RESIDENTIAL APPLIANCE EFFICIENCY INCENTIVES PROGRAM: HIGH EFFICIENCY REFRIGERATION 1994 FIRST YEAR STATEWIDE LOAD IMPACT STUDY

Final Report

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E EXECUTIVE SUMMARY

This report presents the results of the First Year Statewide Load Impact Evaluation of 1994 Residential High Efficiency Refrigerator Rebate Programs. This project involved conducting an impact evaluation to determine the gross and net impacts resulting from refrigerator rebate programs sponsored by Southern California Edison (Edison) and San Diego Gas & Electric (SDG&E).

This Executive Summary presents the key findings of the analysis.

E.1 PROGRAM BACKGROUND

The programs analyzed in this evaluation were the Southern California Edison and San Diego Gas & Electric residential refrigerator rebate programs. Both Edison's and SDG&E's programs offered incentives, in the form of rebates, to residential customers who purchased new high efficiency refrigerators that consumed 85 percent or less electricity than the federal standards allowed for the particular model purchased based on its size and attributes.

E.2 GROSS IMPACTS

The following sections present the gross impact findings for Edison and SDG&E. The analysis was conducted by comparing the energy consumption of each rebated model with the federal energy consumption standard for the same model.

E.2.1 Total Energy Savings

Table E-1 shows the total energy savings for the 1994 Edison and SDG&E programs.

Table E-1
Annual Energy Consumption Data for the Edison and SDG&E 1994 Refrigerator Rebate Programs

Utility	Number of Refrigerators	Base Usage (from Standards) (kWh/year)	Program Refrigerator Usage (kWh/year)	Gross Energy Savings (kWh/year)
Edison	23,006	18,911,986	15,153,858	3,758,128
SDG&E	32,009	24,638,403	19,920,623	4,717,780
Combined	55,015	43,550,389	35,074,481	8,475,908

E.2.2 Average Energy Savings

The average energy savings for participating refrigerators were about 154 kWh per year or about 19.5 percent savings from the federally mandated energy consumption standards for refrigerators of the same size and attributes. Table E-2 shows the average energy savings for the 1994 Edison and SDG&E programs.

Table E-2
Average Savings for the Edison and SDG&E 1994 Refrigerator Rebate Programs

Utility	Average per-unit Energy Consumption Standards for Program Refrigerators (kWh/year)	Average per-unit Energy Consumption for Program Refrigerators (kWh/year)	Average Annual per-unit Gross Energy Savings (kWh/year)	Average per-unit Percentage Savings
Edison	822	659	163	19.9%
SDG&E	770	622	147	19.1%
Combined	792	638	154	19.5%

E.2.3 Peak Load Impacts

Table E-3 shows the total peak load savings for the 1994 Edison and SDG&E programs. The demand savings were calculated by applying a peak demand coincident factor to the energy savings.

Table E-3
Total Peak Demand Consumption and Savings Data for the Edison and SDG&E 1994 Refrigerator Rebate Programs

Utility	Number of Refrigerators	Standards Base Peak Usage (kW)	Program Refrigerator Peak Usage (kW)	Gross Peak Demand Savings (kW)
Edison	23,006	2,893	2,318	575
SDG&E	32,009	3,769	3,047	722
Combined	55,015	6,662	5,365	1,297

E.2.4 Average Peak Demand Savings

The average peak demand savings for participating refrigerators were about 24 watts. Table E-4 shows the average peak demand savings for the 1994 Edison and SDG&E programs. The demand savings were calculated by applying a peak demand coincident factor to the energy savings.

Table E-4
Peak Demand Savings for the Edison and SDG&E 1994 Refrigerator Rebate Programs

Utility	Average per-unit Standards Based Peak Usage (Watts)	Average per-unit Program Refrigerator Peak Usage (Watts)	Average per-unit Gross Peak Demand Savings (Watts)	Average per-unit Percentage Savings
Edison	126	101	25	19.9%
SDG&E	118	95	23	19.1%
Combined	121	98	24	19.5%

E.3 NET-TO-GROSS ANALYSIS

The net-to-gross analysis was conducted by comparing the energy efficiency of refrigerators purchased in 1994 in California to refrigerators purchased in comparison areas without similar rebates. Data was collected through a survey of California residents and residents of five cities outside California. Electric utilities serving the out-of-California areas have never offered a residential refrigerator rebate program. The methodology for the study was developed for CADMAC in an earlier scoping study and incorporated into the California *Protocols and Procedures for the Verification of Costs,*

Benefits, and Shareholder Earnings fro Demand-Side Management Programs[1].

This study calculated the net-to-gross ratio to be 0.97 for 1994 California refrigerator rebate programs.

E.3.1 Data Collection

The survey used to conduct the net-to-gross analysis used random digit dialing to reach residential customers in both the California and out-of-state study areas. In the course of the study, 93,169 telephone calls were placed and 10,815 surveys were completed. Of the surveys completed, 412 participants purchased refrigerators in 1994 and were able to provide a refrigerator model number that could be used in the analysis.

[1] Scoping Study of Efficient Refrigerator Impact Parameters and Evaluation Methods, HBRS, Inc., prepared for the California DSM Measurement Advisory Committee, July 1994.

1 INTRODUCTION

1.1 OVERVIEW

This report presents impact evaluation results for the Southern California Edison (Edison) and San Diego Gas & Electric (SDG&E) residential refrigerator rebate programs for 1994. Tracking-system-based engineering analysis and a survey-based net-to-gross analysis were used to develop gross and net savings for the refrigerator rebate programs.

1.2 PROGRAM DESCRIPTIONS

Edison's and SDG&E's refrigerator rebate programs were designed to encourage refrigerator purchasers to save energy by buying new, high efficiency refrigerators. Both programs provided rebates for the purchase of refrigerators that consumed less energy than is allowable under federal appliance standards. The amount of rebate offered depended on the rated energy consumption of the refrigerator relative to the federal energy consumption standard for the refrigerator.

1.2.1 Edison's Program

Edison's refrigerator rebate program was offered from July 1994 through September 1994. Table 1-1 presents the relationship between the percentage of energy savings beyond standards to the rebate offered.

Table 1-1
Refrigerator Rebates Offered by Edison's Program

Percentage Energy Savings Beyond Federal Standards	Rebate Amount
14.5-19.49%	$30
19.5-29.49%	$50
39.5% and more	$75

1.2.2 SDG&E's Program

SDG&E's refrigerator rebate program was offered throughout 1994. Table 1-2 presents the relationship between the percentage of energy savings beyond standards to the rebate offered.

Table 1-2
Refrigerator Rebates Offered by SDG&E's Program

Percent Energy Savings Beyond Federal Standards	Rebate Amount
15-19.99%	$50
20-24.99%	$75
25% and more	$100

1.3 EVALUATION APPROACH

The methodology employed in this study was developed for CADMAC in an earlier scoping study[1]. Gross impacts were calculated using an engineering approach. The approach was validated by the California Public Utility Commission (CPUC) and incorporated into the *Protocols and Procedures for the Verification of Costs, Benefits, and Shareholder Earnings for Demand-side Management Programs.* Savings were based on the difference in energy consumption between rebated refrigerators and the federal appliance energy consumption standard for the same refrigerators. Net savings were calculated by applying a net-to-gross factor to the gross savings.

The net-to-gross analysis was conducted by comparing the energy efficiency of refrigerators purchased in 1994 in California to refrigerators purchased in places without similar rebates. Data was collected through a survey of California residents and residents of five cities outside California. Electric utilities serving the out-of-California areas have never offered a residential refrigerator rebate program.

1.4 REPORT ORGANIZATION

The remainder of this report is organized as follows:

- Section 2 contains the key results of the evaluation.
- Section 3 contains a discussion of the methodology employed to conduct the analysis.
- Section 4 presents the analysis of the results and addresses questions raised in the process of performing the evaluation.

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[1] *Scoping Study of Efficient Refrigerator Impact Parameters and Evaluation Methods*, HBRS, Inc., prepared for the California DSM Measurement Advisory Committee, July 1994.

- The survey questions used for the net to gross analysis are presented in Appendix A.
- Appendix B contains refrigerator model number adjustment assumptions used in the data cleaning process.
- Appendix C provides the summary tables.
- Appendix D contains excepts from the CADMAC *Scoping Study of Efficient Refrigerator Impact Parameters and Evaluation Methods* describing the proposed net-to-gross analysis methodology.

2 RESULTS

2.1 OVERVIEW

This section presents results of the Southern California Refrigerator Program Impact Analysis. Results are shown for the Southern California Edison and San Diego Gas & Electric programs.

2.2 GROSS ENERGY SAVINGS

In Table 2-1, total annual energy consumption data are presented for the Edison and SDG&E 1994 refrigerator rebate programs.

Table 2-1
Annual Energy Consumption for the Edison and SDG&E 1994 Refrigerator Rebate Programs

Utility	Number of Refrigerators	Base Usage (from Standards) (kWh/year)	Program Refrigerator Usage (kWh/year)	Gross Energy Savings (kWh/year)
Edison	23,006	18,911,986	15,153,858	3,758,128
SDG&E	32,009	24,638,403	19,920,623	4,717,780
Combined	55,015	43,550,389	35,074,481	8,475,908

The data show that 23,000 high efficiency refrigerators were purchased as part of Edison's program, saving approximately 3.8 million kilowatt-hours per year. Also, approximately 32,000 high efficiency refrigerators were purchased as part SDG&E's program, saving about 4.7 million kilowatt-hours per year.

Table 2-2 provides average per-unit savings for the Edison and SDG&E 1994 Refrigerator Rebate Programs. These data show that the average high efficiency refrigerator purchased through one of the utility rebate programs saved 154 kilowatt-hours per year. The refrigerator consumes about 19.5 percent less energy than a comparable model that simply complies with federal appliance efficiency standards.

Table 2-2
Average Savings for the Edison and SDG&E 1994 Refrigerator Rebate Programs

Utility	Average per-unit Energy Consumption Standards for Program Refrigerators (kWh/year)	Average per-unit Energy Consumption for Program Refrigerators (kWh/year)	Average Annual per-unit Gross Energy Savings (kWh/year)	Average per-unit Percentage Savings
Edison	822	659	163	19.9%
SDG&E	770	622	147	19.1%
Combined	792	638	154	19.5%

2.2.1 Distribution of Gross Savings by Energy Efficiency Level

Table 2-3 shows the distribution of energy savings by the percentage of energy that was saved. The table reveals that about 25,000 rebated refrigerators saved 20 percent and about 22,000 rebated refrigerators saved about 15 percent. This table also illustrates that the refrigerators that saved the greatest percentage of energy, more than 25 percent, were units for which the base case federal consumption standards were higher. Base case standards of units that saved more than 25 percent were, on average, at least 200 kilowatts per year greater than standards for those units that saved 20 percent.

Table 2-3
Distribution of Rebated Refrigerator Savings by the Percentage of Energy Savings

Refrigerator Category	Number of Units	Average per-unit Energy Consumption Standards for Program Refrigerators (kWh/year)	Average per-unit Energy Consumption for Program Refrigerator (kWh/year)	Average Annual per-unit Energy Savings (kWh/year)	Total Annual Energy Savings (kWh/year)
Units that save 15%	21,965	762	645	116	2,558,802
Units that save 20%	24,642	752	600	153	3,758,478
Units that save 25%	6,811	993	742	251	1,706,756
Units that save 30%	1,597	953	670	283	451,872

Figure 2-1 illustrates that 45 percent of the units purchased consumed 20 percent less than that allotted by federal appliance standards and 40 percent of the units sold saved 15 percent beyond standards. The remaining 15 percent of refrigerators rebated saved at least 25 percent beyond the standards.

Figure 2-1
Distribution of the Number of Refrigerators Rebated for the Combined Edison & SDG&E Refrigerator Rebate Programs

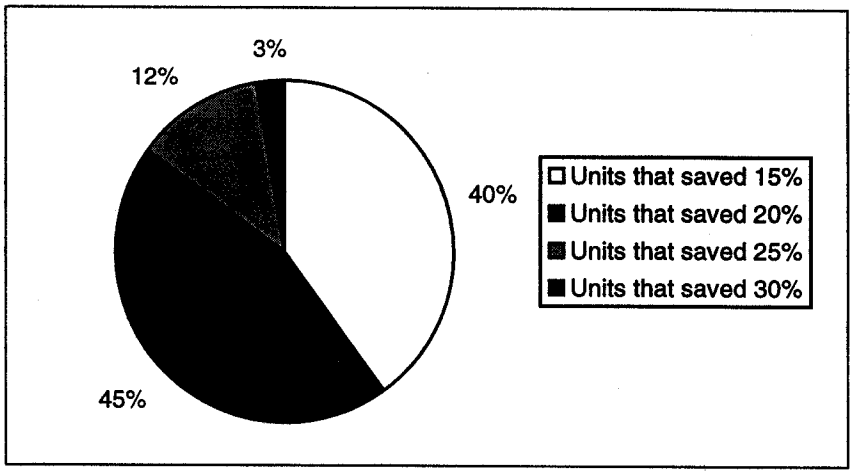
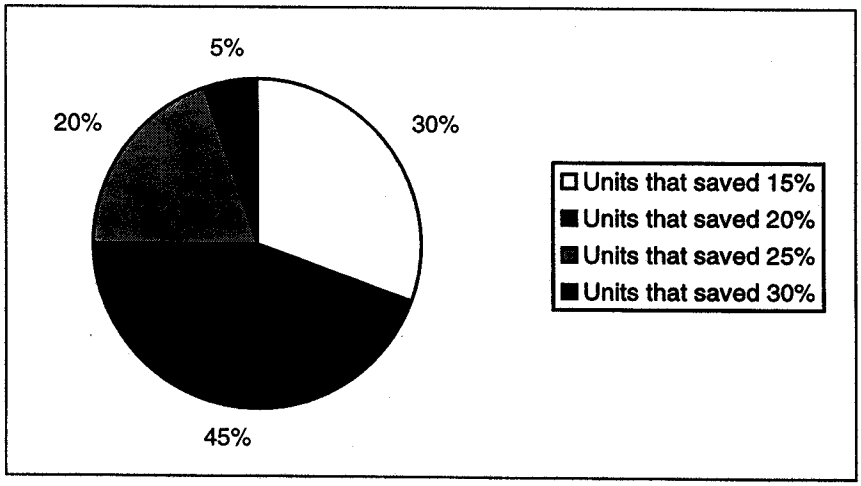


Figure 2-2 illustrates that 45 percent of the energy savings were realized by units that saved 20 percent and that 30 percent of the savings were realized by the units that saved 15 percent beyond federal standards. The remaining 25 percent of energy savings were realized by the 15 percent of the refrigerators that saved at least 25 percent beyond the federal standards.

Figure 2-2
Distribution of Energy Savings for the Combined Edison & SDG&E Refrigerator Rebate Programs



2.2.2 Distribution of Gross Energy Savings by Refrigerator Size Category

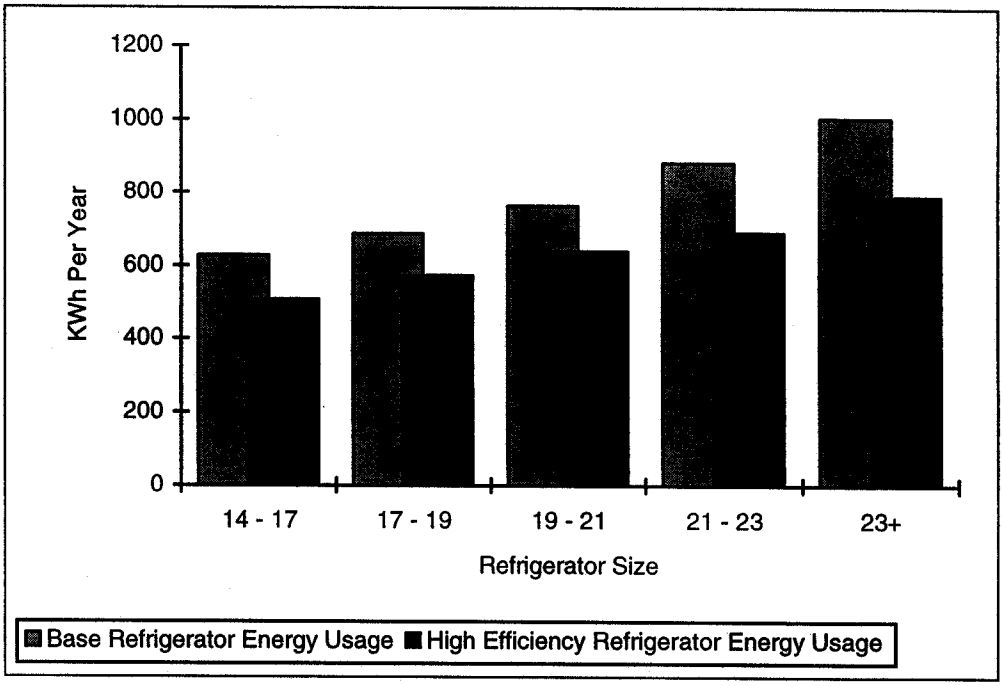
Table 2-4 provides a disaggregation of program energy savings by refrigerator size. As would be expected, the average base case energy consumption increased as size increased, and correspondingly, the average energy savings increased as size increased. In general, the percent savings increased with size, with the exception that 19 percent average energy savings were realized for the 14 through 17 cubic foot models.

Table 2-4
Distribution of Rebated Refrigerator Savings by Refrigerator Size

Refrigerator Size	Number of Units	Average per-unit Energy Consumption Standards for Program Refrigerators (kWh/year)	Average per-unit Energy Consumption for Program Refrigerators (kWh/year)	Average Annual per-unit Gross Energy Savings (kWh/year)	Percentage Energy Savings
14 - 17	16318	632	510	122	19%
17 - 19	11170	694	580	114	16%
19 - 21	6927	775	649	126	16%
21 - 23	7290	893	698	194	22%
23+	13310	1023	803	219	21%

Figure 2-3 graphically depicts an average energy consumption for rebated refrigerators relative to standard units of the same size.

Figure 2-3
Average Energy Use Comparison for Rebated Refrigerators and Relevant Standards



2.3 GROSS LOAD IMPACTS

Table 2-5 presents total peak demand consumption data for the Edison and SDG&E 1994 refrigerator rebate programs.

Table 2-5
Total Peak Demand Consumption Data for the Edison and SDG&E 1994 Refrigerator Rebate Programs

Utility	Number of Refrigerators	Standards Base Peak Usage (kW)	Program Refrigerator Peak Usage (kW)	Gross Peak Demand Savings (kW)
Edison	23,006	2,893	2,318	575
SDG&E	32,009	3,769	3,047	722
Combined	55,015	6,662	5,365	1,297

The data show that approximately 23,000 high efficiency refrigerators were purchased as part of Edison's program, saving 575 peak watts. These data also show that approximately 32,000 high efficiency refrigerators were purchased as part SDG&E's program, saving about 722 peak watts.

Table 2-6 provides average per-unit savings for the Edison and SDG&E 1994 Refrigerator Rebate Programs. These data show that the average high efficiency refrigerator purchased through one of the utility rebate programs saved 24 peak watts.

Table 2-6
Peak Demand Savings for the Edison and SDG&E 1994 Refrigerator Rebate Programs

Utility	Average per-unit Standards Based Peak Usage (Watts)	Average per-unit Program Refrigerator Peak Usage (Watts)	Average per-unit Gross Peak Demand Savings (Watts)	Average per-unit Percentage Savings
Edison	126	101	25	19.9%
SDG&E	118	95	23	19.1%
Combined	121	98	24	19.5%

2.4 NET SAVINGS

The results of the net-to-gross analysis produced a net-to-gross ratio of 0.96. This would indicate that the programs are achieving about what they set out to accomplish. Table 2-7 shows the net-to-gross range based on 80 and 90 percent confidence intervals.

Table 2-7
Net-to-Gross Estimate Confidence Intervals

	Point Estimate	Low	High
Net-to-gross @ 90% Confidence	97%	35%	162%
Net-to-gross @ 80% Confidence	97%	49%	148%

As discussed in the methodology section of this report, the net-to-gross ratio is based on the distinction between California's and the control areas' average refrigerator energy consumption relative to federal standards. The survey conducted as part of this study addressed those energy savings differences. Highlights of the distinctions between the California and out-of-state 1994 refrigerators are presented in Table 2-8. The In-state Average Annual Energy Savings includes the savings from both program participants and nonparticipants.

Table 2-8
Telephone Survey Results: A Comparison of California and Control Area 1994 Purchased Refrigerator Energy Consumption

	Number of Model Numbers Collected	Average Annual Refrigerator Energy Consumption (kWh/year)	Average Federal Standards Annual Energy Consumption (kWh/year)	Average Annual Energy Savings (kWh/Year)	Size (Cubic Feet)
In-state	218	728	827	99	21.0
Out-of-state	194	740	818	78	20.6

Applying the 0.97 net-to-gross ratio to the above gross savings estimates produces the results presented in Table 2-9. These data show that the net energy savings for Edison was about 3.7 GWh/year and the peak demand savings was 0.57 MW. The data also show that the net energy savings for SDG&E was 4.7 GWh/year and the peak demand savings was 0.71 MW.

Table 2-9
Net Savings for the Edison and SDG&E 1994 Refrigerator Rebate Programs

Utility	Number of Refrigerators	Net Energy Savings (kWh/year)	Average per-refrigerator Net Energy Savings (kWh/year)	Net Peak Demand Savings (kW)	Average per-refrigerator Net Peak Demand Savings (Watts)
Edison	23,006	3,635,973	158	556	24
SDG&E	32,009	4,564,432	143	698	22
Combined	55,015	8,200,404	149	1,254	23

2.5 MOST POPULAR REFRIGERATORS

Table 2-10 presents the top ten selling refrigerators that were purchased through the Edison and SDG&E refrigerator rebate programs. The best selling refrigerator was Hotpoint, which saved 129 kWh/year. The second best selling refrigerator was Roper, which saved 125 kWh/year. The two best selling models were relatively small, 14.4 cubic feet, with energy savings of about 20 percent beyond federal standards.

Table 2-10
Ten Most Popular Rebated Models in 1994

Rank	Number of Units Purchased	Brand	Manufacturer	Model	Size (Cubic Feet)	Style	Energy Savings (kWh/year)	Percentage Savings
1	3092	HOTPOINT	GE	CTH14CYS	14.4	TF	129	21%
2	2355	ROPER	WHIRLPOOL	RT14HD*B*0*	14.38	TF	125	20%
3	2075	GE	GE	TFH24PRS	23.6	SI	202	20%
4	1537	HOTPOINT	GE	CTH16CYS	15.62	TF	129	20%
5	1527	WHIRLPOOL	WHIRLPOOL	ED25DQ*B*0*	25.19	SI	262	25%
6	1513	GE	GE	TBH18DAT	18.17	TF	142	20%
7	1317	KENMORE	WHIRLPOOL	106.95457**	25.21	SI	262	25%
8	1278	HOTPOINT	GE	CTH14CYT	14.44	TF	129	21%
9	1161	ROPER	WHIRLPOOL	RT16DK*B*0*	16.42	TF	99	15%
10	1149	AMANA	AMANA	TPI21A3	20.7	TF	116	16%

TF = refrigerator-freezer with top mount freezer

SI = side-by-side refrigerator-freezer

3 METHODOLOGY

3.1 OVERVIEW

This section describes the methodology employed to conduct this Statewide Impact Evaluation of High Efficiency Refrigerator Programs. Our approach followed the general method presented in the scoping study conducted for CADMAC in 1994, with some modifications. The approach employed a quasi-experimental design that incorporated gross spillover effects and used out-of-state control areas to calculate free ridership.

3.2 TECHNICAL APPROACH

Both gross and net calculations are based on estimating the difference between refrigerator energy consumption and the refrigerator energy consumption standard.

The method employed for calculating savings beyond standards in this analysis differs slightly from the method described in the Scoping Study. The Scoping Study describes calculating between the difference of the average refrigerator energy consumption and the average refrigerator energy consumption standard. This method calculates that difference between refrigerator energy consumption and the energy consumption standard for each refrigerator and then averages those differences. This method was chosen over the Scoping Study method because it is less likely to product errors due to aggregation.

3.2.1 Gross Impacts

Gross impacts were calculated using an engineering approach. This approach was validated by the CPUC and is consistent the California protocols for high efficiency refrigerator impact studies. Savings were based on data contained in Edison's and SDG&E's 1994 Refrigerator Rebate Program tracking systems. These databases contained both annual energy consumption and the federal annual energy consumption standards for each refrigerator rebated. Both annual consumption and federal standards were confirmed by comparing the tracking system databases with the data contained in the CEC's Directory of Certified Refrigerators and Freezers.

Gross Energy Savings

The energy savings were calculated for each refrigerator by subtracting the model's annual energy consumption from the annual energy consumption standard for a model of the same size and attributes. The total energy savings for each utility were calculated by summing the annual energy savings for all rebated refrigerators.

The equation used to calculate the gross energy is as follows:

$$GEI = \sum_{i}^{nr} \left(kWhStd_i - kWhRtd_i \right)$$

where:

GEI	= Gross Energy Impact
$kWh\ Std_i$	= the rated kWh per year consumption of units just meeting the Federal DOE standards, computed by using the attribute characteristics and adjusted volume of the rebated unit
$kWh\ Rtd_i$	= the rated kWh per year consumption of rebated unit
i	= for rebated unit i
nr	= the total number of rebated units

Gross Load Impacts

The gross load impact for each refrigerator was calculated by applying a normalized refrigerator load factor applicable to the peak load hour to the average refrigerator load. The average load was calculated by dividing the gross energy impacts by 8,760 hour per year.

The equation used to calculate the gross load impact is as follows:

$$GLI = GEI * \frac{NRL}{8760hr / yr}$$

where:

GLI	= Gross Load Impact
NRL	= Normalized Refrigerator Load, which is a factor relating the load at a given time to the average annual load = 1.34[1]

[1] *Analysis of SCE and PG&E Refrigerator Load Data, AAG & Associates, Inc.*, prepared for the California DSM Measurement Advisory Committee, April 5, 1995.

3.2.2 Net Impacts

Net impacts were calculated by following the general method outlined in the Scoping Study conducted for CADMAC in 1994, with some modifications. This approach employs a quasi-experimental design that produces an estimate of net energy savings. The method automatically incorporates the calculation of gross spillover effects and free ridership.

Technical Approach

The net impacts were calculated by examining the difference in market penetration of high efficiency refrigerators between the sponsors' territories (the treatment area) and the non-program areas (the control area). Spillover was calculated as the difference between the total energy savings for 1994 refrigerators within the treatment areas and the savings realized by 1994 refrigerator rebate program participants. The penetration of high efficiency refrigerators in the non-program areas served as a proxy for "naturally-occurring" or "free-rider" purchases within the sponsors' territories. Net savings were calculated by summing the gross programs savings with the spillover savings and subtracting the naturally occurring savings.

Gross Spillover

To estimate the *gross spillover* effect, it was necessary to estimate the total high efficiency savings from all units purchased in the treatment areas. This is the *Total High-Efficiency Impact (THEI)* in the treatment area:

$$THEI_t = \left(Average\left(kWhStd_t - kWhRtd_t\right)\right) \times Total\,Units_t$$

where:

t	= the treatment area
$THEI_t$	= the total high efficiency refrigerator energy savings in the treatment areas
$Total\,Units_t$	= the total number of units in the treatment area calculated by multiplying the total number of residential customers by the percentage of survey respondents that purchased refrigerators in 1994

Gross spillover is calculated as the difference between the total high efficiency impact and the program's gross energy impact.

$$\text{Gross Spillover} = THEI_t - GEI$$

Free Ridership

The naturally occurring or free ridership estimated as the *Total High-Efficiency Impact (THEI)* in the control area is:

$$THEI_c = \left(Average\left(kWhStd_c - kWhRtd_c\right)\right) \times AAF \times Total\ Units_t$$

where:

c	= refers to the control area
AAF	= attribute adjustment factor

Attribute Adjustment Factor

The AAF was used to adjust the average high efficiency impact of units in the control area for differences in unit attributes relative those in the treatment area. This issue was addressed in the scoping study but the example used only shows an adjustment for differences in adjusted volume. The other critical difference that would have to be corrected for is the distribution of the types of refrigerators in both areas (e.g., door configuration and through-the-door ice and water features). A simple ratio of the adjusted volumes is not a correct scalar because all of the consumption equations in the federal standards have large intercept terms. Within a given refrigerator category of the federal standards, the correct adjustment for volume differences is:

$$Volume\ Adjustment = \frac{\beta \times AV_t + \alpha}{\beta \times AV_c + \alpha} = \frac{Average\ kWhStd_{type,t}}{Average\ kWhStd_{type,c}}$$

where:

AV	= adjusted volume
$type$	= attributes (door configurations, defrost options, etc.)

β and α are coefficients that depend on the type of refrigerator

Net Savings

Finally, the above data are combined to produce estimates of gross spillover and net impacts as follows:

Net Program Impact (NPI) = GEI + Spillover - Free Riders

Net Program Impact (NPI) = $THEI_t$ - $THEI_c$

$$NPI = \left[\left(Average\left(kWhStd_c - kWhRtd_c\right)\right) - \left(Average\left(kWhStd_c - kWhRtd_c\right)\right) \times AAF\right] \times Total\ Units_t$$

NPI = 8,200,404 ≅ (99.24 - 78 * 1.0059) * 394,674

Net-to-Gross Ratio = NPI/GEI = 8,200,404 ÷ 8,475,908 = 0.97

3.2.3 Net-to-Gross Precision Estimate

The net-to-gross precision was estimated using a two sample independent *t* test. The equation to calculate the sampling distribution around the difference between means is as follows:

$$\sigma_{\bar{x}_1-\bar{x}_2} = \sqrt{s^2_{pooled}\left(\frac{1}{N_1}+\frac{1}{N_2}\right)}$$

where:

$\sigma_{\bar{x}_1-\bar{x}_2}$ = standard error of the difference
s^2_{pooled} = pooled variance estimate
N_n = number of observations

The range of net savings = Net savings estimate ± $\sigma_{\bar{x}_1-\bar{x}_2}$ * *t*

where:

t = critical value for *t* test at appropriate confidence interval

3.3 DATA DEVELOPMENT

3.3.1 Gross Energy Impacts

Gross energy savings were based on data from Edison's and SDG&E's 1994 Refrigerator Rebate Program tracking systems in conjunction with information from the federal appliance efficiency standards and the CEC's Directory of Certified Refrigerators and Freezers. The program tracking systems contained the total population of the programs' participants. These databases contained refrigerator model numbers, volume, annual energy consumption, and the federal annual energy consumption standards for each refrigerator rebated.

3.3.2 Gross Peak Savings Impacts

The critical factor to change energy saving to peak demand saving is the Normalized Refrigerator Load factor. This factor was derived through metering studies for Edison and is documented in the *Analysis of SCE and PG&E Refrigerator Load Data,* April 5, 1994, by AAG & Associates, Inc.

3.3.3 Net-to-Gross

The data necessary for the net-to-gross and spillover analyses was collected via telephone surveys using random digit dialing of residential customers to locate customers who purchased new refrigerators in 1994 in both the treatment and control areas. The control areas were selected from utility service territories in Arizona, Nevada, Utah, Idaho, Oklahoma, and Louisiana. The electric utilities in each of these areas had never offered residential energy efficiency refrigerator rebate programs to their customers.

Surveys were carried out in English and Spanish. Households in which English or Spanish was not spoken were excluded from the sample because the survey could not be carried out in other languages.

The telephone survey was conducted by Freeman Sullivan & Company (FSC), a firm specializing in telephone market research studies.

Sample Size and Design

The target population for both the treatment and control areas was defined as residential customers that purchased new refrigerators in 1994. A telephone survey was conducted using random digit dialing to find a sample of customers from the total residential population who purchased new refrigerators in 1994.

Telephone surveys always include some coverage errors. By coverage error, we mean error arising from the fact that sampling frame (i.e., the population of telephone numbers) does not completely overlap with the population if interest (in this case, the population of households that purchased refrigerators). We believe that the coverage error in this study was minimal because the behavior of interest (i.e., purchase of a new refrigerator) is confined to households that have sufficiently surplus income to afford new appliance. While the exact incidence of telephones in households that replaced their refrigerators is unknown, it is reasonable to assume that it is higher than 99 percent, as the incidence rate for telephones is more than 99 percent in households with income above the poverty line, and presumably those who bought new refrigerators are above the poverty line.

The CADMAC protocol for the net-to-gross study called for telephone surveys of 900 residential customers who purchased refrigerators in 1994: 450 within California and 450 out-of-state. It was assumed that one in every 12 households purchased a new refrigerator in 1994, thus requiring 10,800 calls. In the course of the survey, 93,169 telephone

calls were placed. The final number of surveys completed for households with and without refrigerators purchased in 1994 is shown in Table 3-1.

Table 3-1
Number of Telephone Calls to Each Location

Location	Number of Calls Completed
Boise, Idaho	1,031
Las Vegas, Nevada	1,045
Phoenix, Arizona	1,042
Tulsa, Oklahoma	1,123
Shreveport, Louisiana	1,168
SDG&E	2,269
Edison	3,137
Total	10,815

Number of Households

The total number of refrigerators purchased in 1994 in the treatment area was estimated by multiplying the number of households in the treatment area by the saturation of 1994 refrigerators. This study found that 8.7 percent of the households surveyed in the combined Edison and SDG&E service territories purchased refrigerators in 1994. The numbers of households used in this analysis are presented in Table 3-2. Using this method, the total number of refrigerators purchased in the treatment area was estimated to be 394,674.

Table 3-2
Number of Households in the Edison and SDG&E Service Territories

	Number of Households
Edison	3,500,000
SDG&E	1,012,500
Total	4,512,500

Procedures Used for Telephone Surveys

In the surveys, FSC randomly sampled telephone numbers from the control and treatment areas. The survey respondents were asked whether they replaced or purchased a new refrigerator in 1994 to determine their eligibility for the remainder of the interview. Respondents who reported that they purchased a new refrigerator in 1994 were asked a short series of demographic, utility program participation, and refrigerator characteristic questions and *then* were asked to report the make and model of their new refrigerator after inspecting the nameplate of the appliance, located on the inside of the unit. Guidance was provided to help the participant locate the model number.

The FSC Computer Assisted Telephone Interview (CATI) system program contained a list of model numbers for all refrigerators registered with the CEC. If the surveyors could not match a model number on the CATI screen, they would type in any model number the participant provided. When the participant could not find the model number or the model numbers did not match the CEC list, the participant was offered five dollars to call back with a valid model number.

Data Cleaning

Each model number reported by a participant but not listed by the CEC was examined. The model number was compared to other similar numbers of the same brand and manufacturer. The first round of analysis considered clear character errors, omissions, or additions. The next round of analysis considered similar model numbers to identify characters or strings of characters that provided a clue to the energy use characteristics. Whenever possible, numbers were restated to a number listed with the CEC, thus allowing the use of the observation in the analysis. All model number changes used in this cleaning process are listed in Appendix B.

4 ANALYSIS

4.1 GROSS SAVING ANALYSIS

The gross savings estimates for the refrigerator programs from both utilities are accurate and free of any sampling errors. All units and each unit's energy savings were counted. Three caveats are associated with the method employed, however:

- The gross savings estimates for both utilities are as good as the testing and rating procedures used in the refrigerator industry. The California Energy Commission's published energy consumption data was used as a basis for the analysis. Whether the energy consumption ratings capture consumption during true operating conditions is beyond the scope of this study.
- The records of participating refrigerators were maintained in each utility's tracking system database. Tracking system errors could result in miscounting or mis-identifying participating refrigerators. No significant irreconcilable errors of this type were detected.
- The method used to calculate peak load savings is completely dependent on the comparison of refrigerator peak load to refrigerator average load. Refrigerator metering studies have been conducted to estimate the relationship between peak and average refrigerator loads. The data show that the relationship is temperature dependent. The 1995 study that compared Edison and PG&E refrigerator load data concluded that the peak to average load differs by utility and cannot be totally explained by weather differences[1]. The percentage of air-conditioned households is a likely factor contributing to the difference. The study concludes with a call for additional analysis incorporating air conditioning and indoor temperatures. The 1995 study results indicate some uncertainty regarding the peak-to-average load estimate that we are using and its applicability for calculating SDG&E peak demand savings.

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[1] *Analysis of SCE and PG&E Refrigerator Load Data*, AAG & Associates, Inc., prepared for the California DSM Measurement Advisory Committee, April 5, 1995.

4.2 NET SAVING ANALYSIS

The results of the net-to-gross analysis produced a net-to-gross ratio of 0.97. This net-to-gross value would indicate that the programs are achieving about what they set out to accomplish. While the methodology incorporates the effects of spillover and free ridership, it does not produce estimates of these factors separately. Hence, it is not possible to determine whether spillover and free ridership effects are small or large and canceling each other.

4.2.1 Why Treatment Area Residents Purchased Higher Efficiency Refrigerators Than Control Area Residents

This study shows that the average refrigerator purchased in Edison's and SDG&E's service territories (treatment area) was higher efficiency than those purchased in the control areas. This analysis concludes that the difference in refrigerator energy efficiencies is attributable to the 1994 Edison and SDG&E refrigerator programs.

We found no economic or demographic differences between the treatment area and the control areas that could explain the difference in high efficiency refrigerator purchasing beyond that explained by the existence of the programs.

Programs transform markets. Manufacturers produce more high efficiency refrigerators because they believe that the programs will help sell them. Distributors and retailers stock high efficiency refrigerator because customers want the rebate and purchase those models.

If there was a greater availability of high efficiency refrigerators in the treatment area over the control area, it was due to the programs.

The Effects of Electric Rates

Although the average electric rate is lower in the control area than in the treatment area, it is unlikely that the difference in electric rates explains much of the difference in refrigerator energy consumption. The average residential electric rate in the control areas is about six cents per kWh. This average residential electric rate in the treatment area is about 12 cents per kWh. The difference in energy consumption for the average refrigerator in each area is about 21.24 kWh per year. A simple calculation produces an average difference in annual refrigerator operating cost for the marginal treatment area savings of $1.27/year.

$1.27/year = ($0.12/kWh - $0.06/kWh) * 21.24 kWh/year

Residential large appliance buyers tend to be more concerned about first cost than life-cycle cost. In addition, residential customers generally have high discount rates. Even ignoring these two assumptions, it hard to see a $1.27/year savings have much motivational effect relative to a $30 to $100 first cost savings.

4.2.2 Issues Concerning the Measurement of Spillover in a Specific Time Period

This study shows that, on average, people in Southern California purchased higher efficiency refrigerators than they would have if there were no utility rebate programs. There is also a strong indication that many high efficiency refrigerators were purchased by people who did not participate in the refrigerator rebate programs. This indirect influence of the programs is often referred to as a free driver or spillover.

The purpose of this evaluation was to measure one year of refrigerator program impacts. Consequently, the question arises whether the observed spillover effect was the result of the 1994 refrigerator programs.

At this time, spillover analysis is in its infancy. There are neither the data nor a methodology available that could adequately track the spillover effects from one year of a particular program as it is manifested in that year or others.

It is likely that the spillover effect observed in this study was the result of many years of previous refrigerator rebate programs. By the same token, the spillover effects from the 1994 programs will likely carry over into future years. By all rights, the historic program influences on high efficiency refrigerator purchases during 1994 should be credited to the appropriate years' programs, and it would also be reasonable that future spillover resulting from the 1994 programs be back credited. Neither is likely, nor possible, at this time.

Considering that there is no way to isolate and measure the effects spillover from a particular year, the best we can do is note that trans-annual influences are an issue. Due to lack of data and methodology, we were forced to make the implicit assumption that the trans-annual spillover effects have a net impact that is negligible.

4.2.3 How Much Data Was Really Collected in the Survey?

The original CADMAC scoping study protocols aimed at providing a sample of 900 model numbers, assuming that eight percent of the respondents would have purchased a refrigerator in 1994. Although the scoping study accurately predicted the percentage of respondents who purchased refrigerators in 1994, it underestimated several other key factors, including:

- the portion of the respondents who refused to find refrigerator model numbers;
- the portion of the respondents who tried to find model numbers but were unable to find them;
- the portion of the respondents who found numbers but reported numbers that were not accurate; and
- the portion of the respondents who reported accurate numbers that were not listed with the CEC and, consequently, with no energy or standards data, had no value for the study.

Table 4-1 shows the relationship between completed calls and valid model numbers collected.

Table 4-1
Calls and Valid Model Numbers by Location

Location	Number of Completed Calls	Purchased 1994 Refrigerators	Valid Model Numbers
Boise, Idaho	1,031	90	48
Las Vegas, Nevada	1,045	107	54
Phoenix, Arizona	1,042	59	28
Tulsa, Oklahoma	1,123	80	28
Shreveport, Louisiana	1,168	85	36
Edison	3,137	298	142
SDG&E	2,269	167	76
Total	10,815	886	412

4.2.4 Should More Data Be Collected?

The original objective was to collect 900 model numbers to achieve the desired precision and confidence interval. Based on the model numbers collected, there is a wide precision band for a 90 percent confidence interval on the net-to-gross ratio of 0.35 to 1.62. Two factors

contributed to the confidence interval: the standard deviation and the number of observations. If the sample mean and standard deviation remained the same and the number of observations increased to 450 for California and 450 for the control areas totaling to 900, the precision band would change to between 0.56 and 1.42. If the proportion of model numbers to phone calls remains the same, it would require approximately 13,000 more completed phone calls to achieve that precision band. More than twice as much data would not provide a significantly more precise net-to-gross ratio.

4.2.5 Are the California and Control Area Refrigerators the Same Size?

One factor included in the net-to-gross analysis was the Attribute Adjustment Factor (AAF). The AAF was used to adjust for size differences and attribute between California refrigerators and control area refrigerators. The average California refrigerator was 20.99 cubic feet. The average control area refrigerator was 20.73 cubic feet. The average standard for California refrigerators was 828 kWh/year and the average standard for out of state refrigerators was 823 kWh/year. The difference is less than one percent. The standards for each category of refrigerator for which paired in-state and control-area models were found are shown in Table. 4-2. (Note: Three additional out-of-state refrigerators were not included in the attribute adjustment analysis because they did not have corresponding California counterparts in the same refrigerator attribute category.) The table shows that both California and control area buyers had similar purchasing patterns regarding refrigerator types, styles, and size.

Table 4-2
The Attribute Adjustment Factor by Federal Standards Category

Defrost	Type	Style	Location	Average Unit Total Volume	Average Unit Standard (kWh/year)	# of Units
A	FR	UF	California	15.89	801	2
A	RF	BF	California	21.31	785	9
A	RF	SI	California	24.01	1008	79
A	RF	SS	California	21.37	807	15
A	RF	TF	California	19.18	716	107
A	RF	TI	California	24.88	914	1
M	FR	UF	California	12.35	484	2
M	RE	SD	California	6.55	390	2
All	All	All	California	20.99	828	217

continued...

Table 4-2 (cont.)
The Attribute Adjustment Factor by Federal Standards Category

Defrost	Type	Style	Location	Average Unit Total Volume	Average Unit Standard (kWh/year)	# of Units
A	FR	UF	Out-of-state	16.9	827	2
A	RF	BF	Out-of-state	21.38	786	6
A	RF	SI	Out-of-state	23.35	994	70
A	RF	SS	Out-of-state	21.21	806	10
A	RF	TF	Out-of-state	19.09	714	99
A	RF	TI	Out-of-state	22.36	854	3
M	FR	UF	Out-of-state	5	353	1
M	RE	SD	Out-of-state	9.5	430	1
All	All	All	Out-of-state	20.73	823	192

Attribute Adjustment Factor (AAF) = 828 ÷ 823 = 1.0059

where:

Defrost = Defrost type
- A = Automatic defrost
- M = Manual defrost
- P = Partial automatic defrost

Type = Type
- RE = Refrigerator
- RF = Refrigerator-freezer
- FR = Freezer
- M = Manual defrost
- FR = Freezer only

Style = Style
- BF = Refrigerator-freezer with bottom-mounted freezer
- SS = Refrigerator-freezer with side-mounted freezer
- UF = Upright freezer
- SI = Refrigerator-freezer with side-mounted freezer and through-the-door ice service
- SD = Single door
- TF = Refrigerator-freezer with top-mounted freezer
- TI = Refrigerator-freezer with top-mounted freezer and through-the-door ice service
- IF = Refrigerator with internal freezer

4.3 DEMOGRAPHIC COMPARISONS

The following tables present a comparison of the demographic data collected during the survey. The tables illustrate potential demographic differences between California and control-area residents who purchased refrigerators in 1994. The data presented in the tables are limited to the responses from those 412 survey respondents who provided usable refrigerator model numbers. A study of the tables reveals that the differences between California and control-area residents are negligible. These tables provide no clear reason to believe that anything other than the California refrigerator rebate programs can explain the refrigerator energy efficiency differences between California and control areas.

Table 4-3
What Type of Home Do You Live In?

	California	Out-of-state
Single-family house detached	76%	86%
Duplex, triplex, or fourplex	6%	4%
Apartment of more than four units	12%	6%
Mobile home	1%	3%
Other	3%	1%
Don't Know/Refused	1%	1%

Table 4-4
Do You Own or Rent Your Residence?

	California	Out-of-state
Own/buying	75%	85%
Rent/lease	23%	12%
Other	0%	1%
Don't Know/Refused	1%	2%

Table 4-5
What Was the Highest Level of Schooling that You Completed?

	California	Out-of-state
Grade school or less	2%	0%
Some high school	3%	2%
High school graduate	26%	31%
Some college	28%	25%
Business or technical school	2%	3%
College graduate	26%	28%
Some graduate school	1%	3%
Graduate degree	11%	8%

Table 4-6
Which of the Following Category Best Describes Your Total Household Income from All Sources During 1994 before Taxes?

	California	Out-of-state
Less than $10,000	3%	3%
$10,000 to $19,999	8%	8%
$20,000 to $29,999	11%	11%
$30,000 to $39,999	11%	20%
$40,000 to $49,999	13%	9%
$50,000 to $74,999	15%	15%
$75,000 to $99,999	10%	8%
$100,000 or more	6%	2%
Don't Know/Refused	22%	24%

Table 4-7
The Mean Response to Additional Demographic Questions

	California	Out-of-state
Number of years at address?	8.93	6.14
Number of people living in household?	3.19	3.19
Months per year of occupancy?	11.81	11.90
Number of people under age 12?	0.71	0.71

C

SUMMARY TABLES

C.1 TABLE 6: RESULTS OF IMPACT MEASUREMENT STUDIES USED TO SUPPORT EARNINGS CLAIMS

Residential Appliance Efficiency Incentives Program
High Efficiency Refrigeration 1994 First Year Statewide Load Impact Study

SAN DIEGO GAS & ELECTRIC AND SOUTHERN CALIFORNIA EDISON
M&E PROTOCOLS TABLE 6 - RESULTS USED TO SUPPORT PY94 STATEWIDE HIGH EFFICIENCY REFRIGERATOR APPLIANCE INCENTIVE PROGRAMS
FIRST YEAR LOAD IMPACT EVALUATION, FEBRUARY 1996, CADMAC STUDY ID NO. 2053R

Designated Unit of Measurement: REFRIGERATOR
END USE: RESIDENTIAL REFRIGERATION

				5. A. 90% CONFIDENCE LEVEL		5. B. 80% CONFIDENCE LEVEL	
				LOWER BOUND	UPPER BOUND	LOWER BOUND	UPPER BOUND
1. Average Participant Group and Average Comparison Group		PART GRP		PART GRP	PART GRP	PART GRP	PART GRP
A. Pre-install usage:	Pre-install kW	na		na	na	na	na
	Pre-install kWh	na		na	na	na	na
	Pre-install Therms	na		na	na	na	na
	Base kW	6,662		na	na	na	na
	Base kWh	43,550,389		na	na	na	na
	Base Therms	na		na	na	na	na
	Base kW/ designated unit of measurement	0.121		na	na	na	na
	Base kWh/ designated unit of measurement	792		na	na	na	na
	Base Therms/ designated unit of measurement	na		na	na	na	na
B. Impact year usage:	Impact Yr kW	5,365.0		na	na	na	na
	Impact Yr kWh	35,074,481		na	na	na	na
	Impact Yr Therms	na		na	na	na	na
	Impact Yr kW/designated unit	0.096		na	na	na	na
	Impact Yr kWh/designated unit	638		na	na	na	na
	Impact Yr Therms/designated unit	na		na	na	na	na
2. Average Net and Gross End Use Load Impacts		AVG GROSS	AVG NET	AVG NET	AVG NET	AVG NET	AVG NET
	A. i. Load Impacts - kW	1,297	1,254	2,038	719	1,068	527
	A. ii. Load Impacts - kWh	8,475,908	8,200,404	13,325,612	4,704,654	6,984,791	3,446,242
	A. iii. Load Impacts - Therms	na	na	na	na	na	na
	B. i. Load Impacts/designated unit - kW	0.024	0.023	0.037	0.013	0.020	0.010
	B. ii. Load Impacts/designated unit - kWh	154	149	242	85	127	63
	B. iii. Load Impacts/designated unit - Therms	na	na	na	na	na	na
	C. i. a. % change in usage - Part Grp - kW	19.5%	19.5%	na	na	na	na
	C. i. b. % change in usage - Part Grp - kWh	19.5%	19.5%	na	na	na	na
	C. i. c. % change in usage - Part Grp - Therms	na	na	na	na	na	na
	C. ii. a. % change in usage - Comp Grp - kW	na	na	na	na	na	na
	C. ii. b. % change in usage - Comp Grp - kWh	na	na	na	na	na	na
	C. ii. c. % change in usage - Comp Grp - Therms	na	na	na	na	na	na
D. Realization Rate:	D.A. i. Load Impacts - kW, realization rate	1	na	na	na	na	na
	D.A. ii. Load Impacts - kWh, realization rate	1	na	na	na	na	na
	D.A. iii. Load Impacts - Therms, realization rate	na	na	na	na	na	na
	D.B. i. Load Impacts/designated unit - kW, real rate	1	na	na	na	na	na
	D.B. ii. Load Impacts/designated unit - kWh, real rate	1	na	na	na	na	na
	D.B. iii. Load Impacts/designated unit - Therms, real rate	na	na	na	na	na	na
3. Net-to-Gross Ratios		RATIO		RATIO	RATIO	RATIO	RATIO
	A. i. Average Load Impacts - kW	0.97		1.62	0.35	1.48	0.49
	A. ii. Average Load Impacts - kWh	0.97		1.62	0.35	1.48	0.49
	A. iii. Average Load Impacts - Therms	na		na	na	na	na
	B. i. Avg Load Impacts/designated unit of measurement - kW	0.97		1.62	0.35	1.48	0.49
	B. ii. Avg Load Impacts/designated unit of measurement - kWh	0.97		1.62	0.35	1.48	0.49
	B. iii. Avg Load Impacts/designated unit of measurement - Therms	na		na	na	na	na
	C. i. Avg Load Impacts based on % chg in usage in Impact year relative to Base usage in Impact year - kW	na		na	na	na	na
	C. ii. Avg Load Impacts based on % chg in usage in Impact year relative to Base usage in Impact year - kWh	na		na	na	na	na
	C. iii. Avg Load Impacts based on % chg in usage in Impact year relative to Base usage in Impact year - Thms	na		na	na	na	na
4. Designated Unit Intermediate Data		PART GRP		PART GRP	PART GRP	PART GRP	PART GRP
	A. Pre-install average value	na		na	na	na	na
	B. Post-install average value	na		na	na	na	na
6. Measure Count Data		NUMBER					
	A. Number of measures installed by participants in Part Group	55,015					
	B. Number of measures installed by all program participants in the 12 months of the program year	55,015					
	C. Number of measures installed by Comp Group	na					
7. Market Segment Data		CZone 7					
	Number of Participants -Gas	na					
	Number of Participants - Electric	na					

Note: No comparison group was used for this analysis and therefore all protocol comparison group questions are not applicable.
Note: There is no precision estimate for the gross savings because the whole population was used instead of a sample.

C.2 TABLE 7: DOCUMENTATION OF PROTOCOLS FOR DATA QUALITY AND PROCESSING

A. OVERVIEW INFORMATION

1. Study Title and Study ID: Residential Appliance Efficiency Incentives Program High Efficiency Refrigeration 1994 First Year Statewide Load Impact Study Study ID # 2053R
2. Program, Program Year or Years, and Program Description: 1994 Residential Refrigerator Rebate Program. This program provided rebates for the purchase of refrigerators that consumed less energy than is allowable under federal appliance standards. The amount of rebate offered depended on the rated energy consumption of the refrigerator relative to the federal energy consumption standard for the refrigerator. See Section 1.2 for details.
3. End Uses and/or Measures Covered: The program covered new, high efficiency refrigerators.
4. Method(s) and Model(s) Used: The methodology employed in this study is described in detail in Section 3.
5. Program Participants: Program participants include all people who purchased high efficiency refrigerators and received rebates for Edison or SDG&E in 1994.
6. Analysis of Sample Size: No sample was used for gross savings calculations. The population included 55,015 high efficiency rebated refrigerators. The sample used for the net-to gross analysis was comprised of 412 refrigerators purchased in 1994.

B. DATABASE MANAGEMENT

1. Flow Chart Illustrating Relationships between Data Elements: See Figure C-1, Flow of Data Elements Used in Analysis.
2. Specific Data Sources: See pages 3-5 through 3-8 of report.
3. Data Attrition Process: See pages 3-5 through 3-8 of report.
4. Internal/Organizational Data Quality Checks and Procedures: Not applicable.
5. Summary of the Data Collected but not Used: Not applicable.

C. SAMPLING

1. Sampling Procedures and Protocols: See pages 3-6 through 3-7 and 4-4 through 4-5 of report.
2. Survey Information: Appendix A provides the survey instrument. Response rates are provided in Number of Households, p. 3-6. Reasons for non response are presented 4-4.
3. Statistical Descriptions: Not applicable.

D. DATA SCREENING AND ANALYSIS

1. Procedures used for Treatment of Outliers, Missing Data Points, and Weather Adjustment: See page 3-8 of the report.
2. Controlling for the Effects of Background Variables: See pages 4-2 through 4-3 of the report.
3. Procedures Used to Screen Data: See Procedures Used for Telephone Surveys, pp. 3-6 to 3-8.
4. Regression Statistics: No regression models were used. Not applicable.
5. Specification: **a.** No regression models were used. Not applicable. **b.** No regression models were used. Not applicable. **c.** No regression models were used. Not applicable. **d.** No regression models were used. Not applicable. **e.** No regression models were used. Not applicable.
6. Error in Measuring Variables: See page 4-1 of the report.
7. Autocorrelation: Not applicable.
8. Heteroskedasticity: Not applicable.
9. Collinearity: Not applicable.
10. Influential Data Points: Not applicable.
11. Missing Data: See page 3-8 of the report.
12. Precision: See page 3-5 of the report.

E. DATA INTERPRETATION AND APPLICATION

The method used was chosen because it was able to capture the effect of both freeridership and spillover in the form of free driver. Detailed descriptions of the process and choices made are provided in Sections 3 and 4 of the report.

Figure C-1
Flow of Data Elements Used in Analysis