Customer Energy Efficiency Program
Measurement and Evaluation Program

EVALUATION OF PACIFIC GAS & ELECTRIC COMPANY'S 1995 NONRESIDENTIAL ENERGY EFFICIENCY INCENTIVES PROGRAM FOR COMMERCIAL SECTOR REFRIGERATION TECHNOLOGIES

PG&E Study ID number: 330

March 1, 1997

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PG&E STUDY ID#: 330

FINAL REPORT

March 1, 1997

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1. EXECUTIVE SUMMARY

This section presents a summary of the impact results for the commercial refrigeration technologies offered under the Pacific Gas & Electric Company's (PG&E's) 1995 Nonresidential Energy Efficiency Incentives (EEI) Programs, referred to in this report as the Commercial Refrigeration Program. This evaluation covers refrigeration technology retrofits that were performed at PG&E customer facilities, for all rebates paid in 1995. These retrofits were performed under two different PG&E programs, both the Retrofit Express (RE) and the Customized Incentives Programs. Although PG&E has one additional program (Retrofit Efficiency Options) that offers refrigeration measures, no rebates were paid to customers for installing these measures in 1995.

In conducting this evaluation, one very important participant refused to contribute to the evaluation data collection efforts—both attempts to telephone interview this particular customer and to conduct on-site audits at their facilities were rejected. According to ex post evaluation results, this customer accounted for 61 percent of gross energy impacts within the refrigeration end-use and 30 percent of demand.

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). A Request for Waiver was filed and approved to modify some aspects of the evaluation approach, as detailed in *Appendix G.*

The results are presented in three sections: evaluation results summary (covering the numerical results of the study), major findings, and major recommendations.

1.1 EVALUATION RESULTS SUMMARY

The evaluation results are summarized in terms of energy savings (kWh), demand savings (kW), and realization rates, the ratio of the evaluation results (ex post) to the program design estimates (ex ante). 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 and demand savings results (ex post and ex ante), together with each applicable gross realization rate.

Exhibit 1-1
Summary of Gross Evaluation and Program Design Results
For Commercial Refrigeration Applications

	Gross Impacts					
	Energy			Demand		
Program	Ex Ante (kWh)	Ex Post (kWh)	Realization Rate	Ex Ante (kW)	Ex Post (kW)	Realization Rate
Retrofit Express	4,038,402	4,502,403	1.11	405	822	2.03
Customized Incentives	18,574,174	13,703,974	0.74	1,110	886	0.80
Total	22,612,576	18,206,378	0.81	1,515	1,708	1.13

The ex ante numbers presented above in Exhibit 1-1 and below in Exhibits 1-2 and 1-3 were obtained from PG&E's Management Decision Support System (MDSS), PG&E's 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 in 1995 and 1996, revised in December 1996.

The results illustrate the following key points about the gross commercial refrigeration impacts:

Customized Incentives Program -- Overall, the vast majority of the energy savings are from refrigeration technologies installed through the Customized Incentives Program, but the demand savings are more equally divided between the two programs.

SAE Adjustments -- The ex post gross impacts were slightly lower than the ex ante gross estimates for energy, but exceeded them for demand. This is primarily the result of the application of statistically adjusted engineering (SAE) adjustments to energy (but not demand) impact estimates. For example, the gross unadjusted engineering energy impacts for the RE Program had an 0.53 SAE coefficient applied, yielding a much lower estimate of impact than was predicted using engineering methods alone.

Demand Impacts -- Approximately 1/2 of the RE measures were found to have substantially higher ex post demand impacts than were reported in the ex ante values, leading to a gross realization rate in excess of 2.0 for the RE Program. In contrast Customized Incentives ex ante demand impacts were not realized for several distinct applications, yielding an 0.8 realization rate for the Program.

Energy Impacts -- Only three RE measures were found to have substantially higher energy impacts than reported by the ex ante estimates -- two low temperature case door measures and strip curtains for walk-in coolers -- leading to gross realization rates of greater than 1.0 for the overall RE program.

Strip Curtains -- In particular, strip curtains for walk-in freezers were found to have energy impacts that were 6.61 times greater than the ex ante estimates (and demand impacts that yielded an 11.03 gross realization rate).

Exhibits 1-2 and 1-3, present the net energy and demand impact results, together with the net realization rates, at the same levels presented in Exhibit 1-1. A detailed presentation and discussion of the above findings can be found in *Section 4: Evaluation Results.*

The net ex post impacts fall short of the net ex ante design estimates by 44 percent for energy and by 3 percent for demand. These results reflect the gross realization rates as well as the ex ante and ex post net-to-gross (NTG) ratios for refrigeration measures in the RE and Customized Incentives programs. While the NTG adjustments apply equally to energy and demand impacts, their overall effect depends on the relative importance of the measures to which they are applied.

Exhibit 1-2
Summary of Net Evaluation and Program Design Energy Results
For Commercial Refrigeration Applications

Program	Gross (kWh)	Net-to-Gross Adjustments: Free Ridership (1-FR)	Spillover	NTG Ratio (Unitless)	Net (kWh)
		EX ANTE			
Retrofit Express	4,038,402	0.56	0.10	0.66	2,676,059
Customized Incentives	18,574,174	0.65	0.10	0.75	13,930,632
Total	22,612,576	0.63	0.10	0.73	16,606,690
		EX POST			
Retrofit Express	4,502,403	0.88	0.00	0.88	3,977,515
Customized Incentives	13,703,974	0.39	0.00	0.39	5,276,030
Total	18,206,378	0.51	0.00	0.51	9,253,545
		REALIZATION RATES (Ex Post/Ex Ante)			
Retrofit Express	1.11	NA	NA	NA	1.49
Customized Incentives	0.74	NA	NA	NA	0.38
Total	0.81	NA	NA	NA	0.56

For net energy impacts, the overall ex ante NTG ratio was 0.66 for the RE program and 0.75 for the Customized Incentives Program. The ex post NTG ratio for all RE measures averaged 0.88—substantially higher than the ex ante value. In combination with the relatively high ex post gross energy impacts for these measures, this led to a net realization rate of almost 1.5 for the RE program.

Ex post NTG were determined and applied within the RE Program by measure. These estimates varied in magnitude from 0.43 to 1.00, with only one measure estimate falling below 0.70, and 65 percent of the RE estimates equal to 0.98. In contrast, both the ex post gross impacts and the NTG ratio for the Customized Incentives measures were lower than the ex ante values. As a result, net impacts attributable to these measures were only 38 percent of the predicted ex ante value.

Because Customized Incentives refrigeration measures accounted for such a large proportion of ex ante net energy impacts, the low NTG ratio pulled the overall net realization rate down to 0.56.

Exhibit 1-3
Summary of Net Evaluation and Program Design Demand Results
For Commercial Refrigeration Applications

Program	Gross (kW)	Net-to-Gross Adjustments: Free Ridership (1-FR)	Spillover	NTG Ratio (Unitless)	Net (kW)
		EX ANTE			
Retrofit Express	405	0.56	0.10	0.66	269
Customized Incentives	1,110	0.65	0.10	0.75	833
Total	1,515	0.63	0.10	0.73	1,102
		EX POST			
Retrofit Express	822	0.88	0.00	0.88	725
Customized Incentives	886	0.38	0.00	0.38	341
Total	1,708	0.62	0.00	0.62	1,066
		REALIZATION RATES (Ex Post/Ex Ante)			
Retrofit Express	2.03	NA	NA	NA	2.69
Customized Incentives	0.80	NA	NA	NA	0.41
Total	1.13	NA	NA	NA	0.97

For demand, application of the same ex post NTG ratios had a less dramatic impact on realized savings, with an overall net realization rate of 0.97. The ex post NTG ratio for RE measures was applied to an ex post gross impact that was already double the ex ante estimate, yielding a net demand realization rate of 2.69 for the RE program. Since RE gross demand impacts were equivalent in magnitude to the Customized Incentives impacts, this high realization rate helped offset the lower than predicted net demand savings from the Customized Incentives measures.

Detailed presentation and discussion of the above findings can be found in *Section 4: Evaluation Results*.

1.2 MAJOR FINDINGS

Overall, PG&E's ex ante estimates for the commercial refrigeration technologies paid under the 1995 programs understated impacts for RE measures and overstated them within the Customized Incentives Program. The ex ante gross energy impacts overpredicted the actual savings for all but three measures -- two low temperature case door measures, strip curtains for walk-in coolers, and booster desuperheaters. In contrast, the ex ante gross demand impact estimates significantly understated the actual savings for most measures, resulting in a high realization rate.

Because of 1) the application of an 0.75 SAE coefficient to ex post energy impacts and 2) the additional application of an 0.39 NTG adjustment to both ex post energy and demand, within the Customized Incentives Program, the ex ante impacts were found to significantly overpredict the net Program savings.

The low NTG ratio (and high rate of free-ridership) for Customized Incentives measures suggests that PG&E should consider adopting new marketing strategies that will reduce participant free-

ridership levels. Alternatively, PG&E could adopt programs that are designed to achieve market transformation, thereby counteracting these high free-ridership rates with increased contributions from spillover.

1.3 MAJOR RECOMMENDATIONS

Recommendations that would enhance future program performance and evaluation are summarized below, and are presented in more detail in *Section 5*.

Ex Ante Impacts - All RE paid year 1995 ex ante refrigeration algorithms were thoroughly reviewed. Where necessary, these methods were updated using alternate methods or assumptions, as described in detail in *Appendix B*. It is recommended that PG&E carefully review the updates to these algorithms, and where applicable, update future Advice Filings.

In addition, it was found that the application of the current ex ante algorithms in the MDSS were sometimes mis-applied. Such errors could probably be avoided in the future with a regular and thorough review of the MDSS contents by the program manager or a qualified analyst.

End-Use Classification - Ex ante refrigeration impact estimates in the Customized Incentives Program were often mis-classified by end-use. In those instances, measures were lumped together prior to MDSS data entry. These entry errors are due in part to the design of the Customized Incentives application, because the application form "cover sheet" only has space to enter a single measure. It is recommended that application forms for programs similar to the Customized Incentives Program be modified to allow data entry for multiple measures on the application "cover sheet."

Application Engineering Review is a necessary component of the submittal process, and can be used to effectively screen applications that have significant analysis errors. In some instances, large errors were observed in the Customized Incentives applications submitted, resulting in inaccurate reporting of project impacts. It is recommended that a more intensive application review be used to capture these anomalies.

2. INTRODUCTION

This report summarizes the impact evaluation of Pacific Gas & Electric Company's (PG&E's) Nonresidential Energy Efficiency Incentives (EEI) Program for commercial sector refrigeration technologies (the Refrigeration Evaluation). These technologies are covered by two separate program options, the Retrofit Express (RE), and the Customized Incentives Programs. The evaluation effort includes customers who were paid rebates in 1995. These programs 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, agricultural applications, and food service. Customers were required to submit proof of purchase with these applications in order to receive rebates. The program was marketed primarily to small- and medium-sized commercial, industrial, and agricultural customers. The maximum rebate amount, including all measure types, was $300,000 per account. No minimum amount was required to qualify for a rebate.

Refrigeration end-use rebates were offered in the program for the following groups of technologies:

- Refrigeration load reduction measures, which include:
  - Night covers for display cases
  - Strip curtains for walk-in freezers and coolers
  - Glass or acrylic doors for low temperature display cases
  - New refrigeration display cases with glass or acrylic doors, which replace open refrigeration display cases (both for low and medium temperature display cases)
  - Door gaskets and auto-closers for walk-in freezers or coolers
  - Low heat refrigeration display case doors
- Compressor upgrades, which include:
  - Mechanical subcooler
  - Multiplex compressor system, which replaces a standard compressor system
  - Electronic adjustable speed compressors, which replace fixed speed compressors
  - Floating head pressure controls
- Condenser upgrades, achieved by the installation of oversized evaporative- and air-cooled condensers.
- Evaporator upgrades, achieved through the installation of permanent-split-capacitor (PSC) motors to replace existing standard evaporator motors (for walk-ins and display cases).
- Other refrigeration upgrades, which include:
  - Humidistat controls, which reduce the energy usage of anti-sweat heaters

- Energy efficient ballasts, which replace standard efficiency ballasts in display lighting
- Insulation of suction line
- Non-electric condensate evaporator

2.3 THE CUSTOMIZED INCENTIVES PROGRAM

The Customized Incentives Program offered financial incentives to CIA customers who undertook large or complex projects that save electricity. These customers were required to submit calculations for projected first-year energy impacts with their applications prior to installation of the project. The maximum incentive amount for the Customized Incentives Program was $500,000 per account, and the minimum qualifying incentive was $2,500 per project. The total incentive payment for demand and energy savings was limited to 50 percent of direct project costs for retrofit systems. Since the program also applied to expansion projects, the new systems incentive was limited to 100 percent of the incremental cost to make new processes or added systems energy efficient. Customers were paid 4¢ per kWh and 20¢ per therm for first-year annual energy impacts. A $200 per peak kW incentive for peak demand impacts required that savings be achieved during the hours PG&E experiences high power demand.

The Customized Incentives technologies which were analyzed as part of the evaluation can be grouped into one of the following categories: 1) compressor upgrades, which included technologies such as floating head pressure controls and booster desuperheaters, 2) condenser upgrades achieved through the installation of oversized condensers, and 3) other various refrigeration upgrades, including the installation of energy management system (EMS) controls.

As a result of program design, many of the measures installed were similar to or the same as those for the RE program, but were installed in larger and more complex projects.

2.3 EVALUATION OVERVIEW

The impact evaluation described in this report covers all refrigeration technologies installed at commercial accounts, as determined by the Management Decision Support System (MDSS) sector code, that were included under the RE and Customized Incentives programs. The evaluation covers measures for which rebates were *paid* during calendar year 1995. Although all customers were paid in 1995, only about 2/3 of the applications submitted were applied for in 1995. The remaining 1/3 applied under a previous program year, spanning 1993-1994.

The evaluation impact results, both gross and net, are compared with the program design estimates.

2.3.1 Objectives

The objectives of the evaluation were originally stated in the Request for Proposals (RFP), refined during the project initiation meeting, and documented in the evaluation research plan. These research objectives are as follows:

- Determine first-year net energy and demand impacts by business type and technology group for RE and Customized Incentives refrigeration technologies paid in 1995, and overall impacts for the commercial sector as required by the California Public Utilities Commission (CPUC) protocols.

- Compare evaluation results 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 evaluation and program design estimates.

- Provide recommendations to strengthen the RE program.

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

- Complete tables 6, 7, and 11 of the Protocols.

Results are segmented by technology and building type. Technologies are defined by measures offered under the RE and Customized Incentives programs. Building types for the commercial market sector, as defined by PG&E, are office, retail, college and university, schools, grocery, restaurant, health care, hotel/motel, warehouse, personal service, customer service, and miscellaneous.

While gross impacts account for program participant actions (and the refrigeration end-use benefits and costs associated with those retrofit decisions), net impacts account for customer participation choices and the effect that the refrigeration programs' infrastructure has had on the refrigeration retrofit market. For example, adjustments were made to the gross savings estimates to account for customers that would have installed energy-efficient measures anyway, despite the program (free-riders).

The evaluation investigated and, where possible, explains differences between program design estimates and evaluation results.

2.3.2 Timing

The 1995 Commercial Refrigeration Impact Evaluation began in August 1996, completed the planning stage in December 1996, executed data collection between mid-September and mid-November 1996, and completed the analysis and reporting phase in January 1997.

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.

A retroactive waiver was filed with the California DSM Measurement Advisory Committee (CADMAC) to approve of two deviations from the Protocols (in completing PG&E's 1995 commercial sector evaluation of the refrigeration end-use). The CADMAC accepted a request to: 1) allow the use of self-report survey analysis results to estimate net-to-gross effects, and 2) to use the DUOM of "load impacts per project" for the refrigeration end-use.

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[1] California Public Utilities Commission Decision 93-05-063, Revised January 1996 Pursuant to Decisions 94-05-063, 94-10-059, 94-12-021, and 95-12-054.

2.4 REPORT LAYOUT

This report presents the results of the above evaluation. It is divided into five sections, plus appendices. *Sections 1 and 2* are the *Executive Summary* and the *Introduction*. *Section 3* presents the *Methodology* of the evaluation. It is supported in detail by *Appendices A* through *D*. *Section 4* presents detailed results and discussion and is supported by *Appendix E*. *Section 5* presents recommendations for improving the evaluation, the program measures, the program tracking system, and the CPUC Protocols. *Appendix F* provides impacts by Time-of-Use costing periods. A Request for Waiver was filed and approved to modify some aspects of the evaluation approach, as detailed in *Appendix G*. The survey appendices provide the survey and on-site data collection instruments, and the survey call dispositions, frequencies, and refusal comments.

3. METHODOLOGY

In this section, the methods used to conduct the 1995 Pacific Gas & Electric Company (PG&E) Commercial Refrigeration Technologies Evaluation (the Refrigeration Evaluation) are presented. This section begins with an overview of the evaluation approach. This is followed by more detailed discussions of the specific engineering, billing regression, and net-to-gross (NTG) analysis approaches used in the evaluation. Additional detail on these three approaches is supplied in *Appendices B, C,* and *D,* respectively.

3.1 INTEGRATED EVALUATION APPROACH

This overview of the integrated evaluation approach begins by presenting the data sources and the sample design approach used for the Refrigeration 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.

3.1.1 Data Sources

The Refrigeration 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 Refrigeration program. Of particular importance were PG&E's historical billing data, program participant data (Management Decision Support System [MDSS]), paper copies of Customized Incentives applications, other program-related data, and industry standards information. 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 generate impact estimates for 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.

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.

PG&E 1995 Customer Energy Efficiency Programs Advice Filing[1] - This report documents the ex ante earnings claims, including specific information on the derivation of per-unit ex ante savings

[1] PG&E 1995 Customer Energy Efficiency Programs Advice Letter No. 1867-G/1481-E, filed October 1994.

estimates and the assumptions that go into those estimates. This documentation often includes assumptions such as operating hours and operating factors. This document supplies the best information available on ex ante estimates and assumptions, thus facilitating knowledge-based comparisons to ex post estimates.

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

Copies of Customized Incentives Paper Application Files - QC requested and received complete copies of application files for all Customized Incentives participants. The Customized Incentives files were used to conduct detailed application reviews and, for audited sites, to compare application assumptions against observed operating conditions.

Exhibit 3-1
Data Uses and Sources for Refrigeration Impact Analysis

PG&E Program	Analysis Component	Evaluation Data Sources					
		Advice Filings	Industry Standards	Hard Copy Applications	Customer Billing Records	On-Site Audits	Telephone Survey Data
Retrofit Express	Engineering	●	●				
	Statistical				●		●
	Net-to-Gross	●			●		●
Customized Incentives	Engineering	●	●	●	●	●	
	Statistical				●		●
	Net-to-Gross				●		●

Primary Collected Data

Existing data and primary data were integrated to support the integrated evaluation approach, as shown in Exhibit 3-1. Primary data were collected from both participants and nonparticipants. The sample design developed for the data collection plan 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. The final sample sizes used to evaluate all of PG&E's nonresidential commercial sector programs are summarized in Exhibit 3-2 by end-use element.

In conducting this evaluation, one large participant refused to contribute to the evaluation data collection efforts—all attempts to telephone interview this particular customer and to conduct on-site audits at their facilities were rejected. The customer contact originally responsible for implementing energy efficiency projects is no longer with the company. In addition, this participating company is currently involved in a dispute with PG&E. All attempts to discuss the company's past participation in PG&E energy efficiency programs were referred to the company CFO, who declined to answer our calls. This customer, a large grocery chain, represented 39 of the 53 Customized Incentives sites. According to ex post evaluation results, this customer accounted for 61 percent of gross energy impacts within the refrigeration end-use and 30 percent of demand.

Exhibit 3-2
Commercial Sector Data Collection
For the Refrigeration End Use

Program	End Use	Commercial				
		Telephone Surveys	On-Site Audits	End-Use Metering	Time-of-Use (TOU) Loggers	Combination
Custom	Lighting	18	1	0	0	0
	HVAC	58	32	0	0	0
	Refrigeration	**7**	**16**	**0**	**1**	**1**
Retrofit	Lighting	600	227	5	108	112
	HVAC	434	107	20	13	31
	Refrigeration	**235**	**16**	**0**	**1**	**1**
Total	Lighting	614	228	5	108	112
	HVAC	487	137	20	13	31
	Refrigeration	**241**	**18**	**0**	**2**	**2**
Total Participants (Unique Sites)		1,217	380	20	108	126
Total Nonparticipants (Unique Sites)		808	36	0	0	0
Total (Unique Sites)		2,025	416	20	108	126

Telephone Survey Sample - For all the end-use evaluations, telephone surveys were collected for a total of 2,025 customers, 1,217 of which were participants. 241 of these were refrigeration participants. The remaining 808 were in the comparison group, including 201 in the supplemental refrigeration comparison group and 156 outside the program retrofitters found through the canvass survey (as well as 451 in the original lighting and HVAC comparison group). For the refrigeration end use, given the relatively low level of participation, a census was attempted with the telephone survey, which was used to collect data in support of important customer energy use changes reported for use in the SAE analysis, and to facilitate the measurement of free-ridership and net-to-gross (NTG) rates. Annual energy consumption values were used to group customers into five usage/size strata based upon a Dalenius-Hodges procedure. The comparison group customers are then selected to mirror the underlying distribution of the participant target population by size and business type. (For the customers in the largest size strata, a census was attempted both for among participants and nonparticipants.)

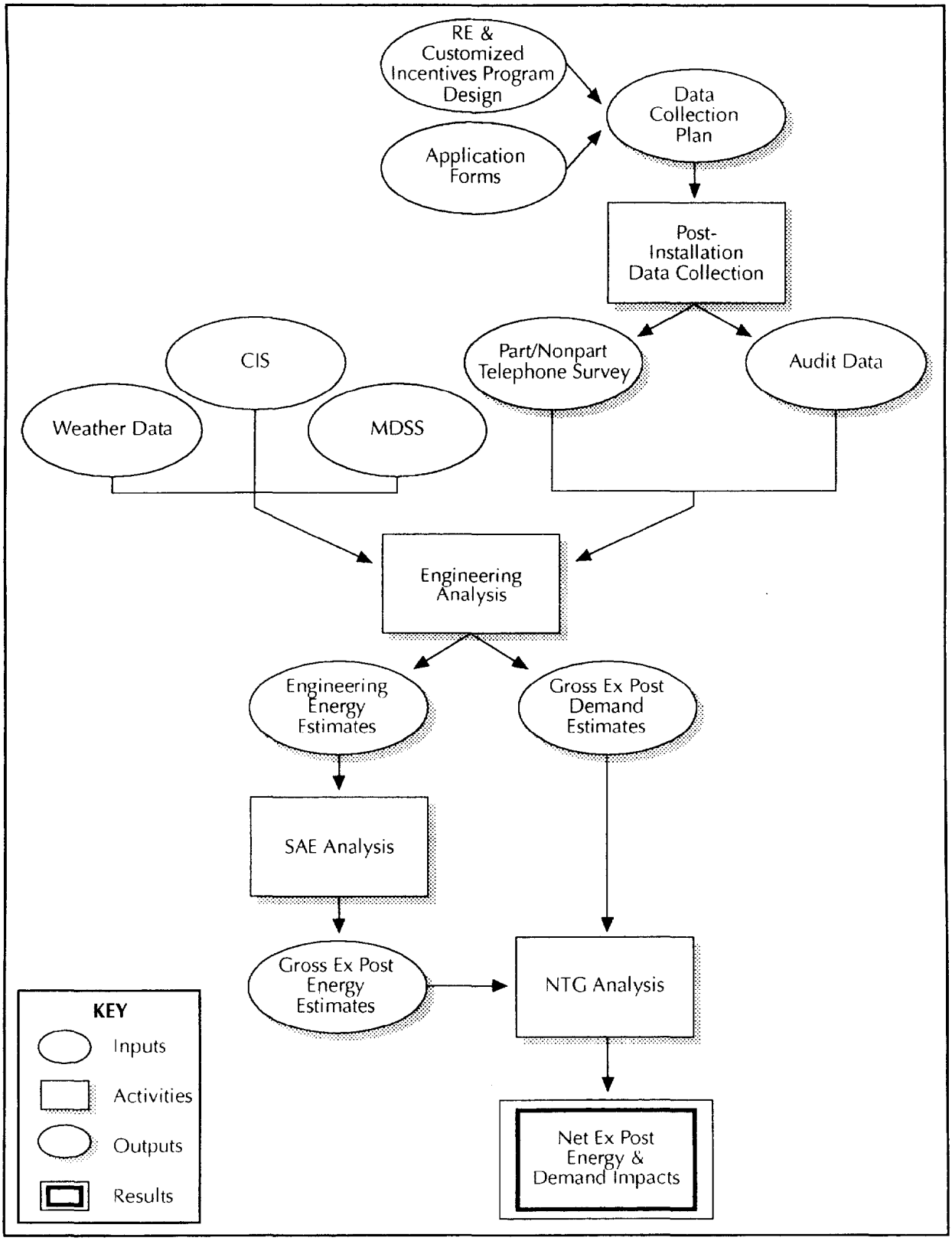
On-Site Audit Sample - For the refrigeration end-use, a census of Customized Incentives program participants was attempted. However, a single grocery chain that represented 39 of the 53 Customized Incentives sites refused to allow audits at their facilities. A total of 13 of the 14 remaining Customized Incentives sites, however, were audited.

3.1.2 Gross Impact Estimates

Per-participant gross energy and demand impacts were developed for specified time-of-use (TOU) costing periods, using engineering and statistically adjusted engineering (SAE) estimates. Steps detailed in this section are displayed in Exhibit 3-3. Slightly different analysis approaches were used for the RE and Customized Incentives measures.

- For RE measures, impacts were estimated based upon a review (and, as required, revision) of the ex ante algorithm for each measure.
- For Customized Incentives sites, every application was reviewed in detail to confirm or modify the input data and the impact calculations.

Exhibit 3-3
Method for Estimating Impacts



Gross Energy Estimates

Gross energy estimates were developed using two distinct analysis steps. Engineering estimates were first developed for each participant, based on the algorithm review for RE measures or on the application review for Customized Incentives sites. These estimates were then adjusted using billing data-derived SAE coefficients.

Gross, unadjusted engineering impacts were developed for each retrofit measure. The engineering methods used are described in greater detail in *Section 3.2*.

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 outputs of the analysis are SAE-adjusted estimates of program energy savings.

Gross Demand Estimates

Gross demand estimates were derived using the algorithm review and recalculation for RE measures, and using an application review and revised calculation for each Customized Incentives measures. Using detailed customer records from each Customized Incentives on-site audit and secondary data from each application, impacts were specifically assessed with the respect to customer usage during the system peak hour. No statistical adjustment was derived nor applied to the demand impact estimates.

3.1.3 Net-to-Gross Estimates

The NTG analysis is designed to adjust gross program impacts for free-ridership and the actions taken by PG&E customers outside the Refrigeration program. Self-reported data were used to estimate the percentage of free-riders in the program; that is, the number of participants who would have undertaken the energy efficiency action promoted by the program in the absence of the program. This self-reported estimate of program NTG was not adjusted for the effects of program spillover, where energy efficiency actions taken outside the program are claimed.

Application of the final NTG adjustments, by technology, yields net program impacts. Each step is taken to achieve final net results is explained in the remainder of this section, starting with the engineering analysis.

3.2 ENGINEERING METHODS

The engineering approach and results that support realized gross impacts in the Refrigeration evaluation are presented in this section. The purpose of a presentation of the engineering computations is to provide detailed intermediate results that either verify or contradict the methods used to generate program design demand and energy impact estimates. The following topics are discussed:

- First, an overview of the evaluation approach is presented.
- Then, the methods used and the engineering estimates developed for refrigeration measures covered by the RE program are discussed.
- Finally, the methods used and the engineering estimates developed for the Customized Incentives Program are summarized.

3.2.1 *Overview of the Evaluation Approach*

The engineering approach to the Refrigeration Evaluation consisted of the analysis of two separate PG&E programs, RE and Customized Incentives. The level of analysis for each program was tailored to its relative importance in generating program impacts.

For each of the RE measures which had paid incentives in 1995, a detailed review of the algorithms and assumptions used to develop ex ante impacts was performed.

Customized Incentives participants accounted for 82 percent and 73 percent of the gross ex ante energy and demand savings calculated for this program, respectively (see Exhibit 3-4). For this reason, a detailed review of each application submitted by a Customized Incentives participants was performed. Thirty-nine of the 53 applications submitted for the Customized Incentives program are from a single supermarket chain, while seven of the applications are from other supermarkets that had retrofit work completed. The remaining seven applications are from various sites, including refrigerated warehouses, shipping facilities and crop cold storage facilities.

Exhibit 3-4
Distribution of Commercial Refrigeration Impacts by Program

PG&E Refrigeration Program	Percentage of Total Gross Ex Ante Impacts	
	Demand	Energy
Retrofit Express	27%	18%
Customized Incentives	73%	82%

3.2.2 *Evaluation Approach: Retrofit Express*

The engineering algorithms used by PG&E to develop ex ante impacts for RE measures were reviewed thoroughly (algorithms were taken from the 1995 Advice Filing[2]). The aim of the evaluation was to either confirm or correct the methods and inputs used in the ex ante estimates. For each measure, the following analysis steps were performed:

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

Then, evaluation impacts were 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.

Exhibit 3-5 provides a summary of the per-unit impacts developed for each RE measure. Detailed information regarding the development of impacts for each RE measure are presented in *Appendix B, Section B.5*.

[2] ibid.

Exhibit 3-5
Summary of Per-Unit Impacts for Retrofit Express Measures

PG&E Measure Code	Measure Code Description	Unit of Impact	Advice Filing Impacts		Evaluation Impacts					
					Recalculated Advice Filing Impacts		Evaluation Impacts		Final Impacts Used to Develop Estimates	
			kWh/yr	kW	kWh/yr	kW	kWh/yr	kW	kWh/yr	kW
R1	A (1995). Night Cover for Display Case	Linear Feet	136.6	0	136.6	0	.	.	136.6	0
R2	B (1995). Strip Curtains for Walk-in	Square Feet	37	0.0035	37	0.0035	386	0.0441	386	0.0441
R3	C (1995). Glass or Acrylic Doors (Low Temperature Case)	Linear Feet	894	0.0846	894	0.0848	1473	0.168	1473	0.168
R4	D (1995). New Refrigeration Case with Doors (Low-Temperature Case)	Linear Feet	894	0.0846	894	0.0848	1473	0.168	1473	0.168
R5	E (1995). New Refrigeration Case with Doors (Medium-Temperature Case)	Linear Feet	345	0.0326	347	0.0328	403	0.0460	403	0.046
R6	F (1995). Low Heat/No Heat Refrigeration Case Door	Linear Feet	312.8	0.0146	312.9	0.0146	181	0.0206	181	0.0206
R7	G (1995). Humidistat Control	Linear Feet	280.5	0.0184	280.5	0.0184	389	0.0449	389	0.0449
R10	H (1995). Case Lighting Electronic Ballast	Lamp(s)	87.5	0.0072	87.5	0.0072	102	0.0125	102	0.0125
R11	I (1995). Insulate Bare Suction Line	Linear Feet	16.02	0	16.67	0	16.310.0018616.3			0.00186
R12	J (1995). Mutilplex Compressor System	Tons	1516.1	0.3754	1516	0.375	1404	0.16	1404	0.16
R20	K (1995). Electronic Adjustable Speed Compressor	hp	462.5	0	462.5	0	514	0.0587	514	0.0587
R14	M (1995). Mechanical Subcooler	THR*	589.7	0.3288	589.7	0.3288	.	.	589.7	0.3288
R19	N (1995). Floating Head Pressure Controller	Tons	548.22	0	548.22	0	.	.	548.22	0
R50	O (1995). Cooler or Freezer Door Gasket	Gasket(s)	1035	0.097	1032	0.097	2091	0.239	2091	0.239
R51	P (1995). Auto-Closer for Cooler or Freezer	Closer(s)	2304	0.65	2304	0.65	3535	0.57	3535	0.57
R52	Q (1995). Cooler or Freezer with Non-Electric Condensate Evaporator	Refrigeration Unit(s)	1681	0.102	1681	0.102	.	0.188	1681	0.188
R15	1994. High Capacity Oversized Condenser, Air-Cooled	*THR*-ΔF*	*71.38*	*0.0078*	*71.38*	*0.0078*	.	*0.0081*	*71.38*	*0.0081*
R18	1994. High Capacity Oversized Condenser, Evaporative-Cooled (Ammonia)	THR*	28.19	0.0051	28.19	0.0051	28.23	0.0032	28.23	0.0032
R8	1993. Energy Efficienct Evaporator Motor, Display	Linear Feet	121.22	0.00475	121.22	0.00475	.	0.0138	121.22	0.0138
R9	1993. Energy Efficienct Evaporator Motor, Walk-in	hp	8355	0.368	8355	0.368	.	0.954	8355	0.954

3.2.3 Evaluation Approach: Customized Incentives

Each application filed for the Customized Incentives Program was thoroughly reviewed. The analysis methods used for each review varied from application to application, depending on the measures covered, additional data gathered, and the application calculations submitted. However, the following analyses were performed for each application:

- The methods and inputs used to derive impacts for each application were reviewed.
- Impacts claimed by applicants were compared with billing data to verify that the impacts were reasonable. For example, impacts greater than 20 percent of the total energy usage of the premise were noted as "suspect."
- Whenever possible, an on-site audit was performed in order to verify installed measures and to gather detailed engineering data.
  - The single grocery chain that represented 39 of the 53 Customized Incentives applications refused to participate in these on-site investigations.
  - Of the remaining 14 participants, 13 on-site audits were completed.

In addition to the analysis methods described above, some or all of the following were performed for select applications:

- On-site monitoring records were collected and reviewed. Examples of these included measured fan loads, condensate temperatures, and energy management system (EMS) downloads.
- Analysis of pre- and post-retrofit billing data to substantiate claimed energy or demand savings
- When necessary, application impact estimates were revised.

Exhibit 3-6 provides a summary of the premise-specific impacts developed for the Customized Incentives program. Detailed information regarding the development of impacts for each Customized Incentives participant are contained in *Appendix B, Sections B.4 and B.6*.

Exhibit 3-6
Summary of Per-Site Impacts for Customized Incentives Participants

	Gross Energy Impacts		Gross Demand Impacts	
Site ID	Ex Ante Impacts (kWh)	Ex Post Unadjusted Impacts (kWh)	Ex Ante Impacts (kW)	Ex Post Unadjusted Impacts (kW)
3110	75,781	82,660	0.00	8.65
3103	264,878	264,878	0.00	8.65
2862	903,671	903,671	268.00	186.00
2909	213,119	175,202	9.20	79.94
396	244,994	244,994	24.70	24.70
390	188,633	188,633	0.94	0.94
5499	213,981	213,981	10.20	10.20
3970	107,048	147,887	0.00	0.00
4519	527,473	527,473	61.00	61.00
2888	369,200	0	101.00	0.00
657	900,322	0	24.00	0.00
3946	484,156	484,156	0.00	0.00
4521	165,042	165,042	0.00	0.00
2396	85,673	85,673	0.00	0.00
Large Supermarket Chain†	13,830,203	14,683,233	605.80	505.98
Total	18,574,174	18,167,483	1104.84	886.06
Realization Rate		98%		80%

† One supermarket chain contributed of 39 distinct applications that were paid in 1995.

The results of the engineering analysis of both RE and Customized Incentives measures were subsequently adjusted using the results of the SAE analysis, as described in the following section.

3.3 BILLING REGRESSION ANALYSIS

The key objective of the billing analysis is to determine the first-year program energy impacts. A statistical analysis is employed to model the differences in customers' energy usage between pre- and post-installation periods. The model is specified using actual customer billing data and

independent variables that explain changes in customers' energy usage including engineering estimates of 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 engineering impact estimates. Realized impacts represent the fractions of the engineering estimates actually "observed" or "detected" in the statistical analysis of actual billing data. The SAE coefficients estimated in the billing analysis regression models are relative to the results of the evaluation-based engineering estimates, not the PG&E Program ex ante estimates. The SAE coefficients are then used to estimate program impacts and realization rates relative to the ex ante estimates.

As discussed 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 the Lighting, HVAC, and Refrigeration end uses. *Appendix C* discusses the billing regression analysis in more detail.

3.3.1 Data Sources for Billing Regression Analysis

The billing regression analysis for the 1995 Commercial Program Evaluation used data from five primary data sources: the PG&E Management Decision Support System (MDSS) tracking database, the billing database, the telephone survey data, the engineering estimates of changes of usage between the pre- and post-installation periods, and the weather data tapes 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 RE, REO, and Customized Incentives programs was maintained as part of the MDSS. It contains program applications, rebate and technical information about installed measures, including measure description, quantity, rebate amount, and ex ante demand, and energy and therm savings estimates. The MDSS database is linked to the billing database and other program databases through PG&E's customers control numbers.

PG&E Billing Data

For this evaluation, the PG&E billing data were obtained from two different data sources within PG&E. 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 *Appendix A*. The billing histories contained in this data base only run through September 1995.

The second billing dataset, which consists only of customer accounts in the surveyed dataset, was later obtained from PG&E Load Data Services. This billing dataset contains bill readings that run through September 1996. 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, from January 1992 to September 1996.

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 and heating 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.

Telephone Survey Data

All available telephone surveys (except for the Canvass surveys, which do not collect detailed information regarding changes that have occurred at the premise) collected as part of the evaluation for the Commercial Sector Program were used in the billing regression. Four telephone survey samples totaling 1,217 participants and 652 nonparticipants were collected for the Commercial Sector Evaluation. The 1,217 participant surveys included 241 Refrigeration participants, 614 Lighting participants, and 487 HVAC participants. Because of the significant levels of cross-over among participants across the Commercial Program end uses, one integrated billing regression model was developed to evaluate all three Commercial 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 sample design and the final sample distribution, see *Appendix A.*

Engineering Estimates

Engineering estimates of savings were estimated for each of the 241 Refrigeration participants. Separate estimates were calculated for every measure installed under the Commercial Sector Program. The engineering estimates were calculated based on expected savings from the pre-installation technology to the post-installation technology. *Appendix B* discusses in greater detail the calculation of the savings estimates used in the billing analysis.

3.3.2 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 had to be aggregated up to the site level. A unique Site ID was created based on a combination of the PG&E service address, premise number and corporation number in the billing system to serve as the key variable for aggregating and linking data.

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

The engineering estimates of change were also aggregated to the Site ID level. 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.

3.3.3 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, almost all customers actually installed measures in 1994 or 1995, with 1995 installations accounting for approximately two-thirds of total installations. *Appendix C* discusses in detail how the selection of an installation date was estimated, since the installation date is not always provided in the MDSS. In summary, the application received date was used as a proxy for the installation date, unless a valid self-reported installation date was provided by the customer through the telephone survey, in which case the self-report date was used.

Billing data were available from January 1992 through September 1996. To maximize the number of post installation months, a post period of October 1995 through September 1996 was used. Because the majority of installations occurred during 1995, the only feasible pre-periods were October 1992 through September 1993 and October 1993 through September 1994. Survey data gathered change information dating back from the beginning of 1993. Therefore, both pre-installation periods could be used. However, the further back the pre-installation period is chosen, the more likely there are to be changes that have occurred at the site. To minimize the number of changes that have occurred outside the program between the pre- and post-installation periods (and to minimize the errors associated with self-reported changes and dates the changes occurred), the October 1993 through September 1994 pre-installation period was selected.

3.3.4 Data Censoring

Prior to implementing the billing analysis models, the customer sample was screened for invalid data and potential outliers. The data screening was applied to the entire participant and nonparticipant billing analysis sample frame. Three primary screening criteria were applied to remove customers that have invalid billing data, that may not have had their bill properly aggregated to the Site ID level, or that were extremely large users which could not be adequately controlled for in the billing analysis model. *Appendix C* described in detail the criteria that were used to remove customers from the billing regression analysis.

Exhibits 3-7 and 3-8 present the final sample sizes used in the billing analysis by business type and technology for participants and by business type for nonparticipants.

Exhibit 3-7
Billing Analysis Sample Used
Post-Censoring
Refrigeration End-Use Technologies

Program and Technology	Business Type												
	Office	Retail	College/ University	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Service	Community Service	Misc.	Total
Retrofit Express Program													
Refrigeration Load Reduction													
Low Temperature Glass/Acrylic Door	-	-	-	-	-	-	-	-	-	-	-	-	-
Heatless Door	-	-	-	-	2	-	-	-	-	-	-	-	2
Cooler/Freezer Door Gaskets	-	1	-	-	11	3	-	-	-	1	-	-	16
Auto Closer for Cooler/Freezer	-	1	-	-	2	1	-	1	-	1	-	-	6
Medium Temperature Case w/ Door	-	-	-	-	6	1	-	-	-	-	-	-	7
Strip Curtains for Walk-in	1	1	-	-	7	5	-	-	1	-	1	-	16
Low Temperature Case w/ Door	-	-	-	-	3	1	-	-	-	-	-	-	4
Night Covers for Display Cases	-	1	-	-	21	1	-	-	-	-	-	-	23
Compressor Upgrades													
Mechanical Subcooler	-	-	-	-	1	-	-	-	-	-	-	-	1
Multiplex Comprssor System	-	-	-	-	1	-	-	-	-	-	-	-	1
Adjustable Speed Drive	-	-	-	-	-	-	-	-	-	-	-	-	-
Floating Head Pressure Controls	-	-	-	-	-	-	-	-	-	-	-	-	-
Condenser Upgrades													
Oversized Air-Cooled Condenser	-	-	-	-	1	-	-	-	-	-	-	-	1
Oversized Evaporative Condenser	-	-	-	-	-	-	-	-	-	-	-	-	-
Evaporator Upgrades													
Walk-in Cooler PSC Evaporator Motor	-	-	-	-	1	-	-	-	-	-	-	-	1
Display PSC Evaporator Motor	-	-	-	-	2	-	-	-	-	-	-	-	2
Other													
Anti-Sweat Heater Control	-	-	-	-	1	-	-	-	-	-	-	-	1
Suction Line Insulation	1	-	-	-	1	-	-	-	-	-	-	-	2
Display Case Electronic Ballast	-	1	-	-	4	-	-	-	-	-	-	-	5
Non-Electric Condensate Evaporator	3	3	1	2	11	87	-	1	1	3	9	-	121
Retrofit Express Total	4	7	1	2	56	94	-	1	2	4	10	-	181
Customized Incentives Program													
Compressor Upgrades													
Floating Head Pressure Controls	-	-	-	-	-	-	-	-	-	-	-	-	-
Booster Desuperheaters	-	-	-	-	-	-	-	-	-	-	-	-	-
Condenser Upgrades													
Oversized Condensers	-	-	-	-	-	-	-	-	-	-	-	-	-
Other													
Refrigeration EMS	-	-	-	-	2	-	-	-	-	-	-	-	2
Refrigeration Add/Change	1	-	-	-	-	-	-	-	-	-	-	-	1
Refrigeration Other	-	-	-	-	-	-	-	-	-	-	-	-	-
Customized Incentives Total	1	-	-	-	2	-	-	-	-	-	-	-	3
Total	5	7	1	2	57	94	-	1	2	4	10	-	183

Exhibit 3-8
Billing Analysis Sample Used
Post-Censoring
Nonparticipants

Program and Technology Group	Business Type												
	Office	Retail	College/ University	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Service	Community Service	Misc.	Total
Total	74	124	1	26	185	34	27	15	53	6	31	44	620

3.3.5 Model Specification

The billing regression analysis for the Commercial Program Evaluation used two different multivariate regression models under an integrated framework, to provide 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. This approach is described in more detail in Appendix C.

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 participants 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 resulting SAE coefficients 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:

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

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 is calculated using the parameters of the baseline models estimated for the 1994 to 1996 analysis period. They both take the same functional form with different segment-level intercept series (α_j) and slopes (β, γ and ϕ):

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

The final functional relation, based on all 620 nonparticipants used in the baseline model, is estimated as follows:

Baseline Model (1994 to 1996):

$$\begin{aligned}\hat{kWh}_{96,i} = {} & -40834 * OFF\_LG + 1349 * OFF\_SM - 19849 * RET\_LG - 120 * RET\_SM \\ & +942 * SCHOOLS + 5378 * GROCERY + 8461 * SUPERMKT + 4756 * REST \\ & +10964 * HEALTH + 2403 * HOTEL + 4167 * WAREHOUS + 675 * PERSONAL \\ & +4795 * COMMUN + 37895 * MISCBT \\ & +1.13 * OFF\_LG4 + 0.91 * OFF\_SM4 + 0.99 * RET\_LG4 + 1.00 * RET\_SM4 \\ & +1.00 * SCHOOLS4 + 0.98 * GROCERY4 + 0.98 * SUPERMKT4 + 0.99 * REST4 \\ & +0.99 * COLLEGE4 + 0.94 * HEALTH4 + 1.02 * HOTEL4 + 1.04 * WAREHOUS4 \\ & +0.94 * PERSONAL4 + 0.95 * COMMUN4 + 0.95 * MISCBT4 \\ & +0.0000456 * CDD_{96-94,i} * kWh_{94,i} + 0.0000324 * HDD_{96-94,i} * kWh_{94,i}\end{aligned}$$

SAE Model

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

$$kWh_{96,i} - F_{94}(kWh_{94}, \Delta CDD\ \Delta HDD) = \sum_m \beta_m' Eng_m + \sum_k \eta_k' Chg_{i,k} + \mu_i$$

The difference between predicted and actual usage in 1996 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 in actual usage from the predicted usage. As discussed above, the predicted usage is estimated using only the comparison group to forecast the 1996 usage as a function of 1994 usage and change of cooling and heating degree days from 1994 to 1996. This usage prediction presents what would have happened in the absence of the program.

3.3.6 Billing Regression Analysis Results

The coefficients of the engineering impact, termed the SAE coefficients, are 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. The exhibit below summarizes the final SAE model results that were estimated using 935 participants (183 Refrigeration participants), as discussed in the *Data Censoring* section, above. Also, summarized below are the independent variables used in the SAE model, together with the t-statistics and the sample sizes available for each parameter estimate.

Exhibit 3-9
Billing Regression Final Model Outputs

Parameter Descriptions	Units	Parameter Estimate	t-Statistic	Sample Size
SAE Coefficients				
Refrigeration				
Custom Refrigeration	kWh	-0.75	2.00	3
RE Refrigeration	kWh	-0.53	1.98	181
Lighting End Use				
Office Flourescents	kWh	-1.00	14.67	116
Other Flourescents	kWh	-0.68	7.41	261
Controls	kWh	-1.38	2.09	57
Warehouse HIDs	kWh	0.02	0.07	10
School HIDS	kWh	0.11	0.30	10
Other RE Lighting	kWh	-1.26	2.15	119
Custom Lighting	kWh	-0.51	3.07	15
HVAC End Use				
Central A/Cs	kWh	-2.07	3.67	184
ASDs	kWh	-1.90	6.75	27
Chillers	kWh	-1.58	2.39	5
EMS	kWh	-1.03	8.38	20
Other Custom HVAC	kWh	-0.65	4.76	5
Office Thermostats	kWh	0.05	1.06	36
Other RE/REO HVAC	kWh	-0.90	2.89	153
Other End Uses	kWh			
Other	kWh	-1.71	2.90	62
Change Variables	kWh			
Cooling System Replacement	(0,1)*kWh	-0.03	0.70	10
Lighting System Replacement	(0,1)*kWh	-0.08	4.17	48
Change in Employees	(±1,0)*kWh	0.01	0.64	57
Square Foot Change	± sqft	4.42	2.37	27
Heating System Replacement	(0,1)*kWh	-0.07	0.04	4
Other Equipment Change	(0,1)*kWh	0.03	1.17	42
Remove Equipment	(0,1)*kWh	0.08	0.64	2
Refrigeration Replacement	(0,1)*kWh	0.00	0.01	3
Add Equipement	(0,1)*kWh	0.11	0.49	11
Other Additions	(0,1)*kWh	0.14	12.41	375

The dependent variable is the difference between the actual and predicted 1996 usage using the 1994 baseline model.

SAE coefficients are calculated for sixteen different combinations of business type and measure, including both Custom refrigeration and RE refrigeration. 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.

The SAE coefficient of 0.75 for Customized Incentives Refrigeration measures is based on a sample size of only three, compared to the 53 unique sites that installed Customized Incentives

Refrigeration measures in 1995. Adjusting the engineering estimates of energy impact by 0.75 for all Customized Incentives measures should be considered conservative because it is likely that a sample size of three may not be representative of the population. An alternative approach would be to adjust only those measures that are similar to the three represented in the billing analysis, and leave the remaining measures unadjusted. It was found that the ratio of the engineering energy to the ex ante gross energy estimate was 98 percent over all 53 unique sites, and 94 percent for the three sites used in the SAE analysis. Because the ratio for the SAE sample is similar to the population's ratio and because the SAE coefficient was statistically significant at the 95 percent confidence level, the conservative approach of adjusting all Customized Incentives Refrigeration measures by 0.75 was chosen.

The SAE coefficients are multiplied by the evaluation estimates of gross energy impact to calculate the gross ex post energy impacts.

3.3.7 Self-Selection

In addition to conducting a billing analysis to estimate gross energy impacts as described above, 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. The net billing analysis model specification differs from the gross billing analysis model, which used two different multivariate regression models (a baseline model using a control group and an SAE model using participants). Instead, the net billing analysis model runs one integrated model combining both the participants and nonparticipants.

A disadvantage of combining both participants and nonparticipants into one model of net energy savings is that the resulting sample is not random. In particular, participants self-select into the program and therefore may not be randomly distributed. As a result, 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. This method was developed by Heckman[3] (1976, 1979) and is used by others (Goldberg and Train[4], 1996) to address the problem of self-selection into energy retrofit programs. The Mills Ratio technique assumes that the unobserved factors that are influencing participation are distributed normally. The influence of these unobserved factors on participation can be approximated by a Mills Ratio which itself is distributed normally. Using the Mills Ratio 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) develops the technique of using an additional 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

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[3] 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.

[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.

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. The additional Mills Ratio accounts for the fact that amount of savings will be correlated with participation.

To correct for self-selection, a probit model of program participation is estimated. Upon estimation, the parameters of the participation model are then used to calculate an Inverse Mills Ratio for both participants and nonparticipants. This Mills Ratio is then included in the net savings regression that combines both participants and nonparticipants. If the Mills Ratio controls for those unobserved factors that determine participation, and the other model assumptions are met, then the net savings model can then be estimated as if participation in the program is randomly determined.

Using the Inverse Mills Ratio to correct for selection relies on several assumptions. First, the net savings due to the program, whether expressed as naturally occurring savings or a net-to-gross ratio, must be normally distributed. In addition, the Mills Ratio must not be highly correlated with the other independent variables used in the net billing regression. In this application, both of these assumptions are found to be violated. Net savings due to the program is biased upward toward large customers and is not distributed normally. The Mills Ratio term used in the net savings regression is also found to be highly correlated with other independent variables, which introduces multi-collinearity into the model. As a result of these violations, the regression analysis using the Mills Ratio technique does not yield reliable estimates in this application. A description of the methods used for this application are provided in *Appendix C.*

Therefore, self-selection is not treated explicitly in the billing regression analysis. However, because the objective of the billing regression analysis is to estimate the program gross energy impacts, the self-selection bias, if it even exists, has very limited impacts on the outputs of such estimation when both cross-sectional and time series data are used. In addition, the effects of free ridership are explicitly modeled in the net to gross analysis, described in *Section 3.4.*

3.3.8 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 sixteen analysis segments that were explicitly modeled and the relative precision estimates based upon the model output are presented in Exhibit 3-10 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.

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

Where β_i and Eng_i are the SAE coefficients and unadjusted engineering impact estimates for segment i, respectively. The program level standard error can be estimated as:[5]

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

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

Where CVi = (std(βi)/βi) 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 3-10
Relative Precision Calculation

SAE Analysis Level	Engineering Gross Energy Impact Estimate (MWh)	SAE Coefficient	t-Statistic	Relative Precision at 80%	Relative Precision at 90%
Refrigeration					
Customized Incentives Refrigeration	18,206	0.75	2.00	64%	82%
RE Refrigeration	8,566	0.53	1.98	65%	83%
Total	26,772	0.68		51%	65%

3.4 NET-TO-GROSS METHOD

In this section of the report, the methods used to derive net-to-gross (NTG) results for the evaluation of PG&E's 1995 Commercial RE and Customized Incentives programs are presented. After a brief discussion of data sources, estimates of free-ridership and spillover from participant self-reports are discussed.

3.4.1 Data Sources

Data used in the NTG analysis include 236 telephone surveys from refrigeration end use participants and 201 telephone surveys from refrigeration end use nonparticipants surveyed in October 1996.

3.4.2 Self-Report-Based Estimates of Free-Ridership

The RE and Customized Incentives participants surveyed installed or adopted the following measures. (Some participants installed more than one measure.)

Measure	N
Cooler or Freezer with Non-Electric Condensate Evaporator	165
Night Covers for Display Case	23
Strip Curtains for Walk-in Boxes	21

New Refrigeration Case with Glass or Acrylic Doors	10
Cooler or Freezer Door Gasket	16
Auto-Closer for Cooler or Freezer	6
Other Measures	13
Custom	6

Because free-ridership often varies by technology, results were calculated for each technology group. However, caution should be employed in interpreting the analysis results, given the small group sizes for some technology groups.

Methods for Scoring Free-Ridership

The 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 *Appendix S-1*. Questions used for the self-report analysis are summarized in *Appendix D*.

As described in the work plan, a series of questions was posed to program participants. If the customer indicated that he had not been shopping for new refrigeration equipment before becoming aware of the program, he was scored initially as a net participant. A customer was then classified as a free-rider if he met the following two conditions: (1) stated that he would have installed high-efficiency equipment within the year and had already selected the equipment; and (2) stated that he would have purchased high-efficiency equipment if the program had not existed.

Free-Ridership Results

NTG results weighted by avoided cost (AC) and calculated by subtracting the free-ridership rates, as described above, are presented in Exhibit D-1. Results are presented overall and by segment. Measures classified as "other" include glass or acrylic doors for low-temperature case, low-heat/no-heat refrigeration case doors, humidistat control, case lighting electronic ballast, insulate bare suction line, multiplex compressor system, subcooler, and floating head pressure controller.

Exhibit 3-11
NTG Weighted by Avoided Cost

	RE Measures								
	New Cases	Nonelectric Condensate Evaporator	Auto-Closers	Night Covers	Strip Curtains	Gaskets	Other	Custom	Overall
N	10	165	6	23	21	16	13	6	260
% Avoided Cost	2.4%	1.6%	0.5%	0.5%	0.4%	0.2%	5.5%	85.8%	91.3%
NTG	1.00	0.753	0.880	0.699	0.871	0.434	0.983	0.385	0.508

Overall, weighted NTG results range from a low of 0.385 for custom measures to a high of 1.00 for new cases. The program-wide NTG, weighted by avoided cost, was 0.508. This result was used as the basis for subsequent adjustment for spillover.

3.4.3 Self-Report-Based Estimates of Spillover

Refrigeration spillover can be defined as refrigeration efficiency improvements implemented outside the program but influenced by the program. Preliminary estimates of refrigeration spillover rates were generated by analyzing responses to a combination of questions asked of 236 participants and 201 nonparticipants.

Methods for Scoring Spillover

The integrated approach to estimating refrigeration spillover is summarized below.

All survey respondents were asked if they had installed refrigeration equipment outside the program since January 1993. Participants who answered "yes" to the first question were asked if these changes were made after participating in the program. Nonparticipants, and participants who said the changes were made after participation, were asked if they made the equipment changes through a PG&E program.

Participants who passed the first two screening questions and had not changed out refrigeration equipment through a PG&E program, and nonparticipants who passed the first two screening questions and were aware of the program at the time of equipment purchase, were asked how influential the program was in their decision. Those who said that the program had influenced their decision[6] were included in the preliminary estimate of program spillover.

Survey-based estimates were applied to the refrigeration participant population and the refrigeration nonparticipant population along with estimates of impact per site, resulting in a final spillover impact.

It should be noted that this analysis provides a preliminary indication of spillover rates and more in-depth analysis is required to quantify spillover impacts.

Spillover Result— Participants

Twenty-nine surveyed participants (12 percent of the total participant sample) reported that since January 1993 they had added refrigeration equipment. Forty-five percent of those participants who added equipment (6 percent of the total participant sample) added the equipment after participating in the program. Thirty-eight percent (5 percent of the total participant sample) did not install the equipment through the program. Two of these respondents (0.85 percent of the total participant sample) reported the program influenced their additional refrigeration equipment installations. Of these two, one installed additional refrigeration in 1995. One of 236 participants yields an initial unweighted spillover rate of 0.42 percent for 1995.

Spillover Results—Nonparticipants

Fifty of 201 program nonparticipants reported making refrigeration changes outside the program, of which 47 respondents confirmed their installations were not done through the program. Nine respondents (4 percent of the total nonparticipant sample) reported they were aware of the program before they purchased the equipment. Of these 9, 2 respondents reported their knowledge of the program was influential on their equipment selection. Neither of these 2

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[6] "To what extent did participating in the program influence your additional equipment selection?" Values of 2, 3, 4, and 5 (slightly influential to very influential) were considered to demonstrate program influence on the purchase.

respondents installed their refrigeration equipment in 1995, indicating there was no 1995 program spillover within the nonparticipant sample, according to our definition.

Because the levels of self-reported spillover were low (0.42 percent) for participants and nonexistent for nonparticipants, it was decided not to apply a correction for spillover. One minus the self-reported rate of free-ridership (0.508) was therefore used as the self-reported NTG ratio for Refrigeration overall, with the corresponding measure-specific NTG ratios used for individual technologies.

4. EVALUATION RESULTS

This section contains the results of the evaluation of the PG&E Commercial Refrigeration Program (the Refrigeration 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. Explanations for 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) and Customized Incentives. All results are aggregated to the entire commercial sector by program.

4.1 EX POST GROSS IMPACT RESULTS

Ex post gross energy and demand impacts for refrigeration technologies installed under the RE and Customized Incentives programs 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 *Appendix F*.

The results in Exhibit 4-1 illustrates the following gross energy impact findings:

Customized Incentives Impacts -- Customized Incentives Program technologies represent approximately 75 percent of the gross energy impacts. Most Customized Incentives Program participants installed refrigeration equipment at large, complex facilities, yielding significant energy savings.

Strip Curtain Impacts -- Strip curtains for walk-in freezers account for 40 percent of RE impacts, and for 10 percent of the program total. This reflects a sharply higher ex post than ex ante impact estimate for this measure. Ex ante algorithm review for this measure found that Advice Filing methods are based upon PG&E Application Note 53-31-81, where impacts are anchored by assumed infiltration reduction, expressed as air changes per hour. Ex post impact calculations were based instead upon an American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) method, supported by Section 26 in the ASHRAE "Refrigeration Systems and Applications" Handbook. This alternate methodology was used to calculate other ex ante impacts (using Advice Filing methods); for example, both the "cooler or freezer door gasket" measure and the "auto-closer for cooler or freezer" measure were calculated using this ASHRAE method. Refer to Appendix B, Section B.5 for additional details surrounding these ex ante and ex post calculation methods.

Customized Incentives Measures -- Among Customized Incentives Program measures, refrigeration energy management systems contribute about 18 percent of the refrigeration end-use total impact. The measure category "refrigeration other," consisting of a variety of site-specific refrigeration applications, represents the largest share of impacts, accounting for 49 percent of the end-use total.

Business Types – The grocery business type represents 75 percent of the refrigeration end-use energy impacts. Miscellaneous business types account for another 20 percent; this Miscellaneous business type includes refrigerated warehouses, shipping facilities and crop cold storage facilities -- an important class of facilities participating in refrigeration retrofits. All other segments had impacts that make up less than 2 percent of the end-use total.

Exhibit 4-1
Ex Post Gross Energy Impacts
By Business Type
For Commercial Refrigeration Technologies Paid in 1995

Program and Technology \ Business Type	First-Year Gross Energy Impacts (kWh)												
	Office	Retail	College/ University	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Service	Community Service	Misc.	Total
Retrofit Express Program													
Refrigeration Load Reduction													
Low Temperature Glass/Acrylic Door	-	-	-	-	46,454	-	-	-	-	-	-	-	46,454
Heatless Door	-	-	-	-	20,359	-	-	-	-	-	-	-	20,359
Cooler/Freezer Door Gaskets	-	29,675	-	-	84,628	39,566	-	-	-	-	-	-	153,869
Auto Closer for Cooler/Freezer	-	53,883	-	-	68,748	1,858	-	1,858	-	-	-	-	126,347
Medium Temperature Case w/ Door	1,271	5,931	-	-	106,801	3,389	-	-	-	-	-	-	117,392
Strip Curtains for Walk-in	3,510	6,492	-	11,767	225,692	19,518	-	-	120,718	-	-	1,425,690	1,813,387
Low Temperature Case w/ Door	-	-	-	-	369,928	-	-	-	9,291	-	-	-	379,218
Night Covers for Display Cases	-	6,893	-	-	233,419	2,010	-	-	-	-	-	-	242,322
Compressor Upgrades													
Mechanical Subcooler	-	-	-	-	5,424	-	-	-	-	-	-	-	5,424
Multiplex Compressor System	-	-	-	-	105,603	-	-	-	-	-	-	4,428	110,030
Adjustable Speed Drive	-	-	-	-	-	-	-	-	4,052	-	-	-	4,052
Floating Head Pressure Controls	-	-	-	-	-	-	-	-	-	-	-	546,914	546,914
Condenser Upgrades													
Oversized Air-Cooled Condenser	-	-	-	-	21,997	-	-	-	-	-	-	-	21,997
Oversized Evaporative Condenser	-	-	-	-	-	-	-	-	-	-	-	346,445	346,445
Evaporator Upgrades													
Walk-in Cooler PSC Evaporator Motor	-	-	-	-	7,905	-	-	-	-	-	-	8,783	16,688
Display PSC Evaporator Motor	-	-	-	-	18,223	-	-	-	-	-	-	-	18,223
Other													
Anti-Sweat Heater Control	-	-	-	-	27,194	-	-	-	-	-	-	-	27,194
Suction Line Insulation	-	-	-	-	32,491	154	-	-	5,367	-	-	1,937	39,949
Display Case Electronic Ballast	6,273	27,771	-	-	49,056	-	-	-	3,110	-	-	-	86,209
Non-Electric Condensate Evaporator	14,137	7,952	2,651	2,651	70,685	246,513	1,767	5,301	5,301	884	19,438	2,651	379,930
Retrofit Express Total	25,191	138,598	2,651	14,418	1,494,604	313,009	1,767	7,159	147,839	884	19,438	2,336,847	4,502,403
Customized Incentives Program													
Compressor Upgrades													
Floating Head Pressure Controls	-	-	-	-	64,488	-	-	-	-	-	-	-	64,488
Booster Desuperheaters	-	-	-	-	111,318	-	-	-	-	-	-	-	111,318
Condenser Upgrades													
Oversized Condensers	-	-	-	-	184,412	-	-	-	-	-	-	-	184,412
Other													
Refrigeration EMS	-	-	-	-	2,816,899	-	-	-	-	-	-	397,039	3,213,939
Refrigeration Add/Change	364,434	-	-	-	-	-	-	-	131,878	-	-	680,211	1,176,523
Refrigeration Other	-	-	-	-	8,829,065	-	-	-	-	-	-	124,230	8,953,295
Customized Incentives Total	364,434	0	0	0	12,006,181	0	0	0	131,878	0	0	1,201,481	13,703,974
Total	389,624	138,598	2,651	14,418	13,500,785	313,009	1,767	7,159	279,717	884	19,438	3,538,328	18,206,378

The results in Exhibits 4-2 illustrate the following findings relative to gross demand impacts:

RE Demand Impacts -- Unlike energy impacts, ex post demand impacts are almost equally divided between the Customized Incentives and RE programs, with RE contributing over 48 percent of the program total. This difference (between energy and demand) is due in part to the significant SAE adjustments that were applied to the gross energy estimates -- 0.53 to all RE measures and 0.75 to all Customized Incentives measures. In addition, the ex post demand to energy impact ratio for RE is larger than for Customized Incentives, where either demand impacts were not applicable for the Customized measures installed, or the conservative impact methods used to derive application estimates did not include an evaluation of demand effects.

Exhibit 4-2
Ex Post Gross Demand Impacts
By Business Type
For Commercial Refrigeration Technologies Paid in 1995

Program and Technology \ Business Type	First-Year Unadjusted Gross Demand Impacts (kW)												
	Office	Retail	College/ University	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Service	Community Service	Misc.	Total
Retrofit Express Program													
Refrigeration Load Reduction													
Low Temperature Glass/Acrylic Door	-	-	-	-	10	-	-	-	-	-	-	-	10
Heatless Door	-	-	-	-	4	-	-	-	-	-	-	-	4
Cooler/Freezer Door Gaskets	-	6	-	-	18	9	-	-	-	-	-	-	33
Auto Closer for Cooler/Freezer	-	17	-	-	21	1	-	1	-	-	-	-	39
Medium Temperature Case w/ Door	0	1	-	-	23	1	-	-	-	-	-	-	25
Strip Curtains for Walk-in	1	1	-	3	49	4	-	-	26	-	-	310	394
Low Temperature Case w/ Door	-	-	-	-	80	-	-	-	2	-	-	-	82
Night Covers for Display Cases	-	-	-	-	-	-	-	-	-	-	-	-	0
Compressor Upgrades													
Mechanical Subcooler	-	-	-	-	6	-	-	-	-	-	-	-	6
Multiplex Compressor System	-	-	-	-	23	-	-	-	-	-	-	1	24
Adjustable Speed Drive	-	-	-	-	-	-	-	-	1	-	-	-	1
Floating Head Pressure Controls	-	-	-	-	-	-	-	-	-	-	-	-	0
Condenser Upgrades													
Oversized Air-Cooled Condenser	-	-	-	-	5	-	-	-	-	-	-	-	5
Oversized Evaporative Condenser	-	-	-	-	-	-	-	-	-	-	-	75	75
Evaporator Upgrades													
Walk-in Cooler PSC Evaporator Motor	-	-	-	-	2	-	-	-	-	-	-	2	4
Display PSC Evaporator Motor	-	-	-	-	4	-	-	-	-	-	-	-	4
Other													
Anti-Sweat Heater Control	-	-	-	-	6	-	-	-	-	-	-	-	6
Suction Line Insulation	-	-	-	-	7	0	-	-	1	-	-	0	9
Display Case Electronic Ballast	1	6	-	-	11	-	-	-	1	-	-	-	20
Non-Electric Condensate Evaporator	3	2	1	1	15	52	0	1	1	0	4	1	81
Retrofit Express Total	6	34	1	3	285	67	0	2	32	0	4	388	822
Customized Incentives Program													
Compressor Upgrades													
Floating Head Pressure Controls	-	-	-	-	-	-	-	-	-	-	-	-	0
Booster Desuperheaters	-	-	-	-	-	-	-	-	-	-	-	-	0
Condenser Upgrades													
Oversized Condensers	-	-	-	-	25	-	-	-	-	-	-	-	25
Other													
Refrigeration EMS	-	-	-	-	138	-	-	-	-	-	-	61	199
Refrigeration Add/Change	-	-	-	-	-	-	-	-	80	-	-	186	266
Refrigeration Other	-	-	-	-	397	-	-	-	-	-	-	-	397
Customized Incentives Total	0	0	0	0	559	0	0	0	80	0	0	247	886
Total	6	34	1	3	844	67	0	2	112	0	4	635	1,708

Strip Curtain Impacts -- Strip curtains contribute the largest share of RE impacts, accounting for 48 percent of the RE total. Although, according to ex ante methods, this ex post result contradicts the level of impact contributed by the Strip Curtain measure, a careful review of those calculations suggests that the ex post methods are both more reliable and consistent with the calculations performed in the assessment of other measures. Refer to Appendix B, Section B.5 for additional details surrounding these ex ante and ex post estimates.

Customized Incentives Measures -- All but 3 percent of the Customized Incentives Program's contribution to demand impacts comes from the refrigeration energy management systems, refrigeration additions/changes, and the "other refrigeration" measures.

Business Types -- As with energy, the grocery and miscellaneous business segments dominate the gross demand contribution, accounting for all but 13 percent of the program total. Given the limited saturation of the commercial refrigeration end-use (and its specialized equipment) in these other segments, it is not surprising that PG&E's refrigeration programs have such a small influence outside of these two segments.

4.2 NET-TO-GROSS ADJUSTMENTS

Exhibit 4-3 presents the NTG values by technology, based on self-reported survey data, as described in detail in *Appendix D, Net-to-Gross Analysis*. Results are presented without participant and nonparticipant spillover. Estimates of 1995 participant and nonparticipant spillover were generated based on self-reported data, but the resulting spillover rates were very low (spillover rates were less than 1 percent). That is, the conservative estimate of the NTG ratio as one minus free-ridership was used for all segments.

Overall, NTG results by measure range from a low of 0.39 for Customized Incentives measures to a high of 1.00 for new cases. The refrigeration end-use ex post NTG across all programs and measures was 0.51.

Customized Incentives NTG – For Customized Incentives Program participants, a single NTG adjustment of 0.39 was applied regardless of the specific technology. This low NTG is due to the high free-ridership levels reported by the Customized Incentives participants interviewed, the majority of which would have installed program qualifying equipment, even in the absence of the program.

RE NTG – In contrast, free-ridership levels were low for the RE participants, where the program had a significant effect upon program participant decisions to purchase program qualifying equipment. This is highlighted by the large NTG adjustments estimated for RE participants -- for most RE measures, a NTG of 0.98 was applied, while the high-impact strip curtain measure NTG ratio was calculated at 0.87. Among other RE measures, only door gaskets had a low NTG, with many participants reporting that they would have installed new gaskets regardless of the program.

Evaluation NTG Results – While ex ante NTG adjustments for the Customized Incentives Program were estimated to be higher than the ex ante RE adjustments (0.75 and 0.66, respectively), evaluation results have clearly shown that the opposite is true, where ex post RE adjustments were more than twice as large as the relatively low, 0.39 NTG adjustment applied to the Customized Incentives Program.

Exhibit 4-3
NTG Adjustments by Refrigeration Technology Installed

Program and Technology \ Business Type	Net-to-Gross Adjustments												
	Office	Retail	College/ University	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Service	Community Service	Misc.	Total
Retrofit Express Program													
Refrigeration Load Reduction													
Low Temperature Glass/Acrylic Door	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	
Heatless Door	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	
Cooler/Freezer Door Gaskets	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	
Auto Closer for Cooler/Freezer	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	
Medium Temperature Case w/ Door	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Strip Curtains for Walk-in	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	
Low Temperature Case w/ Door	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Night Covers for Display Cases	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	
Compressor Upgrades													
Mechanical Subcooler	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	
Multiplex Compressor System	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	
Adjustable Speed Drive	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	
Floating Head Pressure Controls	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	
Condenser Upgrades													
Oversized Air-Cooled Condenser	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	
Oversized Evaporative Condenser	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	
Evaporator Upgrades													
Walk-in Cooler PSC Evaporator Motor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	
Display PSC Evaporator Motor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	
Other													
Anti-Sweat Heater Control	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	
Suction Line Insulation	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	
Display Case Electronic Ballast	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	
Non-Electric Condensate Evaporator	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	
Retrofit Express Total													
Customized Incentives Program													
Compressor Upgrades													
Floating Head Pressure Controls	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	
Booster Desuperheaters	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	
Condenser Upgrades													
Oversized Condensers	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	
Other													
Refrigeration EMS	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	
Refrigeration Add/Change	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	
Refrigeration Other	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	
Customized Incentives Total													
Total													

4.3 EX POST NET IMPACTS

Exhibits 4-4 and 4-5 present the ex post net energy and demand impacts, respectively, for refrigeration technologies paid in 1995 through the RE and Customized Incentives programs.

Exhibit 4-4
Ex Post Net Energy Impacts
By Business Type
For Commercial Refrigeration Technologies Paid in 1995

Program and Technology \ Business Type	First-Year Net Energy Impacts (kWh)												
	Office	Retail	College/ University	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Service	Community Service	Misc.	Total
Retrofit Express Program													
Refrigeration Load Reduction													
Low Temperature Glass/Acrylic Door	-	-	-	-	45,664	-	-	-	-	-	-	-	45,664
Heatless Door	-	-	-	-	20,013	-	-	-	-	-	-	-	20,013
Cooler/Freezer Door Gaskets	-	12,879	-	-	36,728	17,172	-	-	-	-	-	-	66,779
Auto Closer for Cooler/Freezer	-	47,417	-	-	60,498	1,635	-	1,635	-	-	-	-	111,186
Medium Temperature Case w/ Door	1,271	5,931	-	-	106,801	3,389	-	-	-	-	-	-	117,392
Strip Curtains for Walk-in	3,057	5,655	-	10,249	196,578	17,000	-	-	105,145	-	-	1,241,776	1,579,460
Low Temperature Case w/ Door	-	-	-	-	369,928	-	-	-	9,291	-	-	-	379,218
Night Covers for Display Cases	-	4,818	-	-	163,160	1,405	-	-	-	-	-	-	169,383
Compressor Upgrades													
Mechanical Subcooler	-	-	-	-	5,332	-	-	-	-	-	-	-	5,332
Multiplex Compressor System	-	-	-	-	103,807	-	-	-	-	-	-	4,353	108,160
Adjustable Speed Drive	-	-	-	-	-	-	-	-	3,984	-	-	-	3,984
Floating Head Pressure Controls	-	-	-	-	-	-	-	-	-	-	-	537,616	537,616
Condenser Upgrades													
Oversized Air-Cooled Condenser	-	-	-	-	21,623	-	-	-	-	-	-	-	21,623
Oversized Evaporative Condenser	-	-	-	-	-	-	-	-	-	-	-	340,555	340,555
Evaporator Upgrades													
Walk-in Cooler PSC Evaporator Motor	-	-	-	-	7,770	-	-	-	-	-	-	8,634	16,404
Display PSC Evaporator Motor	-	-	-	-	17,913	-	-	-	-	-	-	-	17,913
Other													
Anti-Sweat Heater Control	-	-	-	-	26,731	-	-	-	-	-	-	-	26,731
Suction Line Insulation	-	-	-	-	31,938	152	-	-	5,275	-	-	1,905	39,270
Display Case Electronic Ballast	6,166	27,299	-	-	48,222	-	-	-	3,057	-	-	-	84,744
Non-Electric Condensate Evaporator	10,645	5,988	1,996	1,996	53,226	185,624	1,331	3,992	3,992	665	14,637	1,996	286,088
Retrofit Express Total	21,139	109,987	1,996	12,245	1,315,932	226,377	1,331	5,627	130,744	665	14,637	2,136,834	3,977,515
Customized Incentives Program													
Compressor Upgrades													
Floating Head Pressure Controls	-	-	-	-	24,828	-	-	-	-	-	-	-	24,828
Booster Desuperheaters	-	-	-	-	42,857	-	-	-	-	-	-	-	42,857
Condenser Upgrades													
Oversized Condensers	-	-	-	-	70,999	-	-	-	-	-	-	-	70,999
Other													
Refrigeration EMS	-	-	-	-	1,084,506	-	-	-	-	-	-	152,860	1,237,366
Refrigeration Add/Change	140,307	-	-	-	-	-	-	-	50,773	-	-	261,881	452,961
Refrigeration Other	-	-	-	-	3,399,190	-	-	-	-	-	-	47,829	3,447,019
Customized Incentives Total	140,307	0	0	0	4,622,380	0	0	0	50,773	0	0	462,570	5,276,030
Total	161,446	109,987	1,996	12,245	5,938,312	226,377	1,331	5,627	181,517	665	14,637	2,599,404	9,253,545

Exhibit 4-5
Ex Post Net Demand Impacts
By Business Type
For Commercial Refrigeration Technologies Paid in 1995

Program and Technology \ Business Type	First -Year Net Demand Impacts (kW)												
	Office	Retail	College/ University	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Service	Community Service	Misc.	Total
Retrofit Express Program													
Refrigeration Load Reduction													
Low Temperature Glass/Acrylic Door	-	-	-	-	10	-	-	-	-	-	-	-	10
Heatless Door	-	-	-	-	4	-	-	-	-	-	-	-	4
Cooler/Freezer Door Gaskets	-	3	-	-	8	4	-	-	-	-	-	-	15
Auto Closer for Cooler/Freezer	-	15	-	-	19	1	-	1	-	-	-	-	34
Medium Temperature Case w/ Door	0	1	-	-	23	1	-	-	-	-	-	-	25
Strip Curtains for Walk-in	1	1	-	2	43	4	-	-	23	-	-	270	343
Low Temperature Case w/ Door	-	-	-	-	80	-	-	-	2	-	-	-	82
Night Covers for Display Cases	-	-	-	-	-	-	-	-	-	-	-	-	0
Compressor Upgrades													
Mechanical Subcooler	-	-	-	-	6	-	-	-	-	-	-	-	6
Multiplex Compressor System	-	-	-	-	23	-	-	-	-	-	-	1	23
Adjustable Speed Drive	-	-	-	-	-	-	-	-	1	-	-	-	1
Floating Head Pressure Controls	-	-	-	-	-	-	-	-	-	-	-	-	0
Condenser Upgrades													
Oversized Air-Cooled Condenser	-	-	-	-	5	-	-	-	-	-	-	-	5
Oversized Evaporative Condenser	-	-	-	-	-	-	-	-	-	-	-	73	73
Evaporator Upgrades													
Walk-in Cooler PSC Evaporator Motor	-	-	-	-	2	-	-	-	-	-	-	2	4
Display PSC Evaporator Motor	-	-	-	-	4	-	-	-	-	-	-	-	4
Other													
Anti-Sweat Heater Control	-	-	-	-	6	-	-	-	-	-	-	-	6
Suction Line Insulation	-	-	-	-	7	0	-	-	1	-	-	0	9
Display Case Electronic Ballast	1	6	-	-	11	-	-	-	1	-	-	-	20
Non-Electric Condensate Evaporator	2	1	0	0	11	39	0	1	1	0	3	0	61
Retrofit Express Total	5	28	0	3	261	48	0	1	28	0	3	347	725
Customized Incentives Program													
Compressor Upgrades													
Floating Head Pressure Controls	-	-	-	-	-	-	-	-	-	-	-	-	0
Booster Desuperheaters	-	-	-	-	-	-	-	-	-	-	-	-	0
Condenser Upgrades													
Oversized Condensers	-	-	-	-	10	-	-	-	-	-	-	-	10
Other													
Refrigeration EMS	-	-	-	-	53	-	-	-	-	-	-	23	76
Refrigeration Add/Change	-	-	-	-	-	-	-	-	31	-	-	72	102
Refrigeration Other	-	-	-	-	153	-	-	-	-	-	-	-	153
Customized Incentives Total	0	0	0	0	215	0	0	0	31	0	0	95	341
Total	5	28	0	3	476	48	0	1	59	0	3	442	1,066

Overall, Exhibits 4-4 and 4-5 show reductions of 50 percent in ex post program energy impacts and almost 40 percent in demand impacts (when compared to Exhibits 4-1 and 4-2, gross impacts), as a result of the application of the NTG adjustments presented in Exhibit 4-3. Since spillover was not claimed for any segment, all the individual technology/business segment net impacts are less than or equal to the corresponding gross impacts.

RE Net Impacts – On a net basis, RE measures account for a much larger share of both energy and demand impacts. This is primarily because of the high NTG ratio for RE measures in general and the relatively large strip curtain gross impact estimates.

Customized Incentives Net Impacts – Because of the low NTG ratio applied across all Customized Incentives measures, net impacts are less than half their gross impact counterparts for both energy and demand. Since 75 percent of the gross energy impacts were contributed by the Customized Incentives Program (and a low NTG of 0.39 was applied to that program), energy impacts, in particular, were significantly reduced.

4.4 REALIZATION RATES

Exhibits 4-6 through 4-9 present the gross and net realization rates for energy and demand impacts for the RE and Customized Incentives commercial refrigeration technologies.

4.4.1 Gross Realization Rates for Energy Impacts

Gross energy realization rates are presented in Exhibit 4-6. 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 energy savings, before taking into account customer behavioral effects, both inside and outside the program.

Overall, Exhibit 4-6 shows that the ex ante energy estimates are within 20 percent of the ex post gross energy impact estimates for the program overall, but that the realization rate varies widely between the RE and Customized Incentives programs: at 1.11, the average realization rate for RE measures is 50 percent higher than for Customized Incentives measures. The high realization rate for RE measures can be attributed largely to the fact that the evaluation engineering estimate for strip curtains was more than 12 times larger than the ex ante estimate. For most other measures, gross energy realization rates are driven by the relatively low (0.53) SAE coefficient found in the billing analysis.

The technology-specific results presented in Exhibit 4-6 are the outcome of the algorithm review and recalculation for RE measures and of the application review and analysis for Customized Incentives measures. Specific analytical issues surrounding the estimated impacts for individual measures and sites are discussed in detail in *Appendix B*.

Exhibit 4-6
Gross Energy Impact Realization Rates
By Business Type
For Commercial Refrigeration Technologies Paid in 1995

Program and Technology \ Business Type	Gross Energy Impact Realization Rates												
	Office	Retail	College/ University	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Service	Community Service	Misc.	Total
Retrofit Express Program													
Refrigeration Load Reduction													
Low Temperature Glass/Acrylic Door	-	-	-	-	1.04	-	-	-	-	-	-	-	1.04
Heatless Door	-	-	-	-	0.37	-	-	-	-	-	-	-	0.37
Cooler/Freezer Door Gaskets	-	1.28	-	-	1.28	1.28	-	-	-	-	-	-	1.28
Auto Closer for Cooler/Freezer	-	0.97	-	-	0.97	0.97	-	0.97	-	-	-	-	0.97
Medium Temperature Case w/ Door	0.74	0.74	-	-	0.74	0.74	-	-	-	-	-	-	0.74
Strip Curtains for Walk-in	6.61	6.61	-	6.61	6.61	6.61	-	-	6.61	-	-	6.61	6.61
Low Temperature Case w/ Door	-	-	-	-	1.04	-	-	-	1.04	-	-	-	1.04
Night Covers for Display Cases	-	0.63	-	-	0.63	0.63	-	-	-	-	-	-	0.63
Compressor Upgrades													
Mechanical Subcooler	-	-	-	-	0.63	-	-	-	-	-	-	-	0.63
Multiplex Compressor System	-	-	-	-	0.59	-	-	-	-	-	-	0.59	0.59
Adjustable Speed Drive	-	-	-	-	-	-	-	-	0.70	-	-	-	0.70
Floating Head Pressure Controls	-	-	-	-	-	-	-	-	-	-	-	0.63	0.63
Condenser Upgrades													
Oversized Air-Cooled Condenser	-	-	-	-	0.64	-	-	-	-	-	-	-	0.64
Oversized Evaporative Condenser	-	-	-	-	-	-	-	-	-	-	-	0.64	0.64
Evaporator Upgrades													
Walk-in Cooler PSC Evaporator Motor	-	-	-	-	0.63	-	-	-	-	-	-	0.63	0.63
Display PSC Evaporator Motor	-	-	-	-	0.63	-	-	-	-	-	-	-	0.63
Other													
Anti-Sweat Heater Control	-	-	-	-	0.88	-	-	-	-	-	-	-	0.88
Suction Line Insulation	-	-	-	-	0.65	0.65	-	-	0.65	-	-	0.65	0.65
Display Case Electronic Ballast	0.73	0.73	-	-	0.73	-	-	-	0.73	-	-	-	0.73
Non-Electric Condensate Evaporator	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.66	0.63
Retrofit Express Total	0.76	0.93	0.63	2.42	0.90	0.72	0.63	0.70	2.74	0.63	0.63	1.42	1.11
Customized Incentives Program													
Compressor Upgrades													
Floating Head Pressure Controls	-	-	-	-	0.75	-	-	-	-	-	-	-	0.75
Booster Desuperheaters	-	-	-	-	1.04	-	-	-	-	-	-	-	1.04
Condenser Upgrades													
Oversized Condensers	-	-	-	-	0.75	-	-	-	-	-	-	-	0.75
Other													
Refrigeration EMS	-	-	-	-	0.79	-	-	-	-	-	-	0.28	0.65
Refrigeration Add/Change	0.75	-	-	-	-	-	-	-	0.62	-	-	0.53	0.60
Refrigeration Other	-	-	-	-	0.80	-	-	-	-	-	-	0.75	0.80
Customized Incentives Total	0.75	-	-	-	0.80	-	-	-	0.62	-	-	0.42	0.74
Total	0.75	0.93	0.63	2.42	0.81	0.72	0.63	0.70	1.05	0.63	0.63	0.78	0.81

4.4.2 Gross Realization Rates for Demand Impacts

Gross demand realization rates are presented in Exhibit 4-7. 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 refrigeration market.

Exhibit 4-7
Gross Demand Impact Realization Rates
By Business Type
For Commercial Refrigeration Technologies Paid in 1995

Program and Technology \ Business Type	Gross Demand Impact Realization Rates												
	Office	Retail	College/ University	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Service	Community Service	Misc.	Total
Retrofit Express Program													
Refrigeration Load Reduction													
Low Temperature Glass/Acrylic Door	-	-	-	-	1.98	-	-	-	-	-	-	-	1.98
Heatless Door	-	-	-	-	1.37	-	-	-	-	-	-	-	1.37
Cooler/Freezer Door Gaskets	-	2.46	-	-	2.46	2.46	-	-	-	-	-	-	2.46
Auto Closer for Cooler/Freezer	-	0.88	-	-	0.88	0.88	-	0.88	-	-	-	-	0.88
Medium Temperature Case w/ Door	1.39	1.39	-	-	1.39	1.39	-	-	-	-	-	-	1.39
Strip Curtains for Walk-in	11.03	11.03	-	11.03	11.03	11.03	-	-	11.03	-	-	11.03	11.03
Low Temperature Case w/ Door	-	-	-	-	1.98	-	-	-	1.98	-	-	-	1.98
Night Covers for Display Cases	-	-	-	-	-	-	-	-	-	-	-	-	-
Compressor Upgrades													
Mechanical Subcooler	-	-	-	-	1.00	-	-	-	-	-	-	-	1.00
Multiplex Compressor System	-	-	-	-	0.43	-	-	-	-	-	-	0.43	0.43
Adjustable Speed Drive	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Floating Head Pressure Controls	-	-	-	-	-	-	-	-	-	-	-	-	-
Condenser Upgrades													
Oversized Air-Cooled Condenser	-	-	-	-	1.01	-	-	-	-	-	-	-	1.01
Oversized Evaporative Condenser	-	-	-	-	-	-	-	-	-	-	-	0.64	0.64
Evaporator Upgrades													
Walk-in Cooler PSC Evaporator Motor	-	-	-	-	2.59	-	-	-	-	-	-	2.59	2.59
Display PSC Evaporator Motor	-	-	-	-	2.76	-	-	-	-	-	-	-	2.76
Other													
Anti-Sweat Heater Control	-	-	-	-	2.49	-	-	-	-	-	-	-	2.49
Suction Line Insulation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Display Case Electronic Ballast	1.79	1.79	-	-	1.79	-	-	-	1.79	-	-	-	1.79
Non-Electric Condensate Evaporator	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.93	1.84
Retrofit Express Total	2.03	1.25	1.84	5.80	1.54	1.99	1.84	1.35	7.28	1.84	1.84	2.62	2.03
Customized Incentives Program													
Compressor Upgrades													
Floating Head Pressure Controls	-	-	-	-	-	-	-	-	-	-	-	-	-
Booster Desuperheaters	-	-	-	-	-	-	-	-	-	-	-	-	-
Condenser Upgrades													
Oversized Condensers	-	-	-	-	0.82	-	-	-	-	-	-	-	0.82
Other													
Refrigeration EMS	-	-	-	-	1.61	-	-	-	-	-	-	0.72	1.17
Refrigeration Add/Change	-	-	-	-	-	-	-	-	8.69	-	-	0.50	0.70
Refrigeration Other	-	-	-	-	0.75	-	-	-	-	-	-	-	0.75
Customized Incentives Total	-	-	-	-	0.86	-	-	-	8.69	-	-	0.54	0.80
Total	2.03	1.25	1.84	5.80	1.02	1.99	1.84	1.35	8.23	1.84	1.84	1.06	1.13

Overall, the gross demand estimates are 12 percent higher than the ex ante values, as presented in Exhibit 4-7. Both the RE algorithm updates (which often included the elimination of a coincident diversity factor -- identified as an unnecessary impact component) and the underpredicted ex ante estimate for strip curtains played a significant role in this result. Specific comments and justifications for the results are as follows:

RE Measures - As with energy, the major contribution to the high gross demand realization rate was made by the strip curtains measure. The program design estimate of demand impacts for this measure across all user segments was 36 kW; using a different ASHRAE calculation method, the evaluation estimated impacts of 394 kW. Gross demand realization rates for other measures range from 0.43 to 2.76. However, since none of these measures account for as much as 10 percent of RE demand impacts, their effect on the program-wide realization rate is minimal. For additional details surrounding the derivation of each ex post RE impact and a comparison against ex ante impact methods, refer to Appendix B, Section B.5.

Customized Incentives Measures - Gross demand impacts for refrigeration measures covered under the Customized Incentives Program were approximately 21 percent below the ex ante estimates. The only significant increase in demand as a result of the evaluation came from the refrigeration EMS measure in the grocery business segment, where the cycling of anti-sweat heaters was found to reduce the peak load. For additional details surrounding the differences between ex post and ex ante Customized Incentives impacts, refer to Appendix B, Sections B.4 and B.6.

4.4.3 Net Realization Rates

The net realization rates by segment are presented for energy in Exhibit 4-8 and for demand in Exhibit 4-9. 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 market.

To the extent that they build upon the gross evaluation results, many of the results presented in Exhibit 4-8 and 4-9 can be explained using information from the review of the ex ante estimates and the evaluation engineering and billing regression analyses, as discussed under the review of the gross realization rates. 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 refrigeration program, these differences reflect the low (0.39) NTG ratio for Customized Incentives Program measures and the relatively high (0.88) NTG ratio for the RE program measures. Specific comments and justifications for the results are as follows:

Net Energy Impacts - Because the Customized Incentives Program dominates energy impacts, the low NTG for this program sharply reduces its net energy impacts—and the net realization rate for all refrigeration measures. For the RE program, higher-than-anticipated impacts from the strip curtains measure and the high NTG ratio for most RE measures helped contribute to net impacts that were almost 50 percent higher than the ex ante estimate for the RE program. This was not enough, however, to offset the 8,000 MWh reduction in net impacts attributable to the application of the Customized Incentives Program NTG adjustment.

Net Demand Impacts - RE measures played a larger role in contributing to gross demand impacts than to energy impacts. As a result, the high net demand impact realization rate for these measures helped offset the low realization rates for the Customized Incentives Program measures.

Exhibit 4-8
Net Energy Impact Realization Rates
By Business Type
For Commercial Refrigeration Technologies Paid in 1995

Program and Technology \ Business Type	Net Energy Impact Realization Rates												
	Office	Retail	College/ University	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Service	Community Service	Misc.	Total
Retrofit Express Program													
Refrigeration Load Reduction													
Low Temperature Glass/Acrylic Door	-	-	-	-	1.58	-	-	-	-	-	-	-	1.58
Heatless Door	-	-	-	-	0.55	-	-	-	-	-	-	-	0.55
Cooler/Freezer Door Gaskets	-	0.74	-	-	0.78	0.80	-	-	-	-	-	-	0.78
Auto Closer for Cooler/Freezer	-	1.14	-	-	1.27	1.14	-	1.14	-	-	-	-	1.21
Medium Temperature Case w/ Door	1.14	1.14	-	-	1.14	1.14	-	-	-	-	-	-	1.14
Strip Curtains for Walk-in	8.85	8.85	-	8.85	8.85	8.85	-	-	8.85	-	-	8.85	8.85
Low Temperature Case w/ Door	-	-	-	-	1.61	-	-	-	1.61	-	-	-	1.61
Night Covers for Display Cases	-	0.68	-	-	0.68	0.68	-	-	-	-	-	-	0.68
Compressor Upgrades													
Mechanical Subcooler	-	-	-	-	0.96	-	-	-	-	-	-	-	0.96
Multiplex Compressor System	-	-	-	-	0.89	-	-	-	-	-	-	0.89	0.89
Adjustable Speed Drive	-	-	-	-	-	-	-	-	1.06	-	-	-	1.06
Floating Head Pressure Controls	-	-	-	-	-	-	-	-	-	-	-	0.96	0.96
Condenser Upgrades													
Oversized Air-Cooled Condenser	-	-	-	-	0.96	-	-	-	-	-	-	-	0.96
Oversized Evaporative Condenser	-	-	-	-	-	-	-	-	-	-	-	0.97	0.97
Evaporator Upgrades													
Walk-in Cooler PSC Evaporator Motor	-	-	-	-	0.96	-	-	-	-	-	-	0.96	0.96
Display PSC Evaporator Motor	-	-	-	-	0.96	-	-	-	-	-	-	-	0.96
Other													
Anti-Sweat Heater Control	-	-	-	-	1.33	-	-	-	-	-	-	-	1.33
Suction Line Insulation	-	-	-	-	0.98	0.98	-	-	0.98	-	-	0.98	0.98
Display Case Electronic Ballast	1.11	1.11	-	-	1.11	-	-	-	1.11	-	-	-	1.11
Non-Electric Condensate Evaporator	0.66	0.64	0.64	0.64	0.68	0.67	0.68	0.67	0.72	0.64	0.67	0.73	0.67
Retrofit Express Total	0.91	1.04	0.64	2.85	1.20	0.74	0.68	0.76	3.72	0.64	0.67	1.99	1.49
Customized Incentives Program													
Compressor Upgrades													
Floating Head Pressure Controls	-	-	-	-	0.39	-	-	-	-	-	-	-	0.39
Booster Desuperheaters	-	-	-	-	0.53	-	-	-	-	-	-	-	0.53
Condenser Upgrades													
Oversized Condensers	-	-	-	-	0.39	-	-	-	-	-	-	-	0.39
Other													
Refrigeration EMS	-	-	-	-	0.41	-	-	-	-	-	-	0.14	0.33
Refrigeration Add/Change	0.39	-	-	-	-	-	-	-	0.32	-	-	0.27	0.31
Refrigeration Other	-	-	-	-	0.41	-	-	-	-	-	-	0.39	0.41
Customized Incentives Total	0.39	-	-	-	0.41	-	-	-	0.32	-	-	0.22	0.38
Total	0.42	1.04	0.64	2.85	0.48	0.74	0.68	0.76	0.93	0.64	0.67	0.81	0.56

Exhibit 4-9
Net Demand Impact Realization Rates
By Business Type
For Commercial Refrigeration Technologies Paid in 1995

Program and Technology \ Business Type	Net Demand Impact Realization Rates												
	Office	Retail	College/ University	School	Grocery	Restaurant	Health Care	Hotel/Motel	Warehouse	Personal Service	Community Service	Misc.	Total
Retrofit Express Program													
Refrigeration Load Reduction													
Low Temperature Glass/Acrylic Door	-	-	-	-	2.99	-	-	-	-	-	-	-	2.99
Heatless Door	-	-	-	-	2.08	-	-	-	-	-	-	-	2.08
Cooler/Freezer Door Gaskets	-	1.43	-	-	1.50	1.54	-	-	-	-	-	-	1.50
Auto Closer for Cooler/Freezer	-	1.03	-	-	1.14	1.03	-	1.03	-	-	-	-	1.09
Medium Temperature Case w/ Door	2.14	2.14	-	-	2.14	2.14	-	-	-	-	-	-	2.14
Strip Curtains for Walk-in	14.77	14.77	-	14.77	14.77	14.77	-	-	14.77	-	-	14.77	14.77
Low Temperature Case w/ Door	-	-	-	-	3.04	-	-	-	3.04	-	-	-	3.04
Night Covers for Display Cases	-	-	-	-	-	-	-	-	-	-	-	-	-
Compressor Upgrades													
Mechanical Subcooler	-	-	-	-	1.51	-	-	-	-	-	-	-	1.51
Multiplex Compressor System	-	-	-	-	0.65	-	-	-	-	-	-	0.65	0.65
Adjustable Speed Drive	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Floating Head Pressure Controls	-	-	-	-	-	-	-	-	-	-	-	-	-
Condenser Upgrades													
Oversized Air-Cooled Condenser	-	-	-	-	1.53	-	-	-	-	-	-	-	1.53
Oversized Evaporative Condenser	-	-	-	-	-	-	-	-	-	-	-	0.97	0.97
Evaporator Upgrades													
Walk-in Cooler PSC Evaporator Motor	-	-	-	-	3.92	-	-	-	-	-	-	3.92	3.92
Display PSC Evaporator Motor	-	-	-	-	4.17	-	-	-	-	-	-	-	4.17
Other													-
Anti-Sweat Heater Control	-	-	-	-	3.77	-	-	-	-	-	-	-	3.77
Suction Line Insulation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Display Case Electronic Ballast	2.70	2.70	-	-	2.70	-	-	-	2.70	-	-	-	2.70
Non-Electric Condensate Evaporator	1.91	1.85	1.85	1.85	1.97	1.96	1.98	1.94	2.08	1.85	1.94	2.12	1.96
Retrofit Express Total	2.46	1.39	1.85	6.97	2.15	2.04	1.98	1.46	9.87	1.85	1.94	3.60	2.69
Customized Incentives Program													
Compressor Upgrades													
Floating Head Pressure Controls	-	-	-	-	-	-	-	-	-	-	-	-	-
Booster Desuperheaters	-	-	-	-	-	-	-	-	-	-	-	-	-
Condenser Upgrades													
Oversized Condensers	-	-	-	-	0.42	-	-	-	-	-	-	-	0.42
Other													
Refrigeration EMS	-	-	-	-	0.83	-	-	-	-	-	-	0.37	0.60
Refrigeration Add/Change	-	-	-	-	-	-	-	-	4.46	-	-	0.26	0.36
Refrigeration Other	-	-	-	-	0.38	-	-	-	-	-	-	-	0.38
Customized Incentives Total	-	-	-	-	0.44	-	-	-	4.46	-	-	0.28	0.41
Total	2.46	1.39	1.85	6.97	0.78	2.04	1.98	1.46	6.05	1.85	1.94	1.01	0.97

4.5 *OVERVIEW OF REALIZATION RATES*

In summary, net program demand impacts are very close to those predicted by the ex ante estimate. For energy, however, the overall program ex post impact is lower than predicted, but it should be noted that these results reflect conservative assumptions regarding energy impacts. That is, the SAE coefficient applied to all Customized Incentives measures is based on a sample of a few Customized Incentives Program participants. Therefore, to the extent that review of large custom applications generally led to engineering estimates that were very close to the ex ante estimates, the application of the SAE coefficient may understate the overall energy impacts of Customized Incentives refrigeration measures.

Exhibit 4-10 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 4-10
Commercial Refrigeration Impact Summary
By Technology Group

Business Type / Program and Technology	EX ANTE						EX POST						REALIZATION RATES			
	Gross Program Impact		NTG Adjustment		Net Program Impact		Gross Program Impact		NTG Adjustment		Net Program Impact		Gross Program Impact		Net Program Impact	
	kWh	kW	(1-FR)	Spillover	kWh	kW	kWh	kW	(1-FR)	Spillover	kWh	kW	kWh	kW	kWh	kW
Retrofit Express Program																
Refrigeration Load Reduction																
Low Temperature Glass/Acrylic Door	44,521	5	0.55	0.10	28,939	3	46,454	10	0.98	0.00	45,564	10	1.04	1.98	1.58	2.99
Heatless Door	55,595	3	0.55	0.10	36,137	2	20,359	4	0.98	0.00	20,013	4	0.37	1.37	0.55	2.08
Cooler/Freezer Door Gaskets	120,267	14	0.61	0.10	85,905	10	153,869	33	0.43	0.00	66,779	15	1.28	2.46	0.78	1.50
Auto Closer for Cooler/Freezer	130,038	44	0.61	0.10	92,174	31	126,347	39	0.88	0.00	111,186	34	0.97	0.88	1.21	1.09
Medium Temperature Case w/ Door	138,695	18	0.55	0.10	108,152	12	117,392	25	1.00	0.00	117,392	23	0.74	1.39	1.14	2.14
Strip Curtains for Walk-In	274,483	36	0.55	0.10	178,414	23	1,813,387	394	0.87	0.00	1,579,460	343	6.61	11.03	8.85	14.77
Low Temperature Case w/ Door	363,441	42	0.55	0.10	236,237	27	379,218	82	1.00	0.00	379,218	82	1.04	1.98	1.61	3.04
Night Covers for Display Cases	383,771	0	0.55	0.10	249,451	0	242,322	0	0.70	0.00	169,383	0	0.63	NA	0.68	NA
Compressor Upgrades																
Mechanical Subcooler	8,570	6	0.55	0.10	5,570	4	5,424	6	0.98	0.00	5,332	6	0.63	1.00	0.96	1.51
Multiplex Compressor System	187,610	58	0.55	0.10	121,946	36	110,030	24	0.98	0.00	108,160	23	0.59	0.43	0.89	0.65
Adjustable Speed Drive	5,764	0	0.55	0.10	3,747	0	4,052	1	0.98	0.00	3,984	1	0.70	NA	1.06	NA
Floating Head Pressure Controls	863,286	0	0.55	0.10	561,136	0	546,914	0	0.98	0.00	537,616	0	0.63	NA	0.96	NA
Condenser Upgrades																
Oversized Air-Cooled Condenser	34,551	5	0.55	0.10	22,458	3	21,997	5	0.98	0.00	21,623	5	0.64	1.01	0.96	1.53
Oversized Evaporative Condenser	542,614	117	0.55	0.10	352,699	76	346,445	75	0.98	0.00	340,555	73	0.64	0.64	0.97	0.97
Evaporator Upgrades																
Walk-In Cooler PSC Evaporator Motor	26,352	1	0.55	0.10	17,129	1	16,688	4	0.98	0.00	16,404	4	0.63	2.59	0.96	3.92
Display PSC Evaporator Motor	28,723	1	0.55	0.10	18,670	1	18,223	4	0.98	0.00	17,913	4	0.63	2.76	0.96	4.17
Other																
Anti-Sweat Heater Control	31,020	2	0.55	0.10	20,163	2	27,194	6	0.98	0.00	26,731	6	0.88	2.49	1.33	3.77
Suction Line Insulation	61,885	0	0.55	0.10	40,225	0	39,949	9	0.98	0.00	39,270	9	0.65	NA	0.98	NA
Display Case Electronic Ballast	117,448	11	0.55	0.10	76,341	7	86,209	20	0.98	0.00	84,744	20	0.73	1.79	1.11	2.70
Non-Electric Condensate Evaporator	599,768	44	0.61	0.10	425,367	31	379,930	81	0.73	0.00	286,088	61	0.63	1.84	0.67	1.96
Retrofit Express Total	4,038,402	403	0.56	0.10	2,676,059	269	4,502,403	822	0.88	0.00	3,977,313	725	1.11	2.03	1.49	2.69
Customized Incentives Program																
Compressor Upgrades																
Floating Head Pressure Controls	85,673	0	0.65	0.10	64,255	0	64,488	0	0.39	0.00	24,828	0	0.75	NA	0.39	NA
Booster Desuperheater	107,048	0	0.65	0.10	80,286	0	111,318	0	0.39	0.00	42,957	0	1.04	NA	0.53	NA
Condenser Upgrades																
Oversized Condensers	244,994	30	0.65	0.10	183,746	22	184,412	25	0.39	0.00	70,999	10	0.75	0.82	0.39	0.42
Other																
Refrigeration EMS	4,979,374	170	0.65	0.10	3,734,531	128	3,213,939	199	0.39	0.00	1,237,366	76	0.65	1.17	0.33	0.60
Refrigeration Add/Change	1,970,140	378	0.65	0.10	1,477,610	284	1,176,523	266	0.39	0.00	452,961	102	0.60	0.70	0.31	0.36
Refrigeration Other	11,186,939	532	0.65	0.10	8,390,205	399	8,953,295	397	0.39	0.00	3,447,019	153	0.80	0.75	0.41	0.38
Customized Incentives Total	18,574,174	1,110	0.65	0.10	13,930,632	833	13,703,974	886	0.39	0.00	5,276,030	341	0.74	0.80	0.38	0.41
Total	22,612,576	1,513	0.63	0.10	16,606,690	1,102	18,206,378	1,708	0.51	0.00	9,253,545	1,066	0.81	1.13	0.56	0.97

5. RECOMMENDATIONS

Recommendations that would enhance future program performance and evaluation are presented in this section. Recommendations regarding evaluation methods are followed by those affecting the program's design.

5.1 EVALUATION METHODS

The evaluation team offers the following comments and recommendations regarding methods used in the 1995 evaluation:

Calculation of Ex Ante Impacts - As part of the 1995 Refrigeration Evaluation, an attempt was made to reproduce the Retrofit Express (RE) Program impacts found in the MDSS. This resulted in several observations where ex ante impact methods were misapplied. Such errors could probably be avoided in the future with a regular and thorough review of the MDSS contents by the program manager or a qualified analyst. MDSS staff who currently review the MDSS records may not be trained in the technology-specific details that are essential to conducting meaningful quality checks.

Revisions to the Ex Ante Impact Methods - All RE paid year 1995 ex ante refrigeration algorithms were thoroughly reviewed. Where necessary, these methods were updated using alternate methods or assumptions, as described in detail in *Appendix B, Section B.5*. It is recommended that PG&E carefully review the updates to these algorithms, and apply those updates to future Advice Filings.

End-Use Classification - Ex ante refrigeration impact estimates in the Customized Incentives Program were often mis-classified by end-use. In those instances, measures were lumped together prior to MDSS data entry. These entry errors are due in part to the design of the Customized Incentives application, because the application form "cover sheet" only has space to enter a single measure. While measure-specific results are available in other portions of the application – for example, Attachment 7 includes impacts by measure, which are normally classified by end use as well – this information is not consistently entered into the MDSS. This misclassification of measures typically occurred in the supermarket segment.

It is recommended that application forms for programs similar to the Customized Incentives Program be modified to allow data entry for multiple measures on the application "cover sheet."

Anti-Sweat Heater Demand Impacts - Energy Management System (EMS) retrofits that are installed within the grocery business type generally control store overhead lights, refrigerated case display lights, refrigerant setpoints (for example, the condensing temperature), the HVAC system, and anti-sweat heater runtime. Anti-sweat heaters prevent condensation from forming on the surfaces of refrigerated case displays. These heaters are often oversized and can readily evaporate condensate from the case surfaces with only fifty percent duty cycle. EMS controls will normally cycle the anti-sweat heaters (where the entire anti-sweat load is split across two circuits) using a fifty percent duty cycle, or will cycle these circuits based on real-time dew point and temperature measurements. Using either strategy, anti-sweat loads are significantly reduced.

During PG&E application review, anti-sweat heater demand impacts were rejected, while energy impacts were accepted. However, anti-sweat controls provide significant demand reduction during all hours of the year, including the system peak hour. Evaluation demand impacts are

based upon an assumed 50 percent duty cycle of the anti-sweat heaters. PG&E should consider accepting this control strategy as a valid peak period demand reduction measure.

5.2 MEASURES OFFERED

The exhibits in *Section 4* allow identification of technologies or building types that should be reassessed in terms of their viability. This does not imply that these technologies are not valuable, but rather that the original estimate of design savings was higher than that actually achieved. The following segments should be reviewed for viability as part of the overall assessment.

Energy Management Systems are an effective means of reducing energy consumption, but require a knowledgeable operator to achieve those savings. EMSs used to monitor and control complicated refrigeration plants require significant operator input, ideas and operational decisions to achieve savings. EMSs cannot be expected to save energy without adequate system commissioning. PG&E should require commissioning for these systems (or other complicated measures) and offer incentives based on a performance contract. On-site investigations conducted as part of this evaluation effort have shown that performance contracts are an effective means of ensuring savings from the installation of a particular system.

Application Engineering Review is a necessary component of the submittal process, and can be used to effectively screen applications that have significant analysis errors. In some instances, large errors were observed in the Customized Incentives applications submitted, resulting in inaccurate reporting of project impacts. Since applications submitted for the Customized Incentives Program (or other current programs like Nonresidential New Construction and Advanced Performance Options) can result in relatively large incentives (often based on impact achieved), it is recommended that a more intensive application review be used to capture these anomalies.

Analysis of Reasonableness of Savings should be another method used to assess errors in the application savings estimates. For example, the Customized Incentives application includes this type of comparison information within Attachment 7, where measure savings are compared against both the baseline quantity used and also against total billing records for the site. However, in some instances, these valuable data do not appear to be used in an effort to reject claimed savings. For example, a large grocery participating in the Customized Incentives Program submitted numerous applications with claimed adjustable speed drive energy savings that are (on average) 80 percent of the base case usage.

Additional explanations are offered for other technologies or building segments with low realization rates in *Section 4*.