First Year Impact Studies
1994 Industrial Services and Retrofit Incentive Programs

(Studies 517 and 520)

Prepared for

Southern California Edison Company

Prepared by

Alternative Energy Systems Consulting, Inc.

February 1996

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Prepared for

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1. Executive Summary

Southern California Edison (SCE) retained Alternative Energy Systems Consulting, Incorporated (AESC) to evaluate the first year impacts of SCE's 1994 Energy Management Hardware Rebate (Rebate) and Energy Management Services (Audit) Programs.

SCE provided AESC with a database describing the industrial sites and energy savings measures included in the 1994 Rebate and Audit Programs. The database included 706 rebate measures at 362 sites and 309 audit measures at 211 sites. SCE's estimated *ex ante* energy savings for each measure at a site were summed and the sites were ranked in descending order of savings.

AESC then stratified the site savings rankings into three groups for each program. The first group contained the sites with largest energy savings which, in aggregate, represented 80% of the population energy savings. Group 2 contained the next largest sites representing 10% of the energy savings. Finally, Group 3 contained the remaining sites which represented the last 10% of population energy savings.

AESC selected samples from each of the three groups, then removed five duplicate and erroneous audit measures. Because of the relative importance of the large Group 1 sites and the small number of sites, AESC chose to attempt a census of all measures at these sites. It was not cost/effective to attempt a census of Groups 2 and 3. Therefore, random samples of sites were selected containing 20% of the Group 2 measures and 10% of the Group 3 measures.

SCE also provided the actual coupons which they used to document energy savings estimates from each measure. AESC used the coupons to verify measure characterizations and to obtain *ex ante* impact calculations.

AESC obtained information from the sample participants through telephone surveys, on site surveys and spot monitoring. Telephone surveys provided the information necessary to estimate net-to-gross ratios (NGR) for each audit and rebate measure. The on site surveys provided site and measure operating data, upon which AESC's *ex post* estimates of energy savings were based. AESC monitored an injection molding machine to verify energy savings calculations for this type of measure.

AESC calculated gross *ex post* impacts, NGRs, and net *ex post* impacts for each audit and rebate measure surveyed. These sample results were used to project population impacts. Table 1-1 summarizes AESC's estimated energy savings by program and end use.

Table 1-1 1994 Gross Energy Savings Estimates

SCE Program	End Use	Sample Size	First Year Energy Savings (kWh) Sample	Population
Rebate (EMHR)	HVAC	42	5,750,091	27,285,071
	Lighting	61	13,772,825	42,053,014
	Process	98	137,810,682	202,933,729
	TOTAL	201	157,333,648	272,271,814
Audit (EMS)	HVAC	22	2,977,089	10,116,048
	Lighting	2	212,380	2,483,395
	Process	28	40,229,377	56,677,148
	TOTAL	52	43,418,846	69,276,591

AESC's estimated gross and net *ex post / ex ante* energy savings ratios for each program. The results are summarized in Table 1-2 by end use.

Table 1-2 1994 Calculated Energy Savings Ratios

SCE Program	End Use	*Ex post /Ex ante* Gross	Net
Rebate (EMHR)	HVAC	119%	111%
	Lighting	83%	131%
	Process	105%	144%
Audit (EMS)	HVAC	50%	38%
	Lighting	97%	101%
	Process	83%	81%

Following are AESC's two main recommendations which are intended to improve the results of future impact studies.

- SCE should collect NGR data from customers within three months of measure implementation. Personnel changes and the passage of time impacted the ability of participants to respond to NGR questions during the telephone survey.
- Coupon procedures should be improved to assure a "paper trail" is included which verifies early SCE involvement in measure implementation. Some coupons were found to lack documentation of this involvement.

2. Overview Information

The California Public Utilities Commission and California Energy Commission require Summary Tables and Study Documentation forms for utility impact studies. This document contains the results of two first year impact studies:

- First Year Impact Study of the Industrial Retrofit Incentive Program -1994 (Study 517)
- First Year Impact Study of the Industrial Services Program - 1994 (Study 520)

Therefore, the required forms for both studies are provided on the following four pages.

Summary Table for Completed Load Impact Study
February 26, 1996
Southern California Edison Company

1. **STUDY TITLE**: First Year Impact Study of the 1994 Industrial Retrofit Incentive Program (Study 517)
2. **PROGRAM AND YEAR**: Industrial Energy Management Hardware Rebate (EMHR) Program - 1994 **DESCRIPTION:** The EMHR Program provides incentives to customers who replace existing equipment with high-efficiency equipment.
3. **END USES COVERED:** Industrial Processes, Lighting and HVAC.
4. **STUDY TYPE:** The study involved performing telephone surveys, on site surveys, measure monitoring, and savings calculations for EMHR Program population samples.
5. **METHODS AND MODELS USED:** Estimates of gross savings were calculated using Edison's Measure Analysis and Recommendation System (MARS), Computerized Book of Standards (CBOS), and custom engineering calculations. Net-to-gross ratios were estimated from participant survey responses. This study employed statistical analysis of impacts in participant samples to estimate net, first-year load impacts.
6. **PROGRAM PARTICIPANTS:** A participant was defined as an industrial customer who received a rebate for installing at least one process, lighting or HVAC measure under the 1994 EMHRP.
7. **SAMPLE STRATEGY:** Results are based on 362 EMHRP industrial customer locations with 706 measures. The final participant sample included 201 EMHRP measures taken from three strata in the population.
8. **BILLING PERIOD:** Data were drawn from the 1994 EMHRP computerized tracking system and from 1994 rebate applications (paper coupons).
9. **SUMMARY OF RESULTS:** The impact analysis calculated net *ex post* energy savings which were 138% of the net *ex ante* savings reported in the tracking system. The EMHRP energy savings realization rate was 102% and the NGR was 68%. Process measures had the highest impact ratio of the three end uses. Future impact studies would benefit if NGR data were collected from participants within three months of measure implementation.
10. **UTILITY INTENTIONS FOR USE OF RESULTS:** These results will be used to support SCE's earnings claim in the 1996 Annual Earnings Assessment Proceeding. They should also provide feedback to planners that will improve the delivery and implementation of these programs.

Study Documentation

Southern California Edison Company
First Year Impact Study of the 1994 Industrial Retrofit Incentive Program
(Study 517)

Part I: Data Management

This study used a database which defined the population of program rebate coupons for those industrial customers who received process, lighting or HVAC measure rebates during the 1994 program year. The population was stratified by *ex ante* energy savings and samples were taken from each stratum. The samples contained 398 of the population's 706 measures.

Paper coupons were reviewed for sample measures. Coupons were used to verify measure characterizations and to obtain *ex ante* impact calculations. Independent impact data were gathered for the sample measures through telephone surveys, on site inspections and spot monitoring. Location billing data were obtained and reviewed for the 12 months prior to and after measure implementation.

Gross *ex post* impacts, net-to-gross (NGR) ratios, and net *ex post* impacts were calculated for the samples and the overall population.

Part II: Data Screening and Analysis Criteria

Measures were eliminated from the samples if the participant refused to participate in the surveys (36 measures), if a participant representative could not be contacted (32 measures), if the participant was on "Program Hold" status (37 measures), if site security/safety requirements prevented an on site survey (9 measures), or if the rebate coupon was unavailable (1 measure). The Program Hold status was applied to those participants who were involved in other concurrent CPUC studies (e.g., for measure retention). An additional 82 measures were eliminated because the telephone survey sample size goal was reached before it was necessary to contact them.

Part III: Data Interpretation and Application

The primary goal of this study was to determine the net *ex post* energy savings from the 1994 industrial retrofit incentive program. The first year net *ex post* savings were 138% of the population's net *ex ante* savings. Ratios by end use are 111% for HVAC, 131% for lighting and 144% for industrial process measures.

The study also resulted in recommendations for improving NGR data gathering from participants and for enhancing documentation of SCE's involvement in customer decision making.

Summary Table for Completed Load Impact Study
February 26, 1996
Southern California Edison Company

1. **STUDY TITLE:** First Year Impact Study of the 1994 Industrial Services Program (Study 520)
2. **PROGRAM AND YEAR:** Industrial Energy Management Services (EMS) Program - 1994 **DESCRIPTION:** The EMS Program provides site audits which identify energy saving measures for industrial customers.
3. **END USES COVERED:** Industrial Processes, Lighting and HVAC.
4. **STUDY TYPE:** The study involved performing telephone surveys, on site surveys, and savings calculations for EMS Program population samples.
5. **METHODS AND MODELS USED:** Estimates of gross savings were calculated using Edison's Measure Analysis and Recommendation System (MARS), Computerized Book of Standards (CBOS), and custom engineering calculations. Net-to-gross ratios were estimated from participant survey responses. This study used statistical analysis of impacts in participant samples to estimate net, first-year load impacts.
6. **PROGRAM PARTICIPANTS:** A participant was defined as an industrial customer who implemented in 1994 at least one process, lighting or HVAC measure which was recommended under the EMSP.
7. **SAMPLE STRATEGY:** Results are based on 211 EMSP industrial customer locations with 309 measures. The final participant sample included 52 EMSP measures taken from three strata in the population.
8. **BILLING PERIOD:** Data were drawn from the EMSP computerized tracking system and from 1994 audit applications (paper coupons).
9. **SUMMARY OF RESULTS:** The impact analysis calculated net *ex post* energy savings which were 71% of the net *ex ante* savings reported in the tracking system. The EMSP energy savings realization rate was 76% and NGR ratio was 47%. HVAC measures had very low impact ratios compared with process and lighting measures. Future impact studies would benefit if NGR data were collected from participants within three months of measure implementation.
10. **UTILITY INTENTIONS FOR USE OF RESULTS** These results will be used to support SCE's earnings claim in the 1996 Annual Earnings Assessment Proceeding. They should also provide feedback to planners that will improve the delivery and implementation of these programs.

Study Documentation

Southern California Edison Company
First Year Impact Study of the 1994 Industrial Services Program
(Study 520)

Part I: Data Management

This study used a database containing the population of program audits for industrial customers who implemented process, lighting or HVAC measure recommendations during the 1994 program year. The population was stratified by *ex ante* energy savings and samples were taken from each stratum. The samples contained 158 of the population's 309 measures.

Paper forms were reviewed for sample measures. These forms were used to verify measure characterizations and to obtain *ex ante* impact calculations. Independent impact data were gathered for the sample measures through telephone surveys and on site inspections. Location billing data were obtained and reviewed for the 12 months prior to and after measure implementation.

Gross *ex post* impacts, net-to-gross (NGR) ratios, and net *ex post* impacts were calculated for the samples and the overall population.

Part II: Data Screening and Analysis Criteria

An initial screen eliminated one duplicate measure from the population. Measures were eliminated from the samples if the participant refused to participate in the surveys (28 measures), if a participant representative could not be contacted (27 measures), if the participant was on "Program Hold" status (15 measures), or if the audit form could not be located (3 measures). The Program Hold status was applied to those participants who were involved in other concurrent CPUC studies (e.g., for measure retention). An additional 33 measures were eliminated because the telephone survey sample size goal was reached before it was necessary to contact them.

Part III: Data Interpretation and Application

The primary goal of this study was to determine the net *ex post* energy savings from the 1994 industrial services program. The first year net *ex post* savings were 71% of the population's net *ex ante* savings. Ratios by end use are 38% for HVAC, 101% for lighting and 81% for industrial process measures.

The study also resulted in recommendations for improving NGR data gathering from participants and for enhancing documentation of SCE's involvement in customer decision making.

3. Database Management

3.1 Proposed Data Flow

The flow of information which AESC expected at the beginning of this study is shown graphically in Figure 3-1. The information supplied to AESC by SCE is shown as flowing from left to right in the figure and the results from AESC's work flow from top to bottom.

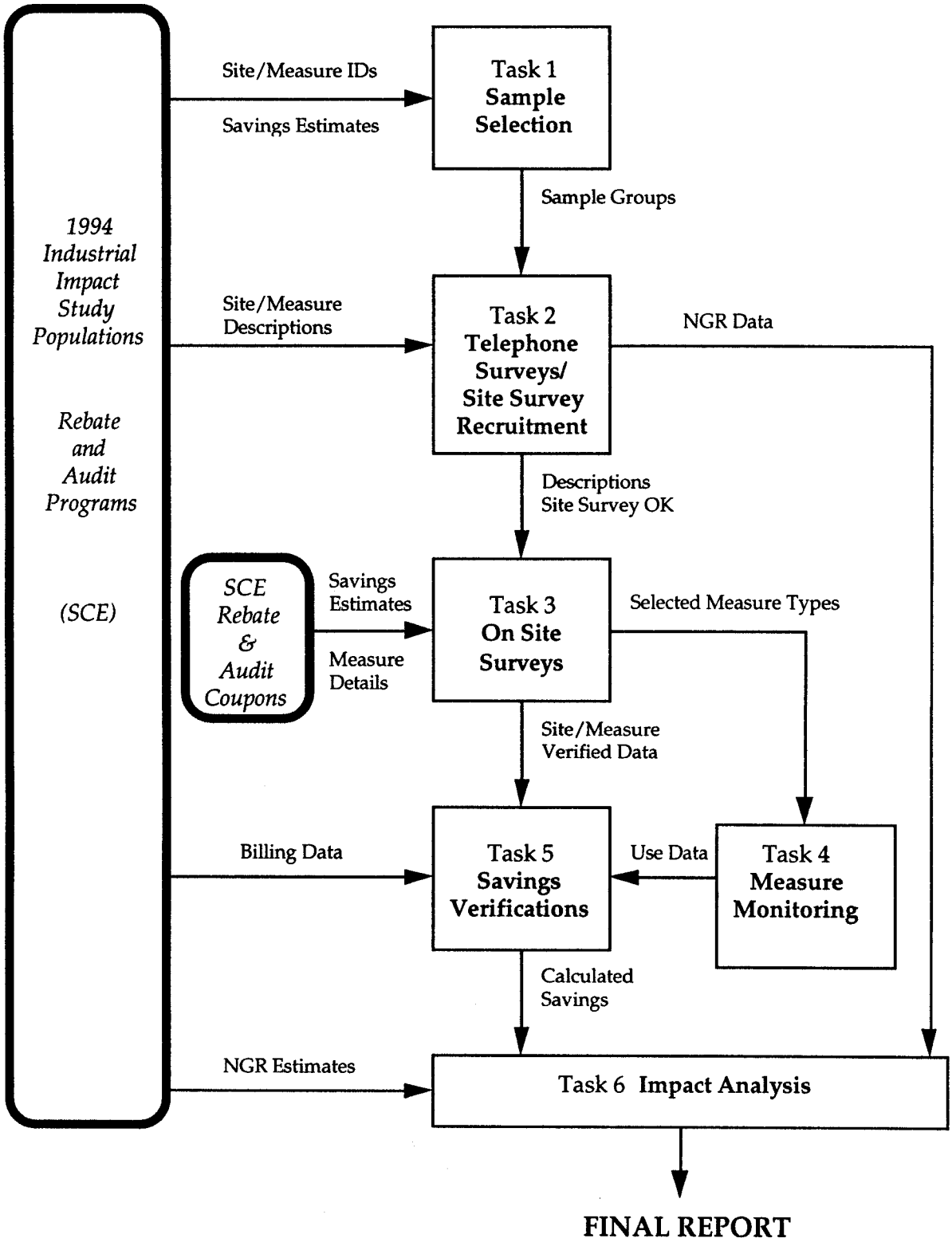
SCE provided AESC with databases describing the industrial sites and energy savings measures included in the 1994 EMHRP (Rebate) and EMSP (Audit) Programs. SCE also provided the actual coupons which they used to document energy savings estimates from each measure. Contents of the Program databases and the techniques which SCE used to develop them are discussed in Section 4.1.

AESC selected samples from SCE's databases (see Section 4.2) and used them to determine the characteristics of the overall populations. This process is depicted as Tasks 2 through 6 in Figure 3-1. AESC obtained information from the sample customers through telephone surveys, on site surveys and spot monitoring. AESC then calculated energy savings for each measure and estimated overall impacts of the industrial Audit and Rebate Programs. The tasks accomplished by AESC and resulting data flows are discussed in detail in Section 5.1 below.

AESC used various procedures to insure that project results were based on accurate information. Information gathered and calculations performed were subjected to independent checks prior to being incorporated in the project database. AESC performed the following data checks:

- Review SCE Population Database
- Check-in and Match Coupons with Sample Measures
- Review SCE Site Billing Data
- Review Telephone Survey Results by Measure,
- Review On Site Survey Packets by Measure
- Review On Site Survey Data by Measure
- Check Energy Savings Calculations
- Review NGR Calculations and Results
- Review Final Impact Analysis

Figure 3-1 Planned Information Flow

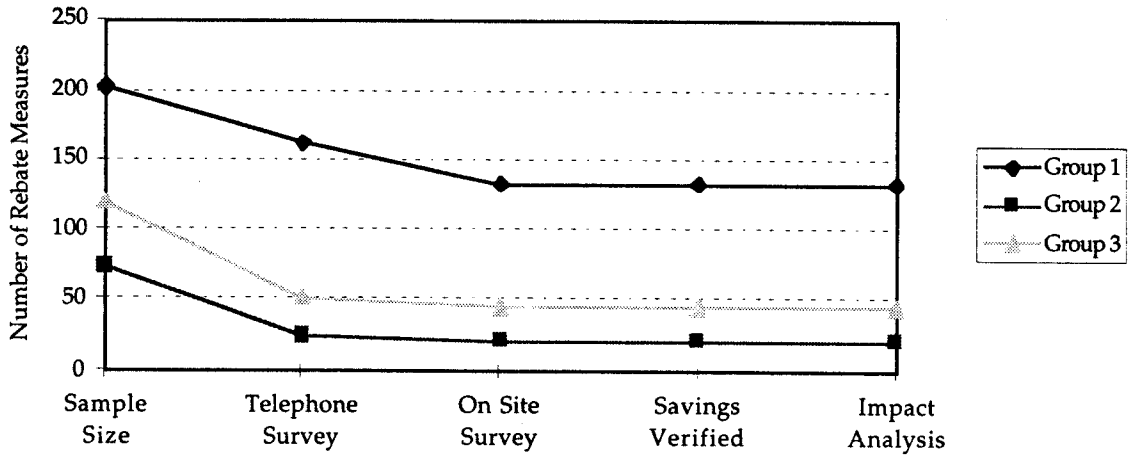


3.2 Actual Data Flow

There were two major differences between the planned and actual data flow experienced in the study. The first involved Task 2. AESC had anticipated that many Group 2 and 3 customers contacted during the telephone survey would be unable or unwilling to arrange an on site survey of their energy savings measures. Therefore, AESC planned to recruit additional customers from SCE's Program populations for the on site surveys. Fortunately, the site recruitment work was not required because the telephone surveys yielded more site survey approvals than were necessary to meet on site survey sample size requirements.

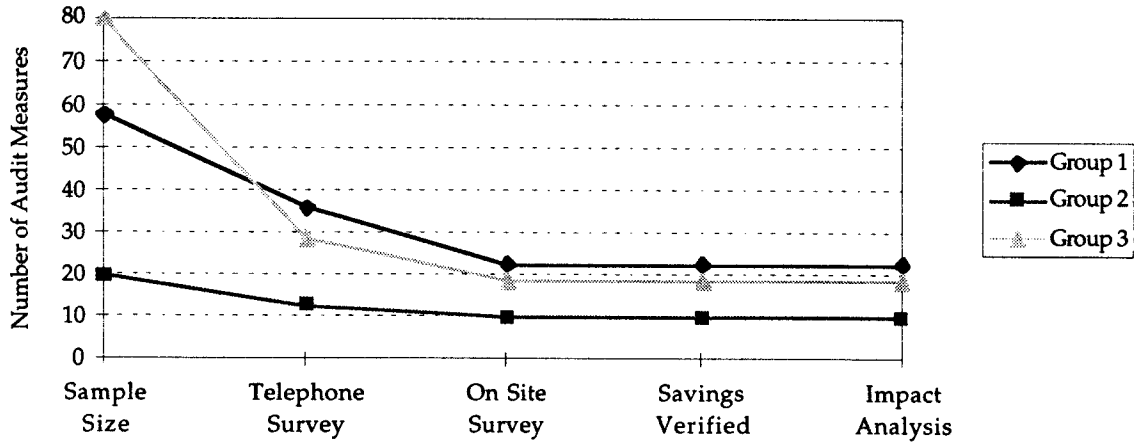
The second major change in data flow was related to attrition. Figure 3-2 illustrates data attrition for the Rebate Program throughout the study's major tasks. The attrition rate for the large rebate sites (Group 1) was higher than expected due to survey participation refusals by many large customers. As discussed in Section 5.1, many large rebate customers had participated in numerous SCE studies and verifications and did not want to spend additional time with SCE representatives. Groups 2 and 3 experienced apparently large attrition in the telephone surveys. As discussed in Section 4.3, this attrition occurred because the telephone survey goals were met with fewer telephone calls than had been expected.

Figure 3-2 Rebate Measure Attrition



The Audit Program attrition shown in Figure 3-3 followed a similar pattern to the rebates. Group 1 participants had high attrition rates because of refusals to participate in the surveys and Group 3 participants experienced high attrition in the telephone survey task because telephone survey goals were met with fewer telephone calls than expected.

Figure 3-3 Audit Measure Attrition



3.3 Unused Data

There were three specific instances where AESC obtained data which could not be used in the study. These are discussed in this section. The first case involves the pilot telephone survey data. As discussed in Section 5.1.1, AESC's subcontractor, Bristlecone Telecommunications, carried out a pilot telephone survey to test the telephone survey instrument. The pilot testing included 57 sites and 114 measures. The survey instrument evolved during the test. Because of the differences between pilot and final survey instruments, the Group 2 and 3 pilot survey results could not be used. Group 1 sites in the pilot survey were resurveyed and remained in the data set.

The second instance of unusable data involves measure attrition between the telephone and on site surveys. Bristlecone completed telephone surveys for 318 measures. However, due primarily to participant refusals, AESC was able to perform on site surveys at sites with only 253 measures. Therefore, AESC was unable to use the telephone survey data from 65 measures.

The final case of unusable data involves customer billing data. SCE provided AESC with billing information for sites in AESC's sample. This information was provided for one year before and one year after each measure was installed. AESC compared the pre- and post-measure data in an attempt to verify customer savings from the measures. In a majority of cases, AESC was unable to determine any energy consumption or demand changes attributable to the measures because the measures represented a small percentage of site usage. In many cases consumption increased after the measures were installed. In AESC's judgment, other impacts, such as growth (or reduction) in product demand, overshadowed the impacts of the measures. Therefore, the billing data was not used in this study.

4. Sampling

4.1 Definition of Sampling Frames

The data used to estimate Southern California Edison's (SCE) 1994 Energy Management Hardware Rebate (EMHR) and Energy Management Services (EMS) Program electricity savings were drawn from several sources. These sources are summarized here. The process of data extraction, cleaning, and merging is summarized in Section 3.2.

EMHR Program Tracking System

SCE provided an extract from its EMHR program tracking system for all measures installed in 1994. The program tracking system is organized by measure, and it records extensive information about the characteristics of the rebated measure and the customer. Important variables include a summary description of the measure, its estimated savings, the method by which the savings were calculated, the date of installation, the account affected by the measure, the annual electricity consumption for that account, and the participant's Standard Industrial Classification (SIC) Code.

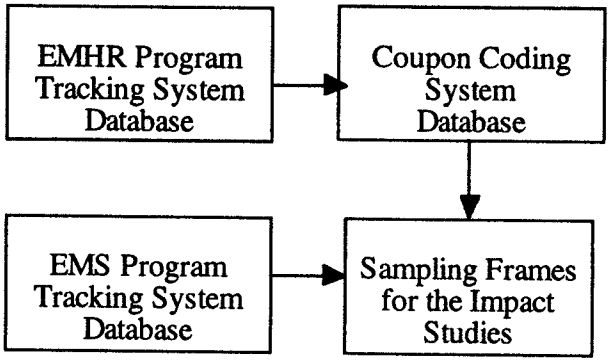
EMS Program Tracking System

SCE also provided an extract of the EMS Program tracking database for the 1994 measures. The EMS Program tracking system contains similar data to that in the EMHR Program tracking system, including measure description, estimated savings, account affected by the measure, and customer characteristics.

Coupon Sample Databases

In addition to the EMHR Program tracking database, SCE has compiled a series of files that record the information coded on the rebate coupons for a sample of approximately 1,000 rebate coupons. These data sets contain more detailed information drawn from the hard copies of the completed coupons. The key data set created from the rebate coupons is organized by measure. (One rebate coupon may contain multiple measures.) It contains a more detailed description of the rebated measure, the estimated consumption of the replaced equipment and the new equipment, the estimated hours of operation of the equipment, and other useful information.

Figure 1. Sampling Frames



The resulting sampling frames defined by SCE for each program were composed as follows.

Table 4-1 Population Overview

	Sites	Measures	Annual Savings
Audit Program	211	309	101,573,224 kWh
Rebate Program	362	706	266,962,091 kWh
TOTALS	485	1015	368,535,315 kWh

The total number of sites shown above is less than the sum of sites in the two programs because some sites had both audit and rebate measures.

Appendix A lists the sites in SCE's Audit and Rebate Program databases.

4.2 Sampling Procedures and Protocols

The Task 1 flow diagram in Figure 4-2 illustrates the procedures which AESC followed to select samples from the sampling frames described in Section 4.1 above. The same procedures were followed for both the audit and rebate programs.

Figure 4-2 Sample Selection Procedures

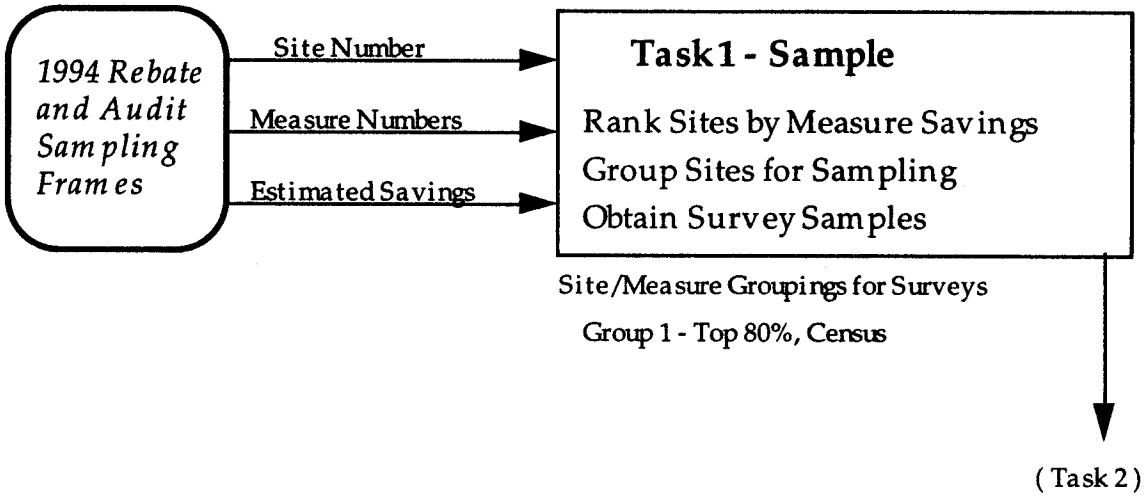


Table 5 of the M&E Protocols requires sample selection based on program participants (i.e. sites). Therefore, the first step in sample selection was to group energy savings measures by site for each population. SCE's estimated energy savings for each measure at a site were summed and the sites were ranked in descending order of savings.

AESC then segmented the site savings rankings into three groups. The first group contained the sites with largest energy savings which, in aggregate, represented 80% of the total population energy savings. Group 2 contained the next largest sites representing 10% of the energy savings. Finally, Group 3 contained the remaining sites which represented the last 10% of population energy savings. Table 4-2 below provides a summary of the groupings for each program's population.

Energy savings for both the Audit and Rebate Programs are heavily weighted toward the larger sites. The Audit Program's largest 31 sites (15% of the sites) contain over 80% of the audit savings. Similarly, 19% of the Rebate Program's sites contain 80% of the savings for that program.

Table 4-2 Measure Groupings for Sampling

Parameter	Audit	Rebate	Both Programs
Program Population(s)			
Number of Sites	211	362	485
Number of Measures	309	706	1,015
Savings (kWh)	101,573,224	266,962,091	368,535,315
Group 1			
Number of Sites	31	68	91
Number of Measures	59	203	262
Savings (kWh)	81,770,193	214,563,570	296,333,763
(% of Population)	80.5%	80.4%	80.4%
Group 2			
Number of Sites	23	45	67
Number of Measures	33	115	148
Savings (kWh)	9,656,772	24,816,790	34,473,562
(% of Population)	9.5%	9.3%	9.4%
Group 3			
Number of Sites	157	249	360
Number of Measures	217	388	605
Savings (kWh)	10,146,259	27,581,731	37,727,990
(% of Population)	10.0%	10.3%	10.2%

The next step was to select samples for telephone and on site surveys from each of the three Groups discussed above. Because of the relative importance of the large Group 1 sites and the small number of sites, AESC chose to attempt a census of all measures at these sites. It was not cost/effective to attempt a census of Groups 2 and 3 because these sites represent 85 to 90% of the populations and contain only 20% of the estimated savings. Therefore, random samples of sites were selected from Group 2 and Group 3 measures. AESC's goal was to complete surveys for 20% of the Group 2 measures and 10% of the Group 3 measures. The number of measures desired for each sample is summarized in Table 4-3.

Table 4-3 Group Sample Size Goals

	Group 1	Group 2	Group 3
Audit Program	59	7	22
Rebate Program	203	23	39
Sample Criteria	Census	Random 20%	Random 10%

As Table 4-3 shows, the total number of measures to be sampled was 88 for the Audit Program and 265 for the Rebate Program. Of these 353 measures, 91 were to be randomly selected from Groups 2 and 3.

AESC instituted an additional screening to select specific measures for the telephone and on site surveys. Many sites in the populations have multiple measures (See Table 4-2). In addition, a site may have measures that reside in both programs. To conserve project resources and insure the minimum disturbance of SCE industrial customers, AESC chose to minimize the number of sites surveyed while still obtaining data for the required number of measures. Therefore, once a site was chosen for survey, all measures applied to that site in 1994 were included in the sample. Using this method allowed telephone and site surveyors to obtain information on measures from both programs during a single call/visit, rather than requiring additional site contacts for each program. It also resulted in surveys for more measures than were required to meet the Group 2 and 3 sample size goals shown in Table 4-3.

AESC calculated precision values, at the 90% confidence level, for each sample data set group. The exact sampling theory method was used to calculate a confidence interval for the mean *ex ante* energy impact for each sample stratum.[1] The precision of the sample mean was then calculated by dividing the confidence interval by the sample mean[2], thus giving a plus or minus percent precision about the sample mean. Attrition of the sample size, discussed in detail in Section 3.2, from 556 to 253 samples resulted in reduced precision of the estimated population mean. The resulting sample precision after attrition is summarized in Table 4-4.

Table 4-4 Post Attrition Sample Precision at the 90% Confidence Level

	Group 1	Group 2	Group 3
Audit Program	51%	18%	29%
Rebate Program	24%	23%	23%

4.3 Survey Information

AESC designed the surveys to answer specific questions required to determine the amount of savings which could be claimed. The telephone survey was intended to determine the impact of SCE's programs on the customer's decision making process for implementing the measures. On site surveys were used to verify measure operation and the parameters used to determine measure

[1] $CI = t_{DF,CL} \bullet S / \sqrt{N}$ where: CI=Confidence Interval, t=t value, DF=Degrees of Freedom, CL=Confidence Level, S=Sample Standard Distribution, N=Sample Count.

[2] $P = CI/Xavg \bullet 100$ where: P=precision, Xavg=Sample Mean *ex ante* Energy Impact

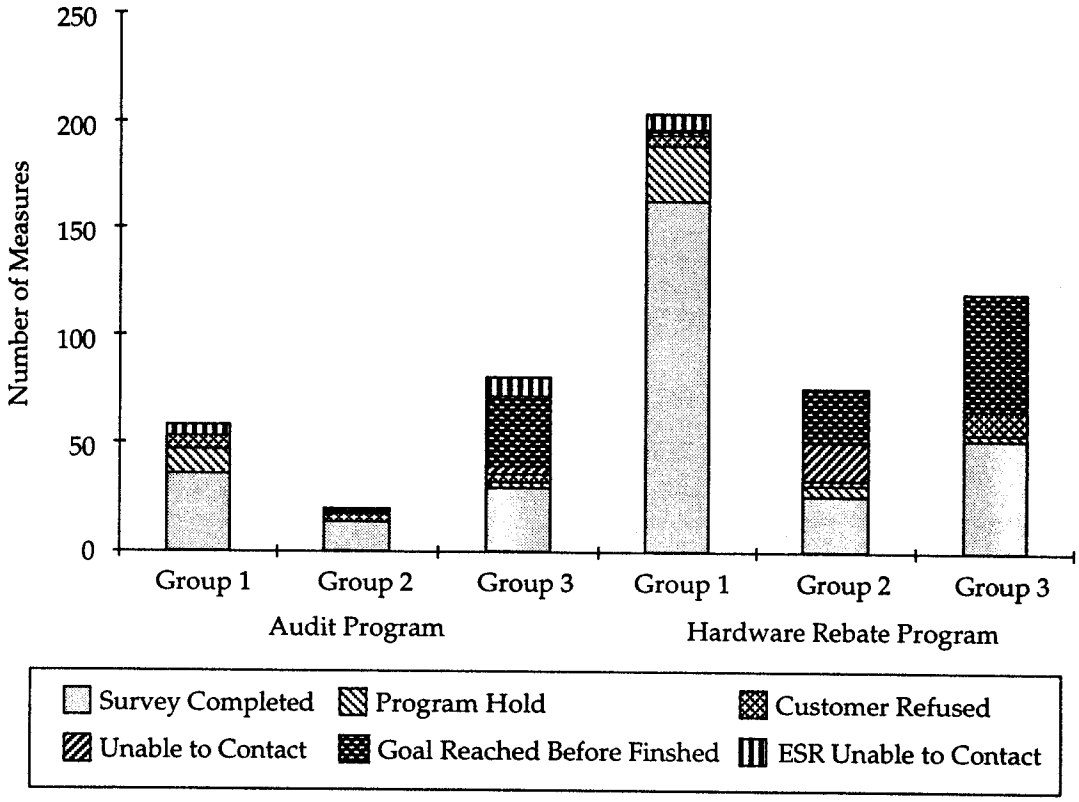
savings. Copies of the survey instruments which AESC used are contained in Appendix B.

The telephone survey was designed to determine each program's effects on a participant's decision to implement a measure. First, it asked when the customer considered the SCE programs relative to other steps in the decision making process. For example, if the customer heard about the rebate program after the equipment was installed, the rebate had no impact on the decision to implement the measure. Second, the customer was asked how important the program was in making the decision and how likely that the measure would have been implemented without the program. Finally the customer was asked when the measure would have been implemented without the SCE program. Responses to these questions were evaluated to assign a proportional Edison influence for each measure surveyed. For details of this process see Section 5.1.4. and Appendix C.

On site surveys were designed to gather *ex post* data on the parameters used to calculate savings resulting from each measure. Typical parameters include operating hours, motor efficiency, number of lamps, area of conditioned space, or production rates. The surveyor was asked to verify the values of key parameters before and after measure implementation. The same forms were used to evaluate measures in both the Audit and Rebate Programs.

Telephone survey responses are categorized for the two programs in Figure 4-3. The Group 1 responses are an attempted census of the group's population. The largest cause of non-response for Group 1 is the "Program Holds." This category represents participants who have recently been involved in another field survey, for whom SCE felt it would be an imposition to participate in this verification program. Customer relations considerations accounted for the second largest non-response category for the Group 1 sites. Many participants either had a large number of measures or were particularly sensitive to on site activities. Therefore, SCE's Energy Service Representatives (ESRs) were asked arrange for appointments during which both the telephone and on site surveys would be completed. This approach was effective in arranging a number of appointments, but there were several customers where appointments could not be arranged.

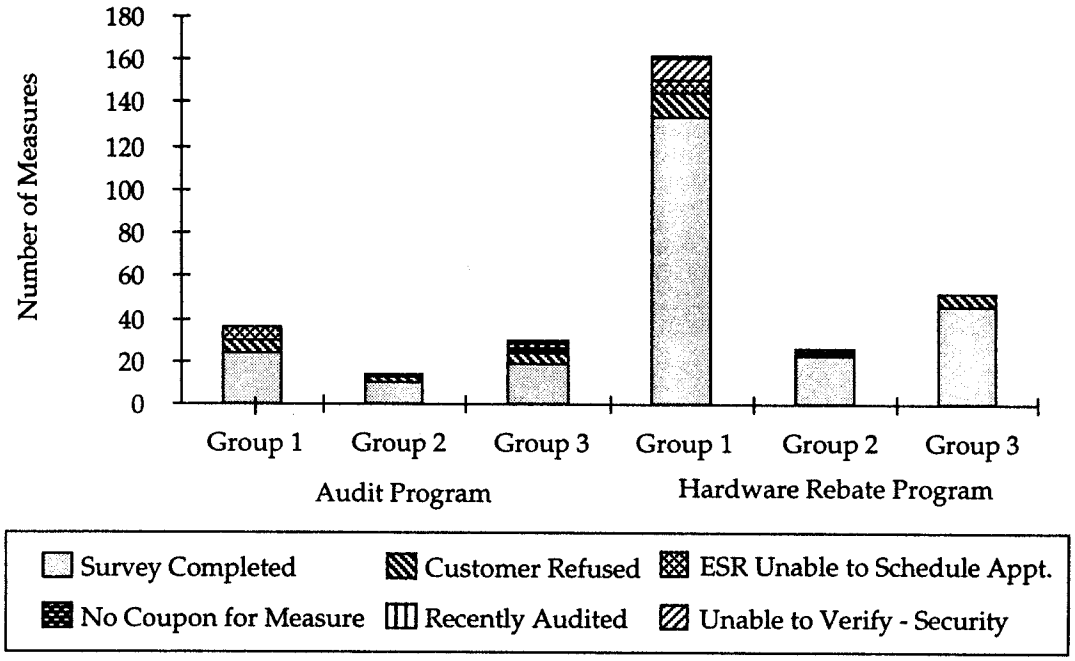
Figure 4-3 Telephone Survey Response



The largest non-response category for the Group 2 and 3 measures involved inability to contact the customer. If four attempts were made to contact the participants in Groups 2 and 3 without success, they were dropped from the survey. Numerous attempts were made to contact the Group 1 participants, after which the ESRs were asked to assist with site contacts.

AESC attempted to schedule on site surveys after the telephone survey was completed. The response to on site surveys is shown in Figure 4-4. The largest non-response category for the on site surveys was customer refusals. Many of the customers complained about the amount of verification associated with the programs, especially the Audit Program. AESC was unable to verify some measures as they were located within secured buildings at defense contractors and building personnel were not available. A similar situation occurred at oil refineries and platforms which require extensive safety training before allowing visitors at their facilities. AESC verified these measures through office interviews which reviewed paper work and plans with facility personnel.

Figure 4-4 On Site Survey Response



Placing sites on the Program Hold status discussed above created a potential bias. The effected measures were evaluated and it was determined that most were well represented in the sample. There were two exceptions to this approach. SCE had placed 2 sites with very large energy saving measures on Program Hold. Because of their large impact, they were removed from Program Hold, included in the sample, and surveys were conducted.

4.4 Statistical Descriptions

AESC used several engineering models to assess energy and demand impact for the sample measures. Key variables changed from one end use type to another. In the case of the process end use type, key variables changed significantly within the end use. Key model variables used by AESC are summarized in Table 4-5.

Table 4-5 Model Variable Descriptions

End-Use	Model Variables	Description of Diversity
HVAC	-HVAC System Type -Cooling Capacity, Tons -Rated Efficiency, EER -Temperature Set-Point -Outside Air Make-Up -Economizer Controls -HVAC Operating Hours -Weather Zone -Building Dimensions -Building Construction -Internal Cooling Loads -Building Hours	Industrial customer HVAC systems provide air conditioning for office facilities and environmental control for production areas. Capacities ranged from a few tons up to hundreds of tons capacity. Locations ranged from coastal regions of SCE's service territory to the high deserts.
Lighting	-Lamp Type -Fixture Type -Ballast Type -Lamp Power Rating -Number of Lamps -Lamp Operating Hours	Industrial customer lighting systems are used in office and production areas. They ranged from 1 watt LED exit signs to 1,000 watt Halogen lamps. Measures were assessed with as little as 5 lamps up to sites with 1,000s of lamps.
Process	-Process Type -Process Demand, kW -Process Load Factor -Process Operating Hours	Process measures are highly diversified and a uniform description is not possible. They range from 5 hp ASD pump motor drives to 1,000s of hp compressors. Process measures also included, environmental control systems, process/storage refrigeration, and high efficiency process modifications.

5. Data Screening and Analysis

5.1 Approach

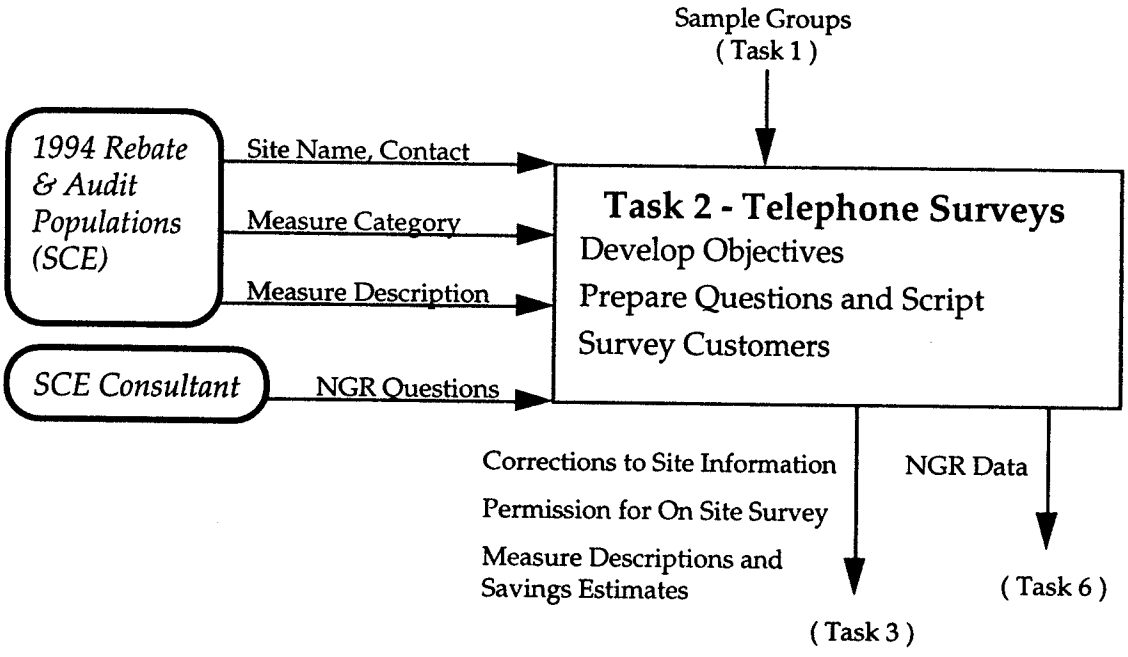
An overview of AESC's approach to this project was presented in Section 3. This was followed in Section 4 with a detailed explanation of the process used to select samples from the program populations.

The following is a detailed description of AESC's approach to gather, screen and analyze site and measure data from SCE audit and rebate customers. The approach is presented by project task, beginning with the first participant data gathering activity, telephone surveys.

5.1.1 Telephone Surveys

Figure 5-1 below illustrates the data flow and analysis activities related to the Telephone Surveys. The primary objective of the surveys was to obtain the information necessary to estimate NGRs for each audit and rebate measure in the samples. Additional objectives included verification of customer name, contact and telephone number, and obtaining customer permission to schedule an on site inspection of the measures.

Figure 5-1 Telephone Survey Procedures



Site and measure data were obtained for each customer in the sample groups selected in Task 1 (see Section 4.2 for details of sample selection). NGR related survey questions were developed by KVD Research Consulting. The underlying logic and process used to develop these questions is discussed in Appendix C, also prepared by KVD.

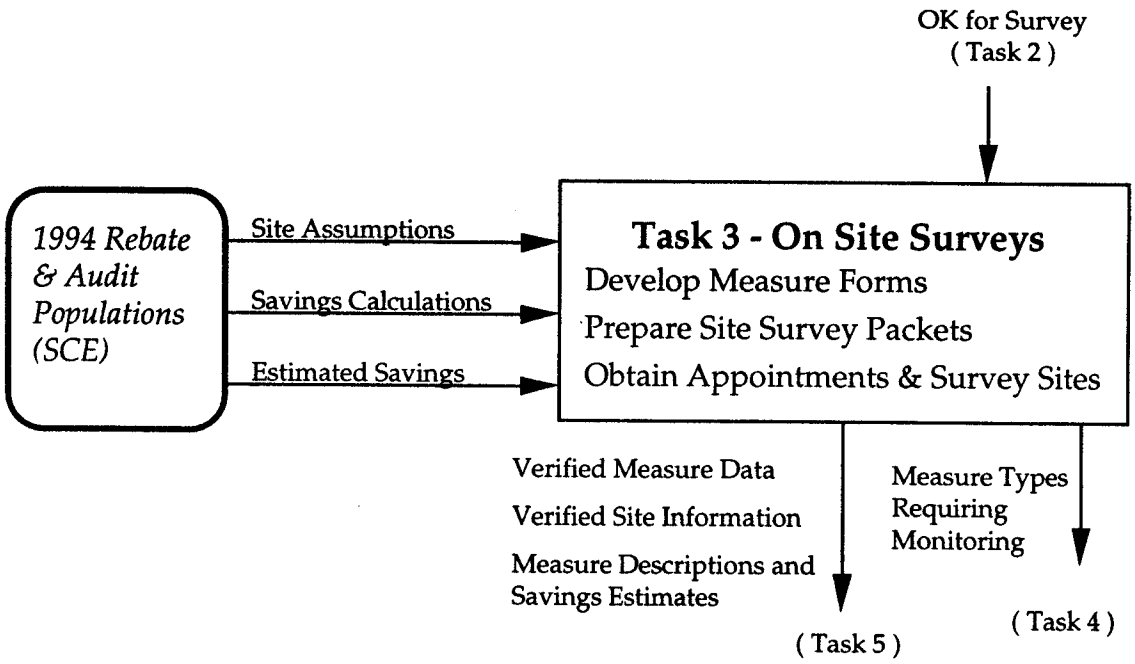
AESC and its subcontractor, Bristlecone Telecommunications, prepared a draft survey which was tested on a sub-set of 57 participants. After making minor revisions, the final survey instrument shown in Appendix B was prepared. These changes included adding questions related to installation of efficient equipment using a scale of 0 to 10, and questions to determine the impact of the Audit Program on participants in the Rebate Program. Minor wording changes were also made to make the interview flow smoothly and effectively. Bristlecone attempted to survey all customers in the samples. Telephone surveys were completed for 318 of the 556 sample measures. Section 4.3 provides a detailed discussion of response rates for both the telephone and on site surveys.

The number of measures surveyed in Groups 2 and 3 were, in some cases, greater than the number required for the sample. These additional measures are a result of the survey methodology. Sites were selected at random from each program and, once a site representative was reached, all measures at that site were surveyed. At some sites measures were surveyed from both programs, resulting in more measure surveys than had been planned. This result was termed "measure crossover" by AESC.

5.1.2 On Site Surveys

The data flow and analysis work completed during the On Site Surveys task is illustrated in Figure 5-2. The objective of the On Site Surveys was to obtain sufficient information from each site in AESC's sample to allow an independent estimate of annual energy savings from each measure. The first activity was to prepare the forms which site surveyors would use to collect the required data. AESC developed a site cover sheet to verify customer name and contact information and to collect general site data such as type of business, area and operating hours. Then AESC determined, for each measure type, the information required to calculate annual energy savings. A form was designed for each measure type.

Figure 5-2 On Site Survey Procedures



Using the assumptions and calculations documented in SCE's Rebate and Audit coupons, AESC integrated the site survey forms into custom packets for each site to be surveyed. These packets included a site cover sheet and measure survey sheets for each measure to be investigated at the site. A sample site survey packet is provided in Appendix B.

Prior to starting the site surveys, AESC trained its engineers and the survey technicians from its subcontractor, Electrical Systems Testing, Inc. (EST). These survey personnel participated in a 8 hour training class which was followed by practice surveys at actual rebate sites. The last step in training was a follow-up classroom session to evaluate practice survey results and answer questions. As a result of the training, site survey forms were modified to simplify the data gathering process and to assure more consistent results from site to site.

On site survey appointments were made at sites where customers had indicated a willingness to participate during the telephone surveys. When the study began, AESC had anticipated that additional sites would have to be recruited because of customer refusals (See Figure 3-1). Refusals were experienced, but they were more than offset by the measure crossover between audit and rebate sites which was discussed in Section 5.1.1.

On site surveys were completed for 253 of the 318 measures which survived the telephone survey. Section 4.3 discusses response rates for both the telephone and on site surveys and Appendix D provides a detailed breakdown of survey activities for all Group 1 sites.

5.1.3 Measure Monitoring

SCE asked AESC to consider if short term electrical monitoring of any specific types of measures would be helpful in verifying energy savings calculations. Monitoring was unnecessary for most measures because sufficient information was obtained from the on site surveys. One measure type, adjustable speed drives (ASDs) for process use was chosen for short term monitoring.

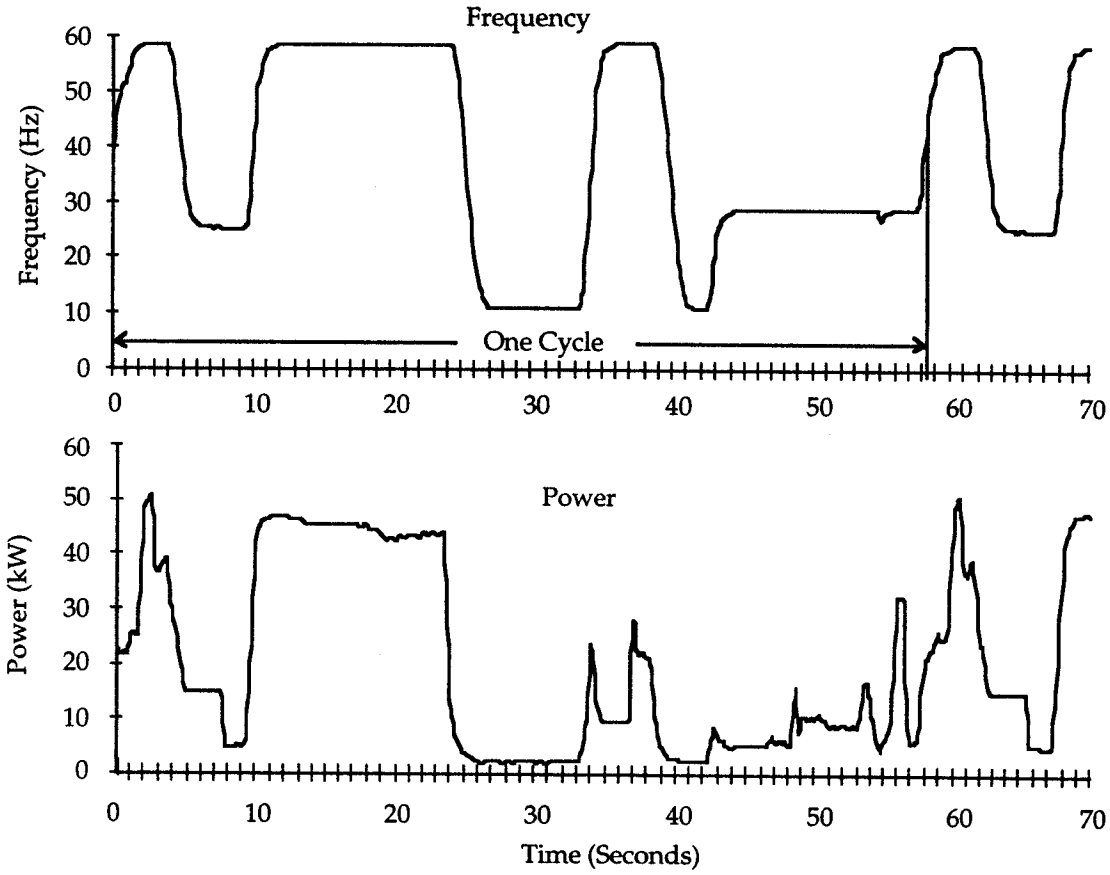
There are numerous industrial applications of ASDs where energy savings are not as well understood as for common ASD applications such as HVAC fans and pumps. AESC chose to monitor retrofitting of injection molders with ASDs to verify energy savings. This is one of the more common ASD applications in the industrial Rebate Program population.

Injection molders use pumps to provide the necessary energy to melt and inject plastic into molds, creating a variety of products ranging from small detailed parts such as bottle caps to large items such as cabinets or housings. Without an ASD, the pump is operated at full load continuously and the pressurized hydraulic fluid is bypassed through a throttling valve when the energy is not needed. ASDs vary the pump's power to meet the process requirements by adjusting electrical frequency provided to the motor.

Electrical savings from an injection molder centrifugal pump follows the same power squared relationship as other centrifugal pumps. That is to say, if the pump speed is reduced to 50% of full speed, the electrical demand is 25% of full load. The controllers of an ASD injection molder allow the operator to input a detailed program which varies the frequency and power of the hydraulic pump motors to meet specific requirements of the part being produced. Typical process cycles range from as few as 20 seconds for small parts to several minutes for large complex items.

AESC monitored the electrical demand and frequency of a 1450 ton injection molder. During the monitoring, this machine was being used to produce TV cabinets. The machine has three motors which are controlled by individual ASDs. Before the ASDs were installed, this machine had an average electrical demand of 100.1 kW and was operated 6,000 hours per year. The average measured demand for all three motors during the monitoring was 55.5 kW. Frequency and power profiles for one motor are shown in Figure 5-3. This motor had an average demand of 19 kW over the 59 second cycle used to produce one TV cabinet.

Figure 5-3 Monitoring Results - Injection Molding Adjustable Speed Drive

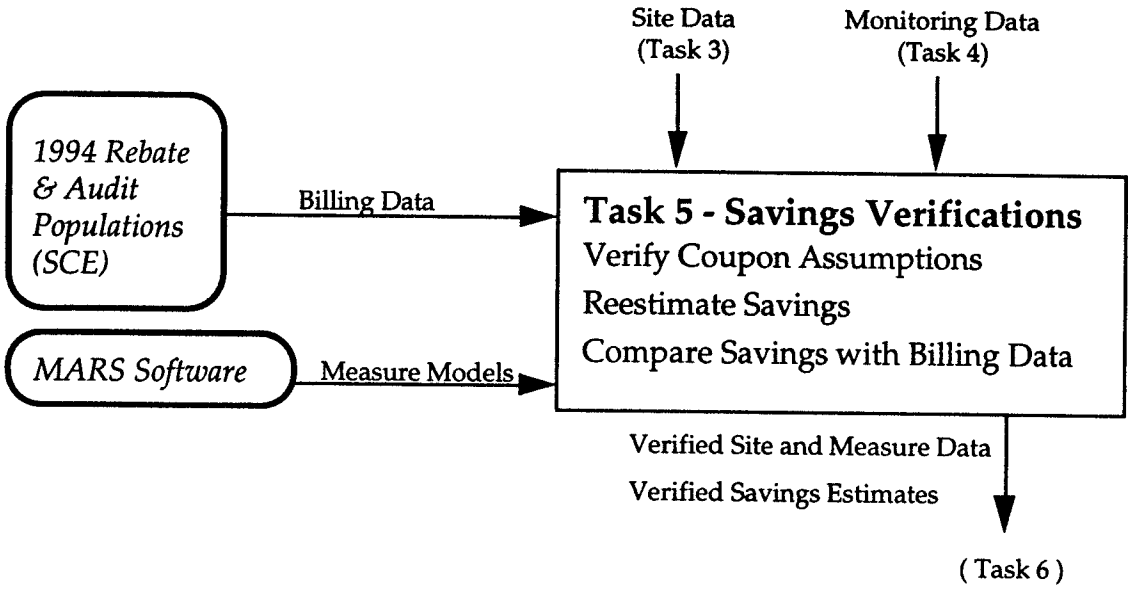


These plots show how ASD output frequency and the resulting energy usage of the pump motor vary over the production cycle. The long high load period (14 seconds) occurs as the machine is compressing and injecting the plastic into the mold. The short power spikes are caused by mold opening and closing. The energy savings achieved with ASDs vary depending on the product being produced as each item has its own cycle. Using the average demand of the monitored injection molder before the ASDs, and the measured average demand for producing a TV cabinet, these ASDs saved 45 percent of the energy, resulting in an estimated annual savings of 276,600 kWh. This level of savings agrees well with the savings claimed at other sites with injection molder ASD measures. Appendix E contains the monitoring results and sample plots for all three motors.

5.1.4 Savings Verifications

AESC used information collected during the on site surveys to prepare independent, *ex post*, estimates of annual energy savings from the Rebate and Audit Program measures. The data flow and analysis activities are illustrated in Figure 5-4.

Figure 5-4 Verification Activities



AESC used the on site survey data to verify and/or correct the savings calculation assumptions contained in the original SCE coupon calculations. Some of the more important assumptions included site and measure operating hours, pre- and post-measure equipment ratings, production rate changes and process/product changes.

AESC used both energy analysis software and custom engineering calculations to estimate 1994 energy and demand savings for each measure. In general, if the coupon was evaluating a simple measure such as a lighting or motor change, SCE used software based on their Commercial/Industrial Book of Standards (CBOS). In most of these cases, AESC used SCE's Measure Analysis and Recommendation System (MARS) to verify the calculations. If the coupon estimates were based on a custom engineering analysis by SCE, vendor or consulting engineers, then AESC performed manual engineering calculations to obtain its estimates. To minimize errors, all measure estimates were checked by one of AESC's Professional Engineers. Table 5-1 presents the number of measures to which each calculation method was applied.

Table 5-1 Energy Savings Calculation Methods

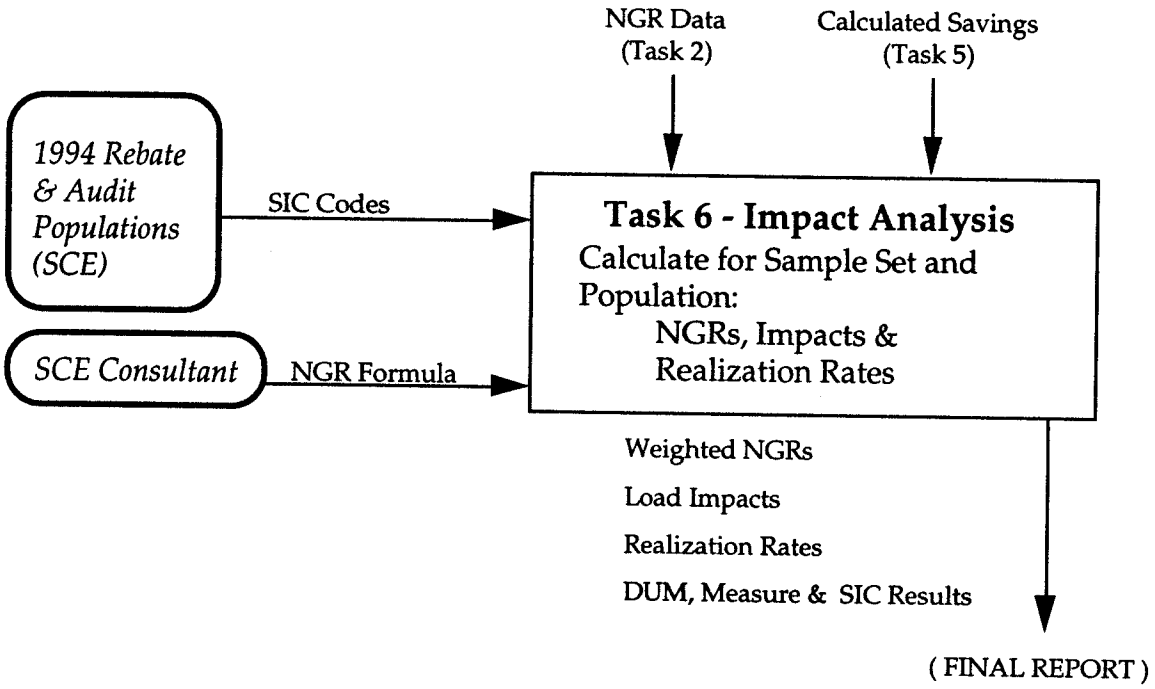
Calculation Method	*Ex Ante*	*Ex Post*
CBOS	129	16
MARS	17	130
Manual	85	101
Feasibility Study	4	4
Vendor Calculations	12	N/A.
Customer Calculations	4	N/A.

AESC attempted to use customer billing data from SCE for an additional check of energy savings calculations. SCE provided AESC with monthly customer billing data for one year before and one year after each measure was implemented. Attempts to correlate these billing data with savings estimates were unsuccessful because the billing data were aggregated by site, making it very difficult to segregate individual measure impacts. Even where measure savings were a significant portion of the billed energy, outside effects such as growth in (or reduction of) product demand overshadowed the impacts of the measures.

5.1.5 Impact Analysis

Figure 5-5 illustrates the approach used to develop the impacts of energy savings measures in the Rebate and Audit populations. AESC's overall objective was to calculate the results specified in Protocol Table 6.

Figure 5-5 Impact Analysis Approach



AESC used NGR data from the telephone survey and impact calculations for each measure in the sample set to calculate the sample and population results required by Protocol Table 6. SCE provided SIC codes for the site of each measure and the formula for calculating each measure's NGR.

AESC's results, which include overall NGRs, load impacts and realization rates, are presented in Section 6.1. The major deviations between Protocol Table 6 and AESC's results include the following: End use element "Motors" was eliminated

and "HVAC" was added per SCE's instructions; Usage data was not reported because it was not available for all measures; No comparison group was required.

5.2 Model Specifications

AESC used several engineering models to assess the impact of industrial customer measures in both the 1994 Rebate and Audit Programs. AESC based model selection on the availability of data, type of measure, and method used for the *ex ante* impact estimate. As discussed in Section 5.1.4, the primary models used were, MARS (Version 2.1), CBOS, and customized manual energy savings calculations.

MARS is a computer program for Windows based IBM-compatible and Apple Macintosh computers. It was developed by SCE and is used by their ESRs to develop energy saving proposals for industrial and commercial customers. MARS allows specification of HVAC, lighting, motors, water heating, insulation, and some industrial applications. Measures may be specified in up to three states: existing, meeting current minimum energy efficiency standards, and recommended or rebated level of efficiency.

For HVAC measures, MARS utilizes the ASHRAE Modified Bin Method[3] to assess electric energy and demand savings. The modified bin method recognizes that building and zone loads consist of time dependent loads (solar and schedule loads) and temperature dependent loads (conduction and infiltration). To compute energy consumption, two or more computational periods are selected, normally representing the occupied period and unoccupied period. For each period, the time dependent loads are averaged and added to the conduction loads such that the load is characterized as a function of outside air temperature for the calculated period. In the MARS implementation of the modified bin method, zone loads are not calculated separately.

MARS uses the CBOS methods to calculate impacts of all other measures. CBOS is a set of computer spreadsheets that use engineering based estimation techniques to determine energy savings from a variety of commercial and industrial measures. CBOS implements the Commercial/Industrial Book of Standards that was developed by SCE's Commercial, Industrial, and Agricultural (CIA) Technical Services staff in the early 1980's. The Book of Standards contains documented formulas for estimating energy and demand savings for lighting, motors, HVAC, water heating, power factor, industrial process and insulation measures. The formulas presented in the Book of Standards, particularly for space conditioning and refrigeration, were developed by averaging a number of

[3] Kneble, David, Simplified Energy Analysis Using the Modified Bin Method, American Society of Air-Conditioning Engineers, 1983.

variables in order to minimize the complexity and time spent in estimating reportable results.

AESC's customized manual energy calculations involved reviewing customer or vendor calculations and proprietary model results, or developing engineering calculations using industry accepted thermodynamic, heat transfer, and power transfer methods. Where appropriate, AESC estimated key variables when no field data were available (e.g., power factor, motor efficiency, etc.) using industry guidelines.

When proprietary customer or vendor models were used to estimate the *ex ante* impact, AESC reviewed model inputs and outputs for reasonableness and developed estimates of impact based on simplified calculations. For example, an oil production motor measure impact was originally estimated using a customer oil pump model. AESC reviewed the changes in strokes per minute and bore diameter for reasonableness and also estimated the reduction in electric demand assuming constant torque loads at lower speed. The customer model results and AESC's results were reasonably close given that the customer's model also determines torque changes from reservoir drawdown, non-linearity in pump friction, and other affects not accounted for in AESC's estimate.

In the cases where significant changes occurred in key variables over time, AESC determined the time periods in which these changes occurred and modeled impacts before and after the change. The most common occurrences of this were changes in hours of operation. Many measures were determined to operate at more or fewer hours than originally estimated. In addition the change in operating hours typically occurred during some period in the impact year. Each period with different operating hours was modeled separately. A similar approach was used where measure use had changed, for example when production rates, or product type had changed.

5.3 Statistics

AESC's approach to impact assessment used engineering models. Statistical methods, such as regression, standard error, and autocorrelation are appropriate for statistical models where data are used to generate appropriate point variables and key relationships. The engineering models and methods that AESC used do not report these statistics since they are based on engineering principles and not statistical analyses.

In terms of overall data, some outliers were identified that skewed the aggregate results, particularly in the Group 1 stratum. Group 1 measures were assessed as a census. Although attrition resulted in a sample, the outlier data points were not removed from the Group 1 data set because they reflected population diversity.

Background variables had an important impact on the results summarized in Table 6-1. The ill-health of the California economy resulted in lower operating hours for many measures at certain industries such as defense industry facilities. Also some measures were not kept operational because some facilities, such as one refinery, shut down while others consolidated. Some consolidation by SCE industrial customers resulted in equipment being moved outside of the service territory into other states. One defense contractor moved equipment that had been modified for higher efficiency to another state shortly after receiving the rebate.

Collection of first hand data from customer sites was made more difficult because of downsizing in many industries. In many of these situations, key personnel, familiar with the measure, had been laid off or moved to other areas of the company. In many instances the customer contact for the utility is in the maintenance or facilities management area, a prime target for cost reduction in many industries.

Industrial process safety and environmental requirements also impacted the results. One customer had erected a new coating facility in the high desert. They received a rebate for a high efficiency air conditioning system. However, during field verification, AESC determined that the customer would have installed the same equipment regardless of the rebate. The particular coating process they were performing required a specific HVAC system designed specifically for their needs. In another example, a customer had upgraded a VOC/ROG control system which resulted in significantly less electric energy use. However, because of environmental constraints and the project economics they had already committed to the upgrade before the rebate was considered.

Spillover affected a few measures. One industrial customer installed 25 times the number of energy efficient lights for which he received a rebate. His decision was based on the additional energy (and dollar) savings which he learned about from the Rebate Program.

Incorrect calculations of *ex ante* estimates also affected the results. In one case, the SCE ESR misunderstood the evaporator fan design in a cold storage warehouse and assumed one motor per ASD. In fact, each ASD was driving three motors and the energy savings were much more than estimated. In another case, the ESR miscalculated the savings from process changes at a carpet pad manufacturer. First, the ESR calculated energy savings only for the increased production volume, neglecting energy savings on the existing volume. Secondly, actual production increases were significantly higher than the ESR estimated, resulting in a very high realization rate.

6. Data Interpretation and Application

6.1 Load Impact Results

AESC estimated the *ex post* impacts for the Rebate and Audit Program populations provided by SCE. The load impact and other key results are summarized in Tables 6-1 through 6-4.

Table 6-1 SCE 1994 Rebate Program Energy Load Impact Results

End-Use	HVAC	Lighting	Process	TOTALS
Sample Count	42	61	98	201
Population Count	142	310	254	706
ex ante Gross Load Impact	22,923,665	50,578,440	193,459,596	266,961,701
Realization Rate	119%	83%	105%	102%
ex post Gross Load Impact	27,285,071	42,053,014	202,933,729	272,271,814
Net-To-Gross Ratio	49%	76%	69%	68%
ex post Net Load Impact	13,499,663	31,758,768	139,036,925	184,295,356

Table 6-2 SCE 1994 Audit Program Energy Load Impact Results

End-Use	HVAC	Lighting	Process	TOTALS
Sample Count	22	2	28	52
Population Count	186	26	92	304
ex ante Gross Load Impact	20,139,495	2,563,049	68,267,459	90,970,003
Realization Rate	50%	97%	83%	76%
ex post Gross Load Impact	10,116,048	2,483,395	56,677,148	69,276,592
Net-To-Gross Ratio	40%	50%	49%	47%
ex post Net Load Impact	4,029,361	1,241,698	27,628,832	32,899,891

Table 6-3 SCE 1994 Rebate Program Demand Load Impact Results

End-Use	HVAC	Lighting	Process	TOTALS
Sample Count	42	61	98	201
Population Count	142	310	254	706
ex ante Gross Load Impact	3,011	6,356	15,975	25,342
Realization Rate	119%	85%	109%	104%
ex post Gross Load Impact	3,573	5,402	17,356	26,332
Net-To-Gross Ratio	35%	82%	70%	68%
ex post Net Load Impact	1,246	4,452	12,197	17,896

Table 6-4 SCE 1994 Audit Program Demand Load Impact Results

End-Use	HVAC	Lighting	Process	TOTALS
Sample Count	22	2	28	52
Population Count	186	26	92	304
ex ante Gross Load Impact	5,069	325	5,313	10,707
Realization Rate	45%	97%	84%	66%
ex post Gross Load Impact	2,290	315	4,489	7,094
Net-To-Gross Ratio	42%	50%	88%	58%
ex post Net Load Impact	955	157	3,936	4,094

Definitions for each row in Table 6-1 through Table 6-4 are listed below.

Program - SCE's industrial programs, Energy Management Hardware Rebate Program (Rebate) or Energy Management Services Program (Audit).

End Use - HVAC, Lighting or Process. Although motors are specified in the Protocols, HVAC was substituted for motors there was a separate SCE Manufacturers' Rebate Program for motors in 1994. HVAC contributed much more to the savings from the industrial programs in that program year.

Sample Count - The number of measures in each end use for savings estimation and assessment.

Population Count - The number of measures reported by SCE of participants in the 1994 Rebate and Audit Programs.

***ex ante* Gross Load Impact** - The estimated impact of the measures as recorded by SCE in their program coupons.

***ex post* Gross Load Impact** - The scaled-up load impact estimated and assessed by AESC from the sample data set. Scaling was accomplished by weighting the *ex post* Gross Load Impact by the ratio of the population *ex ante* Gross Load Impact and the sample *ex ante* Gross Load Impact at the end use and group levels. Then each group's scaled *ex post* Gross Load Impact was summed within the end-use.[4]

Net-to-Gross Ratio - The ratio of net load impact to gross load impact that accounts for customer motivation to implement the measure. This value is generated from the sample data points where NGR was self reported through a set of questions and estimated with an algorithm. NGR calculation at the

[4] $I_e = \Sigma(i_{eg} \bullet I'_{eg} / i'_{eg})$ where: I_e=population *ex post* Gross Load Impact at the end use, i_{eg}=sample *ex post* Gross Load Impact at the group, I'_{eg}=population *ex ante* Gross Load Impact at the group, i'_{eg}=sample *ex ante* Gross Load Impact at the group

measure level is described in detail in Appendix C. NGR at the end-use level is calculated by a weighted average using *ex post* Gross Load Impact data.[5]

***ex post* Net Load Impact** - The product of the *ex post* Gross Load Impact and NGR at the end-use level.

The designated unit of measure (DUM) and load impacts per DUM are summarized in Table 6-5 through 6-8.

Table 6-5 Rebate Energy Impact Designated Unit of Measure Values

End-Use	HVAC	Lighting	Process
Designated Unit of Measure (DUM)	Per Sqft of Conditioned Space	Per Sqft per 1000 hours of operation	Per Project
Average DUM Value	182,306	1,347,157	1
ex ante GLI Per DUM	0.89	0.12	761,652
ex post GLI Per DUM	1.05	0.10	798,952
ex post NLI Per DUM	0.52	0.08	547,389

Table 6-6 Audit Energy Impact Designated Unit of Measure Values

End-Use	HVAC	Lighting	Process
Designated Unit of Measure (DUM)	Per Sqft of Conditioned Space	Per Sqft per 1000 hours of operation	Per Project
Average DUM Value	138,867	714,216	1
ex ante GLI Per DUM	0.78	0.14	742,038
ex post GLI Per DUM	0.39	0.13	616,056
ex post NLI Per DUM	0.16	0.07	300,313

[5] NGRe = Σ(NGReg•Ieg)/Σ(Ieg) where: NGRe=net-to-gross ratio at the end use level, NGReg=net-to-gross ratio at the end use group stratum level. NGReg is calculated using the same weighting, but at the measure level for each end-use group stratum.

Table 6-7 Rebate Demand Impact Designated Unit of Measure Values

End-Use	HVAC	Lighting	Process
DUM	ned :	Per Sqft per 1000 hours of operation	Per Project
Average DUM Value	182,306	1,347,157	1
ex ante GLI Per DUM	1.16E-04	1.52E-05	63
ex post GLI Per DUM	1.38E-04	1.29E-05	68
ex post NLI Per DUM	4.81E-05	1.07E-05	48

Table 6-8 Audit Demand Impact Designated Unit of Measure Values

End-Use	HVAC	Lighting	Process
DUM		Per Sqft per 1000 hours of operation	Per Project
Average DUM Value	138,867	714,216	1
ex ante GLI Per DUM	1.96E-04	1.75E-05	58
ex post GLI Per DUM	8.87E-05	1.69E-05	49
ex post NLI Per DUM	3.70E-05	8.47E-06	43

Definitions for the data rows in Table 6-5 through Table 6-8 are listed below.

DUM - the designated unit of measure. HVAC and lighting DUMs are specified in the protocol. Process DUMs vary greatly, therefore AESC selected a per project DUM to allow aggregation of results for Process measures.

Average DUM Value - the average value for the DUM at the end use level. The DUM value is a weighted average using *ex post* Gross Load Impact by end use. The product of measure DUM value and *ex post* Gross Load Impact are summed over the end-use level and divided by the total *ex post* Gross Load Impact for that end-use.

***ex ante* GLI per DUM** - the total *ex ante* Gross Load Impact divided by the total DUM value at the end-use level.

***ex post* GLI per DUM** - the total *ex post* Gross Load Impact divided by the total DUM value at the end-use level.

***ex post* NLI per DUM** - the total *ex post* Net Load Impact divided by the total DUM value at the end-use level.

AESC prepared distributions of sites and measures by two digit SIC Code for both programs. These may be found in Appendix F.

AESC's approach included the use of engineering models to assess the impact of each sample measure. Because of the nature of industrial measures, where each application is unique, each customer site and measure application was treated as an individual case study. No generalizations were made in terms of population practice or energy use. The Protocols request that a confidence interval be placed around a variety of estimated parameters such as realization rates for gross and net impacts, and NGRs. Confidence intervals are best reported for results from statistical models. AESC utilized a variety of engineering models to verify and assess impact estimates. Therefore, no statistical confidence interval is reported for this study.

6.2 Discussion of Results

The total *ex post* Net Load Impact for SCE's 1994 industrial customer programs are 217,195,247 kWh/yr. and 22,944 kW for energy and demand respectively. These values are 61% of the estimated *ex ante* Gross Load Impact for claimed energy savings, and 64%, for claimed demand savings,.

Realization rates were reasonably high, indicating good estimating techniques by SCE. However, NGR values were as low as 35% for Rebate Program HVAC demand and no higher than 88% for Audit Program Process demand. This indicates that many industrial customers have other motives for installing energy efficient equipment that have not been captured and filtered by SCE during the program implementation. As stated earlier in the report, many industrial customer install higher efficiency equipment to comply with process safety or environmental issues. They also install measures to lower energy costs per unit of product through increased production.

In the Rebate Program the end-use that received the highest NGR was lighting. This concurs with the field data which revealed that many industrial sites do not require high efficiency lighting for process needs. Therefore, SCE had the opportunity and was able to influence the decision making process of the industrial customer to install energy efficient lighting.

6.3 Recommendations for Future Load Impact Studies

During the course of this effort, AESC discovered a number of techniques and procedures which may help SCE to improve subsequent impact studies. These suggested improvements relate to various steps in the rebate/audit process, from initial customer contacts to final impact calculations. AESC's recommendations are provided below.

NGR data should be collected soon after a measure is installed. The current load impact studies are gathering customer NGR data from 9 to 20 months after the measures were installed. AESC found that many customer representatives were unsure of their answers to NGR related questions because they were not involved in measure implementation or they had forgotten the details. These problems can be minimized if NGR data were gathered much sooner after the measure was installed. AESC recommends gathering NGR data at the end of each calendar quarter for measures installed during that quarter.

The most costly and time consuming activity associated with a load impact study is the on site survey. It takes an average of about 4 person-hours to schedule a survey, travel to the site, and collect measure data. Efforts should be made to reduce number of on site surveys required. AESC recommends using expanded telephone surveys to verify measure data for the more standard measures such as changes in equipment operating hours. In addition AESC recommends exploring the trade-offs of reducing both telephone and on site surveys by accepting the lower precision associated with reduced sample sizes.

The coupon "paper trail" was, in general, quite adequate to determine and verify the techniques which SCE used to calculate measure impacts. However, in some cases, AESC discovered that the documentation was insufficient to prove SCE's involvement in the measure prior to its purchase or installation. For example, equipment for one very large measure appeared to be ordered prior to any involvement by SCE. Contacts with the customer verified that SCE was indeed involved in process design and equipment selection. AESC recommends that SCE improve coupon procedures to include documentation of these early contacts.