sufficient data are not available to verify either the CDF or the EFLH values used in the calculation. ELFHs do not take climate zone variation into account.
Evaluation Process:	Using the change in EER for each site (based upon the MDSS), a revised equation was used in conjunction with Advice Filing EFLH and CDF values, to estimate per participant impacts.
Additional Notes:	

Package Terminal AC

1) **Install high efficiency PTAC and PTHP.**
Units must exceed Title 20 standards.

2) **Ex-ante Assumptions Used in Calculations:**

Equivalent Full Load Cooling Hours

Market Segment	Hours/Year
Schools K-12	500
Hotel/Motel	700
Grocery	600
College	1,200
Warehouse	300
Office	1,000
Hospitals	1,900
Other	1,200
Retail	800
Restaurant	1,300
Process Industry	800
Assembly Industry	2,100

Advice Filing, Table 1, p. AC-4

EER = 10.0 - (0.16 x Capacity Btuh)

3) **Advice Filing Estimates:**

Demand Savings:

Measure Demand Savings = kW Title 20 - kW High Efficiency Unit, according to Advice Filing, p. AC-17

kW = 12 x tons/EER according to Advice Filing, p. AC-17

Measure Demand Savings

Tons	Title 20 EER	Title 20 kW	igh Efficiency EER	High Efficiency kW	Demand Savings kW	Demand Savings kW/ton-EER
0.6	8.9	0.809	9.5	0.758	0.051	0.142
0.8	8.6	1.116	9.6	1.000	0.116	0.145
1	8.0	1.500	9.1	1.319	0.181	0.165
1.3	7.6	2.053	9.1	1.714	0.338	0.174
					Average =	0.156

Advice Filing p. AC-17

Advice Filing lists 0.157, the diff. is due to rounding

Coincident Demand Savings = Measure Demand Savings x 0.75 CDF
= 0.156 kW/ton-EER x 0.75 CDF
= 0.117
= 0.117 kW/ton-EER   Advice Filing lists 0.118, the diff. is due to rounding

Energy Savings:

Annual Energy Savings = Measure Demand Savings x EFLCH
= 0.156 kW/ton-EER x EFLCH

Coincident Energy Savings

Market Segment	Hours/Year	Annual Energy Savings kWh/ton-EER
Schools K-12	500	78
Hotel/Motel	700	109
Grocery	600	94
College	1,200	187
Warehouse	300	47
Office	1,000	156
Hospitals	1,900	296
Other	1,200	187
Retail	800	125
Restaurant	1,300	203
Process Industry	800	125
Assembly Industry	2,100	328

Advice Filing, p. AC-18

Values are slightly different than Advice Filing, due to using 0.156 kW/ton-EER as opposed to 0.157 kW/ton-EER

4) Evaluation Estimates:

Demand Savings:

EER is not linear.

For this reason, calculating an impact using the unit kW/ton-EER is only valid for a very small range of EER values.

Demand estimates are developed at a per unit basis.

Demand Savings = (Capacity, Btuh) x (1/EERtitle20 - 1/EERretrofit) x (1kW/1,000 Watts)

Coincident Demand Savings = Demand Savings x CDF

CDF = varies by climate zone and business type (0.75 used in sample calculations)

Tons	Capacity Btuh	Title 20 EER	igh Efficiency EER	Demand Savings kW	Coincident Demand Savings kW
0.6	7,200	8.9	9.5	0.051	0.038
0.8	9,600	8.6	9.6	0.116	0.087
1	12,000	8.0	9.1	0.181	0.136
1.3	15,600	7.6	9.1	0.338	0.254

Energy Savings:

Energy savings are also determined at a per unit level.

= Measure Demand Savings x EFLCH
= Assume 1 ton unit with 1.1 change in EER
= 0.181 kW/ton x EFLCH

Sample Energy Savings Using 0.181 kW/ton

Market Segment	Hours/Year	Annual Energy Savings kWh
Schools K-12	500	91
Hotel/Motel	700	127
Grocery	600	109
College	1,200	217
Warehouse	300	54
Office	1,000	181
Hospitals	1,900	344
Other	1,200	217
Retail	800	145
Restaurant	1,300	235
Process Industry	800	145
Assembly Industry	2,100	380

Reflective Window Film

Measure Description:	Provides an incentive for the installation of reflective window film on clear non-North facing glazing.
Summary of Advice Filing Calculations:	Cooling loads attributable to solar heat gain were calculated using equation 27.41 of the ASHRAE Fundamentals Handbook (p.27.24). Per square foot energy and demand impacts were estimated for applied reflective film.
Comments on Advice Filing Calculations:	Methods used to determine energy and demand impacts are valid.
Comments on Advice Filing Inputs:	A review of the inputs from ASHRAE revealed a discrepancy between the annual solar heat gains listed in ASHRAE and those used in Advice Filing calculations.
Evaluation Process:	Energy and demand estimates were developed using the correctly applied ASHRAE method.
Additional Notes:	

Reflective Window Film

1) Install reflective film on clear glass, non-North facing exposures.

2) Ex-ante Assumptions Used in Calculations:

Clear glass SC = 0.95 — ASHRAE 1993 Fundamentals p.27.19 table 11
Glass with reflective coating SC = 0.45 — ASHRAE 1993 Fundamentals p.27.36 table 28
Solar data based on ASHRAE 1989 Fundamentals, p.27.10,latitude = 40 degrees
Radiation data multiplied by 75% to account for variations in shading and clearness.
Assume 75% fenestration for vertical surfaces.
Average cooling efficiency = 1.3 kW/ton
Conversion of kW/ton to EER:
= 1/[(1.3 kW/ton) x (1 ton/12 kBtu)]
= 9.23
= 9.23 Btu/W (EER)
Sample Building
Height = 30 ft
Footprint = 100 ft x 100 ft
Building Surface Area = 30,000 sqft
While building surface area is not needed for our analysis, the calculation is wrong.
Evaluation Building Surface Area = (4 x 100 ft x 30 ft) + 100 ft x 100 ft
= 22,000
= 22,000 sqft

Solar Load, South = 309 kBtu/sqft-yr
Solar Load, East-West = 241 kBtu/sqft-yr

3) Advice Filing Estimates:

Energy Savings:

Assume 2,250 sqft of glazing per orientation.

Orientation	Area (sqft)	Solar Load (kBtu/sqft-yr)	Annual Solar Load (kBtu/yr)
South	2,250	309	695,250
East	2,250	241	542,250
West	2,250	241	542,250
Sum	6,750		1,779,750

Advice Filing table, p.AC-35

Baseline Solar Gain = 0.95 SC x 1,779,750 kBtu/yr
= 1,690,763
= 1,690,763 kBtu/yr
Retrofit Solar Gain = 0.45 SC x 1,779,750 kBtu/yr
= 800,888
= 800,888 kBtu/yr
Annual Energy Savings = (1,690,763 kBtu/yr) - 800,888 kBtu/yr
= 889,875
Adjust to kWh = 889,875 kBtu/yr x 1ton/12,000Btu/hr x 1,000 Btu/kBtu
= 74,156
= 74,156 ton-hr/yr x 1.3 kW/ton
= 96,403
= (96,403 kWh/yr)/6,750 sqft
= 14.28
= 14.28 kWh/sqft-yr

Demand Savings:

Advice Filing estimate:

Orientation	Average Peak Gain (Btu/hr-sqft)
East	216
South	33.3
West	25
Total	274.3
Average	91.43

Advice Filing, p.AC-36

Total Average Peak Gain = 274.3 Btu/sqft x 2,250 sqft

Alternate Calculation:
Total Average Peak Gain = 91.43 Btu/hr-yr x 6,750 sqft

= 617,175 = 617,153

Account for Load Time Delay = 617,175 Btu x 0.65 mass coefficient
= 401,164

Adjusted to kW = 401,164 Btu/hr x 1 ton/12,000 Btu/hr x 1.3 kW/ton
= 43.46
= 43 kW

Demand Savings =43 kW/6,750 sqft
= 0.0064
= 0.0064 kW/sqft

This would assume a 100% reduction in solar gains during the peak hour.

4) Evaluation Estimates:

Calculate Baseline Solar Gains Using ASHRAE Fundamentals†:

Month	Half Day SHGF East (Btu/hr-sqft)	Half Day SHGF South (Btu/hr-sqft)	Half Day SHGF West (Btu/hr-sqft)	Daily SHGF East-West Btu/sqft-day	Annual SHGF East-West Btu/sqft-yr	Daily SHGF South Btu/sqft-day	Annual SHGF South Btu/sqft-yr
January	452	813	62	514	15,934	1626	50,406
February	648	821	85	733	20,524	1642	45,976
March	832	694	114	946	29,326	1388	43,028
April	957	488	148	1105	33,150	976	29,280
May	1024	358	176	1200	37,200	716	22,196
June	1038	315	188	1226	36,780	630	18,900
July	1008	352	181	1189	36,859	704	21,824
August	928	474	157	1085	33,635	948	29,388
September	787	672	119	906	27,180	1344	40,320
October	623	791	89	712	22,072	1582	49,042
November	445	798	63	508	15,240	1596	47,880
December	374	775	53	427	13,237	1550	48,050
				Sum = 321,137		Sum = 446,290	

ASHRAE Fundamentals† p.27.23, Table 15

East-West Solar Gain = 321,137 Btu/sqft-yr x .75 shading factor
= 241
= 241 kBtu/sqft-yr

South Solar Gain = 446,290 Btu/sqft-yr x .75 shading factor
= 335
= 335 kBtu/sqft-yr

Advice Filing calculates 309 kBtu/sqft-yr for South solar gain, which is not consistent with the Evaluation estimate.
Application of a 75% shading factor renders this a conservative estimate.
Potential loads on unshaded surfaces could be as high as 100% of those estimated.

Calculate Baseline Peak Solar Gains Using ASHRAE Fundamentals†:

	Peak Hour Solar Gains (Btu/hr-sqft)		
	8:00 AM, 4:00 PM	9:00 AM, 3:00 PM	10:00 AM, 2:00 PM
June (ave)	90.67	89.67	83.00
East	216	192	145
South	29	45	69
West	27	32	35
July (ave)	90.67	92.00	87.33
East	216	193	146
South	30	52	81
West	26	31	35
August (ave)	93.33	101.67	99.33
East	216	197	150
South	41	80	116
West	23	28	32
Average	91.56	94.44	89.89
East	**216**	194	147
South	**33.3**	59	88.7
West	**25.3**	30.3	34

ASHRAE Fundamentals† p.27.23, Table 15

Peak solar gains occur during the 9:00 AM or 3:00 PM hour.
Advice Filing uses values from the 8:00 AM or 4:00 PM hour (in bold).

Energy Savings:
Assume 2,250 sqft of glazing per orientation.

Orientation	Area (sqft)	Solar Load (kBtu/sqft-yr)	Annual Solar Load (kBtu/yr)
South	2,250	335	753,750
East	2,250	241	542,250
West	2,250	241	542,250
Sum	6,750		1,838,250

Advice Filing table, p.AC-35

Baseline Solar Gain = 0.95 SC x 1,838,250 kBtu/yr
= 1,746,338
= 1,746,338 kBtu/yr
Retrofit Solar Gain = 0.45 SC x 1,838,250 kBtu/yr
= 827,213
= 827,213 kBtu/yr
Annual Energy Savings = (1,746,338 kBtu/yr) - 827,213 kBtu/yr
= 919,125
Adjust to kWh = 919,125 kBtu/yr x 1ton/12,000Btu/hr x 1,000 Btu/kBtu
= 76,594
= 76,594 ton-hr/yr x 1.3 kW/ton
= 99,572
= (977,527 kWh/yr)/6,750 sqft
= 14.74
= 14.74 kWh/sqft-yr

Demand Savings:
Baseline Peak Gain = (216 Btu/sqft + 33.3 Btu/sqft +25.3 Btu/sqft) x 2,250 sqft
= 617,850
= 617,850 Btu x 0.95 SC
= 586,958
Adjust for Load Time Delay = 586,958 Btu x 0.65 mass coefficient factor
= 381,522
= 381,522 Btu

Retrofit Peak Gain = 617,850 Btu x 0.45 SC
= 278,033
Adjust for Load Time Delay = 278,033 Btu x 0.65 mass coefficient factor
= 180,721
= 180,721 Btu

Demand Savings = 381,522 Btu - 180,721 Btu
= 200,801
Adjusted to kW/sqft = (200,801 Btu x 1 ton/12,000 Btu/hr x 1.3 kW/ton)/6,750 sqft
= 0.0032
= 0.0032 kW/sqft

Coincident Demand Savings = 0.0032 kW/sqft x 0.75 CDF
= 0.0024
= 0.0024 kW/sqft

5) Summary of Results:

Impact Type (per sqft of film)	Impact: Advice Filing	Impact: Evaluation	Recommended Source
Coinc. Demand (kW)	0.0064	0.0024	Evaluation
Annual Energy (kWh)	14.28	14.74	Evaluation

6) Sources

† ASHRAE Handbook, "Fundamentals"; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. Atlanta, GA, 1993

Direct Evaporative Coolers

Measure Description:	Provides an incentive for the replacement of an existing AC unit with an equally sized direct evaporative cooler system. Measure participation is restricted to certain climate zones.
Summary of Advice Filing Calculations:	Demand and energy savings were developed on a per ton basis for each climate zone using fan operating characteristics, temperature design conditions, and cooling degree hours.
Comments on Advice Filing Calculations:	Calculation methods cited in the Advice Filing do not accurately model participant specific retrofits. In some cases, negative demand and energy savings are calculated.
Comments on Advice Filing Inputs:	The inputs used in the calculations do not account for variations in evaporative cooler fan size.
Evaluation Process:	Demand and energy savings were determined using climate zone-specific cooling degree hours, fan motor horsepower and the efficiency of the existing AC unit. Impacts were developed using motor efficiency values listed in the baseline assumptions for the RE Motors program.
Additional Notes:	

Direct Evaporative Cooler

1) **Replace an existing AC unit with an equally sized direct evaporative cooler.**

2) **Ex-ante calculation assumptions:**

1997 Advice Filing Assumptions
High comfort occupancy has an internal requirement of 76 F, 60% RH.
For a 5 F Δt between entering DB and interior design DB, the outside WB temp must be 64 F or lower.
Low comfort occupancy has an internal requirement of 84 F, 60% RH.
For a 5 F Δt between entering DB and interior design DB, the outside WB temp must be 72 F or lower.
4 hp of fan energy is required to move 12,000 cfm at 0.5 in static pressure.
This is consistent with manufactures' data.
Conventional HVAC system efficiency is 1.3 kW/ton.
To convert from hp to kW use 0.746 kW/hp.
The heat capacity of air is 1.08 Btu/hr-F-cfm.

4) **1997 Advice Filing Estimates:**

The following estimates were developed by PG&E for the 1997 Advice Filing†.

Evaporative Capacity:

Q = cfm x Δt x 1.08 Btu/hr-F-cfm

where:
Q = evaporative capacity (Btu/hr)
cfm = cubic feet per minute
Δt = temperature differential between indoor design conditions and supply air temperature
that can be generated without exceeding the moisture ratio of the design conditions.
= indoor design temp - {DB design temp - [70% effectiveness x (DB design temp - WB design temp)]}

Climate Zone	DB Design temp (F)	WB Design temp (F)	Exit temp from evap.	Evaluation Δt (F)	Advice Filing Δt (F)	Capacity (Btu/hr)	Capacity (tons)
2	90	65	72.5	11.5	11.5	149,040	12.42
4	83	71	74.6	8.0	8.0	103,680	8.64
5	77	65	68.6	15.4	15.4	199,584	16.63
11	96	66	75	9.0	9.0	116,640	9.72
12	93	68	75.5	8.5	8.5	110,160	9.18
13	99	71	79.4	4.6	4.6	59,616	4.97
16	99	63	73.8	10.2	10.2	132,192	11.02

Evaporator Fan Demand:

A 4 hp fan can move 12,000 cfm
= 4 hp x 0.746 kW/hp
= 2.984
= 2.984 kW

Demand Savings:

= baseline demand (kW/ton) - [fan demand (kW)/evaporator capacity (tons)]
= 1.3 kW/ton - 2.984 kW/capacity (tons)

Energy Savings:

= demand savings (kW/ton) x cooling degree hours (CDH)

Climate Zone	emand Savings (kW/ton)	AF Dem. Savings (kW/ton)	CDH (hours)	Energy Savings (kWh/ton)	F Energy Savings (kWh/ton)
2	1.06	1.04	1,003	1,063	1,043
4	0.95	0.93	861	822	801
5	1.12	1.11	493	552	547
11	0.99	0.97	1,729	1,717	1,677
12	0.97	0.95	1,331	1,298	1,264
13	0.70	0.65	2,252	1,575	1,464
16	1.03	1.01	720	741	727

5) **Evaluation Estimates:**

Use method described in the RE Motors program, (Advice Filing, p.MT-8).
Baseline efficiency for a 4 hp motor = 83%, according to Advice Filing p.MT-9
Load factor is assumed to be 75%, according to Advice Filing p.MT-8

Fan Demand:

= kW/hp x hp x 1/eff x % load
= 0.746 kW x 4 hp x (1/83% eff) x 75% load
= 2.696
= 2.696 kW/12,000 cfm

Demand Savings:

= [baseline demand (kW/ton)] - [fan demand (kW)/evaporator capacity (tons)]
= [(1.3 kW/ton)] - 2.696 kW/capacity (tons)

Coincident Demand Savings:

= [baseline demand (kW/ton) x CDF] - [fan demand (kW)/evaporator capacity (tons)]
= [(1.3 kW/ton) x 75%] - 2.696 kW/capacity (tons)

Energy Savings:

= demand savings (kW) x cooling degree hours (CDH)

6) Summary of Results:

Climate Zone	Demand Savings		Coincident Demand Savings		Cooling Degree	Energy Savings	
	Evaluation (kW/ton)	997 Advice Filing (kW/ton)	Evaluation (kW/ton)	997 Advice Filing (kW/ton)	Hours (hours)	Evaluation (kWh/ton)	97 Advice Filing (kWh/ton)
2	1.08	1.04	0.76	0.78	1,003	1,086	1,043
4	0.99	0.93	0.66	0.698	861	851	801
5	1.14	1.11	0.81	0.833	493	561	547
11	1.02	0.97	0.70	0.728	1,729	1,768	1,677
12	1.01	0.95	0.68	0.713	1,331	1,339	1,265
13	0.76	0.65	0.43	0.488	2,252	1,705	1,464
16	1.06	1.01	0.73	0.758	720	760	727

7) Sources

† PG&E, "1997 Customer Energy Efficiency Programs, Advice Letter No. 1978-G/1608-E Workpapers"; pp. AC-23 to AC-25

Bypass Timer

Measure Description:	Installation of a bypass timer to control the fans of a space which is intermittently occupied after hours when the space conditioning system is off.
Summary of Advice Filing Calculations:	Using fan motor horsepower, assumed hours of operation and a fan load/efficiency value, energy savings were developed. No demand savings are estimated since bypass timers do not affect the peak demand.
Comments on Advice Filing Calculations:	The percent a fan is loaded is generally independent from efficiency.
Comments on Advice Filing Inputs:	The fan load/efficiency value is not substantiated with documentation. Assumed hours of operation are poorly documented.
Evaluation Process:	Energy impacts were developed using fan load and motor efficiency values listed in the baseline assumptions for RE HVAC measures and the RE Motors program, respectively.
Additional Notes:	

Bypass Timer

1) **Install a bypass timer for a zone intermittently occupied after hours when conditioning is scheduled off.**
Timer controls the fans of a central AC system.

2) **Ex-ante calculation assumptions:**
Average occupancy of zone is 2 hours per night.
Existing fan power = 1.0 hp.
Fans operate at 80% load/efficiency.
This value appears to be a combination of fan load and fan efficiency.
These two variables are independent of each other, and so should not be combined.
To convert from hp to kW use 0.746 kW/hp.
Baseline assumes fans are on for 11 hours a day, 260 days a year after business hours.
According to the Setback Programmable Thermostat measure, business hours are from 7:00 AM to 6:00 PM (11 hrs).
This implies that the system would be off for 13 hours (24 hr - 11 hr).
Retrofit assumes fans are on for 2 hours a day, 5 days a week after business hours.
Savings associated with the compressor are ignored, as night cooling loads are small due to low occupancy and low ambient temperatures.
Heating savings are not determined.

3) **Advice Filing Estimates:**

Baseline Energy Use:
= 1 hp x 0.746 kW/hp x 80% load/eff x 11 hrs/day x 260 days/yr
= 1,707
= 1,707 kWh/yr
Advice Filing lists 1,797 kWh/yr (AC-78)

Energy Savings:
= 1 hp x 0.746 kW/hp x 80% eff. x (11 - 2 hrs/day) x 260 days/yr
= 1,397
= 1,397 kWh/yr
This is 82% of the baseline. 82%
Advice Filing also lists 82% (p.AC-78) which indicates that the 1,797 kWh/yr value was typed incorrectly.

NC Demand Savings:
= 1 hp x 0.746 kW/hp
= 0.746 kW

Cycle Peak Coincident Demand Savings:
= 0.746 kW x 0.82 x 0.75 CDF
= 0.459
= 0.459 kW
Demand savings is counted towards off-peak and partial-peak savings only, and is not applied to the MDSS.

5) **Evaluation Estimates:**
Use method described in the RE Motors proggram, (Advice Filing, p.MT-8).
Baseline efficiency for a 1 hp motor = 77%, according to Advice Filing p.MT-7
Load factor is assumed to be 80%, according to Advice Filing p.NRR-64

Baseline Energy Use:
= 1 hp x 0.746 kW/hp x (1/77% eff.) x 80% load x 11 hrs/day x 260 days/yr 0.9375
= 2,217
= 2,217 kWh/yr

Energy Savings:
= 1 hp x 0.746 kW/hp x (1/77% eff.) x 80% load x (11 - 2 hrs/day) x 260 days/yr
= 1,814
= 1,814 kWh/yr
This is 82% of the baseline. 82%

NC Demand Savings:
= kW x 1/eff x % load x (impact hours/baseline hours)
= 0.746 kW x (1/77% eff) x 80% load x (9 hrs/11 hrs)
= 0.634
= 0.634 kW

Coincident Demand Savings:
Since fans are assumed to run continuously during the peak period, the coincident demand savings are zero.

6) **Summary of Results:**

Impact Type (per timer)	Impact: Advice Filing	Impact: Evaluation	Recommended Source
Coinc. Demand (kW)	0	0	
Annual Energy (kWh)	1,397	1,814	Evaluation

Timeclock

Measure Description:	Installation of timeclocks, which regulate HVAC usage in spaces with regular occupied and unoccupied periods.
Summary of Advice Filing Calculations:	A bin analysis method was employed to create per timeclock energy impacts. Demand impacts were not calculated, as timeclocks do not affect peak demand.
Comments on Advice Filing Calculations:	Program review has shown that the per-unit impacts were applied to each participant with the assumption that each timeclock controlled the conditioning of 5,000 sq ft of office space, regardless of building size or type. These impacts were not adjusted to account for different climate zones.
Comments on Advice Filing Inputs:	Weather data was for San Jose, and thus only represented one climate zone.
Evaluation Process:	Energy and therm impacts were developed using modified return air values during setback hours and binned weather data from all 16 California climate zones. A conditioned square footage value was developed for each participant using MDSS data. Climate zone-specific impacts (leveraged by square footage) were then applied.
Additional Notes:	If the ex ante assumptions for a given premise indicated only energy impacts, then no therm impact was developed.

Timeclock - Electronic:

1) Installs electronic timeclocks in spaces with regular occupied and unoccupied periods.

2) Assumptions used in Advice Filing:

Office hours = 07:00-18:00 M-F
Occupied Hours = 11 hr/day x 5 day/week x 52.14 week/yr
= 2,868
= Listed as 2,870 hr/year
AC size = 10 tons (120,000 Btu)
AC Efficiency = 1.3 kW/ton with out fans
EER = 9.23 Btu/Watt (calculated in spreadsheet "Window Film AF")
Area serviced/ton = 500 sqft/ton
Heating size = 250 kBtu/hr
Heating efficiency = 70%
Area served = 50 Btu/hr-sqft
Total cfm = 5,000
Fan hp = 3
Outside Supply Air = 20%
Location = San Jose, ASHRAE bin weather data

A bin analysis method is used, where:
OSA = outside air temp (F)
Bin = hours per year that temp is in a given range (hr/yr)
% OSA = percent outside air (fixed at 20%)
Ret Air = return air temp (F)
Mix Air = mixed air temperature
= (% OSA x OSA) + [(1 - % OSA) x Ret Air]
67 F = temp at which system switches from cooling to heating
SAT = supply air temp (F)
SAT (cooling) = 67 F + {[67 F - OSA)/5] x 2}
SAT (heating) = 67 F + {[67 F - OSA)/5] x 3}
Heating Loads (kBtu/yr) = [SAT - Mix Air (F)] x Bin (hr/yr) x (1.085 Btu/hr-F-CFM) x Air Flow (CFM)
Cooling Loads (kBtu/yr) = [Mix Air - SAT (F)] x Bin (hr/yr) x (1.085 Btu/hr-F-CFM) x Air Flow (CFM)

Sample Heating and Cooling Load Calculations for San Jose

Outside Air (F)	Total Bin (hr/yr)	% OSA	Return Air (F)	Mixed Air (F)	Supply Air (F)	Cooling (kBtu/yr)	Heating (kBtu/yr)
92	6	20%	74	77.6	57	671	0
87	24	20%	74	76.6	59	2,292	0
82	84	20%	74	75.6	61	6,653	0
77	207	20%	74	74.6	63	13,027	0
72	535	20%	74	73.6	65	24,960	0
67	1,077	20%	74	72.6	67	32,719	0
62	1,756	20%	74	71.6	70	15,242	0
57	1,977	20%	74	70.6	73	0	25,741
52	1,545	20%	74	69.6	76	0	53,642
47	935	20%	74	68.6	79	0	52,753
42	451	20%	74	67.6	82	0	35,232
37	138	20%	74	66.6	85	0	13,775
32	24	20%	74	65.6	88	0	2,916
27	1	20%	74	64.6	91	0	143
Total	8,760				Total	95,564	184,203

Recreated from Advice Filing p.AC-28 (Thermostat Set-back)

Baseline Energy Usage:

Cooing = Cooling Loads (kBtu/yr) x (1 ton-hr/12 kBtu) x 1.3 kW/ton
= 95,564 kBtu/yr x (1 ton-hr/12 kBtu) x 1.3 kW/ton
= 10,353
= 10,353 kWh/yr for San Jose

Heating = Heating Loads (kBtu/yr) x (1 therm/100 kBtu) x 1/Efficiency
= 184,203 kBtu/yr x (1 therm/100 kBtu) x 1/70%
= 2,631
= 2,631 therm/yr for San Jose

Revised Energy Use 7:00AM - 6:00PM

Sample Heating and Cooling Load Calculations for San Jose

Outside Air (F)	Total Bin (hr/yr)	% OSA	Return Air (F)	Mixed Air (F)	Supply Air (F)	Cooling (kBtu/yr)	Heating (kBtu/yr)
92	4	20%	74	77.6	57	447	0
87	16	20%	74	76.6	59	1,528	0
82	53	20%	74	75.6	61	4,198	0
77	122	20%	74	74.6	63	7,677	0
72	293	20%	74	73.6	65	13,670	0
67	516	20%	74	72.6	67	15,676	0
62	608	20%	74	71.6	70	5,277	0
57	563	20%	74	70.6	73	0	7,330
52	395	20%	74	69.6	76	0	13,714
47	200	20%	74	68.6	79	0	11,284
42	78	20%	74	67.6	82	0	6,093
37	19	20%	74	66.6	85	0	1,897
32	3	20%	74	65.6	88	0	365
27	0	20%	74	64.6	91	0	0
Total	2,870				Total	48,473	40,683

Advice Filing lists total bin as 2,879 hours, but calculations do not support this.

Recreated from Advice Filing p.AC-29 (Thermostat Set-back)

Business Hours Energy Usage:

Cooling =	Cooling Loads (kBtu/yr) x (1 ton-hr/12 kBtu) x 1.3 kW/ton
=	48,473 kBtu/yr x (1 ton-hr/12 kBtu) x 1.3 kW/ton
=	5,251
=	5,251 kWh/yr for San Jose
Heating =	Heating Loads (kBtu/yr) x (1 therm/100 kBtu) x 1/Efficiency
=	40,683 kBtu/yr x (1 therm/100 kBtu) x 1/70%
=	581
=	581 therm/yr for San Jose

Additional warm-up/cool-down loads:

Cooling =	16 F x (1.5 hr/day x 3 mo/yr x 22 day/mo) x 1.085 Btu/cfm-deg-hr x 5,000 cfm
=	8,593,200
=	8,593 kBtu/yr
Heating =	24 F x (1.5 hr/day x 3 mo/yr x 22 day/mo) x 1.085 Btu/cfm-deg-hr x 5,000 cfm
=	12,889,800
=	12,890 kBtu/yr

Total Retrofit Energy Use:

Cooling =	48,473 kBtu/yr + 8,593 kBtu/yr
=	57,066
Adjust to kWh =	57,066 kBtu/yr x (1 ton/12,000 Btu) x (1,000 Btu/kBtu)
=	4,756
=	4,756 ton/yr x 1.3 kW/ton
=	6,182
=	6,182 kWh/yr
Heating =	40,683 kBtu/yr + 12,890 kBtu/yr
=	53,573
Adjust to Therm =	53,573 kBtu/yr x (1 therm/100,000 Btu) x (1,000 Btu/kBtu)
=	536
=	536 therm/yr x (1/70%)
=	765
=	765 therm/yr

Energy Savings:

Cooling =	10,353 kWh/yr - 6,221 kWh/yr	
=	4,171	
=	4,171 kWh/yr for a 10 ton unit	According to Advice Filing p. AC-30
Heating =	2,631 therms/yr - 765 therms/yr	
=	1,866	
=	1,866 therms/yr for a 250 kBtuh unit	According to Advice Filing p. AC-30

4) Evaluation Estimates:

See Advice Filing estimates for example using San Jose weather.
Impacts developed for all climate zones.

5) Summary of Results:

Impact Type (per 10-ton unit)	Impact		Recommended
	Advice Filing	Evaluation	Source
NC Demand (kW)	-	-	
Coinc. Demand (kW)	-	-	
Annual Energy (kWh)	4,171	4,171	Evaluation

Climate Zone Specific Impacts:

Climate Zone	kWh/ton
CZ_1	22.9
CZ_2	523.4
CZ_3	202.9
CZ_4	514.7
CZ_5	255.7
CZ_6	547.6
CZ_7	714.4
CZ_8	807.3
CZ_9	913.1
CZ_10	1071.0
CZ_11	1060.5
CZ_12	722.5
CZ_13	1407.9
CZ_14	1364.6
CZ_15	2731.7
CZ_16	460.1

6) Adjust Energy Impacts by Conditioned Area:

Advice Filing Assumptions:

Cooling Energy Savings = 4,171 kWh/yr for a 10 ton unit
= 417.1 kWh/yr-ton
Heating Energy Savings = 1,866 therms/yr for a 250 kBtuh unit
= 7.464 therms/yr-kBtuh

AC Sizing = 1 ton/500 sqft — According to Advice Filing p. AC-28

Furnace Sizing = 50 Btuh/sqft — According to Advice Filing p. AC-28

Evaluation Energy Estimate:

Cooling = (Conditioned Area) x (1 ton/500 sqft) x 417.1 kWh/yr-ton

Heating = (Conditioned Area) x (50 Btuh/sqft) x (7.464 therms/yr-kBtuh) x (1 kBtuh/1,000 Btuh)

Water and Evaporative Cooled Single Package AC Unit

(135,000 Btu/hr)

Remote Condensing Unit (RCU); Air-Cooled

(135,000 Btu/hr)

Remote Condensing Unit (RCU); Water- and Evaporative- Cooled (135,000 Btu/hr)

Measure Description:	All three measures involve the replacement of an existing standard-efficiency AC unit with a high-efficiency unit that exceeds Title20 specifications.
Summary of Advice Filing Calculations:	Demand and energy impacts were developed using equivalent full load hours (ELFHs), coincident demand factors (CDFs), and system efficiency.
Comments on Advice Filing Calculations:	Calculation methods cited in the Advice Filing do not accurately model participant specific retrofits. This is due to a generalized assumption regarding typical efficiency and capacity upgrades.
Comments on Advice Filing Inputs:	Baseline efficiencies are consistent with Title20 standards. Sufficient data are not available to verify either the CDF or the EFLH values used in the calculation. ELFHs do not take climate zone variation into account.
Evaluation Process:	Using the change in EER for each site (based upon the MDSS), a revised equation was used in conjunction with EFLHs (developed as part of the evaluation of the RE Central AC measures), to estimate per participant impacts.

Water and Evaporative Cooled Single-Package AC Unit
Remote Condensing Unit (RCU); Air-Cooled
Remote Condensing Unit (RCU); Water and Evaporative Cooled

1) Installation of high-efficiency AC units using the different technologies described.
Units must exceed Title 20 standards.

2) Ex-ante Assumptions Used in Calculations:
Baseline Title20 Efficiencies:
Evap Single-Package AC = 9.6 EER
RCU Air-cooled = 9.9 EER
RCU Evap-cooled = 12.9 EER
These values were verified using CEC documentation.

Equivalent Full Load Cooling Hours

Market Segment	Hours/Year
Schools K-12	500
Hotel/Motel	700
Grocery	600
College	1,200
Warehouse	300
Office	1,000
Hospitals	1,900
Other	1,200
Retail	800
Restaurant	1,300
Process Industry	800
Assembly Industry	2,100

Advice Filing, Table 1, p. AC-3

3) Advice Filing Estimates:

Demand Savings:
Measure Demand Savings = kW Title 20 - kW High Efficiency Unit, according to Advice Filing, p. AC-15

kW = (12,000 Btuh/ton) x (1kW/1,000Watt) x (tons/EER Btuh/Watt) according to Advice Filing, p. AC-15
Coincident Demand Savings = Measure Demand Savings x 0.75 CDF

Demand Savings

Program	Tons	Title 20 EER	Title 20 kW	High Efficiency EER	High Efficiency kW	Demand Savings kW	Demand Savings kW/ton-EER	Coinc kW Savings kW/ton-EER
Evap. Cooled SPAC	80	9.6	100.000	10.5	91.429	8.571	0.119	
	80	9.6	100.000	11.5	83.478	16.522	0.109	
						Average	**0.114**	**0.085**
Air-Cooled RCU	30	9.9	36.364	10.2	35.294	1.070	0.119	
	60	9.9	72.727	10.5	68.571	4.156	0.115	
						Average	**0.117**	**0.088**
Evap-Cooled RCU	80	12.9	74.419	13.5	71.111	3.307	0.069	
	120	12.9	111.628	14	102.857	8.771	0.066	
						Average	**0.068**	**0.051**

Advice Filing p. AC-15-22
Values may vary slightly due to rounding.

Energy Savings:
Annual Energy Savings = Measure Demand Savings x EFLCH

Coincident Energy Savings

Market Segment	Hours/Year	Evap. Cooled SPAC Annual Energy Savings kWh/ton-EER	Air-Cooled RCU Annual Energy Savings kWh/ton-EER	Evap-Cooled RCU Annual Energy Savings kWh/ton-EER
Schools K-12	500	57	59	34
Hotel/Motel	700	80	82	47
Grocery	600	68	70	41
College	1,200	137	141	81
Warehouse	300	34	35	20
Office	1,000	114	117	68
Hospitals	1,900	216	223	129
Other	1,200	137	141	81
Retail	800	91	94	54
Restaurant	1,300	148	152	88
Process Industry	800	91	94	54
Assembly Industry	2,100	239	246	142

Advice Filing p. AC-15-22
Values may vary slightly due to rounding.

4) Evaluation Estimates:

Demand Savings:

EER is not linear.
For this reason, calculating an impact using the unit kW/ton-EER is only valid for a very small range of EER values.
Demand estimates are developed at a per unit basis.

Demand Savings = (Capacity, Btuh) x (1/EERtitle20 - 1/EERretrofit) x (1kW/1,000 Watts)
Coincident Demand Savings = Demand Savings x CDF
CDF = varies by climate zone and business type

Energy Savings:
Use EFLH's and CDF's developed for the CAC measures for each climate zone.

Energy Savings = Demand Savings x EFLH (climate zone specific)

No efficiency value recorded in the MDSS for the single participant in the RCU Evap-cooled measure.
Using the baseline efficiencies and the kW and kWh impacts, the retrofit efficiency was determined through back-calculations.
Back-calculated Efficiency:

3.723 kW = 0.068 kW/ton- EER x 36.5 tons x (EER - 12.9 EER) x 0.75 CDF
EER = [3.723 kW/(0.068 kW/ton- EER x 36.5 tons x 0.75 CDF)] + 12.9
= 14.9
= 14.9 EER according to kW impacts

3,416.4 kWh = 34 kWh/ton- EER x 36.5 tons x (EER - 12.9 EER)
EER = 15.65
= 15.65 EER according to kWh impacts

Average EER = 15.28

Attachment 3
Results Tables

Attachment 3-1
Commercial HVAC Ex Ante Gross Energy Impacts
By Business Type and Technology Group

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	2,078,099	403,850	146,156	883,773	44,360	492,200	536,922	46,800	57,647	287,932	777,818	139,270	5,894,829
	Adjustable Speed Drives	2,506,402	864,664	44,918	22,459	-	-	112,294	301,322	-	-	71,120	2,246	3,925,424
	Package Terminal A/C	4,500	-	550	2,419	86	18,429	-	454,771	3,937	-	807	1,346	486,845
	Set-Back Thermostat	1,648,348	370,688	325,616	2,110,264	69,177	264,655	272,716	48,831	215,747	454,941	586,124	134,285	6,501,391
	Reflective Window Film	2,873,700	213,663	100,642	22,896	27,002	28,471	118,669	1,140	123,434	374,605	81,210	73,375	4,038,809
	Water Chillers	49,962	-	25,746	-	-	-	311,367	7,794	-	-	37,986	-	432,855
	Other HVAC Technologies	2,074	3,111	-	-	28,502	43,913	-	5,574	-	13,621	33,476	-	130,271
	Retrofit Express Program Total	9,163,086	1,855,976	643,627	3,041,812	169,127	847,668	1,351,967	866,234	400,766	1,131,100	1,588,542	350,520	21,410,424
REO	Adjustable Speed Drives	2,111,770	-	-	-	-	-	-	-	-	-	-	-	2,111,770
	Water Chillers	195,759	246,332	552,057	-	-	-	155,502	-	-	611,031	107,941	-	1,868,622
	Cooling Towers	40,356	-	-	-	-	-	-	-	-	-	27,401	-	67,757
Retrofit Efficiency Options Program Total		2,347,885	246,332	552,057	0	0	0	155,502	0	0	611,031	135,343	0	4,048,149
APO	Adjustable Speed Drives	758,725	-	-	-	-	-	-	-	-	-	-	-	758,725
	Water Chillers	892,937	-	315,951	-	-	-	642,462	-	-	-	-	-	1,851,350
	Customized EMS	795,479	-	375,348	-	-	-	-	-	-	-	118,500	-	1,289,327
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	174,298	-	174,298
	Other Customized Equip	-	-	-	-	-	-	-	-	-	790,105	-	-	790,105
	Other HVAC Technologies	68,599	-	-	-	-	-	-	-	284,346	-	-	-	352,945
Advanced Performance Options Program Total		2,515,740	0	691,300	0	0	0	642,462	0	284,346	790,105	292,798	0	5,216,750
Total		14,026,711	2,102,308	1,886,983	3,041,812	169,127	847,668	2,149,931	866,234	685,112	2,532,236	2,016,682	350,520	**30,675,323**

Attachment 3-2
Commercial HVAC Ex Ante Net Energy Impacts
By Business Type and Technology Group

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	1,358,655	264,036	95,557	577,808	29,002	321,799	351,038	30,598	37,690	188,249	508,535	91,054	3,854,022
	Adjustable Speed Drives	1,638,679	565,315	29,367	14,684	-	-	73,418	197,004	-	-	46,498	1,468	2,566,431
	Package Terminal A/C	2,942	-	359	1,582	56	12,049	-	297,328	2,574	-	528	880	318,298
	Set-Back Thermostat	1,077,685	242,354	212,887	1,379,685	45,228	173,031	178,301	31,925	141,055	297,439	383,206	87,795	4,250,591
	Reflective Window Film	1,878,817	139,692	65,799	14,970	17,654	18,614	77,585	746	80,701	244,916	53,095	47,972	2,640,561
	Water Chillers	32,665	-	16,832	-	-	-	203,571	5,096	-	-	24,835	-	282,999
	Other HVAC Technologies	1,356	2,034	-	-	18,634	28,710	-	3,645	-	8,905	21,887	-	85,171
Retrofit Express Program Total		5,990,799	1,213,432	420,801	1,988,728	110,575	554,203	883,912	566,341	262,019	739,510	1,038,584	229,169	13,998,073
REO	Adjustable Speed Drives	1,593,080	-	-	-	-	-	-	-	-	-	-	-	1,593,080
	Water Chillers	147,677	185,828	416,462	-	-	-	117,308	-	-	460,950	81,429	-	1,409,653
	Cooling Towers	30,444	-	-	-	-	-	-	-	-	-	20,671	-	51,115
Retrofit Efficiency Options Program Total		1,771,201	185,828	416,462	0	0	0	117,308	0	0	460,950	102,100	0	3,053,848
APO	Adjustable Speed Drives	572,368	-	-	-	-	-	-	-	-	-	-	-	572,368
	Water Chillers	673,615	-	238,348	-	-	-	484,661	-	-	-	-	-	1,396,624
	Customized EMS	600,095	-	283,156	-	-	-	-	-	-	-	89,394	-	972,644
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	131,487	-	131,487
	Other Customized Equip	-	-	-	-	-	-	-	-	-	596,041	-	-	596,041
	Other HVAC Technologies	51,750	-	-	-	-	-	-	-	214,505	-	-	-	266,255
Advanced Performance Options Program Total		1,897,827	0	521,504	0	0	0	484,661	0	214,505	596,041	220,881	0	3,935,419
Total		9,659,827	1,399,260	1,358,766	1,988,728	110,575	554,203	1,485,881	566,341	476,525	1,796,501	1,361,565	229,169	**20,987,340**

Attachment 3-3
Commercial HVAC Unadjusted Engineering Energy Impacts
By Business Type and Technology Group

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	1,090,075	167,934	24,584	203,652	65,256	267,759	199,472	54,476	116,714	154,273	422,353	59,303	2,825,851
	Adjustable Speed Drives	4,506,150	1,794,906	108,742	28,189	-	-	377,716	1,570,481	-	-	176,635	5,016	8,567,835
	Package Terminal A/C	3,412	-	619	2,236	91	17,417	-	401,041	3,210	-	654	1,364	430,044
	Set-Back Thermostat	1,226,475	454,677	250,121	2,038,223	60,853	224,008	234,999	47,502	195,836	359,754	601,051	130,932	5,824,429
	Reflective Window Film	3,043,272	226,271	106,581	24,247	28,596	30,151	125,673	1,207	130,717	396,711	86,003	81,934	4,281,363
	Water Chillers	50,318	-	33,957	-	-	-	133,381	13,595	-	-	3,945	-	235,196
	Other HVAC Technologies	2,006	3,009	-	-	26,881	50,022	-	3,451	-	14,491	51,796	-	151,655
Retrofit Express Program Total		9,921,708	2,646,797	524,603	2,296,547	181,676	589,356	1,071,241	2,091,753	446,477	925,228	1,342,438	278,549	22,316,374
REO	Adjustable Speed Drives	1,098,067	-	-	-	-	-	-	-	-	-	-	-	1,098,067
	Water Chillers	289,619	43,302	663,928	-	-	-	34,410	-	-	1,187,535	28,493	-	2,247,286
	Cooling Towers	5,300	-	-	-	-	-	-	-	-	-	13,261	-	18,562
Retrofit Efficiency Options Program Total		1,392,987	43,302	663,928	0	0	0	34,410	0	0	1,187,535	41,754	0	3,363,915
APO	Adjustable Speed Drives	1,555,672	-	-	-	-	-	-	-	-	-	-	-	1,555,672
	Water Chillers	892,937	-	110,489	-	-	-	96,232	-	-	-	-	-	1,099,657
	Customized EMS	795,479	-	375,348	-	-	-	-	-	-	-	118,500	-	1,289,327
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	174,298	-	174,298
	Other Customized Equip	-	-	-	-	-	-	-	-	-	260,131	-	-	260,131
	Other HVAC Technologies	47,833	-	-	-	-	-	-	-	409,419	-	-	-	457,252
Advanced Performance Options Program Total		3,291,921	0	485,837	0	0	0	96,232	0	409,419	260,131	292,798	0	4,836,337
Total		14,606,616	2,690,099	1,674,368	2,296,547	181,676	589,356	1,201,883	2,091,753	855,896	2,372,895	1,676,989	278,549	**30,516,627**

Attachment 3-4
Commercial HVAC Gross Energy Impact SAE Coefficients
By Business Type and Technology Group

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
	Adjustable Speed Drives	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	
	Package Terminal A/C	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
	Set-Back Thermostat	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
	Reflective Window Film	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
	Water Chillers	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
	Other HVAC Technologies	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
Retrofit Express Program Total														
REO	Adjustable Speed Drives	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	
	Water Chillers	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
	Cooling Towers	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
Retrofit Efficiency Options Program Total														
APO	Adjustable Speed Drives	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	
	Water Chillers	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
	Customized EMS	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
	Convert To VAV	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
	Other Customized Equip	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
	Other HVAC Technologies	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
Advanced Performance Options Program Total														
Total														

Attachment 3-5
Commercial HVAC Ex Post Gross Energy Impacts
By Business Type and Technology Group

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	1,157,127	178,264	26,096	216,179	69,270	284,229	211,742	57,827	123,893	163,763	448,332	62,951	2,999,672
	Adjustable Speed Drives	3,843,931	1,531,129	92,761	24,046	-	-	322,207	1,339,685	-	-	150,677	4,279	7,308,715
	Package Terminal A/C	3,622	-	657	2,374	97	18,489	-	425,709	3,407	-	694	1,448	456,496
	Set-Back Thermostat	1,301,916	482,644	265,506	2,163,596	64,596	237,787	249,454	50,423	207,882	381,883	638,023	138,986	6,182,696
	Reflective Window Film	3,230,467	240,189	113,136	25,739	30,355	32,005	133,404	1,281	138,758	421,113	91,294	86,974	4,544,714
	Water Chillers	50,318	-	33,957	-	-	-	133,381	13,595	-	-	3,945	-	235,196
	Other HVAC Technologies	2,129	3,194	-	-	28,534	53,098	-	3,663	-	15,382	54,982	-	160,983
Retrofit Express Program Total		9,589,510	2,435,420	532,114	2,431,933	192,851	625,608	1,050,188	1,892,185	473,940	982,140	1,387,947	294,637	21,888,473
REO	Adjustable Speed Drives	936,696	-	-	-	-	-	-	-	-	-	-	-	936,696
	Water Chillers	289,619	43,302	663,928	-	-	-	34,410	-	-	1,187,535	28,493	-	2,247,286
	Cooling Towers	5,300	-	-	-	-	-	-	-	-	-	13,261	-	18,562
Retrofit Efficiency Options Program Total		1,231,616	43,302	663,928	0	0	0	34,410	0	0	1,187,535	41,754	0	3,202,544
APO	Adjustable Speed Drives	1,327,052	-	-	-	-	-	-	-	-	-	-	-	1,327,052
	Water Chillers	892,937	-	110,489	-	-	-	96,232	-	-	-	-	-	1,099,657
	Customized EMS	795,479	-	375,348	-	-	-	-	-	-	-	118,500	-	1,289,327
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	174,298	-	174,298
	Other Customized Equip	-	-	-	-	-	-	-	-	-	260,131	-	-	260,131
	Other HVAC Technologies	47,833	-	-	-	-	-	-	-	409,419	-	-	-	457,252
Advanced Performance Options Program Total		3,063,301	0	485,837	0	0	0	96,232	0	409,419	260,131	292,798	0	4,607,717
Total		13,884,427	2,478,722	1,681,879	2,431,933	192,851	625,608	1,180,829	1,892,185	883,360	2,429,806	1,722,498	294,637	29,698,734

Attachment 3-6
Commercial HVAC Gross Energy Impact Realization Rates
By Business Type and Technology Group

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	0.56	0.44	0.18	0.24	1.56	0.58	0.39	1.24	2.15	0.57	0.58	0.45	0.51
	Adjustable Speed Drives	1.53	1.77	2.07	1.07	-	-	2.87	4.45	-	-	2.12	1.91	1.86
	Package Terminal A/C	0.80	-	1.20	0.98	1.12	1.00	-	0.94	0.87	-	0.86	1.08	0.94
	Set-Back Thermostat	0.79	1.30	0.82	1.03	0.93	0.90	0.91	1.03	0.96	0.84	1.09	1.04	0.95
	Reflective Window Film	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.19	1.13
	Water Chillers	1.01	-	1.32	-	-	-	0.43	1.74	-	-	0.10	-	0.54
	Other HVAC Technologies	1.03	1.03	-	-	1.00	1.21	-	0.66	-	1.13	1.64	-	1.24
Retrofit Express Program Total		1.05	1.31	0.83	0.80	1.14	0.74	0.78	2.18	1.18	0.87	0.87	0.84	1.02
REO	Adjustable Speed Drives	0.44	-	-	-	-	-	-	-	-	-	-	-	0.44
	Water Chillers	1.48	0.18	1.20	-	-	-	0.22	-	-	1.94	0.26	-	1.20
	Cooling Towers	0.13	-	-	-	-	-	-	-	-	-	0.48	-	0.27
Retrofit Efficiency Options Program Total		0.52	0.18	1.20	-	-	-	0.22	-	-	1.94	0.31	-	0.79
APO	Adjustable Speed Drives	1.75	-	-	-	-	-	-	-	-	-	-	-	1.75
	Water Chillers	1.00	-	0.35	-	-	-	0.15	-	-	-	-	-	0.59
	Customized EMS	1.00	-	1.00	-	-	-	-	-	-	-	1.00	-	1.00
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	1.00	-	1.00
	Other Customized Equip	-	-	-	-	-	-	-	-	-	0.33	-	-	0.33
	Other HVAC Technologies	0.70	-	-	-	-	-	-	-	1.44	-	-	-	1.30
Advanced Performance Options Program Total		1.22	-	0.70	-	-	-	0.15	-	1.44	0.33	1.00	-	0.88
Total		0.99	1.18	0.89	0.80	1.14	0.74	0.55	2.18	1.29	0.96	0.85	0.84	**0.97**

Attachment 3-7
Commercial HVAC Net-to-Gross Adjustments
By Business Type and Technology Group

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	0.81	0.68	0.74	0.77	0.78	0.78	0.77	1.18	0.98	1.55	0.85	0.70	0.85
	Adjustable Speed Drives	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
	Package Terminal A/C	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
	Set-Back Thermostat	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
	Reflective Window Film	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
	Water Chillers	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
	Other HVAC Technologies	0.81	0.68	0.74	0.77	0.78	0.78	0.77	1.18	0.98	1.55	0.85	0.70	[illegible]
Retrofit Express Program Total		0.88	[illegible]	0.84	0.82	[illegible]	[illegible]	[illegible]	[illegible]	0.88	[illegible]	[illegible]	[illegible]	0.87
REO	Adjustable Speed Drives	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	[illegible]
	Water Chillers	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	[illegible]
	Cooling Towers	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
Retrofit Efficiency Options Program Total		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
APO	Adjustable Speed Drives	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
	Water Chillers	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
	Customized EMS	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	[illegible]
	Convert To VAV	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	[illegible]
	Other Customized Equip	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	[illegible]
	Other HVAC Technologies	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	[illegible]
Advanced Performance Options Program Total		[illegible]	[illegible]	0.68	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.68	[illegible]	[illegible]	[illegible]	[illegible]
Total		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Attachment 3-8
Commercial HVAC Ex Post Net Energy Impacts
By Business Type and Technology Group

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	938,488	121,841	19,182	165,916	54,240	221,573	162,195	68,437	120,878	253,558	381,822	43,842	2,551,973
	Adjustable Speed Drives	3,539,296	1,409,785	85,410	22,140	-	-	296,672	1,233,514	-	-	138,735	3,940	6,729,492
	Package Terminal A/C	1,816	-	330	1,191	48	9,272	-	213,497	1,709	-	348	726	228,937
	Set-Back Thermostat	1,070,981	397,032	218,410	1,779,815	53,138	195,608	205,206	41,479	171,008	314,144	524,850	114,332	5,086,003
	Reflective Window Film	2,873,885	213,677	100,648	22,898	27,004	28,472	118,678	1,140	123,442	374,630	81,217	77,373	4,043,064
	Water Chillers	34,354	-	23,183	-	-	-	91,063	9,282	-	-	2,694	-	160,575
	Other HVAC Technologies	1,727	2,183	-	-	22,343	41,393	-	4,335	-	23,816	46,825	-	142,624
	Retrofit Express Program Total	8,460,546	2,144,519	447,163	1,991,959	156,773	496,319	873,814	1,571,684	417,037	966,149	1,176,491	240,214	18,942,668
REO	Adjustable Speed Drives	862,462	-	-	-	-	-	-	-	-	-	-	-	862,462
	Water Chillers	197,732	29,563	453,283	-	-	-	23,492	-	-	810,765	19,453	-	1,534,288
	Cooling Towers	3,619	-	-	-	-	-	-	-	-	-	9,054	-	12,673
Retrofit Efficiency Options Program Total		1,063,813	29,563	453,283	0	0	0	23,492	0	0	810,765	28,507	0	2,409,422
APO	Adjustable Speed Drives	1,221,882	-	-	-	-	-	-	-	-	-	-	-	1,221,882
	Water Chillers	609,634	-	75,434	-	-	-	65,700	-	-	-	-	-	750,768
	Customized EMS	543,097	-	256,261	-	-	-	-	-	-	-	80,903	-	880,261
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	118,998	-	118,998
	Other Customized Equip	-	-	-	-	-	-	-	-	-	177,599	-	-	177,599
	Other HVAC Technologies	32,657	-	-	-	-	-	-	-	279,522	-	-	-	312,179
Advanced Performance Options Program Total		2,407,269	0	331,695	0	0	0	65,700	0	279,522	177,599	199,901	0	3,461,687
Total		11,931,628	2,174,082	1,232,141	1,991,959	156,773	496,319	963,007	1,571,684	696,559	1,954,512	1,404,899	240,214	**24,813,777**

Attachment 3-9
Commercial HVAC Net Energy Impact Realization Rates
By Business Type and Technology Group

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	0.69	0.46	0.20	0.29	1.87	0.69	0.46	2.24	3.21	1.35	0.75	0.48	0.66
	Adjustable Speed Drives	2.16	2.49	2.91	1.51	-	-	4.04	6.26	-	-	2.98	2.68	2.62
	Package Terminal A/C	0.62	-	0.92	0.75	0.86	0.77	-	0.72	0.66	-	0.66	0.83	0.72
	Set-Back Thermostat	0.99	1.64	1.03	1.29	1.17	1.13	1.15	1.30	1.21	1.06	1.37	1.30	1.20
	Reflective Window Film	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.61	1.53
	Water Chillers	1.05	-	1.38	-	-	-	0.45	1.82	-	-	0.11	-	0.57
	Other HVAC Technologies	1.27	1.07	-	-	1.20	1.44	-	1.19	-	2.67	2.14	-	1.67
	Retrofit Express Program Total	1.41	1.77	1.06	1.00	1.42	0.90	0.99	2.78	1.59	1.31	1.13	1.05	1.35
REO	Adjustable Speed Drives	0.54	-	-	-	-	-	-	-	-	-	-	-	0.54
	Water Chillers	1.34	0.16	1.09	-	-	-	0.20	-	-	1.76	0.24	-	1.09
	Cooling Towers	0.12	-	-	-	-	-	-	-	-	-	0.44	-	0.25
Retrofit Efficiency Options Program Total		0.60	0.16	1.09	-	-	-	0.20	-	-	1.76	0.28	-	0.79
APO	Adjustable Speed Drives	2.13	-	-	-	-	-	-	-	-	-	-	-	2.13
	Water Chillers	0.91	-	0.32	-	-	-	0.14	-	-	-	-	-	0.54
	Customized EMS	0.91	-	0.91	-	-	-	-	-	-	-	0.91	-	0.91
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	0.91	-	0.91
	Other Customized Equip	-	-	-	-	-	-	-	-	-	0.30	-	-	0.30
	Other HVAC Technologies	0.63	-	-	-	-	-	-	-	1.30	-	-	-	1.17
Advanced Performance Options Program Total		1.27	-	0.64	-	-	-	0.14	-	1.30	0.30	0.91	-	0.88
Total		1.24	1.55	0.91	1.00	1.42	0.90	0.65	2.78	1.46	1.09	1.03	1.05	**1.18**

Attachment 3-10
Commercial HVAC Ex Ante Gross Demand Impacts
By Business Type and Technology Group

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	1,563	379	92	1,329	56	284	212	50	144	181	488	84	4,862
	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	0
	Package Terminal A/C	3	-	0	4	0	11	-	489	10	-	1	1	519
	Set-Back Thermostat	-	-	-	-	-	-	-	-	-	-	-	-	0
	Reflective Window Film	412	31	14	3	4	4	17	0	18	54	12	11	579
	Water Chillers	38	-	16	-	-	-	123	8	-	-	24	-	209
	Other HVAC Technologies	2	2	-	-	10	24	-	5	-	12	11	-	66
Retrofit Express Program Total		2,017	412	123	1,336	70	323	353	553	171	246	535	96	6,234
REO	Adjustable Speed Drives	128	-	-	-	-	-	-	-	-	-	-	-	128
	Water Chillers	111	174	156	-	-	-	36	-	-	419	43	-	939
	Cooling Towers	30	-	-	-	-	-	-	-	-	-	6	-	36
Retrofit Efficiency Options Program Total		270	174	156	0	0	0	36	0	0	419	49	0	1,104
APO	Adjustable Speed Drives	88	-	-	-	-	-	-	-	-	-	-	-	88
	Water Chillers	207	-	222	-	-	-	82	-	-	-	-	-	511
	Customized EMS	-	-	-	-	-	-	-	-	-	-	-	-	0
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	-	-	0
	Other Customized Equip	-	-	-	-	-	-	-	-	-	278	-	-	278
	Other HVAC Technologies	86	-	-	-	-	-	-	-	43	-	-	-	129
Advanced Performance Options Program Total		381	0	222	0	0	0	82	0	43	278	0	0	1,006
Total		2,667	585	501	1,336	70	323	470	553	214	943	585	96	**8,344**

Attachment 3-11
Commercial HVAC Ex Ante Net Demand Impacts
By Business Type and Technology Group

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	1,019	247	60	867	36	185	138	33	94	118	318	55	3,170
	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	0
	Package Terminal A/C	2	-	0	2	0	7	-	319	6	-	0	1	338
	Set-Back Thermostat	-	-	-	-	-	-	-	-	-	-	-	-	0
	Reflective Window Film	268	20	9	2	3	3	11	0	12	35	8	7	377
	Water Chillers	24	-	11	-	-	-	80	5	-	-	16	-	136
	Other HVAC Technologies	1	2	-	-	7	16	-	3	-	8	7	-	43
Retrofit Express Program Total		1,315	268	80	871	46	211	230	361	112	160	349	62	4,064
REO	Adjustable Speed Drives	96	-	-	-	-	-	-	-	-	-	-	-	96
	Water Chillers	84	131	118	-	-	-	27	-	-	315	32	-	707
	Cooling Towers	23	-	-	-	-	-	-	-	-	-	5	-	27
Retrofit Efficiency Options Program Total		203	131	118	0	0	0	27	0	0	315	37	0	830
APO	Adjustable Speed Drives	66	-	-	-	-	-	-	-	-	-	-	-	66
	Water Chillers	156	-	167	-	-	-	62	-	-	-	-	-	385
	Customized EMS	-	-	-	-	-	-	-	-	-	-	-	-	0
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	-	-	0
	Other Customized Equip	-	-	-	-	-	-	-	-	-	209	-	-	209
	Other HVAC Technologies	65	-	-	-	-	-	-	-	32	-	-	-	97
Advanced Performance Options Program Total		286	0	167	0	0	0	62	0	32	209	0	0	757
Total		1,804	399	365	871	46	211	319	361	144	685	386	62	**5,651**

Attachment 3-12
Commercial HVAC Unadjusted Engineering Demand Impacts
By Business Type and Technology Group

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	919	226	27	345	31	163	142	30	71	90	281	39	2,363
	Adjustable Speed Drives	1,189	397	21	11	-	-	40	99	-	-	28	1	1,785
	Package Terminal A/C	3	-	0	1	0	8	-	444	8	-	0	1	466
	Set-Back Thermostat	-	-	-	-	-	-	-	-	-	-	-	-	0
	Reflective Window Film	587	30	10	2	4	6	24	0	17	51	13	10	755
	Water Chillers	18	-	3	-	-	-	61	8	-	-	9	-	99
	Other HVAC Technologies	2	2	-	-	13	24	-	5	-	8	9	-	62
Retrofit Express Program Total		2,719	655	61	359	48	200	267	586	96	149	341	50	5,531
REO	Adjustable Speed Drives	230	-	-	-	-	-	-	-	-	-	-	-	230
	Water Chillers	116	143	116	-	-	-	74	-	-	219	28	-	696
	Cooling Towers	14	-	-	-	-	-	-	-	-	-	7	-	21
Retrofit Efficiency Options Program Total		360	143	116	0	0	0	74	0	0	219	35	0	946
APO	Adjustable Speed Drives	264	-	-	-	-	-	-	-	-	-	-	-	264
	Water Chillers	207	-	130	-	-	-	-	-	-	-	-	-	337
	Customized EMS	-	-	-	-	-	-	-	-	-	-	-	-	0
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	-	-	0
	Other Customized Equip	-	-	-	-	-	-	-	-	-	177	-	-	177
	Other HVAC Technologies	56	-	-	-	-	-	-	-	135	-	-	-	191
Advanced Performance Options Program Total		527	0	130	0	0	0	0	0	135	177	0	0	968
Total		3,605	798	306	359	48	200	340	586	231	545	376	50	**7,445**

Attachment 3-13
Commercial HVAC Ex Post Gross Demand Impacts
By Business Type and Technology Group

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	919	226	27	345	31	163	142	30	71	90	281	39	2,363
	Adjustable Speed Drives	1,189	397	21	11	-	-	40	99	-	-	28	1	1,785
	Package Terminal A/C	3	-	0	1	0	8	-	444	8	-	0	1	466
	Set-Back Thermostat	-	-	-	-	-	-	-	-	-	-	-	-	0
	Reflective Window Film	587	30	10	2	4	6	24	0	17	51	13	10	755
	Water Chillers	18	-	3	-	-	-	61	8	-	-	9	-	99
	Other HVAC Technologies	2	2	-	-	13	24	-	5	-	8	9	-	62
Retrofit Express Program Total		2,719	655	61	359	48	200	267	586	96	149	341	50	5,531
REO	Adjustable Speed Drives	230	-	-	-	-	-	-	-	-	-	-	-	230
	Water Chillers	116	143	116	-	-	-	74	-	-	219	28	-	696
	Cooling Towers	14	-	-	-	-	-	-	-	-	-	7	-	21
Retrofit Efficiency Options Program Total		360	143	116	0	0	0	74	0	0	219	35	0	946
APO	Adjustable Speed Drives	264	-	-	-	-	-	-	-	-	-	-	-	264
	Water Chillers	207	-	130	-	-	-	-	-	-	-	-	-	337
	Customized EMS	-	-	-	-	-	-	-	-	-	-	-	-	0
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	-	-	0
	Other Customized Equip	-	-	-	-	-	-	-	-	-	177	-	-	177
	Other HVAC Technologies	56	-	-	-	-	-	-	-	135	-	-	-	191
Advanced Performance Options Program Total		527	0	130	0	0	0	0	0	135	177	0	0	968
Total		3,605	798	306	359	48	200	340	586	231	545	376	50	**7,445**

Attachment 3-14
Commercial HVAC Gross Demand Impact Realization Rates
By Business Type and Technology Group

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	0.59	0.60	0.30	0.26	0.55	0.57	0.67	0.60	0.49	0.50	0.58	0.46	0.49
	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	-
	Package Terminal A/C	0.83	-	0.63	0.41	0.70	0.79	-	0.91	0.79	-	0.74	0.95	0.90
	Set-Back Thermostat	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reflective Window Film	1.43	0.99	0.67	0.51	1.10	1.35	1.42	1.23	0.99	0.95	1.13	0.96	1.30
	Water Chillers	0.48	-	0.19	-	-	-	0.50	0.93	-	-	0.39	-	0.48
	Other HVAC Technologies	1.29	0.77	-	-	1.29	1.00	-	1.05	-	0.66	0.79	-	0.95
Retrofit Express Program Total		1.35	1.59	0.50	0.27	0.69	0.62	0.76	1.06	0.56	0.61	0.64	0.53	0.89
REO	Adjustable Speed Drives	1.79	-	-	-	-	-	-	-	-	-	-	-	1.79
	Water Chillers	1.05	0.82	0.74	-	-	-	2.04	-	-	0.52	0.64	-	0.74
	Cooling Towers	0.45	-	-	-	-	-	-	-	-	-	1.12	-	0.57
Retrofit Efficiency Options Program Total		1.33	0.82	0.74	-	-	-	2.04	-	-	0.52	0.70	-	0.86
APO	Adjustable Speed Drives	3.01	-	-	-	-	-	-	-	-	-	-	-	3.01
	Water Chillers	1.00	-	0.58	-	-	-	-	-	-	-	-	-	0.66
	Customized EMS	-	-	-	-	-	-	-	-	-	-	-	-	-
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	-	-	-
	Other Customized Equip	-	-	-	-	-	-	-	-	-	0.63	-	-	0.63
	Other HVAC Technologies	0.65	-	-	-	-	-	-	-	3.13	-	-	-	1.48
Advanced Performance Options Program Total		1.38	-	0.58	-	-	-	-	-	3.13	0.63	-	-	0.96
Total		1.35	1.36	0.61	0.27	0.69	0.62	0.72	1.06	1.08	0.58	0.64	0.53	**0.89**

Attachment 3-15

Commercial HVAC Net-to-Gross Adjustments for Demand Impacts

By Business Type and Technology Group

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	0.81	0.68	0.74	0.77	0.78	0.78	0.77	1.18	0.98	1.55	0.85	0.70	
	Adjustable Speed Drives	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	
	Package Terminal A/C	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	
	Set-Back Thermostat	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	
	Reflective Window Film	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	
	Water Chillers	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	
	Other HVAC Technologies	0.81	0.68	0.74	0.77	0.78	0.78	0.77	1.18	0.98	1.55	0.85	0.70	
Retrofit Express Program Total														
REO	Adjustable Speed Drives	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	
	Water Chillers	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	
	Cooling Towers	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	
Retrofit Efficiency Options Program Total														
APO	Adjustable Speed Drives	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	
	Water Chillers	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	
	Customized EMS	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	
	Convert To VAV	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	
	Other Customized Equip	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	
	Other HVAC Technologies	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	
Advanced Performance Options Program Total														
Total														

Attachment 3-16
Commercial HVAC Ex Post Net Demand Impacts
By Business Type and Technology Group

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	746	154	20	265	24	127	109	36	69	140	239	27	1,954
	Adjustable Speed Drives	1,095	365	19	10	-	-	37	91	-	-	26	1	1,643
	Package Terminal A/C	1	-	0	1	0	4	-	223	4	-	0	0	234
	Set-Back Thermostat	-	-	-	-	-	-	-	-	-	-	-	-	0
	Reflective Window Film	522	27	9	1	4	5	21	0	16	46	12	9	671
	Water Chillers	12	-	2	-	-	-	42	5	-	-	6	-	68
	Other HVAC Technologies	2	1	-	-	10	19	-	6	-	12	8	-	57
Retrofit Express Program Total		2,378	548	50	277	38	154	208	361	88	197	291	37	4,628
REO	Adjustable Speed Drives	211	-	-	-	-	-	-	-	-	-	-	-	211
	Water Chillers	79	98	79	-	-	-	50	-	-	150	19	-	475
	Cooling Towers	9	-	-	-	-	-	-	-	-	-	5	-	14
Retrofit Efficiency Options Program Total		300	98	79	0	0	0	50	0	0	150	24	0	701
APO	Adjustable Speed Drives	243	-	-	-	-	-	-	-	-	-	-	-	243
	Water Chillers	142	-	88	-	-	-	-	-	-	-	-	-	230
	Customized EMS	-	-	-	-	-	-	-	-	-	-	-	-	0
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	-	-	0
	Other Customized Equip	-	-	-	-	-	-	-	-	-	121	-	-	121
	Other HVAC Technologies	38	-	-	-	-	-	-	-	92	-	-	-	130
Advanced Performance Options Program Total		423	0	88	0	0	0	0	0	92	121	0	0	724
Total		3,101	646	218	277	38	154	258	361	180	467	315	37	**6,052**

Attachment 3-17
Commercial HVAC Net Demand Impact Realization Rates
By Business Type and Technology Group

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	0.73	0.62	0.33	0.31	0.66	0.68	0.78	1.08	0.74	1.19	0.75	0.49	0.62
	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	-
	Package Terminal A/C	0.64	-	0.48	0.32	0.54	0.61	-	0.70	0.60	-	0.57	0.73	0.69
	Set-Back Thermostat	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reflective Window Film	1.95	1.35	0.91	0.70	1.50	1.84	1.93	1.68	1.35	1.30	1.54	1.30	1.78
	Water Chillers	0.50	-	0.19	-	-	-	0.52	0.98	-	-	0.41	-	0.50
	Other HVAC Technologies	1.61	0.80	-	-	1.55	1.19	-	1.91	-	1.57	1.04	-	1.34
Retrofit Express Program Total		1.81	2.04	0.63	0.32	0.84	0.73	0.91	1.00	0.79	1.23	0.83	0.59	1.14
REO	Adjustable Speed Drives	2.19	-	-	-	-	-	-	-	-	-	-	-	2.19
	Water Chillers	0.95	0.75	0.67	-	-	-	1.85	-	-	0.48	0.58	-	0.67
	Cooling Towers	0.41	-	-	-	-	-	-	-	-	-	1.02	-	0.52
Retrofit Efficiency Options Program Total		1.48	0.75	0.67	-	-	-	1.85	-	-	0.48	0.64	-	0.84
APO	Adjustable Speed Drives	3.69	-	-	-	-	-	-	-	-	-	-	-	3.69
	Water Chillers	0.91	-	0.53	-	-	-	-	-	-	-	-	-	0.60
	Customized EMS	-	-	-	-	-	-	-	-	-	-	-	-	-
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	-	-	-
	Other Customized Equip	-	-	-	-	-	-	-	-	-	0.58	-	-	0.58
	Other HVAC Technologies	0.59	-	-	-	-	-	-	-	2.84	-	-	-	1.35
Advanced Performance Options Program Total		1.48	-	0.53	-	-	-	-	-	2.84	0.58	-	-	0.96
Total		1.72	1.62	0.60	0.32	0.84	0.73	0.81	1.00	1.25	0.68	0.81	0.59	**1.07**

Attachment 3-18
Commercial HVAC Ex Ante Gross Therm Impacts
By Business Type and Technology Group

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	-	-	-	-	-	-	-	-	-	-	-	-	0
	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	0
	Package Terminal A/C	-	-	-	-	-	-	-	-	-	-	-	-	0
	Set-Back Thermostat	-	-	-	-	-	-	-	-	-	-	-	-	0
	Reflective Window Film	-	-	-	-	-	-	-	-	-	-	-	-	0
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	0
	Other HVAC Technologies	-	-	-	-	-	-	-	-	-	-	-	-	0
Retrofit Express Program Total		0	0	0	0	0	0	0	0	0	0	0	0	0
REO	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	0
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	0
	Cooling Towers	-	-	-	-	-	-	-	-	-	-	-	-	0
Retrofit Efficiency Options Program Total		0	0	0	0	0	0	0	0	0	0	0	0	0
APO	Adjustable Speed Drives	12,649	-	-	-	-	-	-	-	-	-	-	-	12,649
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	0
	Customized EMS	-	-	-	-	-	-	-	-	-	-	5,553	-	5,553
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	5,609	-	5,609
	Other Customized Equip	-	-	-	-	-	-	-	-	-	-	-	-	0
	Other HVAC Technologies	-	-	-	-	-	-	-	-	-	-	-	-	0
Advanced Performance Options Program Total		12,649	0	0	0	0	0	0	0	0	0	11,162	0	23,811
Total		12,649	0	0	0	0	0	0	0	0	0	11,162	0	**23,811**

Attachment 3-19
Commercial HVAC Ex Ante Net Therm Impacts
By Business Type and Technology Group

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	-	-	-	-	-	-	-	-	-	-	-	-	0
	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	0
	Package Terminal A/C	-	-	-	-	-	-	-	-	-	-	-	-	0
	Set-Back Thermostat	-	-	-	-	-	-	-	-	-	-	-	-	0
	Reflective Window Film	-	-	-	-	-	-	-	-	-	-	-	-	0
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	0
	Other HVAC Technologies	-	-	-	-	-	-	-	-	-	-	-	-	0
Retrofit Express Program Total		0	0	0	0	0	0	0	0	0	0	0	0	0
REO	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	0
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	0
	Cooling Towers	-	-	-	-	-	-	-	-	-	-	-	-	0
Retrofit Efficiency Options Program Total		0	0	0	0	0	0	0	0	0	0	0	0	0
APO	Adjustable Speed Drives	9,487	-	-	-	-	-	-	-	-	-	-	-	9,487
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	0
	Customized EMS	-	-	-	-	-	-	-	-	-	-	4,165	-	4,165
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	4,207	-	4,207
	Other Customized Equip	-	-	-	-	-	-	-	-	-	-	-	-	0
	Other HVAC Technologies	-	-	-	-	-	-	-	-	-	-	-	-	0
Advanced Performance Options Program Total		9,487	0	0	0	0	0	0	0	0	0	8,372	0	17,858
Total		9,487	0	0	0	0	0	0	0	0	0	8,372	0	**17,858**

Attachment 3-20
Commercial HVAC Unadjusted Engineering Therm Impacts
By Business Type and Technology Group

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	-	-	-	-	-	-	-	-	-	-	-	-	0
	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	0
	Package Terminal A/C	-	-	-	-	-	-	-	-	-	-	-	-	0
	Set-Back Thermostat	-	-	-	-	-	-	-	-	-	-	-	-	0
	Reflective Window Film	-	-	-	-	-	-	-	-	-	-	-	-	0
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	0
	Other HVAC Technologies	-	-	-	-	-	-	-	-	-	-	-	-	0
Retrofit Express Program Total		0	0	0	0	0	0	0	0	0	0	0	0	0
REO	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	0
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	0
	Cooling Towers	-	-	-	-	-	-	-	-	-	-	-	-	0
Retrofit Efficiency Options Program Total		0	0	0	0	0	0	0	0	0	0	0	0	0
APO	Adjustable Speed Drives	12,649	-	-	-	-	-	-	-	-	-	-	-	12,649
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	0
	Customized EMS	-	-	-	-	-	-	-	-	-	-	5,553	-	5,553
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	5,609	-	5,609
	Other Customized Equip	-	-	-	-	-	-	-	-	-	-	-	-	0
	Other HVAC Technologies	-	-	-	-	-	-	-	-	-	-	-	-	0
Advanced Performance Options Program Total		12,649	0	0	0	0	0	0	0	0	0	11,162	0	23,811
Total		12,649	0	0	0	0	0	0	0	0	0	11,162	0	**23,811**

Attachment 3-21
Commercial HVAC Ex Post Gross Therm Impacts
By Business Type and Technology Group

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	-	-	-	-	-	-	-	-	-	-	-	-	0
	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	0
	Package Terminal A/C	-	-	-	-	-	-	-	-	-	-	-	-	0
	Set-Back Thermostat	-	-	-	-	-	-	-	-	-	-	-	-	0
	Reflective Window Film	-	-	-	-	-	-	-	-	-	-	-	-	0
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	0
	Other HVAC Technologies	-	-	-	-	-	-	-	-	-	-	-	-	0
Retrofit Express Program Total		0	0	0	0	0	0	0	0	0	0	0	0	0
REO	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	0
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	0
	Cooling Towers	-	-	-	-	-	-	-	-	-	-	-	-	0
Retrofit Efficiency Options Program Total		0	0	0	0	0	0	0	0	0	0	0	0	0
APO	Adjustable Speed Drives	12,649	-	-	-	-	-	-	-	-	-	-	-	12,649
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	0
	Customized EMS	-	-	-	-	-	-	-	-	-	-	5,553	-	5,553
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	5,609	-	5,609
	Other Customized Equip	-	-	-	-	-	-	-	-	-	-	-	-	0
	Other HVAC Technologies	-	-	-	-	-	-	-	-	-	-	-	-	0
Advanced Performance Options Program Total		12,649	0	0	0	0	0	0	0	0	0	11,162	0	23,811
Total		12,649	0	0	0	0	0	0	0	0	0	11,162	0	**23,811**

Attachment 3-22
Commercial HVAC Gross Therm Impact Realization Rates
By Business Type and Technology Group

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	-	-	-	-	-	-	-	-	-	-	-	-	-
	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	-
	Package Terminal A/C	-	-	-	-	-	-	-	-	-	-	-	-	-
	Set-Back Thermostat	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reflective Window Film	-	-	-	-	-	-	-	-	-	-	-	-	-
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	-
	Other HVAC Technologies	-	-	-	-	-	-	-	-	-	-	-	-	-
Retrofit Express Program Total		-	-	-	-	-	-	-	-	-	-	-	-	-
REO	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	-
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	-
	Cooling Towers	-	-	-	-	-	-	-	-	-	-	-	-	-
Retrofit Efficiency Options Program Total		-	-	-	-	-	-	-	-	-	-	-	-	-
APO	Adjustable Speed Drives	1.00	-	-	-	-	-	-	-	-	-	-	-	1.00
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	-
	Customized EMS	-	-	-	-	-	-	-	-	-	-	1.00	-	1.00
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	1.00	-	1.00
	Other Customized Equip	-	-	-	-	-	-	-	-	-	-	-	-	-
	Other HVAC Technologies	-	-	-	-	-	-	-	-	-	-	-	-	-
Advanced Performance Options Program Total		1.00	-	-	-	-	-	-	-	-	-	1.00	-	1.00
Total		1.00	-	-	-	-	-	-	-	-	-	1.00	-	**1.00**

Attachment 3-23
Commercial HVAC Net-to-Gross Adjustments for Therm Impacts
By Business Type and Technology Group

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	0.81	0.68	0.74	0.77	0.78	0.78	0.77	1.18	0.98	1.55	0.85	0.70	-
	Adjustable Speed Drives	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	
	Package Terminal A/C	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	
	Set-Back Thermostat	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	
	Reflective Window Film	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	
	Water Chillers	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	
	Other HVAC Technologies	0.81	0.68	0.74	0.77	0.78	0.78	0.77	1.18	0.98	1.55	0.85	0.70	
Retrofit Express Program Total														
REO	Adjustable Speed Drives	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	
	Water Chillers	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	
	Cooling Towers	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	
Retrofit Efficiency Options Program Total														
APO	Adjustable Speed Drives	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	
	Water Chillers	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	
	Customized EMS	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	
	Convert To VAV	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	
	Other Customized Equip	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	
	Other HVAC Technologies	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	
Advanced Performance Options Program Total														
Total														

Attachment 3-24
Commercial HVAC Ex Post Net Therm Impacts
By Business Type and Technology Group

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	-	-	-	-	-	-	-	-	-	-	-	-	0
	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	0
	Package Terminal A/C	-	-	-	-	-	-	-	-	-	-	-	-	0
	Set-Back Thermostat	-	-	-	-	-	-	-	-	-	-	-	-	0
	Reflective Window Film	-	-	-	-	-	-	-	-	-	-	-	-	0
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	0
	Other HVAC Technologies	-	-	-	-	-	-	-	-	-	-	-	-	0
Retrofit Express Program Total		0	0	0	0	0	0	0	0	0	0	0	0	0
REO	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	0
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	0
	Cooling Towers	-	-	-	-	-	-	-	-	-	-	-	-	0
Retrofit Efficiency Options Program Total		0	0	0	0	0	0	0	0	0	0	0	0	0
APO	Adjustable Speed Drives	11,647	-	-	-	-	-	-	-	-	-	-	-	11,647
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	0
	Customized EMS	-	-	-	-	-	-	-	-	-	-	3,791	-	3,791
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	3,829	-	3,829
	Other Customized Equip	-	-	-	-	-	-	-	-	-	-	-	-	0
	Other HVAC Technologies	-	-	-	-	-	-	-	-	-	-	-	-	0
Advanced Performance Options Program Total		11,647	0	0	0	0	0	0	0	0	0	7,621	0	19,267
Total		11,647	0	0	0	0	0	0	0	0	0	7,621	0	**19,267**

Attachment 3-25
Commercial HVAC Net Therm Impact Realization Rates
By Business Type and Technology Group

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	-	-	-	-	-	-	-	-	-	-	-	-	-
	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	-
	Package Terminal A/C	-	-	-	-	-	-	-	-	-	-	-	-	-
	Set-Back Thermostat	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reflective Window Film	-	-	-	-	-	-	-	-	-	-	-	-	-
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	-
	Other HVAC Technologies	-	-	-	-	-	-	-	-	-	-	-	-	-
Retrofit Express Program Total		-	-	-	-	-	-	-	-	-	-	-	-	-
REO	Adjustable Speed Drives	-	-	-	-	-	-	-	-	-	-	-	-	-
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	-
	Cooling Towers	-	-	-	-	-	-	-	-	-	-	-	-	-
Retrofit Efficiency Options Program Total		-	-	-	-	-	-	-	-	-	-	-	-	-
APO	Adjustable Speed Drives	1.23	-	-	-	-	-	-	-	-	-	-	-	1.23
	Water Chillers	-	-	-	-	-	-	-	-	-	-	-	-	-
	Customized EMS	-	-	-	-	-	-	-	-	-	-	0.91	-	0.91
	Convert To VAV	-	-	-	-	-	-	-	-	-	-	0.91	-	0.91
	Other Customized Equip	-	-	-	-	-	-	-	-	-	-	-	-	-
	Other HVAC Technologies	-	-	-	-	-	-	-	-	-	-	-	-	-
Advanced Performance Options Program Total		1.23	-	-	-	-	-	-	-	-	-	0.91	-	1.08
Total		1.23	-	-	-	-	-	-	-	-	-	0.91	-	**1.08**

Attachment 3-26
Commercial HVAC Measures
Measure Code Key

Business Type / Program and Technology Group	PG&E Measure Classification	
	Measure Code	**Action Code**
Retrofit Express Program		
Central A/C	S2, S160-S163	
Adjustable Speed Drives	S22	
Package Terminal A/C	S6	
Programmable Thermostat	S17, S18	
Reflective Window Film	S20	
Water Chiller	S12, S13	
Other HVAC Technologies	S21	
Retrofit Efficiency Options Program		
Adjustable Speed Drives	S89, S90, S92, S93	
Water Chillers	S97, S98, S99	
Cooling Tower	S94, S96	
Advanced Performance Options Program		
Adjustable Speed Drives	S0	248
Water Chillers	S0	232
Customized EMS	S0	204
Convert to VAV	S0	230
Other Customized Equipment	S0	299
Other HVAC Technologies	S0	234, 271

Attachment 3-27
Time-of-Use Impact Distribution by Costing Period

PG&E Cost Period	Time-of-Use Impact Distribution	
	kW Adjustment Factor	kWh Adjustment Factor
Summer On-Peak: **May 1 to Oct. 31** **12:00 PM - 6:00 PM Weekdays**	1.0000	0.1320
Summer Partial Peak: **May 1 to Oct. 31** **8:30 AM - 12:00 PM &** **6:00 PM - 9:30 PM Weekdays**	0.9020	0.1320
Summer Off-Peak: **May to Oct. 31** **9:30 PM - 8:30 AM**	0.5320	0.2990
Winter Partial Peak: **Nov. 1 to April 31** **8:30 AM - 9:30 PM Weekdays**	0.5150	0.2620
Winter Off-Peak: **Nov. 1 to April 31** **9:30 PM - 8:30 AM Other**	0.4300	0.1750

Attachment 4

Protocol Tables 6 and 7

PROTOCOL TABLES 6 AND 7

1997 COMMERCIAL EEI PROGRAM
EVALUATION OF HVAC TECHNOLOGIES

PG&E STUDY ID #333B

This Attachment presents Tables 6 and 7 for the above referenced study as required under the "Protocols and Procedures for the Verification of Cost, Benefits, and Shareholder Earnings from Demand Side Management Programs" (the Protocols), as adopted by the California Public Utility Commission (CPUC) Decision 93-05-063, Revised March 1998 Pursuant to Decisions 94-05-063, 94-10-059, 94-12-021, 95-12-054, 96-12-079, and 98-03-063.

Table 6 Assumptions

In some instances, interpretation of the Protocols allows for a variety of results to be presented. For HVAC technologies, the interpretation of these terms are:

- Items 1.A, 1.B, 2.C, 3.C: The change model of estimates did not require an evaluation of base usage for these technologies.
- Item 2.B: The per-unit gross and net impacts required by the Protocols specify one term in the denominator, square footage. The interpretation of this term is:
    - Square footage estimates of the conditioned area were derived using survey responses for total area affected by the retrofit.
- Items 6 and 7: The number of measures reported are the purchased number in the MDSS. As such, they reflect a variety of units of measure, including square feet, number of units, feet of window film, number of thermostats, etc.

The Table 7 synopsis of analytical methods applied follows Items 1 through 7 of Protocol Table 6.

Protocol Table 6
Items 1-5
PG&E HVAC Study ID #333B

Table Item			Relative Precision	
Item Number	**Description**	**Estimate**	**90% Confidence**	**80% Confidence**
1.A†	Pre-installation usage, Base usage, and Base usage per designated unit* of measurement.	N/A	N/A	N/A
1.B†	Impact Year usage, Impact year usage per designated unit* of measurement.	N/A	N/A	N/A
2.A	Gross Peak kW (Demand) Impacts	7,445	61%	47%
	Gross MWh (Energy) Impacts	29,698,734	36%	28%
	Gross thm (Therm) Impacts	23,811	61%	47%
	Net Peak kW (Demand) Impacts	6,052	61%	47%
	Net MWh (Energy) Impacts	24,813,777	36%	28%
	Net thm (Therm) Impacts	19,267	61%	47%
2.B	Per designated unit* Gross Demand (kW) Impacts	0.00017	61%	47%
	Per designated unit* Gross Energy (kWh) Impacts	0.65926	36%	28%
	Per designated unit Gross Therm Impacts	0.00053	61%	47%
	Per designated unit* Net Demand (kW) Impacts	0.00013	61%	47%
	Per designated unit* Net Energy (kWh) Impacts	0.55082	36%	28%
	Per designated unit Net Therm Impacts	0.00043	61%	47%
2.C†	Percent change in usage (relative to base usage) of the participant group and comparison group.	N/A	N/A	N/A
2.D	Gross Demand Realization Rate	0.890	61%	47%
	Gross Energy Realization Rate	0.970	36%	28%
	Gross Therm Realization Rate	1.000	61%	47%
	Net Demand Realization Rate	1.070	61%	47%
	Net Energy Realization Rate	1.180	36%	28%
	Net Therm Realization Rate	1.080	61%	47%
3.A	Net-to-Gross ratio based on Avg. Load Impacts	0.836	3%	3%
3.B	Net-to-Gross ratio based on Avg. Load Impacts per designated unit* of measurement.	0.836	3%	3%
3.C†	Net-to-Gross ratio based on Avg. Load Impacts as a percent change from base usage	N/A	N/A	N/A
4.A	Pre-installation Avg. (mean) Sq. Foot (participant group)	49,734	19.9%	15.5%
	Pre-installation Avg. (mean) Sq. Foot (comparison group)	54,569	20.3%	15.8%
	Pre-installation Avg. Hours of Operation (participant group)			
	Pre-installation Avg. Hours of Operation (comparison group)			
4.B	Post-installation Avg. (mean) Sq. Foot (participant group)	50,456	19.9%	15.5%
	Post-installation Avg. (mean) Sq. Foot (comparison group)	55,934	20.5%	16.0%
	Post-installation Avg. Hours of Operation (participant group)			
	Post-installation Avg. Hours of Operation (comparison group)			

† The change model estimates of impact did not require an evaluation of base usage
* The per designated unit used was Sq. Ft.
Shaded cells were not evaluated because per designated unit calculations did not use these estimates.

Protocol Table 6
Item 6: HVAC Measure Count Data
PG&E Study ID #333B

	Number of Measures Paid in 1997		
Program and Technology Group Description	**All Participants (Item 6.B)**	**Participant Sample (Item 6.A)**	**Comparison Group (Item 6.C)**
Retrofit Express Program			
Central A/C	2,663	1,662	918
Adjustable Speed Drives	250	84	0
Package Terminal A/C	2,464	376	230
Set-Back Thermostat	1,596	1,596	11
Reflective Window Film	290,459	43,581	4
Water Chillers	13	3	24
Other HVAC Technologies	22	6	94
Total for Retrofit Express:	**297,467**	**47,308**	**1,281**
Retrofit Efficiency Options Program			
Adjustable Speed Drives	5	3	[redacted]
Water Chillers	11	3	[redacted]
Cooling Towers	3	1	[redacted]
Total for REO:	**19**	**7**	**0**
Advanced Performance Options Program			
Adjustable Speed Drives	3	1	[redacted]
Water Chillers	3	0	[redacted]
Customized EMS	4	0	[redacted]
Convert to VAV	1	0	[redacted]
Other Customized Equipment	1	0	[redacted]
Other HVAC Technologies	2	1	[redacted]
Total for APO:	**14**	**2**	**0**
TOTAL:	**297,500**	**47,317**	**1,281**

Protocol Table 6
Item 7.A: HVAC Market Segment Data
by Business Type
PG&E Study ID # 333B

Business Type	HVAC	
	# of Part.	% of Part.
Office	385	29%
Retail	147	11%
Col/Univ	26	2%
School	139	10%
Grocery	28	2%
Restaurant	93	7%
Health Care/Hospital	115	9%
Hotel/Motel	83	6%
Warehouse	65	5%
Personal Service	73	5%
Community Service	141	11%
Misc. Commercial	42	3%
TOTAL:	**1337**	**100%**

Protocol Table 6
Item 7.B: HVAC Market Segment Data
by 3-Digit SIC Code
PG&E Study ID # 333B

Industry (3-Digit SIC Code)	HVAC # of Part.	HVAC % of Part.
652	181	14%
821	139	10%
581	93	7%
701	81	6%
866	61	5%
650	37	3%
799	34	3%
801	28	2%
802	27	2%
594	20	1%
422	17	1%
541	17	1%
737	17	1%
822	16	1%
653	15	1%
832	15	1%
504	14	1%
806	14	1%
809	14	1%
551	13	1%
804	13	1%
531	12	1%
723	12	1%
805	12	1%
871	12	1%
593	11	1%
753	11	1%
873	11	1%
922	11	1%
74	10	1%
602	10	1%
508	9	1%
571	9	1%
573	9	1%
913	9	1%
431	8	1%
553	8	1%
599	8	1%
864	8	1%

Protocol Table 6
Item 7.B: HVAC Market Segment Data
by 3-Digit SIC Code
PG&E Study ID # 333B

Industry (3-Digit SIC Code)	HVAC	
	# of Part.	% of Part.
506	7	1%
824	7	1%
919	7	1%
921	7	1%
507	6	0%
514	6	0%
533	6	0%
554	6	0%
591	6	0%
633	6	0%
641	6	0%
738	6	0%
835	6	0%
495	5	0%
521	5	0%
606	5	0%
721	5	0%
811	5	0%
841	5	0%
872	5	0%
483	4	0%
525	4	0%
569	4	0%
592	4	0%
733	4	0%
735	4	0%
941	4	0%
944	4	0%
951	4	0%
481	3	0%
494	3	0%
498	3	0%
501	3	0%
523	3	0%
546	3	0%
562	3	0%
621	3	0%
726	3	0%
729	3	0%

Protocol Table 6
Item 7.B: HVAC Market Segment Data
by 3-Digit SIC Code
PG&E Study ID # 333B

	HVAC	
Industry (3-Digit SIC Code)	# of Part.	% of Part.
784	3	0%
807	3	0%
823	3	0%
829	3	0%
836	3	0%
839	3	0%
861	3	0%
863	3	0%
869	3	0%
874	3	0%
72	2	0%
421	2	0%
449	2	0%
484	2	0%
509	2	0%
519	2	0%
539	2	0%
544	2	0%
549	2	0%
552	2	0%
559	2	0%
572	2	0%
603	2	0%
614	2	0%
636	2	0%
651	2	0%
672	2	0%
792	2	0%
793	2	0%
943	2	0%
953	2	0%
964	2	0%
16	1	0%
75	1	0%
254	1	0%
458	1	0%
473	1	0%
489	1	0%
503	1	0%

Protocol Table 6
Item 7.B: HVAC Market Segment Data by 3-Digit SIC Code
PG&E Study ID # 333B

Industry (3-Digit SIC Code)	HVAC # of Part.	HVAC % of Part.
511	1	0%
515	1	0%
555	1	0%
557	1	0%
561	1	0%
564	1	0%
566	1	0%
616	1	0%
631	1	0%
632	1	0%
637	1	0%
655	1	0%
702	1	0%
703	1	0%
704	1	0%
736	1	0%
750	1	0%
764	1	0%
769	1	0%
783	1	0%
791	1	0%
808	1	0%
833	1	0%
862	1	0%
962	1	0%
971	1	0%
972	1	0%
17	0	0%
179	0	0%
327	0	0%
344	0	0%
349	0	0%
357	0	0%
367	0	0%
411	0	0%
415	0	0%
472	0	0%
490	0	0%
502	0	0%

Protocol Table 6
Item 7.B: HVAC Market Segment Data
by 3-Digit SIC Code
PG&E Study ID # 333B

	HVAC	
Industry (3-Digit SIC Code)	# of Part.	% of Part.
505	0	0%
512	0	0%
513	0	0%
516	0	0%
517	0	0%
518	0	0%
526	0	0%
527	0	0%
542	0	0%
543	0	0%
556	0	0%
565	0	0%
615	0	0%
662	0	0%
679	0	0%
724	0	0%
731	0	0%
734	0	0%
751	0	0%
752	0	0%
754	0	0%
794	0	0%
820	0	0%
899	0	0%
931	0	0%
TOTAL	**1337**	**100%**

PROTOCOL TABLE 7

1997 COMMERCIAL EEI PROGRAM
EVALUATION OF HVAC TECHNOLOGIES
PG&E STUDY ID #333B

The purpose of this section is to provide the documentation for data quality and processing as required in Table 7 of the California Public Utility Commission (CPUC) Evaluation and Measurement Protocols (the Protocols). Although other important considerations are addressed throughout this section, 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.

A. OVERVIEW INFORMATION

1. Study Title and Study ID Number

Study Title: Evaluation of PG&E's 1997 Commercial EEI Program for HVAC Technologies.

Study ID Number: 333B

2. Program, Program Year and Program Description

Program: PG&E Commercial EEI Program.

Program Year: Rebates Received in the 1997 Calendar Year.

Program Description:

The Commercial Energy Efficiency Incentives Program for HVAC technologies offered by PG&E has three primary components: the Retrofit Express (RE) Program, the Retrofit Efficiency Options (REO) Program and the Advanced Performance Options (APO) Program.

The RE and REO Programs comprise the majority of total impacts. The RE and REO Programs offer fixed rebates to PG&E's customers that install specific gas or electric energy-efficient equipment in their facilities. Both Programs cover most common energy-saving measures: lighting, air conditioning, refrigeration/food service, and motors. To receive a rebate, the customer is required to submit proof of purchase along with the application. The RE Program is primarily marketed to small and medium commercial, industrial, and agricultural customers. The maximum total rebate amount of the RE Program is $300,000 per account. This includes participation in any combination of the lighting, air conditioning, refrigeration/food service, and motor program options.

For the REO Program, customers are required to submit calculations for the projected first-year energy savings along with their application prior to installation of the high efficiency equipment. PG&E representatives work with customers to identify cost-effective improvements, with special emphasis on operational and maintenance measures at the customers' facilities. Marketing efforts are coordinated amongst PG&E's divisions, emphasizing local planning areas with high marginal electric costs to maximum the program's benefits.

3. *End Uses and/or Measures Covered*

End Use Covered: HVAC Technologies.

Measures Covered: For the list of Program measures covered in this evaluation, see Attachment 2, Exhibit 2-26.

4. *Methods and Models Used*

The PG&E Commercial HVAC Technologies consisted of three key analysis components: engineering analysis, billing data regression analysis, and net-to-gross analysis. This integrated approach reduces a complicated problem to manageable components, while incorporating the comparative advantages of each analysis method. This approach describes per-unit net impacts as follows:

Net Impact = (Gross Impact) x (SAE Realization Rate) x (Net-to-Gross)

Gross Impact -- Gross impact is computed as the change in energy consumption for a particular HVAC technology relative to a baseline, typically defined by Title 24, and computed using CEC long term weather data. A detailed discussion of the HVAC impact calculations can be found in *Section 3.2*.

SAE Realization Rates -- The SAE Realization Rates were estimated based on a Statistically Adjusted Engineering (SAE) analysis using cross-sectional time series data and incorporating prior engineering estimates. As a result, the SAE realization rates could be defined as the percentage of a savings estimate that is detected or realized in the statistical analysis of actual changes in energy usage. The SAE realization rates were then applied to an impact estimate based upon the program baseline, equipment purchased under the program, and typical weather. A detailed discussion of the final SAE model specification can be found in *Section 3.3*.

Net-to-Gross -- The net-to-gross (NTG) ratio adjusts the program baseline derived from estimates of free ridership and spillover associated with the program. Two approaches were used to capture the NTG effect: (1) a discrete choice model used to estimate free ridership and spillover effects and (2) the NTG ratio calculation based on survey self report using a representative nonparticipant sample to account for naturally occurring conservation. The NTG analysis approach is presented in detail in *Section 3.4*. A third approach using the net billing model was used to verify the results of the first two approaches, and is described in detail in *Section 3.3.9*.

5. *Participant and Comparison Group Definition*

Participant

Participants are defined as those PG&E commercial customers who received PG&E rebates in the 1997 calendar year for installing at least one HVAC measure under the CEEI Program.

Comparison Group

The comparison group for this study is defined as a group of PG&E commercial customers who did not receive any HVAC end-use rebates in the 1997 calendar year under the CEEI Program, and who share as many characteristics as possible with the commercial sector participant group in terms of annual usage and business type distribution. Customers who participated in previous years or those who simply participated by installing a non-HVAC end-use measure, are eligible for the comparison group.

6. *Analysis Sample Size*

The final analysis dataset has 1,409 observations based upon 1,409 telephone survey completes (of which 443 were HVAC end-use participants, and the remaining 966 served as a comparison group for that sample). In addition, 156 on-site audits were conducted at HVAC end-use participant sites, which included the installation of end-use loggers at 30 of these sites. The distribution of the sample by business type and technology is presented in *Section 3.1.*

B. DATABASE MANAGEMENT

1. Data Description and Flow Chart

The Commercial HVAC Evaluation was based on a sample design approach that was fully Protocol compliant. The objectives of the sample design were to:

- Determine the optimal sample allocation for first-year gross impact analysis, based upon sample size and evaluation accuracy requirements of the Protocols and available project resources.
- Allocate sufficient sample points to meet net-to-gross (NTG) objectives.
- Reallocate available resources, wherever feasible, to focus on measures and/or program features deemed most important by PG&E staff, while not compromising the overall accuracy of the evaluation.

All data elements mentioned above were linked to the final analysis database through the unique customer identifier -- the evaluation 'site_id' variable. For this evaluation, the analysis database served as a centralized tracking system for each customers' billing history, program participation, and sampling status, which helped to reduce data problems such as account mis-match, double counting, or repeated customer contacts. Exhibit A below illustrates how each key data element was used to create the final analysis database for the Evaluation.

2. *Key Data Elements and Sources*

A complete list of data elements and their sources can be found in *Section 3.1*. The key analysis data elements and their sources are listed below:

Program Participant Tracking System. The participant tracking system for the RE, REO and APO programs was maintained as part of the PG&E MDSS. It contains program application, rebate, and technical information about installed measures, including measure description, quantity, rebate amount, and ex ante demand, energy, and therm saving estimates.

PG&E Billing Data. The PG&E billing data were obtained from two separate data requests. The original nonresidential billing dataset contains monthly energy usage for all nonresidential accounts in PG&E's service territory, and was used in the sample design as described in *Section 3.1*. The billing histories contained in this database run for 1993 through 1997.

The second billing dataset, was later obtained from PG&E's Load Data Services.[1] This billing dataset contains bill readings that run for January 1998 through September 1998, and was therefore used in the billing regression analysis. In addition, the billing series from this database is the PG&E pro-rated monthly usage data, a series calculated by PG&E for each calendar month.

Telephone Survey Data. Two telephone survey samples (443 participants and 966 comparison group customers) were collected as part of this evaluation. They were designed to be representative of the population of each business type. The telephone survey supplies information on customer decision-making, equipment operating characteristics, equipment stocks, and energy-related changes at each site for the billing period covered by the statistical billing analysis.

On-Site Audit Data. On-site audit data were collected as part of this evaluation for both the participant and comparison group. The on-site audit is designed to support the telephone sample for the largest participation segments. This sample contributes site-specific equipment details, and better estimates of operating hours and operating factors. There were a total of 156 participant on-site audits conducted for this HVAC end-use evaluation.

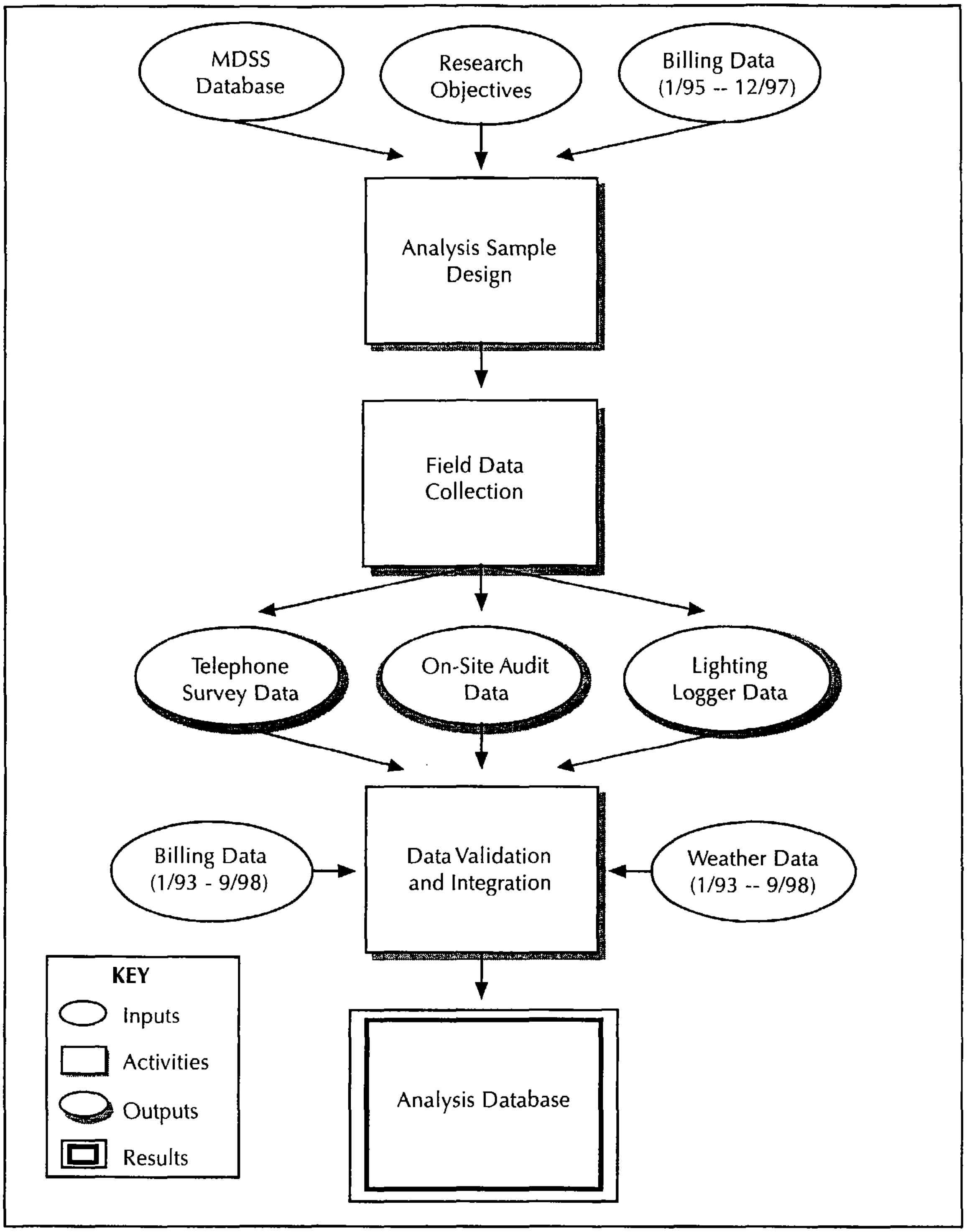
End Use Logger Data. The logger data collected for the Evaluation provides operating information for central air conditioner (CAC) measures. For the CAC measures, the logger data are used to calibrate the DOE-2.1 E Models.

Weather Data. The hourly dry bulb temperature collected for 25 PG&E load research weather sites is used in the billing regression analysis to calculate total monthly cooling and heating degree days for each month in the analysis period. For each customer in the analysis dataset, the appropriate weather site is linked to that customer by using the PG&E-defined weather site to PG&E's local office mapping.

---

[1] A preliminary analysis has concluded that the monthly usage and bill read date information in these two datasets is consistent.

Exhibit A
Analysis Database Development



Other data elements include PG&E program marketing data, PG&E internal SIC code mapping/segmentation scheme, program procedural manuals and other industry standard data sources.

3. Data Attrition Process

All data elements mentioned above were first validated and then merged together to form the final analysis dataset. Records with out-of-range or questionable data were either deleted or flagged to ensure that only those records with sufficient data, both in terms of data quality and representativeness, were used in the analysis. The key data attrition decisions are summarized in *Section 3.3.5.*

4. Internal Data Quality Procedures

The Evaluation contractor of this project, Quantum Consulting Inc. (QC), has performed extensive data quality control on all categories of program data, including utility billing data, program tracking data, telephone survey data, and on-site audit data. QC's data quality procedures are consistent with PG&E's internal database guidelines and the guidelines established in the Protocols.

Throughout the course of sample design and creation, survey data collection, and data analysis, several data quality assurance procedures were in place to ensure that all energy usage data used in analysis and all telephone survey data collected was of high quality and would prove useful in later analysis. The stages of data validation undertaken and the methods employed are detailed below:

Pre-Survey Usage and Account Characteristic Data Validation. The goal of this stage of data validation was to screen out customers who had unreasonable or unreliable usage data, or who had changes in key elements of their billing data over the 1995 to 1997 period. Accounts for which changes were observed in account numbers, service addresses, SIC codes, electric rate schedules, electric meter numbers, or corporation and premise identification variables, were excluded from sample eligibility. Usage data reliability screening first eliminated from the sample, all accounts which experienced service interruptions, exhibited inconsistent read dates, or for which bills were estimated. Additionally, based on comparisons of account usage between years, and between different months in the same year, customers with unusual usage patterns such as unusually high variation in monthly or yearly usage were given special attention and, in some cases, excluded from the sample frame. A more detailed discussion of the steps undertaken in the pre-survey usage and account characteristics data validation, is provided in the discussion of survey sample creation in *Section 3.1.*

Real Time Survey Data Validation. Survey data collection was performed using QC's 24 station Computer Aided Telephone Interviewing (CATI) center. Data entry applications, programmed using a third-party software package, employed logical branching routines and real-time data validation procedures to ensure that survey questions were appropriate for each customer's situation and that recorded responses were reasonable and logical. Data entry applications also performed real time range checks and field protection for out of range values during the data collection process thereby affording an additional means of ongoing data validation. Finally, because the software package used to program the data collection software could output the survey data in the form of a SAS dataset, the survey data was on-line continuously throughout the course of data collection. This allowed for the generation of frequency distributions and cross-tabs on data at regular stages throughout the survey fielding to facilitate QC's internal early detection and correction of data entry errors.

Final Survey Data Validation. Following the completion of survey data collection, all data was subjected to a final stage of validation and cleaning during which illogical responses were identified and corrected or flagged, and corrections were made to any mis-coding of data not detected in earlier stages of cleaning and validation. All activities undertaken in the course of survey were documented in accordance with QC's Enumerated Quality Assurance Logs and Standards (EQUALS) survey data collection documentation Protocols.

5. *Unused Data Elements*

Without exception, all data collected specifically for the Evaluation were utilized in the analysis.

C. *SAMPLING*

1. *Sampling Procedures and Protocols*

The sample design for the Commercial HVAC Evaluation was based upon analysis of 1997 program participation data and PG&E billing data. The goal of the sample design was to achieve the most efficient utilization of project resources in order to estimate the first-year gross and net impacts in a manner that met the sample size and evaluation accuracy requirements defined by the Protocols.

The telephone survey sample was selected based upon the stratified random sampling techniques for both participant and comparison groups. The objective of stratification is to improve the overall reliability of estimates by restricting the sample to reasonably homogeneous segments, while at the same time ensuring that sufficient representation of the population is preserved. The sample segmentation is developed across two dimensions: business types and technology groups.

The customer segment is defined primarily by the business types, which were determined based upon the MDSS database (for participants), and the Second Standard Industrial Classification (SIC2) code—which represents building activity—from the billing dataset (for the comparison group). Within each business type, the annual energy consumption is used as proxies to group customers into usage bins, and sample points are selected to reflect the underlying distribution of the participant population.

Technology segmentation is important because the use of electricity, and therefore the program impacts, varies by program measure. Therefore, by grouping together common technologies, the variation in impacts is reduced, which, in turn, results in more accurate estimates of the SAE realization rates. For example, all Central Air-Conditioning (CAC) retrofit measures are grouped together, despite the fact that variation in capacity and efficiency will yield different levels of projected energy impacts. These factors are directly accounted for in the engineering estimates. That is, the engineering estimates account for inter-participant variation so that what is assumed is that the fraction of the expected impact is stable within a segment, rather than the level of the impact. This assumption is the basis for SAE models.

The sampling unit for both participant and comparison groups was defined as customer premise. A premise is defined as all billing accounts that correspond to the same location and customer. The final participant sample frame consists of 1,337 premises drawn from the eligible population of program participants who were paid in 1997 from the RE, REO, and APO programs. Because of the limited sample frame for participants, a census was conducted.

The comparison group sample frame consists of 187,524 customers drawn from the eligible population of over 400,000 commercial accounts. In drawing the sample frame, targets are established for each business type and usage segment, so that the sample frame distribution, by business type and usage segment, is the same as that of the participant population.

The process of reduction to the eligible sample involved the elimination of customers that had 1) moved during the period of interest; or 2) had billing records with significant missing data. Customers were further screened to identify those who had high-quality data for each month, for all three years of the analysis window.

Finally, the achieved samples and their distributions can be found in *Section 3.1*. Based on the total energy usage, the sample relative precision's were estimated to be 5.7 percent at the 90 percent level. The procedures used in the relative precision calculation and a summary of how the Evaluation sample design meets the Protocols' requirement in terms of sample size and relative precision are presented in *Section 3.1*.

2. *Survey Information*

Telephone survey instruments are presented in the *Survey Appendices, Appendix A* (for participants) and *Appendix B* (for comparison group customers). Participant and comparison group customer's survey response frequencies are presented in *Appendices E* and *F*, respectively. Finally, reasons for refusals are presented in *Appendices K* and *L*.

On-site audit instruments are presented in the *Survey Appendices, Appendix D*.

3. *Statistical Descriptions*

As mentioned above, a complete set of participant and comparison group customer's responses frequencies are presented in *Survey Appendices E* and *F*. In addition, statistics on usage and engineering impact variables that were used in the billing data regression models are also presented in *Section 3.3*.

D. DATA SCREENING AND ANALYSIS

A detailed discussion of the billing data regression data analysis is presented in *Section 3.3*. The statistical billing model described in this section incorporates analysis for two distinct end uses: lighting and HVAC (for Study ID's 333A and 333B, respectively). Specific procedures and modeling issues are discussed below.

1. *Outliers, Missing Data and Weather Adjustment*

Three types of data censoring screens were applied to the billing analysis sample frame to remove customers: those that had invalid billing data, or that may not have had their bill properly aggregated to the Site ID level, or that were extremely large users.

Invalid Usage

For customers to be included in the final billing analysis, customers had to have billing data that met the following criteria:

The pre- and post-installation annual bills had to have been comprised of at least nine non-zero monthly bills. If there were four or more monthly bills with zero energy, the customer was removed from the analysis. If there were between one and nine monthly bills with zero energy, the remaining months were prorated to an annual estimate.

The pre-installation annual bill could not be more than three times or less than one third the post-installation bill. If this occurred, the customer was removed from the analysis.

The number of employees at the facility could not have doubled, or been cut in half. This criteria is only applied to customers with at least 100 employees. Furthermore, the size of the facility in square feet could not have doubled, or been cut in half. If either of these criteria were met, the customer was removed from the analysis.

Finally, customers were removed from the analysis if they had a measure installed under the program that would result in an increase in usage. These individuals were identified through customer interviews.

Section 3.3 presents the number of participants and nonparticipants that were deleted for each of the above criteria. Note that only 29 nonparticipants were deleted, whereas 99 participants were deleted. This is due to the fact that the nonparticipants were pre-screened to have relatively valid billing data prior to being selected into the nonparticipant survey sample frame. The participants, however, were often a census and no pre-screening was done on their billing data prior to being selected into the participant survey sample frame. Of the 99 participants, 69 were deleted due to the zero bill criteria.

Large Customers

Customers whose annual pre-installation energy consumption that exceeded three million kWh were excluded from the billing analysis. A total of 49 participants and 34 nonparticipants were dropped for this reason. This decision was made *a priori* to collecting the survey data, as is documented in the Evaluation Research Plan; and is based upon the results of the previous three Lighting Evaluations, all of which were unsuccessful in obtaining reliable results when including customers with usage above this level. This is also consistent with the recommendations made by the Verification Reports of PG&E's 1995 and 1996 Commercial Lighting Evaluation, which stated in 1995 that "program effects can be difficult to detect for large customers," and recommended censoring large customers for the final billing analyses.

Although the decision to censor these customers was made *a priori,* large participants and nonparticipants were still surveyed (as discussed above in the *Section 3.1, Sample Design*) in order to meet other evaluation objectives.

Aggregation to Site ID Level

As mentioned above, one concern with aggregating to the Site ID level is that there may be control numbers associated with a different premise number, service address, or corporation number that are in the same physical site and are being affected by the installed measures. Therefore, a comparison was made between the engineering energy impact and the aggregated pre- and post-installation bills to identify any customers where this problem of bill aggregation may exist. In addition, both a ratio of energy to square feet (from the MDSS and the survey), and energy to employee was calculated for each participant to further aid in the identification of poorly aggregated sites.

There were 241 HVAC and/or lighting participants that were identified as having total Commercial Sector Program energy impacts that were either more than 50 percent of their pre-installation usage or whose energy to square foot or energy to employee ratio was in the bottom 10^{th} percentile of the participant population. These 241 participants were further analyzed to determine whether the impact was large relative to usage because of a problem in aggregating the bill, or if the engineering estimates were just over-estimated. In the latter case, the customer would **not** be removed from the billing analysis.

Three criteria were used to determine if there was a problem with aggregating the bill for these 241 participants. If a participant failed any of these criteria, the customer was removed from the analysis on the basis that their billing data were not properly aggregated to the Site ID level, and the entire impact would not be detected in an analysis of the customer's billing data.

- If the customer's energy impacts were greater than 100 percent of their pre-installation usage and any one of their annual kWh per square foot or annual kWh per employee was in the bottom tenth percentile of all participants, the customer was removed.

- If the customer's energy impacts were greater than 50 percent of their pre-installation usage and either their annual kWh per square foot or annual kWh per employee was in the bottom tenth percentile of all participants, the customer was removed.

- If the customer's energy impacts were greater than 25 percent of their pre-installation usage and all three of the annual kWh per square foot and annual kWh per employee ratios were in the bottom tenth percentile of all participants, the customer was removed.

As a result of these three criteria, 61 of the 241 premises were removed. Of the 61 removed customers, 24 also failed the invalid usage data screening checks. Therefore, only an additional 37 premises were removed based solely upon the data screening criteria described above.

Section 3.3 presents the number of participants that were removed from the analysis for each of the above criteria.

In summary, out of the original sample frame of 549 nonparticipants, 62 were removed for bad billing data or for being an extremely large customer. This low attrition rate can be attributed to the fact that the nonparticipant sample was pre-screened for invalid billing data (though not for large usage, as they may have served as a control group for the participants). Of the original sample of 860 HVAC and lighting participants, 181 were removed because of bad billing, improper site aggregation, or because they were large customers. Of these 181 customers, 94 were HVAC participants.

2. *Background Variables*

Background variables, such as interest rates, unemployment rates and other economic factors, were not explicitly controlled for in the final model, However, the effect of these factors was explicitly accounted for when a cross-sectional time series model was used with a comparison group. This is based on the assumption that the comparison group was equally impacted by the same set of background variables.

3. *Data Screen Process*

As explained in *Section 3.3*, the final model was fitted in two steps. The first step is to estimate a baseline model to develop the relationship between the pre-installation year usage and the post-installation year usage, followed by an SAE model to estimate the SAE realization rates based on the engineering estimates of program impacts. Section 1 above describes in detail all of the data screening criteria. *Section 3.3* also details the number of customers that were screened for each criteria.

4. *Regression Statistics*

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

A baseline model is initially estimated using only the comparison group sample. This model estimates a relationship that is then used to forecast the post-installation-year energy consumption for both participants and the comparison group, as a function of pre-installation-year usage. In this way, baseline energy usage is forecasted for participants by assuming that their usage will change, on average, in the same way that usage did for the comparison group. The outputs of the baseline model are presented in *Section 3.3.*

The estimated SAE realization rates are used to adjust the engineering estimates of expected annual energy impacts for the entire participant population. The regression statistics for the final SAE model are presented in the following exhibits, and a more detailed discussion can be found in *Section 3.3.*

Exhibit B
Final SAE Model Output

Parameter Descriptions	Analysis Variable Name	Units	Parameter Estimate	t-Statistic	Sample Size
SAE Coefficients					
Lighting End Use					
Lighting Offices	LGTOFF5	kWh	-0.856125	-5.15	154
Lighting Retails	LGTRET5	kWh	-1.357155	-2.10	78
Lighting Schools	LGTSCH5	kWh	-0.613314	-1.91	51
Lighting Miscellaneous	LGTMSC5	kWh	-0.859361	-2.35	92
HVAC End Use					
Retrofit Express Measures	RETX5	kWh	-1.061511	-3.43	324
ASDs	ASD5	kWh	-0.853041	-2.94	25
Custom HVAC	CSTHVC5	kWh	-10.290247	-4.05	3
Other End Uses					
Other Impacts	OTHMEAS5	kWh	1.413001	2.45	22
Change Variables					
Part Lighting Changes	LGT_CHG5	kWh	-0.174985	-8.83	74
Part HVAC Changes	AC_CHG5	kWh	-0.004323	-0.22	123
Part Other Equipment Changes	OTH_CHG5	kWh	0.148858	5.00	39
Part Square Footage Changes	SQFT_CH5	# Sqft*kWh	2.540250	0.92	32
Part Employee Changes	EMP_CHG5	# Emp*kWh	138.243740	0.92	137
Nonpart Lighting Changes	LGT_NON5	kWh	-0.042143	-2.06	47
Nonpart HVAC Changes	AC_NON5	kWh	-0.022783	-1.01	60
Nonpart Other Equipment Changes	OTH_NON5	kWh	0.137414	4.27	40
Nonpart Square Footage Changes	SQFT_NO5	# Sqft*kWh	12.151441	4.57	31
Nonpart Employee Changes	EMP_NON5	# Emp*kWh	574.101061	1.97	91

The dependent variable is the difference between the actual and predicted 1998 usage using the 1995 baseline model.

SAE coefficients are calculated for seven different combinations of business type and measure. Primarily those measures that have broad participation and relatively high expected impacts were supported by separate SAE coefficients. In addition, a separate SAE coefficient was calculated for other Commercial Program measures outside the Lighting and HVAC end uses.

Attempts were made to estimate the SAE coefficients at a finer level of segmentation, but generally either one of two problems were encountered. First, available sample sizes were too small to support a finer level of segmentation. Or second, certain parameters were correlated with each other and needed to be combined into a single parameter (a standard econometric solution to solving the problem of collinearity). For example, it was determined that there was a high incidence of central air conditioners and setback thermostat installations at the same site in office buildings. Therefore, there was enough correlation between the central air conditioners and setback thermostat engineering estimates to warrant combining the two estimates into a single office estimate in the model.

Because of the high incidence of many types of standard HVAC measures being installed at the same premise and some of the low sample sizes, the HVAC analysis was conducted for three distinct technology groupings: ASDs, other RE measures, and other Custom measures. ASDs were modeled separately because the model indicated a highly significant result for ASDs, and there was little cross participation among ASDs and other HVAC measures. Other RE measures were modeled separately from Custom measures because the application of the technologies is very different, and there is a lower rate of incidence of RE measures being installed with Custom measures.

All of the HVAC SAE coefficients are significant at the 95 percent confidence level, and all were of the correct sign. The Custom HVAC parameter estimate, however, was found to be extremely large, 10.3, indicating that the actual impact was ten times as large as the engineering estimate. Because the sample for Custom HVAC consisted of only 3 sites, and because the engineering estimates were based on calibrated engineering models, the SAE results for Custom HVAC were not used. Instead, the calibrated engineering estimates were used as the ex-post energy estimates (which is equivalent to setting the SAE coefficient to one). It should be noted that this approach is Protocol compliant, as the Protocols accept calibrated engineering estimates in lieu of a statistically adjusted engineering impact.

Impact estimates from the MDSS for other end uses were included in the model for customers that installed measures outside the Lighting and HVAC end uses. It is not recommended that this value be used because the sample may not be representative of the population of participants installing these measures.

In addition to the SAE Coefficients, independent variables were included to capture changes in lighting, HVAC and other equipment, made outside of the program, as well as changes made to the size (square footage) of the building and with the number of employees. Separate change variables were developed for participants and nonparticipants.

5. *Model Specification*

The model specifications are presented in *Section 3.3*. Specific model specification issues are further discussed below:

Cross-sectional Variation. The final model specification recognizes the potential heterogeneity problem in the model and uses the following procedures to eliminate the impacts of the cross-sectional variation: (1) observations with highest usage values were removed in the model to reduce the overall variance of the sample in terms of usage and size; and (2) independent variables were all interacted with the pre-installation usage to ensure that change of independent variable will be proportional to the usage value.

Time Series Variation. The key factors to control for the time series variation in the final model are: (1) use of the comparison group to define the relationship of the energy consumption between two different time periods and (2) elimination of the multiple time period interactions by only one yearly pre-installation period and one yearly post-installation period for each stage.

Self-selection. One solution to the problem of self-selection in the gross billing model is to include an Inverse Mills Ratio in the model to correct for self-selection bias. This method was

Attachment 3-15
Commercial HVAC Net-to-Gross Adjustments for Demand Impacts
By Business Type and Technology Group

Program and Technology Group		Office	Retail	College/Univ	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Svcs.	Comm. Svcs.	Misc.	Total
Retrofit Express	Central A/C	0.81	0.68	0.74	0.77	0.78	0.78	0.77	1.18	0.98	1.55	0.85	0.70	[redacted]
	Adjustable Speed Drives	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	[redacted]
	Package Terminal A/C	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	[redacted]
	Set-Back Thermostat	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	[redacted]
	Reflective Window Film	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	[redacted]
	Water Chillers	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	[redacted]
	Other HVAC Technologies	0.81	0.68	0.74	0.77	0.78	0.78	0.77	1.18	0.98	1.55	0.85	0.70	[redacted]
Retrofit Express Program Total		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
REO	Adjustable Speed Drives	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	[redacted]
	Water Chillers	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	[redacted]
	Cooling Towers	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	[redacted]
Retrofit Efficiency Options Program Total		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
APO	Adjustable Speed Drives	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	[redacted]
	Water Chillers	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	[redacted]
	Customized EMS	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	[redacted]
	Convert To VAV	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	[redacted]
	Other Customized Equip	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	[redacted]
	Other HVAC Technologies	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	[redacted]
Advanced Performance Options Program Total		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

addressed by Heckman (1976, 1979[2]) and is used by others (Goldberg and Train, 1996[3]). Goldberg and Train develop the technique of including a second Inverse Mills Ratio in the savings regression to account for the possibility that participation is correlated with the size of energy savings. The second Mills Ratio is interacted with a measure of energy savings, which allows the amount of net savings to vary with participation. A complete description of the methods used to calculate the Inverse Mills Ratios, and the results of the net billing model, are described in detail in *Section 3.3.9.*

Collinearity. Various statistical tests (such as COLLIN and VIF options in SAS) were used to check multiple collinearity problem among independent variables in the model to ensure that the final parameter estimates are robust.

Net Impact. As mentioned in the Self-selection section above, a net billing model was implemented using the double inverse Mills ratio approach. The net billing model's estimates of the term (1-FR) were used to verify the results of the self-report and discrete choice models. The net billing model's estimates of (1-FR) were the highest of all three models tests. To be conservative, a the net impacts were derived from the gross billing analysis model and adjusted by a net-to-gross ratio using a combination of the discrete choice and self-report methods. For a detailed discussion on the selection of the NTG ratios, refer to *Section 3.4.4.*

6. *Measurement Errors*

For the billing data regression analysis, the main source of measurement errors is the telephone survey. Our approach has been to proactively stop the problem before it happens so that statistical corrections are kept to a minimum.

Measurement errors are a combination of random and non-random error components that plague all survey data. The non-random error frequently takes the form of systematic bias, which includes, but is not limited to, ill-formed or misleading questions and mis-coded study variables. In this project, we have implemented several controls to reduce systematic bias in the data. These steps included: (1) thorough auditor/coder training; (2) instrument pretest; and (3) cross-validation between on-site audit data and telephone survey responses.

The random measurement error, such as data entry error, has no impact on estimating mean values because the errors are typically unbiased. For the measures that were modeled in the billing regression analysis, the impact of random unbiased measurement errors was accounted for as part of the overall standard variance in the parameter estimate.

---

2 Heckman, J. 'The Common Structure of Statistical Models of Truncation, Sample Selection and Limited Dependent Variables and a Simple Estimator for Such Models.", Annals of Economic and Social Measurement, Vol. 5, pp. 475-492, 1976.

Heckman, J. "Sample Selection Bias as a Specification Error." Econometrica, Vol. 47, pp. 153-161, 1979.

3 Goldberg, Miriam and Kenneth Train. 'Net Savings Estimation: An analysis of Regression and Discrete Choice Approaches', prepared for the CADMAC Subcommittee on Base Efficiency by Xenergy, Inc. Madison, WI, March 1996.

7. *Autocorrelation*

The autocorrelation problem exists if the residuals in one time period are correlated with the residuals in the previous time period. Since the final model is based on a yearly pre- and post-installation period comparison with only one year in each period, the autocorrelation problem was unlikely to occur under this scenario, as was confirmed by examining the Durbin-Watson statistic for these models.

8. *Heteroskdasticity*

See discussion above.

9. *Collinearity*

See discussion above.

10. *Influential Data Points*

See discussion above.

11. *Missing Data*

See discussion above.

12. *Precision*

The precision calculation for the gross SAE realization rates are presented in *Section 3.3.* Relative precision's for net estimates were calculated using the following procedure:

- First, NTG ratios, N_i, were computed for all technology groups that were represented in the telephone survey.

- Then, the program level NTG and program level standard error for the NTG were calculated using the classic stratified sample techniques. The program level NTG was a weighted average of technology level NTG values with adjusted gross impacts per technology group providing the weights.[4] The functional relation can be best described in the following equations:

$$\overline{N} = \sum_i w_i * \overline{N_i} \text{ with } w_i = MWh_i$$

$$StdErr_{NTG} = \sqrt{\sum_i \left[(w_i)^2 * StdErr_i^2 \right]}$$

Where,

NTG = Net-to-Gross Value;

i = Technology Group i; and,

w_i = Weight of technology group i.

- Then, the relative precision[5] for the program NTG value for energy was calculated and combined with the relative precision of the gross energy impact to yield an overall relative precision for the net energy impacts:

$$RP_{NTG\_Energy} = \frac{t_{\alpha=10} * StdErr}{NetMWh}$$

$$RP_{NetEnergy} = \sqrt{RP^2_{NTG\_Energy} + RP^2_{GrossEnergy}}$$

- Finally, the relative precision net demand impacts were calculated using a scaled version of the relative precision for the net energy impact. The sample sizes of the on-site audits and telephone surveys served as the scalars:

$$RP_{NetDemand} = RP_{NetEnergy} * \sqrt{\frac{N_{OnSite}}{N_{Telephone}}}$$

- Per-unit NTG relative precision data appearing in Table 6 (Items 1-5) were calculated in a similar fashion.

[4] Technology groups with no standard errors were excluded from this calculation.

[5] The example shown is for the 90 percent confidence level. Relative precision was also calculated at the 80 percent confidence level.

E. DATA INTERPRETATION AND APPLICATION

The program net-to-gross analysis was conducted based on a discrete choice analysis and on survey self-report. For a detailed NTG analysis discussion, see *Section 3.4.*

Self Report Method

The self-report method used to score free-ridership uses participant responses to survey questions regarding the timing of and reasons for equipment replacement actions. The complete text of the participant surveys may be found in the *Survey Appendices, Appendix A.* Questions used for the self-report analysis are summarized in *Section 3.4.*

The net-to-gross ratio using the self-report method included estimates of free-ridership and spillover. These results yielded the lowest estimates of net participation, and were used in all circumstances with the exception of RE CAC and Other HVAC Technologies, where the results of the discrete choice method were used.

Discrete Choice Method

A discrete choice logit model is used to estimate both a net-to-gross ratio and the free ridership rate associated with PG&E's Commercial HVAC Program (the HVAC Program). The decision to purchase high-efficiency equipment is explained in the logit model by the cost and savings of the equipment, any rebate offered by the HVAC Program, awareness of the HVAC Program, and other customer characteristics. In this application, the high-efficiency equipment examined is CAC and Other RE HVAC Technologies. Once estimated, the model can be used to determine the probability of purchasing high-efficiency equipment in the absence of the HVAC Program. This is simulated by setting both the rebate and program awareness variables to zero and re-calculating the probability of purchasing high efficiency HVAC equipment.

The net-to-gross ratio is calculated using the probability of purchasing high-efficiency equipment both with and without the existence of the retrofit program. The expected impact with the program is the probability of choosing high-efficiency equipment multiplied by the energy impact of the equipment. Similarly, the expected energy impact in absence of the HVAC Program is the probability of purchasing high-efficiency equipment without the program multiplied by the energy impact of the equipment. The net-to-gross ratio is the net savings due to the program divided by the expected energy that results from having the program. As discussed in *Section 3.4,* this method is also used to determine free ridership rates and nonparticipant spillover.

Attachment 5

PG&E Response to Verification Report for Studies #349 & 351

And

Independent Reviewers' Report to the CPUC Regarding Studies #349 & 351

Memorandum

FROM: Elsia Galawish, PG&E

TO: Joshua Faulk, Randy Podzena, ECONorthwest

DATE: 9 September, 1998

RE: Response to Verification Report for PG&E CEEI Studies # 349 and 351

CC: Don Schultz, CPUC-ORA; Ralph Prahl, Jeff Schlegel, Independent Reviewers

The purpose of this memo is to respond to the recommendations and assessments made in the verification report (VR). Because the issues surrounding PG&E's response are nearly identical for the lighting and HVAC reports, we have combined our response into one memo.

This response is divided into two sections. The first section is directed towards addressing the recommended changes to the load impacts presented in Table 6 of the CEEI Study #349 & #351 VRs. The second section discusses our concerns about statements made in both lighting and HVAC VRs,.

Section I: Response to Overall Recommendations

Although the VR presented alternative methods and results for many different aspects of the evaluation, the report only recommended two changes to the final evaluation results.

- The first was to **adjust the Gross Billing Analysis** such that a consistent set of "change" variables was maintained. Specifically, the VR recommends that the coefficients on site-change variables estimated in the baseline model be used to predict the baseline energy use of participants, and these variables be removed from the participant gross impact regression.

- The second recommendation was specific only to the HVAC evaluation, where a **slight modification was made to the self-report free ridership estimate**. The recommendation was to delete from the analysis, customers that provided contradictory responses regarding their hypothetical HVAC purchase action in the absence of the program. **Because the reasoning behind the change is reasonable and justified, PG&E agrees to implement this change to the approach.**

1. Gross Billing Model Analysis.

PG&E's response is structured in the following manner:

- Clarification of the intention of our modeling approach. PG&E believes the VR team's recommendation stems, in part, from the erroneous perception that we have violated our own modeling intentions;
- Detailed explanation of the approach chosen for the Gross Billing Analysis; and
- Illustration that shows the recommended approach should not be applied given sample limitations.

a. Model Intention

The VR team recommends that the coefficients on site-change variables estimated in the baseline model be used to predict the baseline energy use of participants; and these variables should then be removed from the participant gross impact regression.

On pages 7 and 8, the VR claims that "failure to employ the site-change variables for participants in the baseline model potentially introduces bias in the impact estimates. That is, we cannot be certain that the estimated (baseline) kWh will represent what it is intended to represent: the amount of energy that these participants would have used in the absence of the CEEI program." Furthermore, in the VR's summary of our analysis on page 4, the VR states that our approach estimated "post-period kWh for lighting and HVAC program participants in the absence of these incentive programs."

Both of these statements have incorrectly assessed the intent and thus the final outcome of our modeling approach. The intent of the baseline model and application of the results to the participants was never intended to estimate "the amount of energy that these participants would have used in the absence of the CEEI program." The objective of this step in the analysis was to estimate what post-period usage would have been for participants in the absence of *ANY* changes made at the facility. This is clearly documented not only on page 3-40 of the Final Lighting Report and page 3-44 of the Final HVAC Report, but also on page 2-27 of the Final CEEI Research Plan (*see Attachment 1*), which was authored prior to any analysis taking place.

The VR claims that there is inconsistency and bias in our model. However, the VR provides little or no basis for these assessments, other than to incorrectly state the intent of our approach. For example, on page 8, the VR states that "the estimated (post-period) kWh will only represent the amount of energy that nonparticipants would have used had they both not participated in the CEEI program and not made any site changes.

This statement correctly defines the objective of our approach. However, the use of the word "only" indicates that ORA may not have understood that this was the model's intention. The VR team goes on to claim that this approach may not be an unbiased estimate of baseline participant behavior. It is unclear why it may not be unbiased, as it is unclear how The VR team is defining baseline participant behavior.

PG&E's approach is to estimate baseline participant behavior in the absence of any changes at the facility, in which case our estimate *is* unbiased. However, the VR reflects the perception that we are trying to estimate baseline participant behavior in the absence of the program. This is neither the intent nor the application of our approach.

b. Model Justification

Justification for PG&E's approach begins with a discussion two types of events that would cause a business' energy consumption to change:

- *Controlled* events, such as remodeling, retrofitting, or expansion.
- *Uncontrolled* events, such as changes in weather or economic indicators.

Recall that the nonparticipant baseline model estimates post-period usage as a function of pre-period usage, interacted with business type and size, changes in weather, and other site changes made at the facility. The nonparticipant baseline model specification attempts to account for changes in energy usage that are attributable to controlled and uncontrolled events. The uncontrolled events are appropriately accounted for by the business type and size, and weather variables; whereas the controlled events are accounted for with the other site-change variables.

Uncontrolled events are simply that, uncontrolled. The business operators and decision makers have no control over the weather, for example. We would expect that uncontrolled events affect similar businesses in similar climate zones in a similar fashion. If there were no uncontrolled events that occurred (e.g., weather was constant), we would expect the majority of changes in energy usage over time to be due to controlled events.

Controlled events are a function of actions taken by building operators and decision makers. These events may not effect similar businesses in a similar fashion. The decisions building operators and decision makers make are dependent on much more than their business type and size. For example, awareness of PG&E's energy efficiency program may affect the decisions that they make. The fact of their participation distinguishes the character of their business decisions in the area of equipment adoption.

PG&E believes that a comparison group of nonparticipants is best utilized to estimate the effects on participant usage over time due to *uncontrolled* events. Furthermore, using a comparison group of nonparticipants is likely to provide a *biased* estimate of the effects of controlled events on participant usage. The building operators and decision makers among nonparticipants are not representative of the building operators and decision makers among participants. It is for this reason that we do not apply the coefficients for the nonparticipant site-change variables to estimate the effects of non-rebated site-changes on participant usage.

Take for example, the case where changes in weather between a pre- and post-period are negligible. We would then expect the estimate of post-period usage in the absence of any site-changes to be very similar to the pre-period usage. In fact, this was the case for the 1996 CEEI evaluation, where the majority of the coefficients on pre-period usage interacted with business type were near to one. Under this scenario, the post-period would have been near equal to the pre-period had no controlled events occurred. Therefore, the difference between the pre- and post-period usage for a group of participants can be explained by the measures installed under the program plus any additional changes made at the facility. This is exactly how our approach is intended to simulate behavior: by estimating as a baseline, what the post-period usage would have been if no uncontrolled events occurred.

Consider another scenario where no uncontrolled events occurred over the pre- to post-periods, and participants and nonparticipants each made an equivalent number of HVAC, lighting, employee and other equipment changes outside of the program. In this example, "equivalent" refers to the number of participants or nonparticipants that make changes, without regard to size, efficiency, or application. Under this scenario, the VR suggests that, for the participants, the difference between the pre- and post-period usage should equal the savings associated with measures installed under the program plus the *nonparticipants'* savings associated with the measures they installed.

The approach recommended in the VR assumes that the nonparticipants make similar types of changes with regard to type, efficiency and application. Given that these are controlled events, driven by the building operators and decision makers, it is very unlikely that the nonparticipants would have made similar types of changes: they are less likely to be aware of PG&E's programs, less likely to be aware of the benefits of energy efficiency, and less likely to have recently made the decision to install energy efficiency measures under the program. Furthermore, some of the nonparticipant changes *were rebated* in other program years, which may not be representative of the types of non-rebated measures being installed by participants.[1] It is evident that the nonparticipant changes would be different from those installed by participants outside of the program.

c. Sample Design Issues

[1] A nonparticipant is defined as a customer that did not receive a rebate in 1996 through PG&E's CEEI program. Therefore, customers receiving rebates in 1994, 1995 or 1997 may be included in the nonparticipant control group.

Using the approach suggested in the VR hinges on the fact that the effects on energy usage due to controlled events are similar among nonparticipant actions and participant non-rebated actions. Regardless of whether or not this statement is true, there is still the issue of sample representativeness to consider.

The Protocols require a sample of 350 nonparticipants to be used in the final analysis dataset. We exceeded this value by including 428 nonparticipants in our analysis. This sample was developed to be representative of the participants with respect to business type and size, specifically to account for uncontrolled events. In order for the nonparticipant sample to be representative of controlled events, we would require a sufficient sample of controlled events to have occurred across the nonparticipant sample. Among the 428 nonparticipants, only 41 made lighting changes and 53 made HVAC changes. Given the diversity of the sample in terms of building type and size, and given the variety of types of lighting and HVAC changes that may have occurred, it is unreasonable to expect a representative sample of nonparticipant changes. This is why we conducted a canvass survey of an additional 3,796 nonparticipants. This enabled us to obtain a representative sample of nonparticipant changes for use in the net-to-gross analysis.

We were able to isolate the effects of the controlled events in our nonparticipant baseline model, such that we obtained an accurate relationship between the uncontrolled events and energy usage. We believe that our sample of 428 nonparticipants is representative of the participants with respect to business type and size, such that we can apply the relationship of uncontrolled events and energy usage from the nonparticipant sample to the participants. However, we do not believe that the coefficients estimated for site-change variables are representative of the participant population.

Conclusion

To summarize, the objective of the nonparticipant baseline model was to develop an estimate of what participant post-period usage would have been in the absence of *ANY* changes made at the facility. Our approach utilizes a nonparticipant group to account for uncontrolled events, such as changes in weather. We believe that nonparticipants and participants in similar businesses, of similar size, will behave similarly with respect to uncontrolled events, such as changes in weather. Furthermore, we do not believe that nonparticipants *choose to undertake* controlled events in a manner similar to participants because of underlying differences in the decision makers. Therefore, we do not believe the nonparticipant group should be used to estimate the effects on post-period usage of non-rebated participant changes.

This decision was made *a priori*, as is documented in our evaluation research plan (see Attachment 1). We would also like to point out this was an issue in last year's evaluation, where the independent reviewers stated that the "handling of specific business change variables essentially boil down to a matter of differing modeling preferences." The independent reviewer made no statements regarding inconsistency or bias with this approach.

Section II. Concerns with the Verification Reports Assessment of the Evaluation

PG&E has serious concerns about statements that are made in the VR. It would appear that the verification team is attempting to justify its recommended results by (a) illustrating how it could have produced much lower results had it chosen to do so, and by (b) making false and unfounded claims that PG&E results were "cherry picked".

- First, the VR produces an extra set of results for Protocol Table 6, even though the VR team does not recommend using the results. These results are based on a discrete choice model that we believe to be seriously flawed, and provides unrealistically low estimates of net effects. Our concern is that the VR team may have chosen to report these results, hoping that the reader may incorrectly infer that the VR recommendations are conservative or represent a "middle ground". We discuss our concerns with the changes to the discrete choice model in more detail below.

- Second, the report makes the statement more than once that all of the modifications explored by VR team have the effect of lowering the estimated net impacts. This is contradictory to the fact that the alternative model that the VR team explored for the net billing analysis for HVAC measures had the effect of *increasing* the net-to-gross ratio. In addition, by following the VR team's recommendation of removing the HVPART variable in the net billing model, and following the remainder of the Study's net billing model approach, the net lighting impacts *increase*. Finally, by removing the interaction of the Mills ratio from the net billing model as suggested by the VR, and reverting to a single Inverse Mills Ratio approach, the net impacts would also *increase*.

One would expect that a goal of the verification team is to reduce net impacts. Therefore, while exploring alternative methods, PG&E expects that the verification team would attempt to identify changes that would reduce the net load impacts. We take great offense to their accusation that we "cherry-picked" methodologies. In fact, there are a number of recommendations that were made by PG&E where a methodology was selected that provided *lower* net load impacts. (For example, page 79 of the Lighting Report states "the selection of the discrete choice model provides the most conservative estimates of the three net-to-gross approaches.") We will point out these instances, as well as provide examples of reasonable modifications to our models that we would expect the verification team to have explored during their verification process, which resulted in higher net impacts.

1. Discrete Choice Analysis

The VR had two criticisms of the discrete choice model used for the net to gross analysis. The first concerns using program awareness as an exogenous variable in the discrete choice model. The second involves an accusation of 'cherry picking' or deliberately constructing the model to give only the most favorable results. Each of these issues is discussed below.

In the discrete choice model, PG&E uses an awareness variable (AWARE2) that indicates those customers that became aware of the program before they began shopping for lighting or HVAC equipment. Awareness of the program is included in the model for two reasons. The obvious reason is that only those that are aware of the program will be able to participate. In addition, program awareness serves as a proxy for all of the other program benefits outside the rebate. Program awareness plays an important role in the purchase decision and omitting it entirely from the purchase model would result in a serious mis-specification. When awareness is excluded from the model, program effects are only captured through equipment rebates in the model. As a result, there is no mechanism in the model to estimate spillover, since actions outside the program are not affected by rebates. Therefore, at a minimum, all effects of spillover are ignored, not to mention the incremental effects awareness has on participants beyond the effects of the rebate.

Considerable effort was spent designing survey questions to get an accurate measure of program awareness. The issues raised by the independent reviewers on the discrete choice model implemented during the 1997 AEAP (PY1995 CEEI evaluation) were addressed during the PY1996 CEEI evaluation.[2] It was our intention from the start to implement a more conservative definition of program awareness that could be used as an exogenous determinant of equipment purchases.

To get an estimate of program awareness, questions were asked to ascertain when people became aware of the program and to screen out those who became aware of the program while they were shopping for equipment, even if they ultimately participated in the program. In addition, a high efficiency predisposition variable (PREDISP) was created to flag those customers that have a predisposition to purchase high efficiency equipment and likely would have done so in the absence of the program. The result is a definition of awareness which includes only those customers that became aware of the program before they began shopping for the equipment. For this group of customers it can be said that awareness of

---

[2] The independent reviewers raised two primary concerns with how awareness was used in the discrete choice model in the PY95 Evaluation: (1) that the act of shopping for equipment may cause awareness of the program, and (2) that a customer's predisposition to purchase high efficiency equipment may increase their likelihood to also be aware of the program. We addressed these issues by first defining the awareness variable in the purchase model to only flag customers as being aware if they were aware of the program prior to shopping for equipment. Furthermore, we addressed the second issue by including an independent variable in the equipment selection model, PREDISP, that flagged those customers that have a predisposition to purchase high efficiency equipment and likely would have done so in the absence of the program

the program encouraged them to purchase high efficiency lighting. Under this more conservative definition of awareness, only 80 percent of the participants in the sample were aware of the program before they began shopping for equipment, in contrast to 100 percent of participants who ultimately became aware of the program.
The VR suggests that this awareness variable may be biased, since customers were asked about program awareness after they had already purchased the equipment. While awareness was asked after the fact, it is the *only* way that awareness can be determined since it is virtually impossible to identify purchasers and determine program awareness before the equipment is purchased.

The VR also suggests that respondents may not answer the awareness questions accurately and may overstate program awareness to please the interviewer. However, it is equally plausible that a portion of respondents may understate their awareness of the program. For example, respondents may also claim that they did not become aware of the program until after they began shopping for equipment when in fact they were aware before then. Both types of measurement error would have the effect of biasing the coefficient estimate on awareness toward zero. In this case, the model used by PG&E would understate the importance of awareness rather than overstating as the VR claims.

A more serious issue suggested in the verification report is that PG&E "cherry-picked" the models to provide only the highest net estimates. This is an incorrect statement. As demonstrated below, reasonable and protocol-compliant variations on the reported model will produce substantially higher net to gross estimates.

The model relies on two program variables AWARE2 and CINDEX, the latter of which is defined as cost minus rebate divided by cost. Obviously, removing either of these variables will reduce the overall net to gross estimate, as the verification report shows. However, alternative model specifications using these variables result in even higher net to gross estimates. These alternative specifications were apparently not explored by the verification team but are discussed below.

- In the first alternative model, the conservative awareness variable AWARE2 is replaced with a less stringent AWARE, where a customer is coded as aware of the program if they became aware before or at the same time as when they purchased the equipment. Using this definition of awareness, one minus free ridership increases from the original .71 to .81 and the resulting net to gross ratio rises from .81 to .94.

- A second alternative model uses the original awareness variable, but in the equipment choice model the CINDEX variable is replaced with COST and REBATE as separate variables. This alternative yields a net to gross estimate of 1.16, 43 percent higher than the .81 originally reported.

Both of these alternative models are reasonable specifications and provide higher net to gross estimates than what were ultimately reported. The fact that we did not report these results and went with a lower estimate shows that we were not 'cherry picking' but were in fact concerned with developing the most applicable, defensible, and Protocol-compliant model possible.

2. PG&E Selected CONSERVATIVE Net-to-Gross Ratios, NOT the Highest

As mentioned above, the VR suggests that PG&E may have made a "'cherry picking' approach to model and variable selection," with regard to estimating net-to-gross effects. Three approaches were taken to model the net-to-gross effects. Exhibit 3-47 of the lighting report and Exhibit 3-42 of the HVAC report provide the results of each of the three approaches.

In the case of lighting, the Discrete Choice model provided a net-to-gross ratio of 82%, compared to a result of 85% based on self-report and 99% based on the net billing model. Both models follow the Quality Assurance Guidelines, are Protocol-compliant, and have been used in previous evaluations. Clearly, the recommended result using the Discrete Choice model provided significantly lower net load impacts. Had we chosen the net billing model, our result would have been 21% larger.

Similarly, in the case of HVAC, the Discrete Choice model provided a net-to-gross ratio of 53%, compared to a result of 54% based on self-report and 90% based on the net billing model. In this case, had we chosen the net billing model, our result would have been 67% larger.

3. Incorrect Statement Made in Verification Report

The VR provides suggestions on how each of these models could, or should, be modified. In each case, the VR suggests a method that results in lower net-to-gross ratios, and claims that "all modifications explored by the VR team have the effect of lowering the estimated net impacts." Clearly, it is the objective of the ORA and their verification team to identify alternative approaches that have the effect of reducing net impacts, which in itself may bias the approaches investigated by the VR team. However, we have identified three cases where we have followed all or a portion of the VR team's recommendations, which resulted in *higher* net-to-gross and/or net impact estimates.

On page 9 of the HVAC VR for Study ID #351, Table 2 presents a comparison of results between PG&E's Net Billing Model, and the revised Net Billing Model explored by the VR team. Under the VR's methodology, the resulting net-to-gross ratio for Retrofit Express Measures and ASDs increase from 76% to 88%, and from 93% to 115%, respectively; whereas the resulting net-to-gross ratio for Custom HVAC decreases from 103% to 92%. The overall result is that the total HVAC net-to-gross ratio *increases* when the verification teams recommended model is applied.

On page 11 of the lighting VR for Study ID #349, the VR recommends re-estimating the probit model without the HVPART variable. If this recommendation is implemented, and the remainder of the Study's net billing model approach is followed, the resulting net load impacts *increase*.

Finally, page 9 of Study #351 VR states that its "primary concern with the (net billing) model was the use of the Mills ratio interacted with other variables." If we address this concern by reverting to the single Inverse Mills Ratio approach, which is not interacted with other variables, the resulting net load impacts *increase*.

4. Examples of Modifications Resulting in Higher Load Impacts

As discussed above, three models were employed to estimate the net-to-gross ratios: self-report, net billing model, and discrete choice model. The VR states that "all modifications explored by the VR team have the effect of lowering the estimated net impacts." We have already pointed out that recommendations made in the VR surrounding the net billing model have resulted in higher net impacts, not less as stated in the VR. Furthermore, the self-report results recommended by the VR resulted in a change in net impacts by less than one tenth of one percent. Finally, the recommended revisions to the discrete choice model were to remove variables that could *only reduce* net effects, because they were (awareness) variables that explained the net benefits provided by the program.

Below, PG&E provides examples of how reasonable and Protocol-compliant modifications to the self-report and net billing model would have resulted in higher net impacts. The section above which discusses the discrete choice model also provides two examples of how the model could have been modified to increase the net impacts. In fact, we are surprised to find that the verification team did not test at least one of these changes. Two of the modifications shown below directly address concerns raised by the VR team.

a. Modifications to the Self-Report Model

The changes recommended to the self-report model by the verification team result in negligible decreases in net load impacts: less than one tenth of one percent. The self-report approach looks at three sets of survey questions to assign an estimate of free ridership. It attempts to assign the estimate of free ridership base on the first set of questions (e.g., PD110/PD115 for Lighting), and if data are missing or indeterminant, it uses the second set (e.g., PD110 for Lighting), and then the third set (e.g., PD050 for Lighting),. One alternative to this method would be to change the order in which the sets of survey questions are analyzed. If we simply switch the order of the first two sets of questions (e.g., for lighting we first analyze PD100, and then PD110/PD115), we would get a lower free ridership estimate. In the case of lighting, free ridership decreases from 13% to 11% when we change the order of the algorithm. Similarly, for HVAC, free ridership decreases from 48% to 44%.

b. Modifications to the Net Billing Model

The VR states that its "primary concern with (the net billing) model was the use of the Mills ratio interacted with other variables." The VR team claims that it is "unnecessary" to interact the Mills ratio with the engineering estimates in addition to being included in level form" and that it "potentially confounds the effect of the self-selection bias correction."

Although our model is a slight variant[3] on the Double Inverse Mills Ratio approach (DIMR) developed by Goldberg and Train (1996)[4], the DIMR approach does interact the Mills ratio with the engineering estimates in addition to being included in level form. The DIMR is a widely accepted methodology in this industry and was presented to the CADMAC Subcommittee on Base Efficiency as a recommended approach for estimating net savings for Commercial Energy Efficiency Incentive programs. The VR team provides no justification for why they believe the DIMR approach should not be used, nor do they provide any basis for the approach that they have recommended.

Nevertheless, as discussed above, the VR states it has a concern with interacting the Mills ratio with the engineering estimates. As discussed above, an obvious alternative methodology would then be to apply the (single) Inverse Mills Ratio approach, which does not interact the Mills ratio with the engineering estimate, and is another common industry methodology used in estimating net effects. This methodology provided similar results to the DIRM approach, with slightly lower net impact results for the lighting technologies, and slightly higher net impact results for the HVAC technologies. In addition, the Study's results are all statistically significant with one exception. However, the approach recommended in the VR did not provide statistically significant results for *any* of the HVAC measures.

PG&E would also like to address a comment that was made in the VR, with which we do not agree. The report attempts to justify the removal of a variable (HVPART) in the probit model that estimates the probability of participating in the lighting program, by stating "the HVAC participation decision is likely made simultaneously with the lighting participation decision." Of the 3,253 sites participating in lighting in PY96, only 124 (or 4%) participated in the PY96

---

[3] Our method does not include the engineering estimate without interacting it with the Mills Ratio, as is suggested by Goldberg and Train, referenced below.

[4] Goldberg, Miriam and Kenneth Train. 'Net Savings Estimation: An analysis of Regression and Discrete Choice Approaches', prepared for the CADMAC Subcommittee on Base Efficiency by Xenergy, Inc. Madison, WI, March 1996. Other references for correcting for self-selection bias using the Mills ratio technique include:

Heckman, J. 'The Common Structure of Statistical Models of Truncation, Sample Selection and Limited Dependent Variables and a Simple Estimator for Such Models.", Annals of Economic and Social Measurement, Vol. 5, pp. 475-492, 1976.

Heckman, J. "Sample Selection Bias as a Specification Error." Econometrica, Vol. 47, pp. 153-161, 1979.

HVAC program. Furthermore, of these 124 customers, only 52 submitted an application for the PY96 HVAC program during the same month. In addition, 225 PY96 lighting participants participated in either the PY94, PY95 or PY97 HVAC program. These statistics lead us to believe that the HVAC participation decision is *not* made simultaneously with the lighting participation decision. Furthermore, as is discussed above, the removal of the HVPART in the Study's net billing model results in *higher* net impacts.

Conclusion

In summary, PG&E is left with the impression that the strategy taken by the VR team was to attempt to lead the reader into believing that:

1. PG&E's filed results are an upper bound of net impacts because the methodologies used were "cherry-picked";

2. The revised net impacts using the modified discrete choice model provide a lower bound of net impacts; and

3. The net impacts recommended by the VR are some "middle ground", and therefore, reasonable (as inferred by presenting alternative results in Table 6, which are not recommended, and are unrealistically low).

PG&E has clearly illustrated that all three of these points are incorrect and misleading. We have shown that:

1. PG&E's filed results are conservative, reasonable, protocol-compliant and unbiased;

2. The VR's results based on the modified discrete choice model are unrealistically low, in fact should be considered below any acceptable lower bound; and

3. The VR team's recommended results are biased and underestimate the gross and net load impacts.

Closing Comments

The only significant recommendation made by the VR team is the change to the gross billing model. PG&E has clearly justified the intent of our model, and illustrated that it is not an inconsistent or biased approach. The VR team provides no justification for its claims of inconsistency or bias.

When comparing PG&E's filed results to the results recommended by the VR, the result presented for the modified discrete choice model should be ignored. This result is not recommended, it does not represent a lower bound, and it provides an unrealistically low result as it ignores the effects of program awareness and all related program benefits.

We look forward to discussing our response in more detail with any of the ORA staff.

ATTACHMENT 1
Excerpt from PY96 CEEI Research Plan
Pages 2-26 to 2-29

2.3.4 Model Specifications

Because many participants tend to install rebated measures in more than one program, it is expected that many customers will have participated in both the lighting and HVAC end uses. Therefore, one integrated billing model will be run incorporating participants from both these end uses.

Gross Billing Regression Analysis

Two separate multivariate regression models will be integrated to provide unbiased and robust model estimates of gross energy impacts. The key feature to this approach is that it employs a simultaneous equation approach to account for both the year-to-year and cross-sectional variation in a manner that consistently and efficiently isolates program impacts.

A baseline model will initially be estimated using only the comparison group (nonparticipant) sample. This model will estimate a relationship that is then used to forecast the post-installation-year energy consumption for all participants as a function of pre-installation year usage. In this way, baseline energy usage is forecasted for participants by assuming their usage will change, on average, in the same way that usage did for the comparison group. The baseline model explains post-installation usage as a function of pre-installation energy usage, weather changes, and customer self-reports of factors that could affect energy usage. The baseline model has the following functional form:

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

Where,

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

ΔCDD_i and ΔHDD_i are the annual change of cooling and heating degree days (base 65°F) between the post-installation year and pre-installation year;

$Elec_i$, is an indicator variable (0/1) for the ith customer, which equals 1 if the customer has electric heating;

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

α_j is the indicator variable (0/1) for the jth business type, which equals 1 if the customer is in that business type and 0 otherwise;

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

ε is the random error term of the model.

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

$$k\hat{W}h_{post,i} = F_{pre}(kWh_{pre}, \Delta CDD, \Delta HDD) = \sum_j(\alpha_j + \beta_j kWh_{pre,i}) + \gamma(\Delta CDD_i) * kWh_{pre,i} + \phi(\Delta HDD_i) * Elec_i * kWh_{pre,i}$$

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

$$kWh_{post,i} - F_{pre}(kWh_{pre}, \Delta CDD, \Delta HDD) = \sum_m \beta'_m Eng_m + \sum_k \eta'_k Chg_{ik} + \mu_i$$

The difference between predicted and actual usage in the post period will be used as the dependent variable in the SAE model. Based upon the estimated participation month, the pro-rated engineering estimates and change variables will be used to explain the deviation in actual usage from the predicted usage. As discussed above, the predicted usage will be estimated using only the comparison group to forecast the post period usage as a function of pre period usage and change of cooling and heating degree days from pre to post. This usage prediction presents what would have happened in the absence of the program and other changes that may have occurred at the premise.

The coefficients of the engineering impact, termed the SAE coefficients, will then be used to calculate the ex post gross energy impacts. Independent realization rates will be estimated to provide PG&E with business type and technology group level results.

Net Billing Regression Analysis

The net billing regression analysis uses a model specification similar to the baseline model used in the gross billing analysis, with three significant differences:

- Both participants and nonparticipants are included in the model.
- An Inverse Mills Ratio (Mills Ratio) is entered into the model in two ways. First, an Mills Ratio is entered for participants and nonparticipants to correct for self-selection

bias. Second, an additional Mills Ratio term is interacted with a participation indicator variable.

- Using two different model specifications, the Mills Ratio terms are used to estimate both impacts and net-to-gross ratios at the technology level.

To calculate the Mills Ratio, the first step is to estimate a probit model of program participation. The probit model will include all factors thought to influence the decision to make an equipment purchase:

$$\text{PARTICIPATE} = \alpha + \beta'X + \beta'Y + \beta'Z + \varepsilon$$

where PARTICIPATE is an indicator variable with a value of one for program participants and a value of zero for nonparticipants. The X term includes firmographic variables such as business type and electricity usage, Y includes variables reflecting equipment characteristics such as cost and electricity savings, and Z reflects program variables such as rebate amount and program awareness. Information on these variables for both participants and nonparticipants will be obtained from the MDSS as well as from the participant and nonparticipants surveys.
From the probit estimation results, a Mills Ratio is calculated for both participants and nonparticipants:

$$\text{Mills Ratio} = \phi(Q) / \Phi(Q) \text{ (for participants)}$$
$$= -\phi(Q) / \Phi(-Q) \text{ (for nonparticipants)}$$

$$Q = \alpha + \beta'X + \beta'Y + \beta'Z$$

where ϕ is the probability density function and Φ is the cumulative density function for the normal distribution.

In the net billing model, the first Mills Ratio is included for both participants and nonparticipants to control for self-selection bias. The second Mills Ratio is interacted with the participation indicator variable so that only participants have a nonzero value for this term. The result is a coefficient estimate reflecting the impact for participants that corrects for any unobserved influences that affect both program participation and size of impact for participants.

Using the Double Inverse Mills Ratio technique, two separate net billing regression models will be estimated. In both models, the second Mills Ratio term is broken out by technology type. Model 1 includes engineering estimates interacted with the Mills Ratio. With this model, the coefficient estimates on the second Mills Ratio will reflect one minus the free-ridership rate for that technology. Model 2 is similar to Model 1 except that the second Mills Ratio is not interacted with an engineering impact estimate. This results in the coefficient estimate on the second Mills Ratio to be the net impact associated with that technology. Both model specifications are given below.

Model 1

$$kWhPost_i = \Sigma_j (\alpha_j + \beta_j\text{'}kWhpre_i) + \gamma\text{'}(\Delta CDD)*kWhpre_i + \phi\text{'}(\Delta HDD)*Elec_i*kWhpre_i + \Sigma_k\eta\text{'}chg_{i,k} + \delta\text{'}Mills + \Sigma_k \lambda_k\text{'}Mills*D_i + \varepsilon$$

Model 2

$$kWhPost_i = \Sigma_j (\alpha_j + \beta_j\text{'}kWhpre_i) + \gamma\text{'}(\Delta CDD)*kWhpre_i + \phi\text{'}(\Delta HDD)*Elec_i*kWhpre_i + \Sigma_k\eta\text{'}chg_{i,k} + \delta\text{'}Mills + \Sigma_k \lambda_k\text{'}Mills*Eng_k*D_i + \varepsilon$$

Where,

$kWhpost_i$ and $kWhpre_i$ are customers i's annualized energy usage for the post- and per-installation periods;

ΔCDD and ΔHDD are the annual change of cooling and heating degree days between the post-installation and pre-installation year;

$Elec_i$ is an indicator variable which equals 1 if the customer has electric heating and 0 otherwise;

$Chg_{i,k}$ are the customer self-reported change variables from the survey data;

Mills is the Mills Ratio;

D is a indicator variable indicating program participation;

α_j is an indicator variable for the jth business type;

Eng_k is the ex post engineering impact for the kth technology;

β, γ, δ, λ, η are coefficients to be estimated;

i,j, and k are index variables indexing customers, business types, and technology respectively;

ε is the normally distributed random error term.

Application Nos: 98-05-001, 98-05-005,
98-05-013, 98-05-018

Exhibit No: ____________________

ALJ: Meg Gottstein

REPORT TO THE CPUC ENERGY DIVISION ON DISPUTED SAVINGS CLAIMS IN THE 1998 AEAP AND CONSENSUS RECOMMENDATIONS FOR PROTOCOL CHANGES

1998 Annual Earnings Assessment Proceeding (AEAP)
ALJ: Meg Gottstein

October 12, 1998

By
Ralph Prahl and Jeff Schlegel
Independent Reviewers

Table Of Contents

INTRODUCTION 2

PG&E 1996 CEEI PROGRAM 7

PG&E AND SCE 1996 NRNC PROGRAMS .... ERROR! BOOKMARK NOT DEFINED.

SDG&E 1996 NRNC PROGRAM .... ERROR! BOOKMARK NOT DEFINED.

SCG 1996 CEEI PROGRAM .... ERROR! BOOKMARK NOT DEFINED.

CROSS-CUTTING ISSUES INVOLVING PY 1996 INDUSTRIAL STUDIESERROR! BOOKMARK NOT DEFINED

PG&E 1996 IEEI PROGRAM .... ERROR! BOOKMARK NOT DEFINED.

SCE 1996 IEEI PROGRAM .... ERROR! BOOKMARK NOT DEFINED.

SDG&E 1996 IEEI PROGRAM .... ERROR! BOOKMARK NOT DEFINED.

PRODUCTION INCREMENTS ISSUE .... ERROR! BOOKMARK NOT DEFINED.

MISCELLANEOUS PY 1997 POLICY ISSUE: DEFINITION OF PROGRAM YEARERROR! BOOKMARK NOT

INTRODUCTION

This report summarizes the findings of Ralph Prahl and Jeff Schlegel, independent reviewers of the activities of CADMAC for the CPUC Energy Division, regarding two issues for the 1998 AEAP: (1) consensus recommendations for changes to the protocols; and (2) a number of disputes over utility savings claims.

CONSENSUS RECOMMENDATIONS FOR PROTOCOL CHANGES

CADMAC included two consensus proposals for protocol modifications in its testimony dated September 8, 1998 (section II, sub-sections A and B). We have reviewed both of these consensus proposals. In addition, following the renewal of our contracts with the CPUC on May 20, one or both of us attended all of the CADMAC meetings at which these consensus proposals were developed, discussed, and approved by CADMAC. At these meetings, we provided comments and suggestions on proposals that appeared to be nearing consensus so that the issues could be discussed fully at CADMAC. We also reviewed and provided comments on a draft of the CADMAC testimony to ensure that any unresolved issues associated with the consensus protocols were addressed in the testimony.

Based on our review, we find that both of the consensus proposed protocol modifications are reasonable. Both provide benefits, and do so without increasing risks in a major or unacceptable manner. For example, the proposed language regarding handling of persistence studies in support of the third and fourth earnings claims should help to reduce future controversies due to ambiguities regarding these issues, while the proposed modifications to the *Quality Assurance Guidelines* should help to improve the quality of studies in the remaining years of the utility shareholder incentive mechanisms. For these reasons, we recommend that the CPUC adopt both of the consensus proposed protocol modifications.

We note, however, that one of the proposed protocol modifications, the modifications to the *Quality Assurance Guidelines*, described on pages 22-24 and reproduced on pages 25-79 of the testimony, appears to have already become implicated in the disputes between ORA and the utilities regarding several specific studies. Because we believe the *Guidelines* are not problematic in and of themselves, we discuss the role of the *Guidelines* in the disputed studies in the context of the sections of this report on the relevant disputes, rather than here.

Finally, in regard to the market effects studies ordered in the 1996 AEAP and described on pages 79-80 of the CADMAC testimony, we note that: (1) as discussed in the testimony, all of these studies have now been completed under the direction of the CADMAC Market Effects subcommittee, which includes, in addition to the utilities, ourselves and several other non-utility parties; and (2) we believe these studies have already made valuable contributions to the CBEE's efforts to develop and implement effective programs to address the Commission's new market transformation objectives.

SAVINGS DISPUTES

The disputes covered by this report involve both load impact studies for program year 1996 and ex-ante load impact estimates for program year 1997. In the remainder of this section we discuss the approach we used to review these disputes; the scope of our report on the disputes; the organization of the remainder of the report; and two miscellaneous issues pertaining to our recommendations.

Approach

Our assessment of the disputes over savings results was based on the following data sources:

- Review of the original studies, and in some cases of supplementary material provided by the utilities.
- Review of the review memos and verification reports prepared by ORA consultants.
- Review of the testimony and supporting exhibits filed by ORA and by the utilities.
- Review of the data requests exchanged between parties, as well as of a small number of data requests of our own.
- Participation in the Case Management Meeting on October 8.

For reasons of availability, this year Ralph Prahl took the lead in reviewing all disputes, and will be our primary witness regarding both this issue and the consensus proposed protocol modifications. Jeff Schlegel also briefly reviewed the disputes we viewed as most significant either in their financial impact or the importance of the principles being disputed, and consulted with Mr. Prahl on remaining disputes. Both reviewers are in full agreement on all of the findings and recommendations contained in this report.

As in past years, while we were producing this report, discussions were proceeding between the utilities and ORA on some of the disputed issues. In late September, we notified the parties that we would include in our report all significant disputes identified in the utilities' reply testimony to ORA's report, except for any issues for which we received written notification from both the utility and ORA by October 2 that the dispute has been settled. As we did not receive notification of any such settlements by October 2 (or later, for that matter) we did not end up excluding any disputes due to early settlement. On October 7, in connection with the Case Management Meeting, we released a draft summary of our findings and recommendations, intended for purposes of information only. On October 8, we participated in the Case Management Meeting by phone.

Scope of This Report

We have included in the review only those disputes where there are non-trivial differences between ORA and each utility regarding shareholder earnings recommendations. We note that the utilities have disputed some ORA findings and conclusions regarding impact evaluation results which do not, for one reason or another, have any immediate effect on shareholder earnings. We do not plan to comment on these disputes unless directed to do so by the Administrative Law Judge.

For disputes over 1996 load impact studies, our report addresses all those significant disputes of which we are aware. However, for disputes involving ex-ante load impact estimates for 1997, this report addresses only two major issues: (1) the handling of savings claims associated with production increments, or savings from industrial measures which are associated with an increase in efficiency that coincides with an increase in production; and (2) a dispute between SDG&E and ORA regarding how to determine which cases to include in the 1997 program year, which hinges on the definition of program year. While there were a significant number of ex-ante disputes involving other issues still open at the time we completed this report, we have a number of reasons for leaving these disputes out of this report. First, ORA and the utilities are still discussing these issues, and all indications are that many of them -- though not necessarily all -- will be resolved by the time the AEAP hearing commences. Second, these disputes tend to be highly case-specific, often involving differences of opinion over the appropriateness of the value the utility assumed for a specific engineering parameter for a specific participant. We did not believe it was an effective use of our time to review such case-specific disputes until it was clear that ORA and the utilities could not resolve them. Finally, to date, most of these disputes have not been documented adequately by either side for us to develop an informed opinion on them.

We would like to suggest to the utilities that their October 20 rebuttal testimony to this report might be an appropriate forum in which to document any remaining differences with ORA regarding 1997 ex-ante load impact estimates that cannot be resolved between the parties. We would then review these disputes and attempt to be prepared to answer questions regarding them at the hearing.

Organization of This Report

In past years, we have structured our report primarily around individual programs and the disputed studies associated with these programs. However, this year we have done things a little differently. Our review found that there were a large number of disputes that spanned individual studies and programs, and involved ORA taking a common position against multiple utilities. For purposes of narrative clarity, we have tried to reflect this fact in the structure of our report. Where a dispute appears to be limited to a specific study performed in support of a specific program, we have provided a separate section on the program as in past years. However, in several cases we have combined the discussion of multiple programs and even multiple utilities into a single section discussing the set of disputed issues that these programs and utilities have in common.

First, for 1996 Nonresidential New Construction programs, because both PG&E and SCE are involved in disputes with ORA over the same core set of issues, we have combined the discussion of these two programs into a single section.

Second, for PG&E, SCE and SDG&E's 1996 Industrial Energy Efficiency Incentive programs, our review showed a high, albeit incomplete, degree of overlap in the underlying issues driving the disputes between the utilities and ORA. To repeat our basic analysis of these issues for each utility would be repetitious. For this reason, we have grouped our discussion of the IEEI programs together toward the end of the report, and prefaced them with a cross-cutting section that analyzes the underlying differences between ORA and the utilities and provides recommendations regarding the resolution of these differences.

Third, because the disputes between the utilities and ORA over savings associated with production increments span both multiple utilities and multiple program years, we have organized our discussion of this issue into a single section near the end of the report. Consistent with our practice of deferring comment on disputes over the assumptions made in connection with individual cases until it is clear that the parties cannot resolve their differences over these cases, we have limited ourselves to discussing generic principles we believe should be observed in resolving production increment disputes.

Finally, because the dispute between SDG&E and ORA over which cases to include in the 1997 program year is the only issue discussed in the report that is limited solely to the 1997 program year, it is presented at the end of the report.

As in previous years, each section of our report generally contains four sub-sections: (1) a description of the disputed study or issue; (2) a summary of the disputes between ORA and the utility; (3) a discussion of our findings regarding these disputes; and (4) our recommendations.

Two Notes on Recommendations

Finally, we note two miscellaneous issues pertaining to our recommendations.

First, this is the fourth consecutive year in which we have prepared this report, and in that time we have accreted a large number of positions on certain perennially debated energy efficiency impact evaluation issues. Because we believe it is important that regulatory policy on such issues be consistent, where earlier precedents exist, we have generally attempted to make clear why we believe our current recommendation is consistent with them, often quoting directly from our earlier reports.

Second, as in past years, we have generally not attempted in this report to recalculate shareholder earnings for each program and program year based on our recommendations. These calculations are fairly labor-intensive, and in most cases require the use of primary data that we did not have at our command. Instead, we generally recommend that either the utility or ORA be directed to file new E-tables that are consistent with our recommended resolution to each dispute. Whether we recommend that the utility file new tables or ORA do so depends on which set of existing E-tables appears to require the least work to make them consistent with our recommendations.

PG&E 1996 CEEI PROGRAM

Study Numbers 349 (Lighting) and 351 (HVAC)

DESCRIPTION OF STUDY

This large and complex effort was the primary study conducted by PG&E in support of its 1996 earnings claim for the Commercial Energy Efficiency Incentives program. Both PG&E and ORA's consultants have treated the analysis performed for each of the two end-uses listed above as a separate study, resulting in two different evaluation reports and two different verification reports. However, in actuality, the two end-uses were part of the same tightly integrated study, and the two evaluation reports and verification reports are essentially identical except for the numbers they present and a small number of issues unique to each end-use. Thus in this report we treat the disputes between PG&E and ORA surrounding the 1996 CEEI program as involving a single study.

This study used exactly the same research framework, and contractor, that were used to perform last year's study of PG&E's CEEI program. Last year the study was the subject of numerous disputes, which were ultimately resolved outside of the hearing process. PG&E appears to have revised the study framework to address many of the issues that were disputed last year, with the result that far fewer issues are being disputed this year. Methodologically, the study used the following approaches to develop estimated load impacts for the CEEI program:

1. Enhanced ex-post engineering estimates applied to a portion of the program population, using a nested sample of lighting loggers, on-site audits, telephone surveys, and tracking estimates of savings.

2. A billing analysis approach that attempted to estimate the percentage of the gross savings predicted by the enhanced engineering estimates that was actually realized, using both participant and non-participant billing and survey data (henceforth referred to as "the gross savings billing analysis.") This gross savings billing analysis consisted of three phases: (1) a baseline model applied to non-participants that attempted to explain how various kinds of customers changed their consumption over time; (2) application of the results of the baseline model to participants to yield an estimate of what each participant's consumption would have been in the 1997 in the absence of the program; and (3) a Load Impact Regression Model that sought to explain differences between each participant's actual and predicted consumption in 1996 as a function of program participation, among other factors.

3. An entirely separate billing analysis that used participant and non-participant billing data and the survey data to estimate net program savings (henceforth referred to as "the net savings billing analysis.")

4. An analysis of free riding among participants and spillover effects among both participants and non-participants based on self-reports from the surveys. Multiple questions were asked on the issue of free riding, and algorithms were developed to interpret the sometimes conflicting responses.

5. A behavioral model that used survey data to attempt to estimate the overall effect of the program on the adoption of energy efficiency measures by both participants and non-participants, including both free riding and spillover effects.

These disparate analyses are integrated in various ways to yield estimates of program energy, demand and therm savings by end-use.

SUMMARY OF DISPUTES

The only issue for this study that is disputed and has a financial impact involves the specific modeling methods PG&E used to perform the gross savings billing analysis described in #2 above. The dispute over these methods focuses not on the broad approach followed by PG&E but on the specific independent variables PG&E used in its models to represent changes in participating businesses other than participation in the program. Such changes, which can include changes in the number of employees, the size of the building, and equipment holdings, are both a constant challenge in billing analysis studies and a perennial source of contention between the performers and the reviewers of these studies. In this case, PG&E used the following approach to incorporate business changes into its models:

- Several specific business change variables based on customers' self-reports were included in the baseline model applied to non-participants.

- Similarly, several specific business change variables, which overlapped partially with those used in the baseline model, were included in the load impact regression model.

ORA argues that this approach to representing business changes was inappropriate, and that instead of the approach described above, PG&E should have applied the coefficients for business change variables resulting from the non-participant baseline model to participants – i.e., it should have multiplied these coefficients by the values of the parallel business change variables for participants and added the result to predicted 1997 consumption in the absence of the program. In the words of the Verification Report by ORA's consultants:

> ...The failure to employ the site-change variables for participants in the baseline model potentially introduces bias in the impact estimates.
>
> That is, we cannot be certain that the estimated (baseline) kWh will represent what it is intended to represent: the amount of energy that these participants would have used in the absence of the CEEI program. Instead, the estimated kWh will only represent the amount of energy that nonparticipants would have used had they both not participated in the CEEI program and not made any site changes... The participant site-change variables are ultimately included in the gross impact regression that is estimated using participant data, but there is no reason to believe that this compensates for the bias. (ORA Verification Report for Study 349, pp. 7-8.)

ORA's consultants accordingly re-performed the gross savings billing analysis making the recommended change in the modeling procedure. The result is a lower overall energy savings estimate for the program, with a resulting decrease of approximately $2.6 million in the estimated shareholder incentives for which PG&E is eligible.

In its rebuttal testimony and in a technical memo distributed to us and to ORA, PG&E argues that its approach to modeling business changes was appropriate, and ORA's inappropriate. Specifically, it argues that: (1) contrary to the interpretation given in the Verification Report, the baseline model and the application of the results of this model to participants was never intended to estimate the amount of energy that participants would have used in the absence of the program, but to estimate what post-period usage would have been for participants in the absence of any facility changes of any kind; (2) business changes were instead modeled appropriately in the final savings model; (3) this approach to modeling business changes was planned up front as part of an explicit effort to distinguish between the modeling of *uncontrolled* changes in consumption such as weather in the estimation of baseline consumption, and of *controlled* changes such as business changes; (4) ORA has not shown that this approach to modeling business changes can be expected to result in bias; and (5) ORA's alternative approach produces bias because it fails to recognize either that there are likely to be differences in the business change patterns of participants and non-participants, or that the lighting measures undertaken by non-participants are not likely to be equivalent to the non-rebated lighting measures adopted by participants.

In addition to the key dispute described above, a number of other issues have been disputed in connection with this program that either do not have any immediate financial impact or did not make their way into PG&E's rebuttal testimony. Notably, the Verification Report suggests that PG&E's modeling efforts show some evidence of "cherry picking," or of systematically basing subjective modeling decisions on which approach yields the higher savings estimate. In the technical memos distributed to the parties, PG&E took vigorous objection to this accusation, arguing that in a number of different cases it voluntarily chose a modeling approach that yielded lower savings than the alternative.

Finally, in the Verification Report, ORA's consultants identified what they characterized as a problem with the algorithms used to interpret the survey results, and adjusted the algorithms to correct for this alleged problem. PG&E does not appear to object to ORA's diagnosis of this problem or its adjustment to the algorithms, so this issue results in a minor, undisputed change in PG&E's initial savings estimates.

FINDINGS

We focus our review of the issues solely on the key dispute over modeling techniques that drives the $2.6 million gap between PG&E's and ORA's estimates of shareholder earnings. While we would regard any evidence of "cherry picking" on PG&E's part as a serious matter if a convincing case could be made, as will become clear, we do not believe it is necessary to assess whether or not PG&E engaged in cherry picking in general in order to assess the objectivity of the decisions it made in connection with the specific modeling decisions that drive the gap in earnings estimates.

The exact same issue regarding how to model participant business changes was the subject of dispute in connection with last year's study of the same program, and we addressed this issue in our report for the 1997 AEAP. Because we believe it is important that there be continuity and consistency in the way methodological disputes are handled, we will quote at length from our previous report:

> *Handling of Specific Business Change Variables.* We regard ORA's... criticisms of PG&E's handling of business change issues as... ambiguous... We believe the reason PG&E chose to exclude the business change coefficients resulting from the non-participant baseline model in estimating participants' baseline 1996 consumption is that it included these variables in the final participant savings model. Also including business change issues in the estimation of baseline consumption would have resulted in double-counting...In short, it appears to us that ORA's secondary criticisms of PG&E's handling of specific business change variables essentially boil down to a matter of differing modeling preferences. Our own preferences are closer to ORA's than to PG&E's...While we do not regard PG&E's decision to represent business change issues in the participant savings model rather than in the estimation of baseline participant consumption as a straightforward error, we do tend to believe it would have been more justifiable on theoretical grounds to take the opposite tack -- as did ORA in its re-estimation of the model -- reflecting the fact that business changes affect energy consumption regardless of the presence or absence of the program.
>
> While we prefer ORA's approach to the handling of specific business change variables, we were initially undecided as to whether it offers enough comparative advantages to justify overturning PG&E's handling of the issue. After all, researchers need to have some flexibility to build billing analysis models based on their own modeling procedures and preferences, as long as these do not represent

> clear errors or instances of one-sidedness. For this reason, in our data request we asked PG&E to provide information intended to help us assess the magnitude of the impact of the secondary disputes involving business change variables compared to the impact of the critical "other business change" issue discussed above. The results suggest that the impact of the handling of specific business change variables has very little effect on the results of the model. Given that there is little impact, we are comfortable that it is reasonable to rely on the results of ORA's approach. (Independent Reviewers' 1997 AEAP report, pp. 23-24.)

In short, last year we saw arguments on both sides of the issue. On ORA's side, we concluded that, while PG&E's approach to modeling business changes was not erroneous, and did in fact capture participant business changes in a reasonable manner, ORA's approach might be an improvement in that it correctly represented the fact that business changes affect consumption regardless of the presence or absence of the program. On PG&E's side, we concluded that it was unclear whether or not any improvement was sufficient to justify overturning PG&E's modeling decisions given that no clear error had been made. Ultimately, we did not attempt to resolve the issue but recommended accepting ORA's estimate simply because: (1) which approach was used had very little effect on the final savings estimate; and (2) since we had sided with ORA on other modeling-related issues, accepting ORA's modeling technique avoided the need to ask one of the parties to produce another iteration of a rather complicated analysis framework.

This year the same difference in modeling techniques that produced little difference in savings estimates in 1997 produces a $2.6 million difference in shareholder earnings. Should PG&E's modeling decisions again be overturned?

We believe the answer is no. Our reasons are as follows.

First, we believe ORA's consultants are incorrect in arguing that PG&E's modeling efforts do not adjust for site changes among participants. They simply do so in a different manner than ORA's consultants would prefer. PG&E's approach to billing analysis uses a system of three different, tightly interwoven regression equations to estimate savings. The ability of this approach to provide an unbiased measure of savings can only be determined by assessing this system as a whole, not by focusing on what confounding effects are captured by any one equation in the system.

Second, we believe PG&E has made a stronger case this year than it did last year that ORA's alternative modeling approach would be likely to lead to bias due to differences in business change trends and non-rebated lighting retrofits between participants and non-participants. While ORA's consultants have argued that any admission of such differences on PG&E's part would be tantamount to admitting that the entire modeling framework is suspect, we do not agree with this analysis. Self-selection effects in regression analysis, of which this is an example, are both ubiquitous and extremely difficult to control for. After years of debate among evaluators regarding proper techniques, full consensus still does not exist. We regard the assertion made by PG&E in its technical memos that self-selection effects regarding business change trends bar ORA's modeling approach as simply a recognition of the fact that, despite its best efforts, these effects probably have not been entirely controlled for.

Third, and perhaps most importantly, we continue to be uncomfortable with the concept of ORA's consultants substituting their modeling judgment for PG&E's when they have not identified a clear error in PG&E's procedures. Even if ORA's modeling approach did constitute an improvement over PG&E's – and as the preceding paragraph should make clear, it is not at all clear to us that this is the case – we believe the proper scope of ORA's review activities is to identify and correct for errors and instances of one-sidedness in the utilities' procedures, and not to substitute its own subjective modeling preferences for PG&E's.

Finally, we are comfortable that, regardless of whether or not PG&E indulged in cherry picking in the study as a whole, it did not do so in its selection of this particular modeling technique. First, as noted by PG&E, the company clearly described the approach it would use to model participant business changes before it began the study. Second, as shown in the passage from our report from last year that is excerpted above, PG&E vigorously defended its chosen modeling approach in the 1997 AEAP, despite the fact that virtually no dollars were at stake on the basis of it. These facts lead us to conclude that PG&E's preference for its own modeling technique over ORA's is not being driven by financial considerations, but instead reflects a legitimate difference of opinion regarding the relative merits of two technically plausible approaches.

RECOMMENDATIONS

We recommend that: (1) PG&E be directed to produce new e-tables identical to those it filed initially, with the sole exception that the error that both parties agree exists in the algorithm for interpretation of free rider survey data be corrected; and (2) PG&E's shareholder incentives be based on these tables.

Certificate of Service

I, Ralph Prahl, hereby certify that I have this day caused a copy of the *Report to the CPUC Energy Division on Disputed Savings Claims in the 1998 AEAP and Consensus Recommendations for Protocol Changes*, dated October 12, 1998, to be mailed to all parties of record in Application 98-05-001, et al.

Executed at Madison, Wisconsin, on October 12, 1998.

____

Ralph Prahl

Attachment 6

PG&E Retroactive Waiver for 1997 Commercial Sector EEI Programs

Lighting and HVAC End Use Net-to-Gross Analysis

PACIFIC GAS & ELECTRIC COMPANY
RETROACTIVE WAIVER FOR
1997 COMMERCIAL SECTOR EEI PROGRAMS
Lighting and HVAC End Use
Net-to-Gross Analysis
STUDY IDs: 333a & 333b
Approved by CADMAC on January 20, 1999

Program Background

Pacific Gas & Electric Company (PG&E) fielded DSM programs to the Commercial sector (among others) during 1997. The primary purpose of the 1997 Commercial Program (Programs) was to promote the installation of energy efficient equipment retrofits. The Programs offered a wide variety of energy efficient prescriptive lighting and HVAC measures ranging from compact fluorescent lamps to custom non-prescriptive lighting and HVAC measures. The impact evaluation associated with this waiver is designed to assess the actual load impacts resulting from the lighting and HVAC measures rebated during 1997.

1997 Program Summary: Indoor Lighting End Use

Technology	Unique Sites	Avoided Cost	Percentage of Avoided Cost
Compact Fluorescent Lamps	1,956	8,194,724	13.9%
Controls	461	1,086,778	1.8%
Customized Lighting	6	1,388,314	2.3%
Delamp Fluorescent Fixtures	807	14,394,387	24.3%
Efficient Ballast Changeouts	81	90,564	0.2%
Exit Signs	742	1,810,353	3.1%
Halogen	174	80,706	0.1%
High Intensity Discharge	444	5,148,037	8.7%
Incandescent to Fluorescent Fixtures	95	1,128,552	1.9%
T-8 lamps and Electronic Ballasts	3,488	25,818,156	43.7%
TOTAL (Unique Sites)	2,796	59,140,572	100.0%

1997 Program Summary: HVAC End Use

Technology	Unique Sites	Avoided Cost	Percentage of Avoided Cost
Adjustable Speed Drives	136	1,639,531	14.8%
Central A/C	1,266	3,988,213	35.9%
Convert To VAV	1	44,489	0.4%
Cooling Towers	3	41,073	0.4%
Customized EMS	4	305,430	2.8%
Other Customized Equip	1	320,628	2.9%
Other HVAC Technologies	16	229,621	2.1%
Package Terminal A/C	115	397,752	3.6%
Reflective Window Film	243	874,147	7.9%
Set-Back Thermostat	438	1,041,759	9.4%
Water Chillers	25	2,223,580	20.0%
TOTAL (Unique Sites)	1,337	11,106,223	100.0%

Proposed Waiver

This waiver requests deviations from the Protocols by PG&E for the 1997 Commercial Sector Evaluation, lighting and HVAC end uses. PG&E seeks CADMAC approval to allow the use of self-report based algorithms to estimate free ridership and spillover effects for certain technologies should the discrete choice and LIRM models fail to produce statistically reliable results of net-to-gross estimates. Therefore, the self-report methodology would only apply to those technologies (not the entire end-use) for which the discrete choice and LIRM models fail to produce statistically reliable results.

Rationale

It is our expectation that the discrete choice model will provide statistically reliable results for all lighting technologies and CAC HVAC technologies, as was the case in the 1996 evaluation. However, for custom types of HVAC installations and lower penetrated HVAC technologies, sample sizes of nonrebated installations are too small to implement a discrete choice model. Furthermore, low levels of participation for some of these technologies also reduce the likelihood of obtaining statistically reliable results from a LIRM model.

If, after following procedures that are generally accepted as best practices for developing statistical models (see Table 7 of the Protocols) we are unable to build a reliable discrete choice model or LIRM for certain technologies, we propose relying on the self-report estimates of free-ridership and spillover. Methods used for the self-report analysis will follow the Quality Assurance Guidelines, and are documented in PG&E's Evaluation Research Plan, which has been submitted to the ORA.

The primary reason why the discrete choice model may not be used for some technologies is an insufficient number of adoptions identified in the nonparticipant and canvass survey. For example, we do not expect to find a sufficient number of cooling tower adoptions to warrant its inclusion in the discrete choice model. Examples of conditions that could lead to the rejection of the net LIRM approach might include the following: (1) a small number of observations control the model results; (2) intractable collinearity; or (3) intractable nonsignificant t statistics. Based on our experience (particularly with the HVAC end use), we believe these problems (and possibly others) are very likely to materialize. The prevailing criterion for assessing this decision would be that a verification study or peer review would lead to a similar conclusion. Results from all three models will be presented in the final Study, as they were for the 1996 evaluation.