1997 AGRICULTURAL ENERGY EFFICIENCY INCENTIVE PROGRAM IMPACT STUDY

STUDY 569

MARCH 1, 1999

Submitted by:
Southern California Edison

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1997 AEEI Impact Study Report

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1.0 Executive Summary

Southern California Edison (SCE) retained Alternative Energy Systems Consulting, Incorporated (AESC), Ridge & Associates and KVDR, Inc. to evaluate the first year impacts of SCE's 1997 Agricultural Energy Efficiency Incentive (AEEI) Program for agricultural and water service customers. The methods used and the data presented in this evaluation are consistent with the requirements contained in the *Protocols and Procedures for the Verification of Costs, Benefits and Shareholder Earnings from Demand-Side Management Programs* (Protocols) as adopted by D.93-05-063 and most recently revised in March 1999.

SCE provided AESC with a database describing the agricultural sites and energy savings measures included in the 1997 AEEI program. The database included 19 coupons with a total of 23 measures. The small size of the program population permitted AESC to perform a complete census of the customers rather than evaluating a sample of the population.

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

AESC obtained information from the participants through on-site surveys, follow-up telephone calls, and spot-monitoring. The on-site surveys provided site and measure operating data, upon which AESC's *ex post* estimates of energy savings were based. AESC monitored the electrical usage of one of the water pumping measures to verify energy savings calculations.

The gross *ex post* impacts and net *ex post* impacts were calculated for each measure in the agricultural program and summed to provide the population impact. A default NTGR value of 0.75 was established as part of a waiver approved by CADMAC on June 17, 1998. Table 1-1 summarizes AESC's estimated annual gross energy and electric capacity impacts for the program and by end-use. The net energy and electric capacity impacts are presented in Table 1-2 for the program and by end-use.

Table 1-1. 1997 AEEI Gross Load Impact Estimates

End-Use	# Measures	Annual Energy Savings (kWh)	Electric Capacity (kW)
Pumping	13	1,224,739	242.2
Refrigeration	4	545,864	42.4
Process	4	250,522	42.6
Miscellaneous	2	215,972	0.0
Program Totals:	23	2,237,097	327.2

Table 1-2. 1997 AEEI Net Load Impact Estimates

	Annual Energy Savings (kWh)		Electric Capacity (kW)	
End-Use	Impact	NTGR	Impact	NTGR
Pumping	918,554	0.75	181.7	0.75
Refrigeration	409,398	0.75	31.8	0.75
Process	187,892	0.75	32.0	0.75
Miscellaneous	161,979	0.75	0.0	0.75
Program Totals	1,677,823	0.75	245.4	0.75

2.0 Summary Tables and Study Documentation

This document contains the results of the First Year Impact Study of Southern California Edison's (SCE) Agricultural Energy Efficiency Incentive Program - 1997 (Study 569). The California Public Utilities Commission and California Energy Commission require Summary Tables and Study Documentation forms for each utility impact study. Sections 2.1 and 2.2 are provided in accordance with these requirements as described in Tables 6 and 7 of the *Protocols and Procedures for the Verification of Costs, Benefits and Shareholder Earnings from Demand-Side Management Programs* (Protocols) as adopted by D.93-05-063 and most recently revised in March 1999. Section 2.1 provides the impact study results in accordance with Table 6, and Section 2.2 responds to the requirements of Table 7 of the Protocols. For the convenience of the reader, their subsections are labeled as they are in the Protocol tables.

2.1. Summary Tables (in compliance with Table 6 of Protocols)

1. Average Measure Usage:

1.A Base usage and base usage per DUM

	Pumping	Refrig.	Process	Misc.	Program
Energy (kWh)	886,123	716,680	423,786	381,416	602,001
Electric Capacity (kW)	177.7	174.5	156.8	144.1	163.2
Energy/DUM (kWh/DUM)	352	716,680	423,786	4.8	n/a
Elec. Cap./DUM (kW/DUM)	0.007	174.5	156.8	0.0018	n/a

1.B Impact year usage and impact year usage per DUM

	Pumping	Refrig.	Process	Misc.	Program
Energy (kWh)	803,310	653,110	361,117	273,430	522,742
Electric Capacity (kW)	158.8	167.3	146.1	152.6	156.2
Energy/DUM (kWh/DUM)	319	653,110	361,117	3.4	n/a
Elec. Cap./DUM (kW/DUM)	0.06	167.3	146.1	0.0019	n/a

2. Average net and gross end-use load impacts:

2. A. Load impacts

	Pumping	Refrig.	Process	Misc.	Program
Avg. Gross Impact - Energy (kWh)	94,211	136,466	62,631	107,986	100,323
Avg. Gross Impact - Electric Capacity (kW)	18.6	10.6	10.7	0	10.0
Avg. Net Impact - Energy (kWh)	70,658	102,350	46,973	80,990	75,242
Avg. Net Impact - Electric Capacity (kW)	14.0	8.0	8.0	0	7.5

2. B. Load impacts per designated unit of measure

	Pumping	Refrig.	Process	Misc.	Program
Avg. Gross Impact/DUM - Energy (kWh/DUM)	37	136,466	62,631	1.35	n/a
Avg. Gross Impact/DUM - Elec. Capacity (kW/DUM)	0.007	10.6	10.650	0	n/a
Avg. Net Impact/DUM - Energy (kWh/DUM)	28.06	102,349.50	46,972.88	1.012	n/a
Avg. Net Impact/DUM - Elec. Capacity (kW/DUM)	0.006	8.0	8.0	0	n/a

2. C. The percent change in usage (relative to base usage) of the participant group and comparison group. (Comparison group not required, per waiver.).

	Pumping	Refrig.	Process	Misc.	Program
% Change in Usage (kWh)	9%	9%	15%	28%	11%
% Change in Demand (kW)	11%	4%	7%	6%	8%

2. D. Realization rates for 2.A and 2.B

	Pumping	Refrig.	Process	Misc.	Program
Realization Rate for Avg. Gross Impact -Energy	0.7832	0.8379	0.3784	0.3910	0.6523
Realization Rate for Avg. Gross Impact - Electric Capacity	1.4398	0.1259	0.3219	n/a	0.5134
Realization Rate for Avg. Net Impact -Energy	0.5874	0.6285	0.2838	0.2933	0.4892

Realization Rate for Avg. Net Impact - Electric Capacity	1.0798	0.0944	0.2414	n/a	0.3850
Realization Rate for Avg. Gross Impact/DUM - Energy	0.7829	0.8379	0.3784	0.3910	n/a
Realization Rate for Avg. Gross Impact/DUM - Electric Capacity	1.4393	0.1259	0.3219	n/a	n/a
Realization Rate for Avg. Net Impact/DUM - Energy	0.5870	0.6285	0.2838	0.2933	n/a
Realization Rate for Avg. Net Impact/DUM - Electric Capacity	1.0791	0.0944	0.2414	n/a	n/a

3. Net-to-Gross Ratios based on:

3. A. Average load impacts

The net-to-gross ratios for the process, refrigeration, and water pumping end-uses were all set to .75 in a retroactive waiver of Protocol requirements, approved by CADMAC on June 17, 1998. The HVAC end-use falls under the "Miscellaneous End Uses" category, so per Table C-9 of the Protocols, its NTGR can be assumed to be .75.

3. B. Average load impacts per designated unit of measure

The net-to-gross ratios for the process, refrigeration, and water pumping end-uses were all set to .75 in a retroactive waiver of Protocol requirements, approved by CADMAC on June 17, 1998. The HVAC end-use falls under the "Miscellaneous End Uses" category, so per Table C-9 of the Protocols, its NTGR can be assumed to be .75.

4. Designated Unit Intermediate Data

4. A. Pre-installation average values for Participant Group
(Comparison Group not required, per waiver.)

End Use	Designated Unit IntermediateValue	Participant Group Pre-installation Average Value
Water Pumping	acre-feet of water pumped per year	1,779
Refrigeration	project	4
Process	project	4
Miscellaneous	Not Applicable	Not Applicable

4. B. Post-installation average values for Participant Group
(Comparison Group not required, per waiver.)

End Use	Designated Unit IntermediateValue	Participant Group Post-installation Average Value
Water Pumping	acre-feet of water pumped per year	1,756
Refrigeration	project	4
Process	project	4
Miscellaneous	Not Applicable	Not Applicable

5. **Precision:**

Listed below are the 80% and 90% Confidence Intervals (i.e., ± the value) for items 1 - 4 of Protocol Table 6, §5.

Table 6, §5	Parameter	Conf Lvl	Pumping	Process	Refrig.	Misc.	Program
1-A	Avg Base Usage -kWh	80%	384,637	198,028	343,868	176,492	229,124
	Avg Base Usage -kWh	90%	492,816	253,723	440,581	226,130	293,566
1-A	Avg Base Usage -kW	80%	82.50	110.50	125.70	53.60	52.80
	Avg Base Usage -kW	90%	105.70	141.60	161.10	68.70	67.60
1-A	Avg Base Use/DUM -kWh	80%	42,911	198,027	343,868	2.20	95,478
	Avg Base Use/DUM -kWh	90%	54,980	253,723	440,581	2.80	122,331
1-A	Avg Base Use/DUM -kW	80%	8.20	110.50	125.70	0.00067	32.80
	Avg Base Use/DUM -kW	90%	10.50	141.60	161.10	0.0009	42.10
1-B	Avg Impact Usage -kWh	80%	353,960	215,464	350,830	198,926	213,986
	Avg Impact Usage -kWh	90%	453,511	276,063	449,500	254,874	274,196
1-B	Avg Impact Usage -kW	80%	82.30	110.50	133.30	56.60	53.10
	Avg Impact Usage -kW	90%	105.50	141.60	170.10	72.60	68.00
1-B	Avg Impact Use/DUM -kWh	80%	40,268	215,463	350,829	2.50	n/a
	Avg Impact Use/DUM -kWh	90%	51,594	276,062	449,500	3.20	n/a
1-B	Avg Impact Use/DUM -kW	80%	7.90	110.50	133.30	0.0007	n/a
	Avg Impact Use/DUM -kW	90%	10.20	141.60	170.80	0.0009	n/a
2-A	Avg Gr Impact - kWh	80%	45,001	34,722	91,923	22,435	29,865
	Avg Gr Impact - kWh	90%	57,658	44,487	117,776	28,744	38,264
2-A	Avg Gr Impact - kW	80%	17.50	7.60	11.40	0.00	10.10
	Avg Gr Impact - kW	90%	22.50	9.80	14.60	0.00	12.90
2-A	Avg Net Impact - kWh	80%	33,751	26,041	68,942	16,826	22,398
	Avg Net Impact - kWh	90%	43,243	33,366	88,332	21,558	28,698
2-A	Avg Net Impact - kW	80%	13.10	5.70	8.56	0.00	7.60
	Avg Net Impact - kW	90%	16.80	7.30	11.00	0.00	9.70
2-B	Avg Gr Impact/DUM - kWh	80%	3,765	34,721	91,923	0.28	n/a
	Avg Gr Impact/DUM - kWh	90%	4,824	44,487	117,776	0.36	n/a
2-B	Avg Gr Impact/DUM - kW	80%	0.15	7.60	11.40	0.00	n/a
	Avg Gr Impact/DUM - kW	90%	0.19	9.80	14.60	0.00	n/a
2-B	Avg Net Impact/DUM - kWh	80%	2,824	26,041	68,942	0.21	n/a
	Avg Net Impact/DUM - kWh	90%	3,618	33,365	88,332	0.27	n/a
2-B	Avg Net Impact/DUM - kW	80%	0.11	5.70	8.55	n/a	n/a
	Avg Net Impact/DUM - kW	90%	0.14	7.30	10.9	n/a	n/a
2-D/A	Realization Rate- Net-kWh	80%	0.23	0.29	0.45	0.68	0.16
	Realization Rate- Net-kWh	90%	0.30	0.38	0.57	0.88	0.21
2-D/A	Realization Rate- Net-kW	80%	1.25	0.02	0.08	n/a	0.74
	Realization Rate- Net-kW	90%	1.60	0.03	0.11	n/a	0.95

5. Precision (continued):

Table 6, §5	Parameter	Conf Lvl	Pumping	Process	Refrig.	Misc.	Program
2-D	Realization Rate- GR-kWh/DUM	80%	0.23	0.29	0.45	0.68	n/a
	Realization Rate- GR-kWh/DUM	90%	0.30	0.38	0.57	0.88	n/a
2-D	Realization Rate- GR-kW/DUM	80%	1.30	0.02	0.08	n/a	n/a
	Realization Rate- GR-kW/DUM	90%	1.60	0.03	0.11	n/a	n/a
2-D	Realization Rate- Net-kWh/DUM	80%	0.08	0.29	0.45	0.000009	n/a
	Realization Rate- Net-kWh/DUM	90%	0.10	0.38	0.57	0.00001	n/a
2-D	Realization Rate- Net-kW/DUM	80%	0.007	0.02	0.08	n/a	n/a
	Realization Rate- Net-kW/DUM	90%	0.009	0.03	0.11	n/a	n/a
3-A	NTGR - Avg Impact kWh	80%	0.75	0.75	0.75	0.75	0.75
	NTGR - Avg Impact kWh	90%	0.75	0.75	0.75	0.75	0.75
3-A	NTGR - Avg Impact kW	80%	0.75	0.75	0.75	0.75	0.75
	NTGR - Avg Impact kW	90%	0.75	0.75	0.75	0.75	0.75
3-B	NTGR - Avg Impact kWh/DUM	80%	0.75	0.75	0.75	0.75	n/a
	NTGR - Avg Impact kWh/DUM	90%	0.75	0.75	0.75	0.75	n/a
3-B	NTGR - Avg Impact kW/DUM	80%	0.75	0.75	0.75	0.75	n/a
	NTGR - Avg Impact kW/DUM	90%	0.75	0.75	0.75	0.75	n/a
4-A	DUM Intermediate Data-Sqft PreInstall	80%	n/a	n/a	n/a	0	n/a
	DUM Intermediate Data-Sqft PreInstall	90%	n/a	n/a	n/a	0	n/a
4-A	DUM Intermediate Data-Hrs PreInstall	80%	n/a	n/a	n/a	n/a	n/a
	DUM Intermediate Data-Hrs PreInstall	90%	n/a	n/a	n/a	n/a	n/a
4-B	DUM Intermediate Data-Sqft PostInstall	80%	n/a	n/a	n/a	0	n/a
	DUM Intermediate Data-Sqft PostInstall	90%	n/a	n/a	n/a	0	n/a
4-B	DUM Intermediate Data-Hrs PostInstall	80%	n/a	n/a	n/a	0	n/a
	DUM Intermediate Data-Hrs PostInstall	90%	n/a	n/a	n/a	0	n/a

6. Measure Count Data.

6. A. Number of measures installed by participants

Item Code	Component Code	Measure Description	Number of Measures
CU1	10D	PUMP SYS CONTROLS (PUMPING)	1
CU1	15A	MISCELLANEOUS (PROCESS)	1
CU1	15B	MISCELLANEOUS(REFRIGERATION)	2
CU1	27	PROCESS COOLING	1
CU1	2D	EMS (WATER PUMPING)	1
CU1	37	HDWR TO LOWER COND TEMP	2
OM2	3A	MOTORS - THREE PHASE (PROC)	1
OM2	4A	MOTORS - THREE PHASE - ODP (PROCESS)	5
OS1	4B	MOTORS - THREE PHASE - TEFC (PROCESS)	2
OS1	3	ADJ SPD DRIVE (PROCESS)	1
OS1	4	ADJ SPD DRIVE (WATER SVC)	4
SC1	2	CHILLER, 75-200 TONS	1
SC1	3	CHILLER, 200-600 TONS	1

6. B. Number of measures installed by all program participants in the 12 months of the program year

The Study's Participant Group included all 16 program participants, so the information is the same as for the previous subsection, 6. A.

6. C. Number of measures installed by the Comparison Group

A Comparison Group was not required, per waiver.

7. Market Segment Data

Below are listed the industries (3-digit SIC Code) included in the program and the proportion of sites in each segment.

Facility SIC Code	Proportion	Number of Sites	Description
017	0.158	3	Agricultural Production-Crops: Fruits and Tree Nuts
025	0.053	1	Agricultural Production-Livestock: Poultry and Eggs
072	0.210	4	Agricultural Services: Crop Services
494	0.526	10	Electric, Gas, & Sanitary Services: Water Supply
497	0.053	1	Electric, Gas, & Sanitary Services: Irrigation Systems

2.2. Study Documentation (in compliance with Table 7 of the Protocols)

The following information is provided in direct response to the corresponding items in Table 7 of the Protocols. Essential information regarding this evaluation is provided below. When necessary, the reader is directed to the appropriate report section where additional information can be found. For the convenience of the reader, the subsections herein are labeled as they are in Protocol Table 7.

A. Overview Information

1. *Study Title:* Impact Evaluation of the Southern California Edison Company's 1997 Agricultural Energy Efficiency Incentive Programs (Study ID: 569).
2. *Program, program year, and program description:* Agricultural Energy Efficiency Incentive Program. PY1997. Target and deliver financial incentives to SCE agricultural and water service customers that installed energy efficiency equipment. This report addressed all rebate applications that were paid in 1997.
3. *End-uses and/or measures covered*: This evaluation covered: Pumping, Refrigeration, Process, and Miscellaneous end-uses. This latter category consisted of two HVAC measures.
4. *Methods and models used:*

   Gross Savings
   In general, if the coupon involved a simple measure such as a motor change, SCE and AESC used SCE's Measure Analysis and Recommendation System (MARS) to verify the calculations. This software is based on SCE's Computerized Book of Standards (CBOS). If the coupon estimates were based on a custom engineering analysis by SCE, by a vendor or by a consulting engineer, then AESC performed manual engineering calculations to obtain its estimates. Please refer to Section 6 for more details.

   Measure Level Net Impacts and Net-to-Gross Ratios (NTGRs)
   Table C-5 of the Protocols does not require a comparison group. Due to the small number of coupons, SCE requested a waiver of Protocol requirements to allow setting the NTGR to a default value of 0.75. This value was established as part of a retroactive wavier approved by CADMAC on June 17, 1998.

   Net Savings
   The measure-level NTGR (0.75) was multiplied by the measure-level gross impacts to derive net impacts for both kWh and kW. Within each end-use, the net kWh and kW were summed to produce end-use net kWh and kW impacts. Within each end-use, the gross kWh and kW impacts were then summed to produce end-use gross kWh and kW impacts. Within each end-use, the ratio of the net kWh and kW impacts to the gross kWh and kW impacts produced kWh and kW NTGRs for each end-use. As the default value of 0.75 is used for all measures, the average NTGR is 0.75 for both kWh and kW, and the overall program NTGR is 0.75.

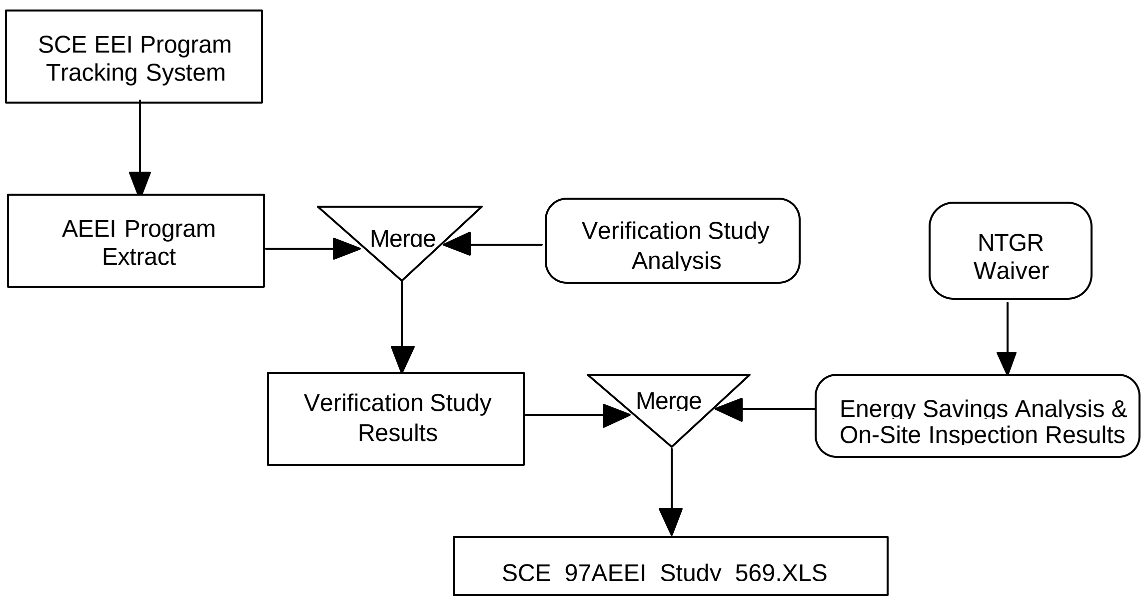
5. *Participants and comparison group definition:* Participants are defined as all agricultural and water services customers who received a rebate during 1997. No comparison groups were used.

6. *Analysis sample size:* A census was attempted and achieved with respect to on-site engineering estimates of gross impacts. The census covered all of the program participants: 16 customers with 19 coupons, and 23 measures.

B. Database Management

1. *Describe and provide flow chart illustrating the relationships between data elements* The flowchart below illustrates the construction of the final analysis database used in estimating the NTGRs and the net kWh and kW impacts. The final database is the original AEEI extract file, with all the research data added directly into it.

Figure 2-1. Data Element Flow Chart



2. *Identify the specific data sources for each data element:* The sources of all data elements are described below:
    - Engineering data for use in estimating gross impacts for all measures was obtained from on-site surveys,
    - Information was available from Program files.

3. *Diagram and describe data attrition process:* There is no significant data attrition. Sample selection processes, recruitment, response rates, and attrition are described in Sections 4 and 5.

4. *Describe the internal organizational data quality checks:*

Gross savings data quality checks: A senior-level engineer reviewed each evaluation and verified the reasonableness of the technical approach, data collected, and evaluation results. Gross savings results were further subjected to data checks that identified measures with negative savings, with large discrepancies compared to the program estimates, and other anomalies. Any outliers were further scrutinized to confirm their correctness.

Net savings data quality checks: The NTGR was set to a default value of 0.75 for all of the measures.

5. *Provide a summary of the data collected specifically for the analysis but not used:* None.

C. Sampling

1. *Sampling procedures and protocols:* A census was attempted with respect to on-site engineering analysis of gross impacts for the 19 coupons and the associated 23 measures. A complete description of the sample design and implementation can be found in Section 4.
2. *Survey information and survey instruments:* Data collection instruments are provided in Appendix D. A census was achieved with respect to on-site engineering analysis of gross impacts. Sample disposition reports are in Section 5.7.
3. *Statistical Descriptions:* Not Applicable

D. Data Screening and Analysis

1. *Describe treatment for outliers, missing data points and weather adjustments:* Once data collection was completed, no significant data points were missing.
2. *Describe control of background effects:* Background variables were not an issue since the analytical methods used to estimate both gross and net impacts were based on an analysis of each individual coupon and its related measure(s). These approaches do not allow for the statistical control of such background effects as changes in economic conditions.
3. *Describe data screening procedures:* No screening of coupons and measures was done prior to data collection. That is, a census was attempted. Also, since analysis did not depend on billing data, many of the usual reasons for screening data did not exist.
4. *Regression statistics*: Not Applicable
5. *Specification:* Not Applicable

6. *Error in measuring variables:* Not Applicable
7. *Autocorrelation:* Not Applicable
8. *Heteroskedasticity*: Not Applicable
9. *Collinearity:* Not Applicable
10. *Influential data points:* Not Applicable
11. *Missing data:* Once data collection was completed, no data points were missing.
12. *Precision*: Both the 80 percent and 90 percent confidence intervals were calculated using the following formula:

$$\bar{y} \pm t s_{\bar{y}}$$

where t = the critical value from the t distribution, and
s = the standard error of $\bar{y}$, the mean NTGR.

The critical values of t for the 80% and 90% levels of confidence are 1.28 and 1.64 respectively

E. Data Interpretation and Application

1. *Net impact calculations*: The methods used to estimate the measure-level net impacts were a combination of the ones listed in §A.5.a.3 and §A.5.a.4 in Table 7 of the Protocols (as revised March 1999).

2. *Describe process, choices made, and rationale for choices made in Section E.1, above:* Per Table 5 of the Protocols, engineering models were used to estimate gross impacts.

3.0 Introduction

The 1997 Agricultural Energy Efficiency Incentive (AEEI) program was designed to target and deliver financial incentives to SCE agricultural and water service customers who install energy efficient equipment. Such activity provides ratepayer benefits as well as increased earnings for SCE. Energy Efficiency Incentives also benefit the customers by making cost-saving, energy efficient measures more affordable. The impact study is intended to estimate the actual energy savings achieved by the program. Alternative Energy Systems Consulting, Inc., Ridge & Associates and KVDR, Inc. performed the 1997 AEEI Impact Study. These firms worked closely with SCE to design an evaluation of the 1997 AEEI Program that meets the requirements specified in the *Protocols and Procedures for the Verification of Costs, Benefits, and Shareholder Earnings from Demand-Side Management Programs* (Protocols) as adopted by the California Public Utilities Commission (CPUC) in May of 1993 and most recently revised in March of 1999. The following sections describe the approach used to perform this study.

3.1 Sample Selection

In the 1997 AEEI Program, there were 23 measures installed across 17 paid coupons and within four end-uses: pumping, refrigeration, process, and HVAC. The small population size permitted a complete census to be taken, rather than a sample of the population.

3.2 Measure Evaluation Process

The measure evaluation process is designed to verify the gross energy savings and demand reductions. The net-to-gross ratio (NTGR) was set at a default value of 0.75. These two pieces of information are combined to determine the *ex post savings* from which the shareholder earnings are calculated.

The NTGR is defined as the change in energy consumption and/or demand attributable to the program (the *net* impacts), divided by the change in energy consumption and/or demand that results directly from the program-related actions taken by program participants (the *gross* impacts). For this study, NTGRs were set at a value of 0.75. This value was established as part of a waiver approved by CADMAC on June 17, 1998.

AESC's first step in evaluating the gross energy savings of a measure was to review the coupon file. In this review process, the nature of the energy savings was learned as well as what information was needed from the customer to verify the energy savings. AESC has developed a set of forms used to gather information related to the different measures included in the AEEI program. After reviewing the coupon, the customer was contacted and a site visit scheduled. During the site visit, the measure hardware was inspected, and the necessary information gathered. Typically, a site visit lasted between 30 to 60 minutes per measure. Site visits were performed for all but one of the agricultural program measures.

The energy savings and demand reduction calculations were thoroughly checked during the review process. AESC calculated the estimated savings using the information gathered during the site visit. Sometimes it was necessary to contact the equipment vendor to verify performance parameters and/or assumptions related to the baseline equipment. The resulting verified energy savings and demand reductions were documented and entered into the database.

3.3 Program-Level Impact Analysis

The verified energy savings and demand reductions were used to calculate the program impacts. The measure-specific evaluations estimated gross savings for all of the coupons. Thus, the end-use and program level net impacts reported in this study are based on all of the kWh and kW savings for each end-use and for the program as a whole.

4.0 Sample Design

4.1 Sample Frame

The sample for this study was developed from an extract taken in early January 1998 from the SCE's tracking system for the Energy Efficiency Incentive Program. In this database there were entries for 23 measures, associated with 19 coupons paid by the AEEI Program in 1997. No coupons or their related measures were dropped from the database as a result of the Verification Study completed in March 1998.

SCE assigned a measure code, indicating a specific type of efficiency technology, to each item. This allowed an end-use code to be assigned to each measure and the 23 measures were subsequently grouped according to the four end-uses that define the four domains of study for this evaluation: pumping, refrigeration, process, and HVAC, which is classified as Miscellaneous. The breakdown of the 23 measures into these end-uses is presented in Table 4-1.

Table 4-1. Breakdown of Measures by End-use

End-use	Number of Measures	Gross Annual Energy Savings Estimate (kWh)	% of Gross Annual Energy Savings Estimate
Pumping	13	1,224,739	54.7%
Refrigeration	4	545,864	24.4%
Process	4	250,522	11.2%
Misc. (HVAC)	2	215,972	9.7%
Total	23	2,237,097	100.0%

Descriptions of all 23 measures are provided in Appendix B.

4.2 Sampling Requirements

The Protocols (Table 5) require that for nonresidential programs, a census will be attempted if the number of participants is less than 350. Therefore, in this evaluation, a census of all 23 measures was attempted. Table C-6 of the Protocols requires that the water pumping end-use be addressed. Table C-9 directs that end uses that exceed 15% of the program's total net resource benefits require a load impact study. Therefore, Refrigeration and Process measures are studied.

5.0 Data Collection

Besides the program tracking system data, all data were collected on-site by qualified engineers between January and December 1998. The instruments used to collect these data are described briefly below, followed by the disposition of the samples.

5.1 Energy Savings Calculation Instruments

On-site energy surveys were designed to gather *ex post* data on the parameters used to calculate the savings resulting from each measure. Typical parameters include operating hours, motor efficiency, area of conditioned space, and production rates. The surveyor was asked to verify the values of key parameters both before and after measure implementation. The objective of the on-site survey was to obtain sufficient information from each site to allow an independent estimate of annual energy savings from each measure.

5.1.1 Site Survey Forms

The first activity was to prepare the forms that 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, production rates and operating hours. AESC used several engineering models to assess energy and demand impact for the measures. Key variables changed from one end-use type to another, so it is important that these parameters were checked as part of the on-site inspection process. Key model variables used by AESC are summarized in Table 5-1.

AESC determined, for each measure type, the information required to calculate annual energy savings. A form was designed for each measure type that included the relevant variables from the list in Table 5-1. AESC used the forms developed for previous EEI impact studies as a starting point and modified them to reflect differences in the 1997 AEEI program. Copies of the different forms are provided in Appendix E.

Using the assumptions and calculations documented in SCE's 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 E.

Prior to starting the site surveys, AESC trained its engineers on how to conduct the on-site inspections. These survey personnel participated in eight hours of training in the use of the various forms and techniques used to gather information needed to verify the energy savings and demand reductions.

5.1.2 Deferred Load Questionnaire and Survey Forms

As noted previously in Section 3.5, we have also attempted to adhere to our understanding of the on-going discussions conducted by the CADMAC Modeling and Base Efficiency Subcommittees. These discussions have provided clarification regarding certain unresolved issues in Chapter 4 of the QAG pertaining to the calculation of deferred load savings.

AESC and Ridge and Associates developed a questionnaire and accompanying survey to insure that issues related to the CADMAC discussions were adequately addressed during the review process. The reviewer completed the questionnaire for each coupon and, if needed, a survey containing questions specific to the CADMAC discussions was completed during the on-site visit. Refer to Section 5.2.2 for additional information on these forms.

Table 5-1. Model Variable Descriptions

End-Use	Model Variables	Description of Diversity
Pumping	-Pump Type -Flow Capacity, gpm -Rated Pump Efficiency -Output Pressure, psi -Motor Size, hp -Motor Efficiency -Operating Hours	Pumping measures include installation of variable speed drives on pump motors, motor replacement with high efficiency motors, and pump controls. The pumping systems are for irrigation or water districts.
Refrigeration	-Refrigeration System Type -Cooling Capacity, Tons -Rated Efficiency, EER -Temperature Set-Point -Economizer Controls -Operating Hours -Weather Zone	Agricultural customer use refrigeration systems for product and process cooling. The four measures include two installations of hardware to reduce condenser temperature, one installation of new DX coils, and insulating cold storage warehouse walls.
Process	-Process Type -Process Demand, kW -Process Load Factor -Process Operating Hours	Process measures are diversified and a uniform description is not possible. They included two measures involving high efficiency motor installations, one process cooling measure, and one installation of a variable speed drive.
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	The HVAC systems provide air conditioning for environmental control for production areas and cooling fruit in storage areas. The capacity of one of the two systems was 160 tons; the other was 320 tons. Both systems were in a facility located in the north coast region of SCE's service territory.

	-Building Hours	

5.2 On-Site Survey Procedures

For each on-site survey, the customer was contacted and an appointment scheduled. AESC contacted the ESR assigned to that customer and invited them to also attend the meeting.

5.2.1 Measure Equipment Inspection

AESC's survey personnel would arrive at the site and request to meet with the site contact. After reviewing the purpose of the site visit, AESC would inspect the equipment that was part of the coupon. The inspection included checking the equipment specifications and verifying proper operation. 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. For some measures such as large lighting projects, it was impractical to verify the installation of all of the items (i.e., thousands of lamps at multiple locations, etc.). In these cases, AESC thoroughly verified the installation of the proper hardware at one location, and then randomly inspected installations at several other locations. The information gathered during the inspections was entered on to the forms and notes on the visit were recorded. For several of the coupons, it was necessary to call the customer and clarify some of the information gathered during the on-site survey. In this fashion, on-site surveys were completed for all 23 measures.

5.2.3 Measure Monitoring

AESC monitored one measure to verify the energy saving calculation methods. The selected measure was chosen due to a specific modification to the energy savings calculation generated by SCE. The revised pump calculations were to overcome static head not accounted for in MARS. NRG Power Inc. obtained energy use data using a data logger over a one month period. During this period, the customer's operating schedule provided 19 days of pump operation data. The energy use data were analyzed and utilized in the energy savings calculations.

5.3 Measure Documentation

AESC received files for each of the coupons for which an incentive had been paid as part of the 1997 Agricultural AEEI Program. These files contained photocopies of all of the program documentation and backup material related to that coupon. Typically these files would contain approximately 30 sheets of paper consisting of a copy of the program checklist and several copies of the coupon at different stages of the incentive process. Measure documentation included receipts for the equipment and services covered by the coupon, the energy savings calculations, and any other documentation supporting the measure. AESC reviewed these coupons and determined if the information contained in the database was the same as in the coupon documentation. If information was missing from the file, the project Energy Service Representative (ESR) was contacted and the missing material obtained from the ESR's files.

AESC maintained these files during the study, adding the impact study forms and documentation as it was completed. At the end of the program, AESC reviewed all of the files and checked that each was complete. These files form the basis of the reported energy savings and demand reductions.

5.4 Data Entry

All data were transferred from the instruments into Excel spreadsheets and subjected to 100 percent verification. All data entry errors were identified and repaired.

5.5 Sample Disposition

All on-site engineering surveys were completed, except with one customer who was so resistant that the effort was discontinued.

6.0 Methodology for Engineering Estimates of Gross Impacts

AESC used information collected during the on-site surveys to prepare independent, *ex post* estimates of annual energy savings for the AEEI Program measures. AESC used both energy analysis software and custom engineering calculations to estimate 1997 energy and demand savings for each measure. In general, if the coupon was for a simple measure such as a HVAC packaged unit or motor change, then both SCE and AESC used the SCE Measure Analysis and Recommendation System (MARS) to verify the calculations. This software is based on SCE's Computerized Book of Standards (CBOS). AESC performed manual engineering calculations if the SCE, vendor, or consulting engineer based the coupon estimates on a custom engineering analysis. To minimize errors, all measure estimates were checked by one of AESC's Professional Engineers. Table 6-1 summarizes the calculation methods that were used.

Table 6-1. Energy Savings Calculation Methods

Calculation Method	*Ex Ante*	*Ex Post*
MARS	11	11
Manual	11	11
Feasibility Study	0	0
Vendor Calculations	1	1
Component Calculations	0	0

AESC used several engineering models to assess the impact of agricultural customer measures in the 1997 AEEI Program. For the *ex ante* impact estimate, AESC selected models based on the availability of data, type of measure, and the original estimation method used. MARS (Version 2.6), algorithms from SCE's Book of Standards, and customized manual energy savings calculations were the primary models used.

6.1 MARS 2.6

MARS is a computer program for Windows-based IBM-compatible computers. It was developed by SCE and is used by its ESRs to develop energy saving proposals for agricultural and commercial customers. MARS allows specification of HVAC, lighting, motors, water heating, insulation, and some agricultural applications. Measures may be specified in up to three states: 1) existing, 2) meeting the current minimum energy efficiency standards, and 3) meeting the recommended or rebated level of efficiency.

For HVAC measures, MARS uses the ASHRAE Modified Bin Method[1] 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, individual zone loads are not calculated.

MARS uses the CBOS (Computerized Book of Standards) 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 industrial and agricultural measures. CBOS implements the 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 variables in order to minimize the complexity and time spent in estimating reportable results.

Some of the energy saving calculations performed by the ESRs early in the year were made with a previous version of MARS. In verifying the savings, AESC used the most current version of the software, MARS 2.6. There were a number of changes made to the software that result in minor changes in the energy savings relative to earlier versions.

6.2 Engineering Calculations

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 used industry guidelines to estimate key variables that were not available from the field data (e.g., power factor, motor efficiency, etc.). An important factor in the manual calculations is establishing the appropriate baseline. Typically, when a customer is upgrading a facility, the existing equipment is old and is less efficient than today's standard equipment. When determining energy savings it is important to determine the usage of currently available equipment. In some cases this can result in the loss of the claimed savings. For instance, in one case, the owner was questioned about what equipment he would have installed without the incentive. The customer stated that they had committed to the purchase of high efficiency motors employing water bearings for environmental reasons. This established the baseline for this customer as the high efficiency motor that was installed and no energy savings were applied for this coupon.

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

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

simplified calculations.

During the evaluation, AESC was notified by SCE that a flaw in MARS had been identified related to calculation of savings associated with installation of VSDs on water pumps. The original MARS savings calculation did not adequately account for the minimum power needed to overcome the differential pressure. For well pumps, this represents the sum of the discharge pressure and suction lift while for booster pumps it is the difference between the discharge and suction pressures. SCE supplied AESC with revised savings estimates for the 4 measures that were affected. AESC reviewed these calculations and modified the savings for each of the affected measures accordingly.

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 the 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. In these instances 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.

For previous impact studies, AESC attempted to use SCE customer billing data as an additional check of energy savings calculations. 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. For these reasons, AESC did not attempt to evaluate billing data for the agricultural customers.

6.3 Deferred Load Evaluation Method

When a customer's energy use increases as a direct result of a production increase or facility expansion, then this usage increase represents added load, and revenue, for the electric utility. When an energy efficient measure is implemented that reduces this increase in load, then load has effectively been "deferred". Energy savings that are achieved in this fashion are therefore referred to as deferred load savings. Deferred load savings is an acceptable incentive program outcome since it reduces the energy use that would have ultimately resulted and therefore provides a ratepayer benefit. However, this ratepayer benefit must be weighed against the incentive's impact on the decision to increase production (and load) and its associated benefit to the utility shareholder. For this reason, it is important that the relationship between the incentive and the decision to increase production be scrutinized. This relationship and the issues surrounding it are the basis for the on-going CADMAC Modeling and Base Efficiency Subcommittee discussions. We have used the outcome of these discussions as a guide in developing our methods for evaluating deferred load.

In general, coupons involving deferred load were evaluated in much the same manner, using the same tools and methods, as coupons that did not involve deferred load. Accordingly, the discussion presented in Sections 6.1 and 6.2 above also applies to evaluation of deferred load savings. The evaluation method differs in that additional investigation and associated analysis was conducted to:

- Identify coupons where a facility expansion or production increase occurred,
- Determine and/or obtain documentation verifying the incentive's impact on the decision to install the measure,
- Estimate the energy savings associated with any increase in production capacity, and
- Estimate the portion of the deferred load that can be attributed to the incentive.

For purposes of evaluation, deferred load coupons can be categorized into one of three types:

> Facility expansion - where the measure did not directly impact production capacity but the customer's overall production capacity, and electric load, increased as a result of the project involving the measure.
>
> Incremental production increase - where an existing piece of equipment was replaced with equipment of higher capacity and/or efficiency.
>
> New production increase - where a new piece of equipment is added of higher capacity and/or efficiency than existing equipment already at the site.

These categories were developed in order to differentiate between coupons where the measure had a direct impact on production capacity and between coupons having totally new production capacity versus an incremental increase. The evaluation method was then tailored for each of the different categories.

6.3.1 CADMAC Questionnaire and Survey Forms

To insure consistent treatment of the deferred load issue, AESC and Ridge and Associates developed a questionnaire and accompanying survey (see Appendix F for copies of the questionnaire and survey forms.) that addressed the issues raised in the CADMAC subcommittee meetings. The questionnaire, completed by the reviewing engineer for each coupon, was used to record whether deferred load was involved and if so, whether the coupon/file contained sufficient documentation (i.e., a properly dated testimonial letter, etc.) to evaluate the impact of the incentive. If the reviewing engineer determined that deferred load was not involved then the reason for this conclusion was recorded as well.

If it was determined that production increased, either as a direct result of the measure or the project that involved the measure, then the questionnaire further asks whether adequate documentation (i.e., testimonial letter, etc.) was present in the file to evaluate the impact of the incentive. If inadequate documentation exists then the decision-maker was questioned using the CADMAC survey as part of the on-site visit. The survey questions were developed to evaluate the relative importance of customer's desire to improve energy efficiency and their desire to increase production on the decision to install the equipment/measure. Survey responses were then used in calculating what portion of the deferred load could be attributed to the incentive.

Note that the survey was employed only for coupons involving an incremental production increase that could be attributed directly to the measure. This was based on the assumption that a decision to install energy efficient measures in a facility expansion is separate from the decision to expand the facility itself. In these cases, the incentive does not influence the decision to expand only the decision to install energy efficient measures as part of the expansion. The survey questions, developed to explore the relationship between the incentive and the decision to increase production, are therefore unnecessary.

6.3.2 Determination of Gross Impact

Deferred load was estimated in one of two ways depending on whether the coupon involved an incremental production increase or was a facility expansion. Coupons involving a facility expansion were treated in the same fashion as coupons without deferred load. For those cases, the baseline usage was the projected usage in the absence of the measure with the deferred load equal to the savings attributed to the measure itself.

For coupons involving an incremental production increase (replacement of existing equipment) savings are a combination of both deferred and direct savings. Where direct savings are savings relative to the baseline equipment operating at the previous production rate and the deferred portion is the savings attributable to the incremental increase in production capacity. For coupons involving new production (addition of new equipment) there is no direct savings component and deferred savings are calculated by multiplying the efficiency improvement by the production capacity of the new equipment.

As with any coupon/measure, establishing a realistic baseline is critical to the evaluation of savings (direct and deferred). The AESC engineer established the baseline equipment efficiency and production capacity based on a variety of indicators. In some cases, the customer was able to identify the baseline equipment (purchased in the absence of the rebate). In other cases, the SCE representative had identified and documented an acceptable baseline in their calculations. This information was reviewed and compared against customer responses to the NTGR survey to determine the appropriate baseline.

6.3.3 Calculation of Modified Gross Impact

In accordance with the CADMAC subcommittee discussions, AESC limited deferred savings to the portion that could be attributed to the customer’s need to increase output. AESC used customer responses to two of the CADMAC survey questions to develop a modifier that could be applied to the gross deferred savings. This CADMAC multiplier was calculated using the responses to two of the survey questions. These two survey questions asked the customer to provide a number between 0 and 10 describing the extent that achieving a lower energy bill and the need to increase production had influenced their decision to increase the output of their facility. The answers to these questions were then used to calculate the CADMAC multiplier (CAD) as follows:

CADMAC Multiplier = Production Increase Influence Response / Sum of both Responses

The deferred load portion of the savings was then multiplied by the CADMAC multiplier to arrive at the portion of the deferred load that could be attributed to the measure. Note that the resulting modified savings value becomes the deferred portion of the gross savings for the measure that is used in subsequent calculations (e.g., calculation of net savings using the NTGR responses). In effect, deferred load is first modified by the CADMAC multiplier to arrive at the portion attributable to the measure and then modified again by the NTGR responses to arrive at the claimed savings value. This method appeared to provide a fair yet conservative approach to calculation of deferred savings.

6.4 Program Level Gross Impacts

AESC's overall objective was to calculate the results specified in Protocol Table 6. AESC used the default NTGR value of 0.75 for each measure to calculate the population results. It was not necessary to scale or extrapolate results since a census was performed and results were obtained for all of the coupons. The overall program parameters such as realization rates are weighted averages of the individual measure results. AESC's results, which include overall NTGRs, load impacts and realization rates, are presented in Sections 7 and 8.

7.0 Results of Engineering Analysis of Gross Impacts

Section 7 summarizes the gross savings associated with the 1997 AEEI program. Gross energy savings and electric capacity parameters are included, as well as the parameters describing the program participants and measure, like market segment and measure type.

The results for all of the individual measures are presented in Appendix A listed by CIR and measure number. Appendix B includes short descriptions of the evaluation process for each coupon. These descriptions are listed by CIR number.

7.1 Average Measure Usage

The base and post-installation energy usage and electric capacity for each measure was determined as part of the impact study using MARS 2.6, engineering analyses or vendor calculations with the results verified by AESC. In many cases the replaced equipment met current efficiency standards and the base usage was the pre-installation usage. The average energy usage and electric capacity for the four end-uses are presented in Table 7-1.

7.2 Gross Savings Impacts

The gross savings impacts are the differences between the base-year and impact-year usage for energy and capacity. These represent some or all of the savings the customer achieves by installing energy efficient equipment rather than standard equipment. The impact study results have been verified by AESC and reflect the actual operating parameters that were gathered as part of the on-site survey effort. The original coupon values are estimates based on the information provided by the customer, equipment specifications and assumptions made on how the equipment would be operated. AESC verified the operation of the equipment and the related parameters used in calculating the values.

The realization rate is defined as the ratio of the gross (or net) savings estimated in the impact study to the gross (or net) savings contained in the first year earnings claim. AESC conducted the Verification Study for the 1997 AEEI program and determined the agricultural gross energy and capacity savings to be 2,237,097 kWh and 327.2 kW, respectively. No additional changes were made to these values as a result of the ORA review.

The gross impacts for the agricultural measures along with the realization rates are presented in Table 7-2. Note that the table values incorporate both deferred load savings and direct savings. Additional discussion of deferred savings impacts follows.

7.3 Gross Deferred Load Savings Impacts

Of the 23 measures included in the 1997 AEEI program, a total of 3 were either originally designated as including deferred load by SCE, or were found to derive some or all of their savings from deferred load. As noted in Section 6.3, measures involving deferred load received additional scrutiny during the evaluation, including application of the CADMAC survey responses (CADMAC multiplier).

Table 7-1. Average Measure Usage for Base and Impact Years

Parameter	Pumping	Refrig.	Process	Misc.	Program
kWh					
Avg. Base Usage	886,123	716,680	423,786	381,416	602,001
Avg. Base Usage/DUM	352	716,680	423,786	5	n/a
Avg. Impact Yr. Usage	803,310	653,110	361,117	273,430	522,742
Avg. Impact Yr. Usage/DUM	319	653,110	361,117	3	n/a
kW					
Avg. Base Usage	177.7	174.5	156.8	144.1	163.2
Avg. Base Usage/DUM	0.1	174.5	156.8	0.0018	n/a
Avg. Impact Yr. Usage	158.8	167.3	146.1	152.6	156.2
Avg. Impact Yr. Usage/DUM	0.1	167.3	146.1	0.0019	n/a

Table 7-2. Gross Load Impact Results

Parameter	Pumping	Refrig.	Process	Misc.	Program
kWh					
Gross Load Impact	1,224,739	545,864	250,522	215,972	2,237,097
Avg. Gross Load Impact	94,211	136,466	62,631	107,986	100,323
Avg. Gross Load Impact/DUM	37	136,466	62,631	1.35	n/a
Realization Rate -Impact Load	0.783	0.838	0.378	0.391	0.652
Realization Rate -Impact/DUM	0.783	0.838	0.378	0.391	n/a
kW					
Gross Load Impact	242.2	42.4	42.6	0.0	327.2
Avg. Gross Load Impact	18.6	10.6	10.7	0.0	9.97
Avg. Gross Load Impact/DUM	0.007	10.6	10.7	0.0	n/a
Realization Rate -Impact Load	1.44	0.126	0.322	n/a	0.513
Realization Rate -Impact/DUM	1.44	0.126	0.322	n/a	n/a

7.3.1 CADMAC Questionnaire/Survey Results

For the agricultural program, only two coupons containing three measures involved deferred load. One case (a coupon with two measures) was for installation of high efficiency motors and adjustable speed drives on new pumps, so the CADMAC survey was not necessary. For the remaining coupon and measure, the responses to the survey questions showed that the decision to install the equipment was equally influenced by energy savings and by the need to increase capacity. The CADMAC multiplier in that case is 0.5. The deferred load savings for this coupon were therefore decreased by 50% based on the CADMAC survey responses.

7.3.2 Deferred Savings Summary

The gross impact of the deferred load savings was found to be 63,767 kWh, which represents less than 3% of the program gross savings. The deferred load savings were associated with two coupons. One coupon was for installation of ASDs and high efficiency motors on added pumping capacity (46,267 kWh). The other coupon was for installation of a new and larger evaporative condenser at a produce storage facility (17,500 kWh).

7.4 Designated Units of Measurement

Designated units of measurement (DUM) are used to normalize the annual energy savings and electric capacity results to enable comparison of results for similar applications. For pumping, the DUM is the load impacts per acre-foot of water pumped. Since the process and refrigeration end-uses have such a wide variety of applications it is difficult to compare results for similar applications and as such there is little value in normalizing the results. For this reason, a unity DUM value is used for all process and refrigeration measures. DUM values were calculated for both the base case and post installation with the post installation DUM values used to calculate the Impact Study Parameters. The average DUM values are shown in Table 7-3.

Table 7-3. Average Designated Units of Measurement

End Use	Designated Unit of Measurement	Participant Group Pre-installation Average Value	Participant Group Post-installation Average Value
Water Pumping	kWh/acre-feet of water pumped	2,518	2,518
Refrigeration	project	1	1
Process	project	1	1
Miscellaneous	Not Applicable	Not Applicable	Not Applicable

7.5 Measure Type

SCE offered incentives for a wide variety of energy-saving measures. In 1997, incentives were paid to Agriculture customers for 13 different types of measures. Measures involving installation of high efficiency motors (8), and adjustable speed drives (5) were the most frequent.

7.6 Market Segments

The incentive program included a wide variety of industries. Table 7-4 summarizes the sites participating in the program based on their 3 digit SIC code. There were several customers that had more than one location participating in the program. Multiple locations result in multiple site listings.

Table 7-4. Market Segment Data, Three-Digit Facility SIC Code

Facility SIC Code	Proportion	Number of Sites	Description
017	0.158	3	Agricultural Production-Crops: Fruits and Tree Nuts
025	0.053	1	Agricultural Production-Livestock: Poultry and Eggs
072	0.210	4	Agricultural Services: Crop Services
494	0.526	10	Electric, Gas, & Sanitary Services: Water Supply
497	0.053	1	Electric, Gas, & Sanitary Services: Irrigation Systems

7.7 Gross Impact Observations

AESC's results varied from the base impact values (kWh savings) in all but 2 of the 23 measures that were evaluated. AESC results were less than the base impact value in 15 measures and higher in 6 measures. Overall, the AESC evaluation resulted in a 40% reduction in the gross savings relative to the original coupon values.

The gross energy savings calculations were affected by several factors. The most significant factors resulting in changes to the base impact estimates include:

1. A MARS program error that resulted in excessive savings estimates for well pumps equipped with VSDs, and
2. Variations in actual versus estimated hours of operation.

As discussed previously in Section 6.2, a flaw in the MARS software resulted in the overestimation of savings for pump applications employing VSDs. Mr. Williams of SCE subsequently corrected these calculations resulting in a 256,380 kWh reduction (49%) in the savings estimates for 3 of the 4 affected measures. Measured energy usage data collected during a one-month period was used to calculate savings for the remaining site.

On-site inspections most often revealed changes in either the equipment load or in the hours of operation. These changes were usually minor and were not unexpected. The incentive coupons and the associated savings estimates are done prior to equipment installation and as such one would have to expect some deviation in equipment loading and in the equipment operating hours.

8.0 Results of Net Impact Analysis

A default NTGR value of 0.75 was established as part of a waiver approved by CADMAC on June 17, 1998. Table 8-1 summarizes the net energy and electric capacity impacts for the program and by end-use.

Table 8-1. Net Load Impact Estimates

	Annual Energy Savings (kWh)		Electric Capacity (kW)	
End-Use	**Impact**	**NTGR**	**Impact**	**NTGR**
Pumping	918,554	0.75	181.7	0.75
Refrigeration	409,398	0.75	31.8	0.75
Process	187,892	0.75	32.0	0.75
Miscellaneous	161,979	0.75	0.0	0.75
Program Totals	1,677,823	0.75	245.4	0.75

Appendix A: Individual Measure Results

Appendix B: Individual Measure Analysis

Appendix C: Waiver Request

Appendix D: References

Appendix E: On-Site Survey Forms

Appendix F: Deferred Load Questionnaire and Survey Forms