1997 Industrial Energy Efficiency Incentive Program

Impact Study

Study 568

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1. 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 Industrial Energy Efficiency Incentive (IEEI) Program for industrial 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 industrial sites and energy savings measures included in the 1997 IEEI program. The database included 177 coupons with a total of 230 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. However, for the net-to-gross ratio (NTGR) evaluation, the population was stratified to identify coupons that, because of the size of their savings, should receive special attention. To achieve this stratification, 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.

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. During the on-site visit a survey was performed with a decision-maker that provided the information necessary to estimate the NTGR for each rebated measure. The on-site surveys also provided site and measure operating data, upon which AESC's *ex post* estimates of energy savings were based. AESC monitored the electrical usage of a number of different types of equipment to verify energy savings calculations for the measures.

The gross *ex post* impacts, NTGRs, and net *ex post* impacts were calculated for each measure in the industrial program and summed to provide the population impact. The estimation of the NTGRs is consistent with the guidelines on the use of the self-report method in Appendix J of the Protocols. The *standard,* self-report NTGRs were based on information gathered in interviews with the person most responsible for deciding to participate in the 1997 IEEI Program. The *standard*, self-report NTGR was calculated using the answers to a series of questions on the decision-maker questionnaire. For those coupons with larger expected impacts, additional quantitative and qualitative data were used to produce what is called a *custom,* self-report NTGR.

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, along with the average NTGR values that incorporate the effects of customization, are presented in Table 1-2 for the program and by end-use.

Table 1-1. 1997 IEEI Gross Impact Estimates

End-Use	# Measures	Annual Energy Savings (kWh)	Electric Capacity (kW)
HVAC	35	17,831,400	625.9
Lighting	72	45,035,218	4,164.4
Process	111	81,798,396	10,409.7
Misc.	12	563,954	38.2
Program Totals:	230	145,228,968	15,238.2

Table 1-2. 1997 IEEI Net Impact Estimates

End-Use	Annual Energy Savings (kWh)		Electric Capacity (kW)	
	Impact	NTGR	Impact	NTGR
HVAC	11,952,781	0.670	313.9	0.501
Lighting	26,607,184	0.591	2,508.2	0.602
Process	54,699,101	0.669	6,300.3	0.605
Misc.	401,854	0.713	25.4	0.665
Program Totals	93,660,921	0.645	9,147.7	0.600

2. Summary Tables

This document contains the results of the First Year Impact Study of Southern California Edison's (SCE) Industrial Energy Efficiency Incentive Program - 1997 (Study 568). The California Public Utilities Commission and California Energy Commission require Summary Tables and Study Documentation forms for each utility impact study. Tables 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. Table 2-1 provides the impact study results in accordance with Table 6 while Table 2-2 responds to the requirements of Table 7 of the Protocols.

Table 2-1. Completed Load Impact Study (Table 6 of Protocols)

1. Average Measure Usage:

1.A. Base usage

	HVAC	Lighting	Process	Misc.	Program
Energy kWh	1,257,468	1,275,579	2,444,995	78,356	1,264,099
Elec. Cap. kW	303.0	181.2	457.4	10.0	237.9
Energy/DUM kWh/DUM	37.63	1.69	2,444,995	78,356	n/a
Elec. Cap./DUM	0.00772	0.000297	457.4	10.0	n/a

1.B. Impact year usage

	HVAC	Lighting	Process	Misc.	Program
Energy kWh	755,010	628,510	2,137,880	31,562	888,241
Elec. Cap. kW	294.0	143.6	428.8	6.7	218.3
Energy/DUM kWh/DUM	30.2112	0.9623	2,137,880	31,562	n/a
Elec. Cap./DUM	0.00728	0.000198	428.8	6.7	n/a

Table 2-1. Completed Load Impact Study (Table 6 of Protocols) continued

2. Average Net and Gross End-Use Load Impacts:

2. A. Load impacts

	HVAC	Lighting	Process	Misc.	Program
Avg. Gross Impact kWh	509,469	625,489	736,922	46,996	479,719
Avg. Gross Impact kW	17.9	57.8	93.8	3.2	43.2
Avg. Net Impact kWh	341,508	369,544	492,785	33,488	309,331
Avg. Net Impact kW	9.0	34.8	56.8	2.1	25.7

2. B. Load impacts per designated unit of measure

	HVAC	Lighting	Process	Misc.	Program
Avg. Gross Impact kWh/DUM	6.98	0.87	736,922	46,996	n/a
Avg. Gross Impact kW/DUM	0.00036	0.00012	93.8	3.2	n/a
Avg. Net Impact kWh/DUM	2.98	0.47	492,785	33,488	n/a
Avg. Net Impact kW/DUM	0.000028	0.000070	56.76	2.12	n/a

2. C. The percent change in usage (relative to base usage) of the participant group and comparison group. Comparison group not applicable to industrial sector.

	HVAC	Lighting	Process	Misc.	Program
% Change in Usage kWh	40.0%	50.7%	12.6%	59.7%	24.2%
% Change in Usage kW	3%	20.7%	6.3%	33.4%	8.4%

Table 2-1. Completed Load Impact Study (Table 6 of Protocols) continued

2. D. Realization rates

	HVAC	Lighting	Process	Misc.	Program
Real. Rate Gross kWh	0.802	1.020	0.822	1.021	0.872
Real. Rate Gross kW	3.366	0.355	1.470	0.945	0.800
Real. Rate Net kWh	1.014	0.793	0.846	0.957	0.848
Real. Rate Net kW	3.184	0.281	1.369	0.826	0.670
Real. Rate Gross kWh/DUM	0.861	1.696	0.822	1.021	n/a
Real. Rate Gross kW/DUM	3.614	0.590	1.470	0.945	n/a
Real. Rate Net kWh/DUM	1.089	1.318	0.846	0.957	n/a
Real. Rate Net kW/DUM	3.420	0.468	1.369	1.021	n/a

3. Net-to-Gross Ratios:

3. A. Average load impacts

	HVAC	Lighting	Process	Misc.	Program
NTGR - Avg. Impact kWh	0.670	0.591	0.669	0.713	0.645
NTGR - Avg. Impact kW	0.501	0.602	0.605	0.665	0.600

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

	HVAC	Lighting	Process	Misc.	Program
NTGR - Avg. Impact kWh/DUM	0.427	0.534	0.669	0.713	n/a
NTGR - Avg. Impact kW/DUM	0.077	0.568	0.605	0.665	n/a

Table 2-1. Completed Load Impact Study (Table 6 of Protocols) continued

4. Designated Unit Intermediate Data:

4. A. Pre-installation average

	HVAC	Lighting	Process	Misc.	Program
DUM Int. Data sq. ft Pre-Inst	161,921	214,405	n/a	n/a	n/a
DUM Int. Data Hours Pre-Inst	n/a	6,424	n/a	n/a	n/a

4. B. Post-installation average

	HVAC	Lighting	Process	Misc.	Program
DUM Int. Data sq ft Post-Inst	161,921	158,168	n/a	n/a	n/a
DUM Int. Data Hours Post-Inst	n/a	5,938	n/a	n/a	n/a

Table 2-1. Completed Load Impact Study (Table 6 of Protocols) continued

5. Precision:

Listed below are the 80% and 90% Confidence Intervals for items 1 - 4 of this table.

Table 6 Ref	Parameter	CL	HVAC	Lighting	Process	Misc.	Program
1-A	Avg Base Usage -kWh	80% CL +/-	301893	399864	652972	53742	346268
	Avg Base Usage -kWh	90% CL +/-	386801	512325	836620	68856	443656
1-A	Avg Base Usage -kW	80% CL +/-	68	52	150	6	76
	Avg Base Usage -kW	90% CL +/-	87.5	66.9	192.1	7.9	97
1-A	Avg Base Use/DUM -kWh	80% CL +/-	19.7	0.36	652972	53741	n/a
	Avg Base Use/DUM -kWh	90% CL +/-	25.22	0.47	836621	68857	n/a
1-A	Avg Base Use/DUM -kW	80% CL +/-	0.004	0.00006	150	6.19	n/a
	Avg Base Use/DUM -kW	90% CL +/-	0.005	0.00008	192.2	7.93	n/a
1-B	Avg Impact Usage -kWh	80% CL +/-	212895	175767	710211	28145	353975
	Avg Impact Usage -kWh	90% CL +/-	272771	225201	909957	36061	453530
1-B	Avg Impact Usage -kW	80% CL +/-	65	52	151	6	76
	Avg Impact Usage -kW	90% CL +/-	83.5	67	194	8.1	97.7
1-B	Avg Impact Use/DUM -kWh	80% CL +/-	17.6	0.17	710211	28145	n/a
	Avg Impact Use/DUM -kWh	90% CL +/-	22.6	0.22	909957	36061	n/a
1-B	Avg Impact Use/DUM -kW	80% CL +/-	0.003	0.00004	151.3	6.32	n/a
	Avg Impact Use/DUM -kW	90% CL +/-	0.004	0.00005	193.9	8.1	n/a
2-A	Avg Gr Impact - kWh	80% CL +/-	172518	304821	197620	26819	124016
	Avg Gr Impact - kWh	90% CL +/-	221039	237909	253200	34362	159017
2-A	Avg Gr Impact - kW	80% CL +/-	9.9	19.2	60.5	1.39	29.9
	Avg Gr Impact - kW	90% CL +/-	12.7	24.6	77.6	1.78	38.4
2-A	Avg Net Impact - kWh	80% CL +/-	150653	154347	138555	21956	85801
	Avg Net Impact - kWh	90% CL +/-	193025	197757	177523	28131	109932
2-A	Avg Net Impact - kW	80% CL +/-	5.7	14.3	34.0	1.3	17.0
	Avg Net Impact - kW	90% CL +/-	7.2	18.3	43.5	1.7	21.8
2-B	Avg Gr Impact/DUM - kWh	80% CL +/-	2.96	0.23	197619	26819	n/a
	Avg Gr Impact/DUM - kWh	90% CL +/-	3.79	0.29	253200	34362	n/a
2-B	Avg Gr Impact/DUM - kW	80% CL +/-	0.0004	0.00003	60.5	1.39	n/a
	Avg Gr Impact/DUM - kW	90% CL +/-	0.0005	0.00004	77.6	1.78	n/a
2-B	Avg Net Impact/DUM - kWh	80% CL +/-	1.54	0.125	138554	21956	n/a
	Avg Net Impact/DUM - kWh	90% CL +/-	1.97	0.16	177523	28131	N/a
2-B	Avg Net Impact/DUM - kW	80% CL +/-	0.0001	0.000015	28.5	1.02	n/a
	Avg Net Impact/DUM - kW	90% CL +/-	0.0002	0.00003	43.5	1.67	n/a
2-D/A	Realization Rate- Net-kWh	80% CL +/-	0.115	0.065	0.063	0.16	0.041
	Realization Rate- Net-kWh	90% CL +/-	0.15	0.08	0.08	0.20	0.05
2-D/A	Realization Rate- Net-kW	80% CL +/-	0.29	0.25	0.115	0.29	0.13
	Realization Rate- Net-kW	90% CL +/-	0.37	0.32	0.15	037	0.18
2-D	Realization Rate- GR-kWh/DUM	80% CL +/-	0.000025	0.000005	0.062	0.011	n/a
	Realization Rate- GR-kWh/DUM	90% CL +/-	0.00003	0.00001	0.08	0.014	n/a
2-D	Realization Rate- GR-kW/DUM	80% CL +/-	0.00017	0.000005	0.103	0.15	n/a
	Realization Rate- GR-kW/DUM	90% CL +/-	0.00022	0.00001	0.132	0.192	n/a
2-D	Realization Rate- Net-kWh/DUM	80% CL +/-	0.000013	0.000004	0.063	0.159	n/a
	Realization Rate- Net-kWh/DUM	90% CL +/-	0.000018	0.00005	0.081	0.203	n/a
2-D	Realization Rate- Net-kW/DUM	80% CL +/-	0.000075	0.000005	0.115	0.291	n/a
	Realization Rate- Net-kW/DUM	90% CL +/-	0.000096	0.000006	0.148	0.373	n/a
3-A	NTGR - Avg Impact kW h	80% CL +/-	0.023	0.015	0.013	0.045	0.008

NTGR - Avg Impact kWh	90% CL +/-	0.030	0.019	0.016	0.058	0.011

Table 2-1. Completed Load Impact Study (Table 6 of Protocols), continued

5. Precision: (continued)

Table 6 Ref	Parameter	CL	HVAC	Lighting	Process	Misc.	Program
3-A	NTGR - Avg Impact kW	80% CL +/-	0.023	0.022	0.015	0.053	0.011
	NTGR - Avg Impact kW	90% CL +/-	0.030	0.028	0.019	0.068	0.013
3-B	NTGR - Avg Impact kWh/DUM	80% CL +/-	0.000008	0.000003	0.034	0.12	0.028
	NTGR - Avg Impact kWh/DUM	90% CL +/-	0.00001	0.000004	0.044	0.151	0.036
3-B	NTGR - Avg Impact kW/DUM	80% CL +/-	0.000008	0.000003	0.034	0.12	0.028
	NTGR - Avg Impact kW/DUM	90% CL +/-	0.00001	0.000004	0.044	0.151	0.036
4-A	DUM Intermediate Data-Sqft PreInstall	80% CL +/-	41307	84651	n/a	n/a	n/a
	DUM Intermediate Data-Sqft PreInstall	90% CL +/-	52925	108464	n/a	n/a	n/a
4-A	DUM Intermediate Data-Hrs PreInstall	80% CL +/-	526	316.9	n/a	n/a	n/a
	DUM Intermediate Data-Hrs PreInstall	90% CL +/-	675	406.1	n/a	n/a	n/a
4-B	DUM Intermediate Data-Sqft PostInstall	80% CL +/-	41307	35145	n/a	n/a	n/a
	DUM Intermediate Data-Sqft PostInstall	90% CL +/-	52925	45029	n/a	n/a	n/a
4-B	DUM Intermediate Data-Hrs PostInstall	80% CL +/-	543	323	n/a	n/a	n/a
	DUM Intermediate Data-Hrs PostInstall	90% CL +/-	695	414	n/a	n/a	n/a

Table 2-1. Completed Load Impact Study (Table 6 of Protocols), continued

6. Measure Count Data:

6. A. and B. Number of measures installed by participants.

Item_ Code	Comp. Code	Measure Description	# of Measures	Item_ Code	Comp. Code	Measure Description	# of Measures
CU1	10A	Pump Sys Cntrls (Process)	2	HW12	3	Component	1
CU1	15A	Misc (Process)	30	LC	2	Engy Mgnmt Sys (Lighting)	7
CU1	15B	Misc (Refrigeration)	1	LD1	1	Daylighting Systems	2
CU1	16	Air Compressor	3	LOR	X	Outdoor Lgting Sys Replace.	6
CU1	18	Power Factor Capacitors	1	LSM	9	Component-LED Exit Signs	10
CU1	19	Air Compressor System	7	LSM	X	Indoor Lgting Sys. Modif	28
CU1	20	Cooling Tower	1	LSR	X	Indoor Lgting Sys Replace.	29
CU1	21	Furnace/Energy Efficient	2	OM1	3A	Motors (Proc) Sgle Phase	1
CU1	25	Plastic Extrusion Equip	5	OM2	1A	Motors (HVAC) Three Phase	2
CU1	27	Process Cooling	3	OM2	3A	Motors (Proc) Three Phase	13
CU1	28	Solid State Controls	1	OS1	1	Adj Spd Drive (HVAC)	15
CU1	29	Vacuum System	2	OS1	2	Adj Spd Drive (Refrig)	1
CU1	2C	Ems (Space Conditioning)	7	OS1	3	Adj Spd Drive (Process)	20
CU1	37	Hdwr To Lower Cond Temp	1	OS1	4	Adj Spd Drive (Water Svc)	1
CU1	47	Air Distribution System	1	SAX	3	Component	1
CU1	49	Economy Cycle	3	SC1	2	Chiller 75 - <200 Tons	2
CU1	59	Injection Molding Machine	11	SC1	3	Chiller 200 - <600 Tons	1
CU1	60	Cooling Tower	4	SC1	4	Chiller 600 - <2000 Tons	1
CU1	9A	Pump System (Process)	2	SHX	3	Air Cooled Single Pkg	1
HW12	2	Component	1				

Table 2-1. Completed Load Impact Study (Table 6 of Protocols), continued

7. Market Segment Data:

Facility SIC	Proportion	# of sites	Description
131	0.0395	7	Crude Petroleum and Natural Gas
142	0.0056	1	Crushed and Broken Stone
145	0.0113	2	Clay, Ceramic, and Refractory Minerals
203	0.0113	2	Preserved Fruits and Vegetables
204	0.0056	1	Grain Mill Products
205	0.0169	3	Bakery Products
206	0.0056	1	Sugar and Confectionery Products
208	0.0056	1	Beverages
209	0.0056	1	Misc. Food and Kindred Products
226	0.0056	1	Textile Finishing, except Wool
227	0.0282	5	Carpets and Rugs
251	0.0113	2	Household Furniture
265	0.0056	1	Paperboard Containers and Boxes
267	0.0395	7	Misc. Converted Paper Products
271	0.0169	3	Newspapers
272	0.0169	3	Periodicals
275	0.0226	4	Commercial Printing
281	0.0113	2	Industrial Inorganic Chemicals
282	0.0226	4	Plastics Materials and Synthetics
283	0.0113	2	Drugs
285	0.0056	1	Paints and Allied Products
308	0.1412	25	Miscellaneous Plastics Products, Nec
322	0.0056	1	Glass and Glassware, Pressed or Blown
323	0.0056	1	Products of Purchased Glass
324	0.0056	1	Cement, Hydraulic
331	0.0282	5	Blast Furnace and Basic Steel Products
335	0.0113	2	Nonferrous Rolling and Drawing
339	0.0113	2	Miscellaneous Primary Metal Products
341	0.0113	2	Metal Cans and Shipping Containers
342	0.0056	1	Cutlery, Handtools, and Hardware
344	0.0056	1	Fabricated Structural Metal Products
346	0.0113	2	Metal Forgings and Stampings
347	0.0113	2	Metal Services, Nec
349	0.0113	2	Misc. Fabricated Metal Products
354	0.0056	1	Metalworking Machinery
355	0.0056	1	Special Industry Machinery
356	0.0282	5	General Industrial Machinery
357	0.0226	4	Computer and Office Equipment
359	0.0226	4	Industrial Machinery, Nec
362	0.0113	2	Electrical Industrial Apparatus
364	0.0056	1	Electric Lighting and Wiring Equipment
367	0.0734	13	Electronic Components and Accessories
369	0.0113	2	Misc. Electrical Equipment and Supplies
371	0.0169	3	Motor Vehicles and Equipment
372	0.1299	23	Aircraft and Parts
376	0.0282	5	Guided Missiles, Space Vehicles, Parts
381	0.0169	3	Search and Navigation Equipment
382	0.0226	4	Measuring and Controlling Devices
384	0.0169	3	Medical Instruments and Supplies
394	0.0056	1	Toys and Sporting Goods
733	0.0056	1	Mailing, Reproduction, Stenographic

Table 2-2. Response to Protocol Table 7

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.

A. Overview Information

1. *Study Title:* Impact Evaluation of the Southern California Edison Company's 1997 Industrial Sector Energy Efficiency Incentives Programs: Lighting; HVAC; Process - Study ID: 568
2. *Program, program year, and program description:* 1997 Industrial Energy Efficiency Incentive (IEEI) Program was designed to target and deliver monetary incentives to Southern California Edison 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 HVAC, lighting, process, and miscellaneous end-uses.
4. *Methods and models used:*

   Gross Savings
   In general, if the coupon involved a simple measure such as a lighting or motor change, SCE and AESC used SCE's Measure Analysis and Recommendation System (MARS) to verify the calculations. This software is based on their 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 Sector 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. Since, in this study, there was no comparison group, the self-report method was used to estimate all NTGRs. Guidelines for the use of this method are contained in Chapter 4 of Appendix J of the Protocols. The measure-level NTGRs were estimated using information gathered from the person at each site most responsible for deciding to participate in the SCE IEEI Program. This information was gathered using one of two surveys depending on the expected savings associated with the coupon. All customers were given a basic NTGR survey referred to as the standard self-report NTGR (SSR_NTGR). For those customers with the largest expected savings, additional steps were taken to estimate their NTGRs. For these customers, additional quantitative and qualitative data were collected and analyzed to produce what is called a custom self-report NTGR (CSR_NTGR). All of the information gathered for each custom

Table 2-2. Response to Protocol Table 7 continued

measure was integrated into a coherent narrative that either supported the standard NTGR or argued for changing it. The narrative for each custom measure is presented in Appendix C of this report.

Net Savings

The measure-level NTGR (for custom measures the *custom* NTGR was used and the *standard* NTGR was used for all others) 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.

The overall NTGRs across both kWh and kW impacts were estimated by first converting both net and gross kWh and kW impacts into a common unit, dollars, using marginal energy and capacity costs. The end-use net impacts for kWh *and* kW were then summed. Next, the end-use gross impacts for kWh and kW were summed. Within each end-use, the *combined* kWh and kW net impacts were divided by the *combined* kWh and kW gross impacts to derive the overall NTGR for each end-use.

Summing the combined net kWh and kW derived the NTGR for the overall Program kWh and kW impacts across the three end-uses. Next, the combined gross kWh and kW impacts were summed across all three end-uses. Finally, calculating the ratio of the net impacts to the gross impacts yielded the overall program NTGR.

As mentioned above, there were two levels of decision-maker NTGR analysis, the standard and the custom. The standard measure-specific free-ridership analysis draws on information obtained from the Standard Decision-Maker survey. An analysis of closed-ended questions included in the decision-maker survey was carried out in order to derive a standard, self-report NTGR.

Inputs

The central inputs to the calculation came from decision-maker survey questions 5, 6, 7, 24, 25 and 26. Note that the values for questions 7 and 24 must first be transposed so that their large values have the same meaning as the large values of the other questions.

Another potential conflict within the survey occurs with question 7 which asks how likely it is that the customer would have installed the same exact measure without the rebate. It is known that question 7 is subject to misunderstanding because of the necessarily negative phrasing of the question. It was necessary to ask if the customer

Table 2-2. Response to Protocol Table 7 continued

would have made the same installation if the program had not been in effect. This negative in the question sometimes causes misunderstandings and, therefore, answers that imply the opposite of what the respondent wanted to communicate. This potential for error was handled by incorporating automatic checks into the survey form that detected clear contradictions between questions 6 and 7 since this is where such a misunderstanding would become visible. Where there was a contradiction between these two answers, the interviewer was instructed in how to resolve the contradiction with suggested phrasing for presenting the apparent conflict to the respondent and requesting resolution. However, if the inconsistency was not or could not be resolved within the interview, questions 6 and 7, together with the other three core questions (24, 25 and 26) were averaged with equal weights.

Next, the issue of deferred free-ridership was considered. Deferred free-riders are customers who, in the absence of the program, would have eventually installed exactly the same equipment that was installed through the program. That is, the utility *accelerated* the installation of the equipment. To address this issue, three questions were used. The respondent was asked (Question 12) whether, before talking with the Edison representative, they were planning to do a project for the same *end use* as was done through the Program. The respondent was also asked (Question 15) whether this planned project would have been the same or different than the rebated project. If the respondent indicated that they were planning a project for the same end use and that this planned project would have been the same as the one rebated, then there was the possibility that the Edison rebate may have accelerated to some extent the installation of the equipment. For respondents providing such a response pattern, Question 13 was taken into account. This question asked when, in the absence of the Program, they would have installed this equipment. Their answer to this question was then associated with a NTGR using the forecast conversion information in the table below.

Table 2-2. Response to Protocol Table 7, continued

Forecasted Installation of Same Equipment	Implied NTGR
Less than 6 months	0.0
6 to 12 months	.125
1 to 2 years	.25
2 to 3 years	.5
3 to 4 years	.75
4 or more years	1.0
Earlier than it was under the Program	0.0

Conditioned on a respondent's answers to questions 12, 13, and 15, any implied NTGR from Table 7-2 was then averaged along with the answers to questions 6, 7, 24, 25, and 26 to produce the Standard NTGR.

The validity of the NTGR based on these five or six questions could be challenged, if in response to question 5, the decision-maker said that he had not learned about the SCE program until after the installation was complete. However, there was no need to develop a method of resolving such conflicts because no decision-maker indicated that he learned about the program after the installation.

The custom analysis involved the collection of additional quantitative and qualitative data. The custom measure-specific free-ridership analysis includes all of the features described above in the standard project-specific analysis, plus additional data collection and analysis. The largest projects are usually the most complex and this fact raises the concern that the questions used to estimate the SSR_NTGR could miss some critical pieces of the decision process. It is important to understand the entire story of the process of thinking about the change, considering alternatives, balancing costs and benefits, making decisions, etc. Because of these complexities and potential differences across customers, a more complete and detailed approach was taken for this group. The thrust of the method was to construct a case study involving a comprehensive, internally consistent description of the decision process. This means gathering information from more sources than were employed in the standard measure-specific analysis, as well as more detailed and narrative descriptions of the processes.

Table 2-2. Response to Protocol Table 7 continued

The sources of information potentially available for estimating the CSR_NTGR are described below. First, additional information was collected from the decision-maker

on the economics of the decision to purchase the efficient equipment, including the financial calculations usually done for capital investments, the company's cutoff point for such calculations, and the results of any calculations for this specific rebated equipment, both with and without the rebate. In addition, the decision-maker was asked a series of open-ended questions as a check on the answers to closed-ended questions and to place the equipment choice in a broader context.

Finally, information from the Program paper files was examined for any other information related to the equipment purchase. Such information as the payback both with and without the rebate was frequently present.

A more detailed description of the method and the aggregation from measure-level net and gross kWh and kW impacts and NTGRs to end-use net and gross kWh and kW impacts and NTGRs, to the overall end-use NTGRs, and finally to the overall Program-level NTGR is provided in Section 7 of this report.

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

Analysis sample size: A census was attempted and achieved with respect to on-site engineering estimates of gross impacts. This covered 163 decision-makers associated with 177 coupons and 230 measures. With respect to self-report interviews used to estimate the NTGR, a census of 163 decision-makers was attempted and a 95.1 percent (155 completed interviews) response rate was achieved covering 167 measures. More details regarding sample sizes are presented in Section 4. Table A6-1 presents the breakdown of the 230 measures by end-use.

Table A6-1. Breakdown of Measures by End-Use

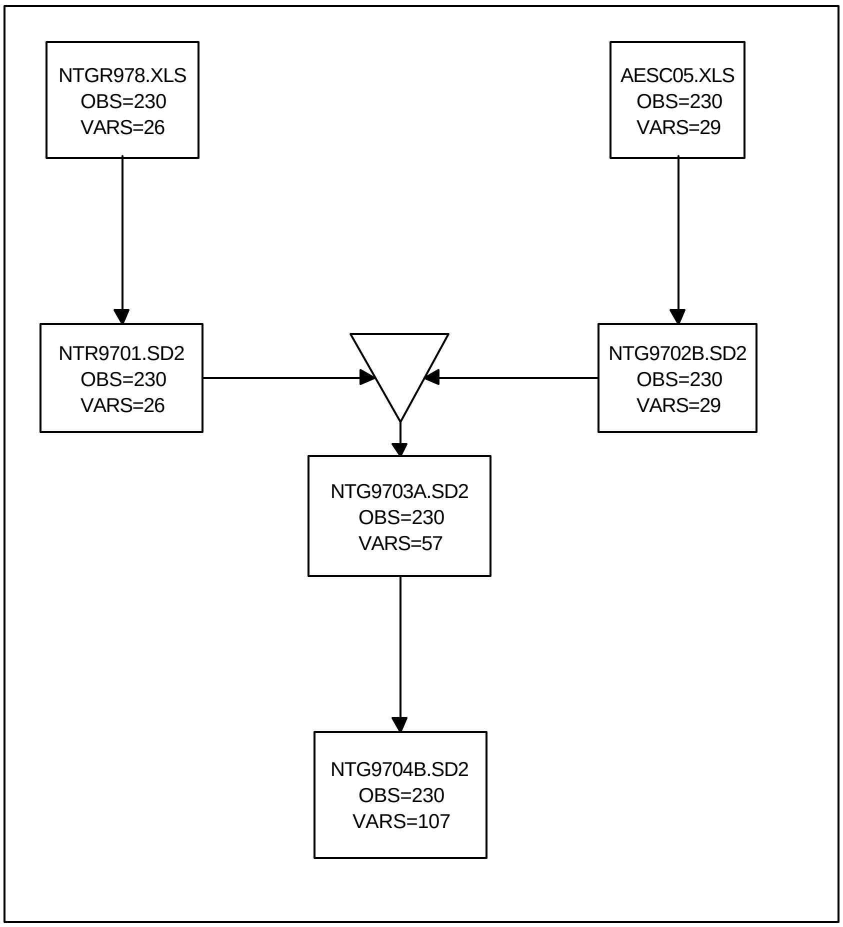
End-Use	Frequency	Percent
Lighting	72	31.3%
Process	111	48.3%
HVAC	35	15.2%
Miscellaneous	12	5.2%
Total	230	100%

Table 2-2. Response to Protocol Table 7 continued

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 construction of the final analysis SAS data set required the preparation of data from three separate sources. The engineering and Program tracking data were collected placed in AESC05.XLS while the survey data were collected and placed in NTGR978.XLS. These two files were first converted to SAS and then merged to produce an intermediate data set, NTG9703A.SD2 and eventually the final analysis data set, NTG9704B.SD2, used to estimate both the standard and custom NTGRs. analysis were kept in Please see Table F-1 in Appendix F for more details about this process, including the number of observations in each file and the function of each SAS job.

Table 2-2. Response to Protocol Table 7 continued

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,
   - Data used in estimating the standard NTGRs were obtained via interviews with the key decision-maker.

   Additional data for estimating custom NTGRs were collected from:
   - interviews with the key decision-maker,
   - interviews with Edison energy services representatives for additional sources of information, and
   - information was available from Program files.

3. *Diagram and describe data attrition process:* There is no significant data attrition. Only eight decision-maker interviews could not be completed. Their missing values were filled and included in the end-use and program level analyses. 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, which 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: internal consistency checks were built into decision-maker interviews, so those interviewers were alerted to internal contradictions. For custom sites, consistency checks were made also between file information, and the decision-maker interviews. Also, consistency between pre-quantified question responses and narrative question responses were reviewed systematically, both for decision-makers and operations staff. Finally, all data entry was 100 percent verified and cleaned prior to analysis.

5. *Provide a summary of the data collected specifically for the analysis but not used:* All data collected were used.

Table 2-2. Response to Protocol Table 7 continued

C. Sampling

1. *Sampling procedures and protocols:* A census was attempted both with respect to on-site engineering analysis of gross impacts and interviews with the 163 decision-makers associated with the 177 coupons and the associated 230 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. A census was attempted with the 163 decision-makers associated with the 177 coupons and 230 measures, resulting in a response rate of 95.1 percent. 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, very few data points were missing. There were only ten measures for which a decision-maker interview could not be completed. For these ten measures, the observed average NTGR for the corresponding end-use was applied.
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

Table 2-2. Response to Protocol Table 7 continued

6. *Error in measuring variables:* Potential errors in measuring customers' level of free-ridership are dealt with by multiple measures of the same concept, increasing reliability of measures. Also, internal consistency checks were provided to detect contradictions and misunderstandings on closed-ended questions during the interview so that they can be addressed on the spot with the respondent. For projects in the custom evaluation group additional checks were provided by asking open-ended questions, whose answers could be compared to the closed-ended questions to check for contradictions. Also in this group were interviews with decision-makers. Whenever possible, input from the operations staff was incorporated during the interview. Any contradictions between the decision-maker and the operations staff were resolved during the interview. Finally, in the custom evaluation group, file information, including payback calculations, was used to detect contradictions in reported motivations for installations, especially pertaining to the role of the rebate.
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, very few data points were missing. Only eight decision-maker interviews were not completed for ten measures. For these, the missing NTGRs were filled using the observed mean NTGR for the corresponding end-use. More details are provided in Section 7.
12. *Precision:* Both the 80 percent and 90 percent confidence intervals for the final, custom NTGRs were calculated for both kWh and kW within each end-use, for the end-use as a whole, and for the program. The 80 percent and 90 percent confidence intervals were also calculated for realization rates. Since these are the critical ratios, these confidence intervals were calculated in two steps. First, the variance of the ratio (either realization rate or NTGR) was estimated using the following equation:

Table 2-2. Response to Protocol Table 7 continued

$$v(\hat{R}) = \frac{(1-f)}{n\bar{x}^2}(s_y^2 + \hat{R}^2 s_x^2 - 2\hat{R}s_{yx})$$ Where:

$v(\hat{R}) =$ Variance of the NTGR

$\hat{R} = \frac{\bar{y}}{\bar{x}}$,the NTGR

f = Sampling fraction

n = Size of sample

$\bar{x}$ = Mean of gross impacts

$\bar{y}$ = Mean of net impacts

s_x^2 = Variance of the gross impacts

s_y^2 = Variance of the net impacts

s_{yx} = Covariance of the gross and net impacts

Once the variance of $\hat{R}$ was estimated, then the following equation is used to estimate the 80 percent and 90 percent confidence intervals:

$$\hat{R} = \pm z\sqrt{v(\hat{R})}$$

where z = The critical values for the 80 percent and 90 percent levels of confidence. i.e., 1.28 and 1.64.

Confidence intervals for other reported variables were calculated using the following formula:

$$\bar{y} \pm ts_{\bar{y}}$$

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

The critical values of t for the 80 percent and 90 percent levels of confidence are 1.28 and 1.64 respectively. These confidence intervals were calculated for the Lighting, HVAC, Process and Miscellaneous end uses.

Table 2-2. Response to Protocol Table 7 continued

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.

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. The self-report method was chosen since Table C-5 does not require a comparison group.

   The challenges of data interpretation and application occurred primarily in the custom analysis of those coupons with the largest savings. The interpretation and analysis of the quantitative and qualitative data for the *custom* measures was a complex task. Without an explicit set of rules that are applied consistently and systematically, any such analysis can become unreliable. To guard against unreliable results, two steps were taken. First, the self-report method was developed so that it is consistent with the guidelines in Chapter 4 of Appendix J of the Protocols. Second, additional rules were developed and applied independently by two analysts. The results were then compared to detect any serious discrepancies in interpretation and analysis. The agreement rate, indicating the reliability of the custom analysis, between the two analysts was 85 percent.

   The principles that were developed and applied are summarized below:

   - The standard NTGR should stand except when there is strong evidence that it should not. No one piece of information should be used to override the standard NTGR. Specifically, more than one piece or source of information should form a larger picture that contradicts the standard NTGR before an override is considered.

   - The standard NTGR should not be changed unless the change is substantial.

3. Introduction

The 1997 Industrial Energy Efficiency Incentives (IEEI) Program was designed to target and deliver monetary incentives to Southern California Edison 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 IEEI Impact Study. These firms worked closely with SCE to design an evaluation of the 1997 IEEI 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 1999. The following sections describe the approach used to perform this study.

3.1 Sample Selection

In the 1997 IEEI Program, there were 230 measures installed across 177 paid coupons and within four end-uses: Process, Lighting, HVAC, and Miscellaneous. The small size of the population 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 and to determine the net-to-gross ratio (NTGR). 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 estimated using information collected from customers regarding the influence of the program on their decisions to install the energy efficient equipment. This information was gathered using questionnaires developed by Ridge & Associates and KVDR, Inc. Depending on the size of the measure's energy savings either a standard or customized survey was completed during the on-site inspection. The customized survey examines the financial decision-making process in more detail, as this aspect of the process is generally more important with larger projects. As part of the on-site inspection, AESC interviewed a decision-maker at the site and completed the appropriate survey. Ridge & Associates and KVDR, Inc. evaluated the survey results and calculated measure specific NTGRs.

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 IEEI program. After reviewing the coupon the customer was contacted and a site visit scheduled. During the site visit, the NTGR survey was performed with a decision-maker, 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 of the industrial program measures, except one site which refused to have the inspection performed.

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 made 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 evaluations estimated gross savings for all but one coupon. For eight coupons, the decision-maker surveys could not be completed. In order to produce estimates of end-use and program-level net savings and NTGRs, the mean NTGRs for the completed interviews within the associated end-use was assigned to these eight 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.

3.4 Protocol Compliance

This evaluation is in strict compliance with the requirements contained in the relevant Protocol tables presented in Table 3-1 below. The summary tables in Section 2 (Tables 2-1 and 2-2) above present the results of this evaluation as required by Tables 6 and 7 of the Protocols.

The methods described in this report for estimating NTGRs are also in full compliance with Chapter 4 of Appendix J of the Protocols, the *Quality Assurance Guidelines for Statistical, Engineering, and Self-Report Methods for Estimating DSM Program Impacts* (QAG). This document, most recently revised in March 1999, provides guidance for utilities that rely on participant self-reporting to estimate net-to-gross ratios.

Table 3-1. Relevant Protocol Tables for the Evaluation of Industrial Incentive Programs

Table	Pertaining To:
5	Protocols for the general approach to load impact measurement
6	Protocols for reporting of results of impact measurement studies used to support an earnings claim
7	Documentation protocols for data quality & processing
8A	Impact and persistence surveys
11	Reporting of load impact results for use in planning & forecasting
C-5	Measurement requirements for industrial incentive programs
C-12	Treatment of data perturbations

4. Sample Design

4.1 Sample Frame

The sample for this study was developed from an extract taken in early 1997 from the SCE's tracking system for the Energy Efficiency Incentive Program.. In this database there were entries for 230 measures, associated with 177 coupons paid by the IEEI Program in 1997.

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 230 measures were subsequently grouped according to the four end-uses that define the four domains of study for this evaluation: Lighting, Process, HVAC, and Miscellaneous. The breakdown of the 230 measures into these end-uses is presented in Table 4-1.

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

End-Use	Frequency	Percent
Lighting	72	31.3%
Process	111	48.3%
HVAC	35	15.2%
Miscellaneous	12	5.2%
Total	230	100%

Descriptions of all 230 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 230 measures was attempted.

Also, Table G-5 of the Protocols requires that three end-uses be addressed: 1) indoor lighting, 2) motors, and 3) industrial process. For this study, the only motors installed were integral to the process or HVAC end-uses. That is, there were no "pure" motor installations in the 1997 Program. There were a number of HVAC measures and these will be treated as a separate end-use.

4.3 Sample Organization

First, the coupon number, measure number, site contact name, site address, and telephone number were retrieved from the program tracking system for each coupon. The sample was then organized by decision-maker (site contact) and then by coupon number with all associated measures.

The sample was also stratified in order to identify coupons that, because of the size of their expected savings, should receive special attention. This stratification was taken from the Verification Study conducted in 1998 for the 1997 IEEI Program, in which the sample unit was the coupon. The sample design for the Verification Study allocated the 177 coupons into 4 strata based on ex-ante estimates of net kWh savings. The appropriate strata for the industrial sector were developed using the Delanius and Hodges technique. Table 4-2 presents the IEEI Program coupons by stratum.

Table 4-2. The Population of IEEI Program Coupons by Stratum

Stratum	Population of Coupons	Percent
1	100	56%
2	51	29%
3	18	10%
4	8	5%
Total	177	100%

Coupons falling in the upper two strata (3 and 4) received what is called a custom analysis. The custom analysis takes much more quantitative and qualitative information into account in estimating the NTGR associated with each measure than was true of non-custom measures. More details regarding the custom analysis process can be found in Section 7.1.4. Of course, this meant that a special survey, the custom decision-maker survey, was used to obtain the additional information for these special cases.

5. Data Collection

Nearly all data were collected on-site by qualified engineers between March 1998 and December 1998. The only exceptions were telephone interviews with vendors and some SCE energy services representatives (ESRs). The instruments used to collect all data are described briefly below, followed by the disposition of the samples.

5.1 NTGR Survey Instruments

Three different data collection instruments were available to collect information for estimating the NTGRs. These instruments were administered in person at the customer location. Occasionally, additional information was collected from these customers by telephone.

5.1.1 Standard Decision-Maker Survey

This survey was used to collect information from the decision-maker, that is, the person who made the decision to participate in the SCE program. These data formed the basis for calculating the standard NTGR for each measure. More details about the use of this questionnaire can be found in Section 7. Appendix D contains a copy of this instrument.

5.1.2 Custom Decision-Maker Survey

For custom coupons, the survey was comprised of all the questions on the standard survey instrument and also included additional closed- and open-ended questions pertaining to the additional information. More details about the use of the custom decision-maker survey can be found in Section 7. Appendix D contains a copy of this instrument.

5.1.3 ESR Interviews

There were three objectives for the ESR interviews. First, we wanted to obtain the Edison ESR's assessment of whether the decision-maker interviewed was sufficiently familiar with the decision to install the rebated measure. This is important since, in the past we have discovered that the decision-maker interviewed was new to the job and therefore not involved in the company's decision to install the rebated measure. Regardless of whether the ESR thought the decision-maker interviewed was sufficiently knowledgeable, the ESR was then asked whether there was anyone else at the customer site who could help us determine the influence of the rebate. Finally, we asked whether there was any other information either in the ESR's files or the customer's files that would help us determine the influence of the rebate. We did not seek to obtain the ESR's assessment of the rebate's influence. More details about the use of the ESR interview can be found in Section 7. Appendix D contains a copy of this instrument.

5.2 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, number of lamps, 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.

5.2.1 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 above list in Table 5-1. AESC used the forms developed for the 1994 EMHRP Impact Study as a starting point and modified them to reflect changes in the 1997 incentive 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 F.

Prior to starting the site surveys, AESC trained its engineers on how to conduct the on-site inspections. These survey personnel participated in an eight hour training class held at AESC's offices. During the class, the field personnel were trained in the use of the various forms and techniques used to gather information needed to verify the energy savings and demand reductions. A portion of the class covered the various NTGR-related questionnaires.

5.2.2 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 6.3 for additional information on the use of these forms. Copies of the different forms are provided in Appendix E.

Table 5-1. 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. 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.

5.3 On-Site Survey Procedures

For each on-site survey, the customer was contacted and an appointment scheduled. In addition, the purpose of the survey was explained, and it was requested that the decision-maker be available for the NTGR survey. AESC contacted the ESR assigned to that customer and invited them to also attend the meeting. As part of the 1997 Verification study, a representative from the CPUC's Office of Ratepayer Advocates (ORA) also attended a number of the on-site inspections.

5.3.1 NTGR and Deferred Load Surveys

AESC's survey personnel would arrive at the site and request to meet with the decision-maker. The inspection process would then be explained and the NTGR survey conducted. Often, the decision-maker would have additional personnel join the meeting to assist in completing the survey.

5.3.2 Measure Equipment Inspection

After the NTGR survey was completed, 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 229 of the 230 measures.

5.3.3 Measure Monitoring

In some instances, the measures involved unique equipment or processes making the energy savings calculations difficult. In these cases, AESC measured the energy use of specific measures to support the energy savings calculations. AESC monitored four measures, three of which required monitoring for an extended period of time while the remaining measure was done with a hand-held power meter during a site visit. Data for three measures were obtained by NRG Power Inc. using data loggers. In each case, one or more data loggers were installed on the equipment of interest and remained in place for 7 to 18 days depending on the nature of the equipment and production cycle. The resulting energy use data were analyzed and used in estimating the energy savings.

The following processes were monitored:

- Specialized bagging equipment for flour products
- Injection-molding machines (toggle-type)
- Vacuum pump equipped with a variable speed drive
- Lighting controls (verification of on/off times)

5.4 Measure Documentation

AESC received files for each of the coupons for which an incentive had been paid as part of the 1997 Industrial IEEI 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. There were several cases where the energy savings described in the energy calculations did not agree with that listed in the database (the coupon had been changed). In each case the SCE program administrator was contacted and the cases discussed and coupon or database values were modified accordingly. For instance in some cases the measure in question involved savings associated with packaged air conditioning equipment, which have a predetermined standard amount of energy savings. In some cases, the ESR had calculated the energy savings with MARS and the amount of energy savings did not equal the set amount. During the program review of the coupons, the mistake was identified and the energy savings changed to reflect the standard amounts.

AESC maintained these coupon files during the study, adding the impact study forms and documentation as each 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.

5.5 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.

5.6 Sample Disposition

The results of all data collection efforts are presented in Table 5-2.

Table 5-2. Sample Disposition for Each Data Source

Data Source	Number Attempted	Number Completed
Engineering On-site Surveys	117	117
Decision-Maker Surveys	163	155
ESR Surveys	24	24

As one can see from Table 5-2, attempts were made to interview all 163 decision-makers associated with the 177 coupons and 230 measures. All decision-makers except eight completed the survey, yielding a response rate of 95 percent. There are ten measures associated with these eight decision-makers.

6. 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 IEEI 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 lighting 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	101	101
Manual	100	104
Feasibility Study	1	0
Vendor Calculations	3	0
Component Calculations	25	25

AESC used several engineering models to assess the impact of industrial customer measures in the 1997 IEEI 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 ESR's 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: 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 and industrial measures. CBOS implements the Computerized 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 were made with earlier MARS versions. 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. There was one MARS modification that has had a significant impact in many of the lighting measures. The MARS program is routinely updated to reflect new standards and new measures. This change resulted from modifications in the minimum efficiency standards for fluorescent lighting. In earlier years the standard was based on a 4 foot, 40 watt bulb. The new standard is based on a 4 foot, 34 watt bulb, resulting in a loss of energy saving of 12 watts per hour per fixture for most applications of T8s and electronic ballasts.

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

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 one case, the owner was questioned about what equipment he would have installed without the incentive. The customer stated that his business was such that he could not compete without the high efficiency equipment. This established the baseline for this customer as the high efficiency models 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 simplified calculations.
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 industrial 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 or deferred savings. Deferred load 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 (see Section 3.5). 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. 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 E 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 instance, one coupon involved a facility expansion by a major electronics manufacturer. Under this coupon, VSDs were installed on the air-handlers serving new clean rooms. In this case, it was unnecessary to assess the impact of the production increase (additional clean rooms) since the equipment installed under the measure (VSDs) did not directly impact the production capacity. The deferred load was therefore estimated with MARS using the observed operating speeds and hours. Since this coupon involved a facility expansion all of the resulting savings are classified as deferred load.

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 instance, in one coupon, a manufacturer of plastic parts replaced an existing injection molding machine with one of higher capacity and efficiency. During the on-site interview the customer indicated that, in the absence of the incentive, they would have installed a higher capacity machine of comparable efficiency to the existing machine thus making the efficiency of the existing machine an acceptable baseline. In this case direct savings were calculated by multiplying the efficiency improvement achieved by the new machine ($kWh/part_{baseline}$ – $kWh/part_{new}$) by the production rate ($parts/yr_{baseline}$) of the existing/baseline machine. Deferred savings were calculated by multiplying the efficiency improvement by the incremental increase in production capacity ($parts/yr_{new}$ - $parts/yr_{baseline}$).

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. In some cases, this resulted in the elimination of deferred load.

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 NTGR data from the on-site survey and impact calculations 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 the NTGR or 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 8 and 9.

7. Methodology for Estimates of Net Impact

Three *types* of analyses were performed in addition to the gross savings analysis described in the preceding section to assess the net impact of the program. The first type of analysis examined the effect of free-ridership on the gross savings for each efficiency measure. The second type of analysis examined the effect of free-ridership on gross savings at the end-use level while the third type of analysis was conducted at the program level.

7.1 Measure-Level Free-Ridership Data Collection and Analysis

Free-ridership refers to participating customers who receive rebates even though they would have implemented an efficiency measure without the rebate; hence, they are getting a "free ride" on the incentive program. In the context of the terminology used here for net savings calculations, a participant may be called a "free rider" if that participant implements a measure that is included in the gross savings of the program, but would have implemented the measure even if the program had not existed.

In some cases, Edison's programs motivate customers to replace equipment prior to the end of its useful life. This will be referred to as an "early replacement" action. Situations in which early replacement is potentially an issue with respect to free-ridership were carefully examined. In other cases, the program motivates the customer to select more efficient equipment when replacing equipment that has reached the end of its useful life. This will be referred to as a "normal replacement" action. The program may also motivate the customer to add new efficient equipment or add new controls to existing equipment. This will be referred to as a "new equipment" action.

7.1.1 Free-Ridership Analysis for Each Class of Projects

Two *levels* of free-ridership analysis were implemented. The most basic level of analysis was applied to the Lighting, Process, HVAC and Miscellaneous coupons in strata one and two. These coupons are associated with smaller savings than are those in strata three and four. This level is referred to as the standard free-ridership analysis. The most detailed level of analysis was applied to the Lighting, Process, HVAC, and Miscelleaneous coupons and their related measures that were in strata three and four. This is referred to as the custom free-ridership analysis.

There were five potential sources of free-ridership information in this study. Each level of analysis relied on information from one or more of these sources. These sources are described below.

1. **Program Files**. As described in previous sections of this report, the program maintains a paper file for each paid application. These can contain various pieces of information that are relevant to the analysis of free-ridership, such as letters written by Edison customer representatives documenting what the customer had planned to do in the absence of the rebate and the customer's motivation for implementing the efficiency measure. Information on the measure payback with and without the rebate may also be available.

2. **Decision-Maker Surveys**. When a site was recruited, the individual involved in the decision-making process leading to the installation of measures under the 1997 program was identified. The Standard Decision-Maker Survey obtained highly structured responses concerning the probability that the customer would have installed the same measure in the absence of the program. The Custom Decision-Maker Survey also included open-ended questions that focused on the customer's motivation for installing the efficiency measure as well as the context of the decision, including information considered, the role of financing, and any alternatives considered. Appendix D contains a copy of this instrument.

3. **Edison Energy Services Representatives.** For all custom projects, interviews were conducted with energy services representatives (ESR) There were three objectives for these interviews. First, we wanted to obtain the Edison ESR's assessment of whether the decision-maker interviewed was sufficiently familiar with the decision to install the rebated measure. This is important since, in the past we have discovered that some decision-makers interviewed were new to the job and therefore not involved in the company's decision to install the rebated measures. Regardless of whether the ESR thought the decision-maker interviewed was sufficiently knowledgeable, the ESR was then asked whether there was anyone else at the customer site who could help us determine the influence of the rebate. Finally, we asked whether there was any other information either in the ESR's files or the customer's files that would help us determine the influence of the rebate. We did not seek to obtain the ESR's assessment of the rebate's influence.

Table 7-1 shows the data sources used in the two levels of free-ridership analysis. Although both levels of analysis may share the same source, the amount of information that is used in the analysis may vary. For example, both levels of analysis obtain data from the Decision-Maker interview. However, in the case of the custom analysis, the Decision-Maker interview contains additional questions that were used to clarify the context and motivation for the decision. These questions were not used for the standard analysis.

Table 7-1. Information Sources for Three Analysis Levels

Information Sources	Standard Measure-Specific	Customized Measure-Specific
Decision-maker Interviews	**X**	**X**
Edison Program Files		**X**
Edison Energy Services Representative		**X**

7.1.2 NTGR Framework

The type of method employed for estimating the NTGR depends on the type of information available. For all sites, the NTGR was first calculated using responses from the person involved in the decision to install the efficient equipment. This method, referred to as the self-report NTGR, is fairly common in situations where a comparison group is not available.

Two types of NTGRs were calculated in this study. The first is referred to as the standard self-report NTGR (SSR_NTGR). The second, done for the measures with larger savings (strata 3 and 4), builds on the SSR_NTGR by using additional information and is referred to as the custom self-report NTGR (CSR_NTGR). The calculations of these two NTGRs are described below.

7.1.3 Standard Measure-Specific Free-Ridership Analysis

The standard measure-specific free-ridership analysis draws on information obtained from the Standard Decision-Maker (DM) survey. An analysis of closed-ended questions included in the DM survey was carried out in order to derive a SSR_NTGR. Using this information, the NTGR was calculated and then multiplied by the estimated *gross* kWh and kW savings to estimate the *net* kWh and kW savings.

The central inputs to the calculation come from DM survey questions 5, 6, 7, 24, 25 and 26. Note that the values for questions 7 and 24 must first be transposed so that their large values have the same meaning as the large values of the other questions. The validity of the NTGR based on the five core questions could be challenged, if in response to question 5, the decision-maker said that he had not learned about the SCE program until *after* the installation was complete. However, there was no need to develop a method of resolving such conflicts because no decision-maker indicated that he learned about the program after the installation.

Another potential conflict within the survey occurs with question 7 which asks how likely it is that the customer would have installed the same thing without the rebate. It is known that question 7 is subject to misunderstanding because of the necessarily negative phrasing of the question. It was necessary to ask if the customer would have made the same installation if the program had *not* been in effect. This negative in the question sometimes causes misunderstandings and, therefore, answers that imply the opposite of what the respondent wanted to communicate. This potential for error was handled by incorporating automatic checks into the survey form that detected clear contradictions between questions 6 and 7 since this is where such a misunderstanding would become visible. Where there was a contradiction between these two answers, the interviewer was instructed in how to resolve the contradiction with suggested phrasing for presenting the apparent conflict to the respondent and requesting resolution. However, if the inconsistency was not or could not be resolved within the interview, questions 6 and 7, together with the other three core questions (24, 25 and 26) were averaged with equal weights.

Next, the issue of deferred free-ridership was considered. Deferred free-riders are customers who, in the absence of the program, would have eventually installed exactly the same equipment that was installed through the program. That is, the utility *accelerated* the installation of the equipment. To address this issue, three questions were used. The respondent was asked (Question 12) whether, before talking with the Edison representative, they were planning to do a project for the same *end use* as was done through the Program. The respondent was also asked (Question 15) whether this planned project would have been the same or different than the rebated project. If the respondent indicated that they were planning a project for the same end use and that this planned project would have been the same as the one rebated, then there was the possibility that the Edison rebate may have accelerated to some extent the installation of the equipment. For respondents providing such a response pattern, Question 13 was taken into account. This question asked when, in the absence of the Program, they would have installed this equipment. Their answer to this question was then associated with a NTGR using the forecast conversion information in Table 7-2.

Table 7-2. Forecast Conversion

Forecasted Installation of Same Equipment	Implied NTGR
Less than 6 months	0.0
6 to 12 months	.125
1 to 2 years	.25
2 to 3 years	.5
3 to 4 years	.75
4 or more years	1.0
Earlier than it was under the Program	0.0

Conditioned on a respondent's answers to questions 12, 13, and 15, any implied NTGR from Table 7-2 was then averaged along with the answers to questions 6, 7, 24, 25, and 26 to produce the Standard NTGR.

The validity of the NTGR based on these five or six questions could be challenged, if in response to question 5, the decision-maker said that he had not learned about the SCE program until after the installation was complete. However, there was no need to develop a method of resolving such conflicts because no decision-maker indicated that he learned about the program after the installation.

7.1.4 Custom Measure-Specific Free-Ridership Analysis

The custom measure-specific free-ridership analysis includes all of the features described above in the standard project-specific analysis, plus additional data collection and analysis. The largest projects are usually the most complex, and this fact raises the concern that the questions used to estimate the SSR_NTGR could miss some critical pieces of the decision process. It is important to understand the entire story of the process of thinking about the change, considering alternatives, balancing costs and benefits, making decisions, etc. The change that Edison has rebated could be a small part of a larger project, or it may be the entire project. Energy efficiency could be the single reason for the change or it could be a small part of a larger picture. Because of these complexities and potential differences across customers, a more complete and detailed approach was taken for this group. The thrust of the method was to reconstruct a case study involving a comprehensive, internally consistent description of the decision process. This means gathering information from more sources than were employed in the standard analysis, as well as more detailed and narrative descriptions of the processes. The sources of information potentially available for estimating the CSR_NTGR are described below.

ESR Interviews

As was mentioned earlier, in most custom projects, interviews were conducted with energy services representatives (ESR) there were three objectives for these interviews. First, we wanted to obtain the Edison ESR's assessment of whether the decision-maker interviewed was sufficiently familiar with the decision to install the rebated measure. This is important since, in the past we have discovered that some decision-makers interviewed were new to the job and therefore not involved in their company's decision to install the rebated measures. Regardless of whether the ESR thought the decision-maker interviewed was sufficiently knowledgeable, the ESR was then asked whether there was anyone else at the customer site who could help us determine the influence of the rebate. Finally, we asked whether there was any other information either in the ESR's files or the customer's files that would help us determine the influence of the rebate. We did not seek to obtain the ESR's assessment of the rebate's influence. The instrument used for these interviews is presented in Appendix D.

Financial Information

In many cases, the Edison representative presented the customer with simple payback information on each measure under consideration for installation. Where that information was included in the Edison program file, or where that or other financial information was reported in the decision-maker interview, it was taken into account in the assessment of the CSR_NTGR. This was accomplished by building in a series of probes contingent on the answer to question 7 versus the financial information from two sources: payback information in the program file and the self-reported financial information from the interview. For example, when financial figures met or exceeded the criteria set by the customer for investment, without the rebate, but the core NTGR questions imply a NTGR greater than 0.5, the respondent was questioned about why the rebate was necessary given the favorable financial calculations. Another example is when the company's financial criteria were not met without the rebate, but were met with it, and the implied NTGR was less than 0.5, the decision-maker was questioned about the low level of program influence. The information gathered by such questioning was considered in the context of the larger qualitative analysis of information for these custom measures.

Program Files

When information contained in program files pertained to timing and motivational issues, the information was noted by the interviewing engineer on the blank survey form, and the NTGR team was consulted for suggestions on how to address the issues during the interview. The results of the suggested special probes were considered as part of the qualitative analysis of the custom measures. The files may have also included information that could not be easily be incorporated into the survey but, nevertheless, could affect the estimate of the CSR_NTGR. Any such information was incorporated into our analysis.

Decision-Maker Open-Ended Interview Questions

This type of question had two uses. The first was to contribute to painting the whole picture of the decision process related to the rebated equipment. The second was to detect misunderstandings embedded in the decision-maker's answers to the structured questions or to pick up complexities in the process that could not fit into structured categories, thus producing unexpected combinations of answers, including contradictory ones. Therefore, the answers to these questions could be compared to the pre-quantified answers to see if there were contradictions across those types of questions.

7.1.5 Summary of NTGR Types

As described in previous sections, the measure-level NTGR was calculated using a variety of data depending on whether a Standard Self-Report NTGR (SSR_NTGR) or a Customized Self-Report NTGR (CSR_NTGR) was required. Table 7-3 indicates the number of implemented measures for which various types of data were available to support the estimation of the standard and the custom NTGRs.

Table 7-3. Number of Measures for Which Data Were Available to Support Two Types of NTGRs

	Standard NTGR	Custom NTGR	Total
Decision-Maker Interviews	125	38	163
Edison Program Files	*	38	38
Edison ESR's	*	38	38

* These data collection procedures were not conducted for the standard NTGR Analysis.

7.1.6 Reliability of the Customization Process

For the custom analysis, quantitative and qualitative data from a variety of sources were combined to produce a final CSR_NTGR. Of course, it was essential that all the custom projects be evaluated consistently using the same instrument. However, in a situation involving both quantitative and qualitative data, interpretations of the data may vary from one measure to another, meaning, in effect, the measurement instrument may vary from one measure to another. Thus, the central issue here is reliability, defined as obtaining consistent results over repeated measurements of the same measures. Put another way, we did not want to use an elastic ruler to measure the NTGR for custom measures. Guidelines for the use of qualitative data are provided in Chapter 4 of the QAG, and these guidelines were followed for this study.

Another issue could be important in determining (and judging) both the reliability and validity of the customization process. While, for the most part, more information is better for making good NTGR decisions, certain kinds of information could bias the judgments of the customizers. Foremost among these types of information is knowledge of the *size* of the savings involved in the project being judged. Objectivity might have been threatened if the customizer knew that reducing the NTGR of a project would result in a large impact on the end-use level or the program-level NTGR, as would be the case for very large projects. To avoid this problem both customizers remained unaware of the size of the savings associated with the projects under analysis.

The Data Integration Process

To insure and to measure reliability, several steps were taken by the two-person NTGR team. First, two principles were established to guide the integration of qualitative and quantitative data from the various sources associated with each site and project. Following are these principles with an explanation of each. While the principles themselves are shown in bold type, the explanation of them, sometimes using examples based on retrospective experience with the customization process, is shown in regular type.

A. **The standard NTGR should stand except when there is strong evidence that it should not. No one piece of information should be used to override the standard NTGR. Specifically, more than one piece or source of information should form a larger picture that contradicts the standard NTGR before an override is considered**. The core, standard NTGR is based on five pre-quantified questions in the decision-maker interview. The use of five items reduces greatly the possibility that the NTGR will be distorted in a large way by measurement error. Because of this multi-question approach, it was judged that this result should not be overridden lightly. There were a number of instances where one comment in the interview could be interpreted to contradict the final standard NTGR. However, given the care with which the standard NTGR was measured, it would be a mistake to override it with one piece of information, which could be misinterpreted by the interviewer or by the customizer. Only when there were multiple items that contradicted the standard NTGR were they seriously considered for forming the basis for changing the NTGR.

B. **The standard NTGR should not be changed unless the change is substantial**. This principle is based on several ideas. Although it was not possible to know the error band around any standard NTGR (certainly not while going through the customization process), conceptually there is some band of uncertainty around any estimate. It seemed unwise to tinker in relatively small ways with the quantified core NTGR the results of which could well fall within reasonable error bands. Such tinkering would be based on qualitative information, which has to be translated to quantitative by the customizer. Unless the potential adjustment is fairly large, it seems less risky to stay with the direct, customer-based quantity than to rely on a qualitative judgment from a third party such as the customizer when that judgment is not based on any legitimate quantitative anchors such as payback. Even where there were quantitative anchors, if the difference between the standard NTGR and the potential customized NTGR was not great, it was judged better to use the standardized approach.

Another basis for estimating a NTGR in the custom process was through the use of payback periods. A conversion of paybacks into NTGR terms was provided in the Protocols.[2] This table (Table 7-4) is repeated below for convenient reference.

Table 7-4. Payback Conversion Table

Payback Period	Implied NTGR
6 months or less	0.40
More than 6 months and less than 2 years	0.75
2 years or more	1.00

With these principles in mind, the following steps were followed:

1. Each member of the team summarized information thought important to consider in customizing the NTGR. These summaries were compared to make sure that there was agreement regarding what constituted relevant information.

2. Each member made independent judgments and categorized interviews and file information for the 26 coupons covering the 38 measures. Each coupon was then put into one of three groups using the principles described above:

- CSR_NTGR should be the same as the SSR_NTGR
- CSR_NTGR should be higher than the SSR_NTGR

CSR_NTGR should be lower than the SSR_NTGR

3. These judgments were compared and a preliminary inter-rater reliability calculation was made. There was agreement on 22 out of the 26 coupons (85 percent).

4. Disagreements on these four coupons were resolved using the principles and further refinements of them.

5. Individual estimates of the NTGRs were then compared and the final custom figures (CSR_NTGR) were produced.

[2] Protocols and Procedures for the Verification of Costs, Benefits, and Shareholder Earnings from Demand Side Management Programs, adopted by the California Public Utilities Commission in May of 1993, and most recently revised in March of 1999. Table C-5: Impact Measurement Protocols for the Industrial Energy Efficiency Incentives Program

6. Rationales for the custom results were written.

7.2 End-Use and Program-Level Net Impacts

In this section, the methods used to derive estimates of net savings and NTGRs within each end-use and at the program level for kW and kWh are described. This process involves several steps and several components. First, the use of measure savings and NTGR results to determine basic end-use and program impacts is discussed. This discussion considers the custom and standard measures. These issues are treated in a general, narrative way first, and then presented in algebraic form. Next, the conversion of kWh and kW savings into dollar impacts through the combined use of costing periods and marginal costs is discussed. This method allows both kWh and kW impacts to be summed to produce an overall NTGR for each end-use and the program as a whole. The final subsections describe the methods used to calculate confidence intervals for the end-use and program-level NTGR estimates, realization rates, and other variables presented to meet Protocol-reporting requirements.

7.2.1 Net Impact Estimation

In this section, a description is provided of the methods used to produce end-use and program-level net impact estimates from the unique configuration of data available for custom and standard measures.

Custom Measures. The decision-maker survey and the custom decision information (additional information gathered for custom measure evaluations from program files and additional questions addressed to the decision-maker) produced estimates of the custom NTGRs for each measure. The engineering analysis produced ex post estimates of the gross impacts for each measure. Given these inputs, the net kWh and kW were calculated in three steps:

1. for each measure within each end-use, the gross kWh and kW were adjusted by the associated gross savings *realization rates* to produce AGkWH and AGkW;
2. for each measure within each end-use, this product was in turn multiplied by the final NTGR; and
3. measure-level kWh and kW impacts were then summed within each end-use.

Note that calculating net impacts at the kW and kWh levels within each end-use allows for NTGRs that are appropriate for use in determining the utility earnings claim.

For custom and standard measure, equations 1 and 2 are provided as another way of looking at these calculations.

$$\text{NetkWh} = \sum_{e=1}^{3} \sum_{i=1}^{N} \left[CSR\_NTGR_{e,i} \times \text{AGKWH}_{e,i} \right] \quad (1)$$

$$\text{NetkW} = \sum_{e=1}^{3} \sum_{i=1}^{N} \left[CSR\_NTGR_{e,i} \times \text{AGKW}_{e,i} \right] \quad (2)$$

where

$CSR\_NTGR_{e,i}$ = the custom NTGR for the i^{th} item in the e^{th} end-use

$AGkWH_{e,i}$ = the gross kWh impacts for the i^{th} item in the e^{th} end-use adjusted by the realization rate

$AGkW_{e,i}$ = the gross kW impacts for the i^{th} item in the e^{th} end-use adjusted by the realization rate.

N = the number of measures within a given end-use (HVAC = 35, Process = 111, Lighting = 72, and Miscellaneous=12.)

Standard Measure. The same process, as was used for *custom* measure, was used to produce savings estimates for the standard measures but *without* the custom decision information. Thus, the SSR_NTGR is used instead of the CSR_NTGR in equations 1 and 2.

In this study year, there were only 10 measures for which a decision-maker interview could not be completed. Therefore, the appropriate end-use-specific mean NTGR was used for these measures.

Note that calculating the net impacts for kW and kWh within each end-use produces NTGRs that are appropriate for use in determining the utility earnings claim. The procedures described above produced adjusted gross and net kWh and kW savings estimates for all items within each end-use for both evaluation groups.

7.2.2 End-Use and Program-Level NTGRs

The overall end-use and program-level NTGRs were calculated by first converting both gross and net kWh and kW impacts into a common unit, dollars, within each end-use and at the program level. However, before net and gross kWh and kW impacts could be multiplied by the marginal energy and capacity costs, these impacts had to be allocated to the various costing periods presented in Tables 7-5 and 7-6. Once the kWh and kW impacts were allocated to costing periods, they were multiplied by the marginal cost associated with each costing period. The appropriate marginal costs were obtained from SCE. Table 7-7 shows the marginal energy costs, and Table 7-8 displays the marginal capacity costs.

Table 7-5. Percent of Total Annual Energy Savings by End-Use by Costing Period

End-Use	Costing Period				
	Summer On Peak	Summer Partial Peak	Summer Off Peak	Winter Partial Peak	Winter Off Peak
Lighting	13	12	10	44	21
Process	11	13	22	24	30
HVAC	15	15	11	44	15

Table 7-6. Percent of Total Annual Capacity Reduction by End-Use by Costing Period

End-Use	Costing Period				
	Summer On Peak	Summer Partial Peak	Summer Off Peak	Winter Partial Peak	Winter Off Peak
Lighting	100	99	65	99	88
Process	100	98	81	70	52
HVAC	100	95	50	79	43

Table 7-7. Marginal Energy Costs by Costing Periods

Costing Period	$/kWh
Summer On Peak	0.0451
Summer Partial Peak	0.021
Summer Off Peak	0.0289
Winter Partial Peak	0.0381
Winter Off Peak	0.0316

Table 7-8. Marginal Capacity Costs by Costing Periods

Costing Period	$/kW
Summer On Peak	8.83
Summer Partial Peak	1.06
Summer Off Peak	0.55
Winter Partial Peak	1.20
Winter Off Peak	1.22

7.2.3 Confidence Intervals

Both the 80 percent and 90 percent confidence intervals for the final, custom NTGRs were calculated for both kWh and kW within each end-use, for the end-use as a whole, and for the program. The 80 percent and 90 percent confidence intervals were also calculated for realization rates. Since these are the critical ratios, these confidence intervals were calculated in two steps. First, the variance of the ratio (either realization rate or NTGR) was estimated using the following equation:

$$v(\hat{R}) = \frac{(1-f)}{n\bar{x}^2}(s_y^2 + \hat{R}^2 s_x^2 - 2\hat{R}s_{yx}) \qquad (3)$$

where

$v(\hat{R})$ = Variance of the NTGR

$\hat{R} = \frac{\bar{y}}{\bar{x}}$,the NTGR

f = Sampling fraction

n = Size of sample

$\bar{x}$ = Mean of gross impacts

$\bar{y}$ = Mean of net impacts

s_x^2 = Variance of the gross impacts

s_y^2 = Variance of the net impacts

s_{yx} = Covariance of the gross and net impacts

Once the variance of $\hat{R}$ was estimated, then the following equation is used to estimate the 80 percent and 90 percent confidence intervals:

$$\hat{R} = \pm z \sqrt{v(\hat{R})} \qquad (4)$$

where z = the critical values for the 80 percent and 90 percent levels of confidence, i.e., 1.28 and 1.64.

Confidence intervals for other reported variables were calculated using the following formula:

$$\bar{y} \pm t s_{\bar{y}} \qquad (5)$$

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

8. Results of Engineering Analysis of Gross Impacts

Section 8 summarizes the gross savings associated with the 1997 IEEI program. Gross energy savings and electric capacity parameters are included as well as the parameters describing the program participants and measure such as market segment and measure types.

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

8.1 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 three end-uses are presented in Table 8-1.

8.2 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 IEEI program and determined the industrial gross energy and capacity savings to be 166,456,139 kWh and 19,038 kW, respectively.

Table 8-1. Average Measure Usage for Base and Impact Years

kWh	HVAC	Lighting*	Process	Process	Program
Avg. Base Usage	1,257,468	1,275,579	2,444,995	78,356	1,264,090
Avg. Base Usage/DUM	37.6	1.7	2,444,995	78,356	n/a
Avg. Impact Yr. Usage	755,010	628,510	2,137,880	31,562	888,241
Avg. Impact Yr. Usage/DUM	30.2	1.0	2,137,880	31,562	n/a
kW					
Avg. Base Usage	303.0	181.2	457.4	10.0	237.9
Avg. Base Usage/DUM	0.0077	0.00030	457.4	10.0	n/a
Avg. Impact Yr. Usage	294.0	143.6	428.8	6.7	218.3
Avg. Impact Yr. Usage/DUM	0.0073	0.00020	428.8	6.7	n/a

* - Excluding lighting data with DUM values < 500

These results are based on verification of a sample of the coupons and scaling the sample to obtain population results. No additional changes were made as a result of the ORA review.

The gross impacts for the industrial measures along with the realization rates are presented in Table 8-2. Note that the table values incorporate both deferred and direct savings. Additional discussion of deferred savings impacts follows.

Table 8-2. Gross Load Impact Results

Parameter	HVAC	Lighting*	Process	Process	Program
kWh					
Gross Load Impact	17,831,400	45,035,218	81,798,396	563,954	145,228,968
Avg. Gross Load Impact	509,469	625,489	736,922	46,996	479,719
Avg. Gross Load Impact/DUM	6.98	0.87	736,922	46,996	n/a
Realization Rate -Impact Load	0.802	1.020	0.822	1.021	0.872
Realization Rate -Impact/DUM	0.861	1.696	0.822	1.021	n/a
kW					
Gross Load Impact	625.9	4,164.4	10,409.7	38.2	15,238.2
Avg. Gross Load Impact	17.88	57.84	93.78	3.18	43.17
Avg. Gross Load Impact/DUM	0.00036	0.00012	93.78108	3.18333	n/a
Realization Rate -Impact Load	3.366	0.355	1.470	0.945	0.800
Realization Rate -Impact/DUM	3.614	0.590	1.470	0.945	n/a

* - Excluding lighting data with DUM values < 500

8.3 Gross Deferred Savings Impacts

Of the 230 measures included in the 1997 IEEI program, a total of 55 were either originally designated as 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).

8.3.1 CADMAC Questionnaire/Survey Results

Table 8-3 summarizes the results of the CADMAC questionnaire/survey. For the 55 measures, 17 involved new facility or new production with an assumed CADMAC multiplier of 1. For 8 of the measures the deferred load was eliminated completely either due to the CADMAC responses (2 measures) or due to baseline considerations (6 measures). For example, in one coupon a manufacturer of extruded aluminum parts had installed a new aluminum-extruding machine of higher capacity and efficiency than the existing equipment. The coupon savings were originally estimated with the existing equipment as the baseline. During the site visit the customer indicated that the extruder manufacturer did not offer an extruder without the energy efficient features. Furthermore, he had a long-term relationship with this manufacturer and had not considered buying anything else. In this case the baseline equipment was not the existing equipment but was actually the equipment that was purchased, thus eliminating all of the claimed savings. In another instance, the customer indicated that the measure had been installed with the sole intent of saving energy. Since increasing production had not been a factor in the decision to install the equipment, the CADMAC multiplier was zero and the deferred savings were eliminated.

Table 8-3. Results of CADMAC Questionnaire/Survey

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Result Description	# of Measures	CADMAC Multiplier
New facility/production	17	1.0*
Savings eliminated due to baseline considerations	6	na
All other measures	32	0.654

* - assumed

The average CADMAC multiplier for the 32 measures where the CADMAC survey was applied was 0.654. On average, the CADMAC survey reduced the deferred savings by approximately 35 percent on coupons where it was applied.

8.3.2 Deferred Savings Summary

The results of the deferred load evaluation are summarized in Table 8-4. The gross impact of the deferred savings was found to be 38,490,398 kWh, which represents 26.5 percent of the program gross savings. The majority of the deferred savings were associated with the 50 process measures, which comprised 74 percent of the program deferred savings. Lighting, with a single measure, accounted for approximately 4 percent of the total.

Table 8-4. Deferred Savings Summary

Parameter	HVAC	Lighting	Process*	Program
Number of Measures	4	1	50	55
kWh				
Gross Deferred Load Impact	8,379,654	1,679,204	28,431,540	38,490,398
Avg. Gross Deferred Load Impact	2,094,914	1,679,204	568,631	699,825
kW				
Gross Deferred Load Impact	0.0	191.7	6,732.1	6,923.8
Avg. Gross Deferred Load Impact	0.0	191.7	134.6	125.9

* - includes process, refrigeration & water service

8.4 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 HVAC measures, the square footage of the conditioned space is used. For lighting measures, results are also normalized based on hours of operation yielding a DUM that is the product of the square feet of lighted area and the annual hours of operation divided by 1000 (khrs/yr.). Since the process end-use has 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 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 8-5.

Table 8-5. Average Designated Units of Measurement

Parameter	HVAC	Lighting*	Process	Misc.
Designated Unit	sqft of cond. space	sqft • op hrs /1000	Project	Project
Avg. Base Case Value	181,705	1,592,637	1	1
Avg. Post-Installation Value	169,190	957,963	1	1

* - Excluding lighting data with DUM values < 500

8.5 Measure Type

SCE offered incentives for a wide variety of energy-saving measures. In 1997, incentives were paid to industrial customers for 38 different types of measures. Miscellaneous process (30), adjustable speed drives (21), injection molding machines (11) and air compressor systems (7) were the most frequent process measures. The miscellaneous process measures included a variety of specialized applications including oxygen extraction , , cement processing and metal galvanizing systems. The most popular lighting measures included indoor lighting system modifications (65) and installing LED exit signs (6). There were relatively few HVAC measures in the study with measures involving adjustable speed drives (15) and EMS systems (7) being the most popular.

8.6 Market Segments

The incentive program included a wide variety of industries. Table 8-6 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 8-6. Market Segment Data, 3 Digit Facility SIC Code

Facility SIC Code	Proportion	Number of sites	Description
131	0.0395	7	Crude Petroleum And Natural Gas
142	0.0056	1	Crushed and Broken Stone
145	0.0113	2	Clay, Ceramic, & Refractory Minerals
203	0.0113	2	Preserved Fruits and Vegetables
204	0.0056	1	Grain Mill Products
205	0.0169	3	Bakery Products
206	0.0056	1	Sugar and Confectionery Products
208	0.0056	1	Beverages
209	0.0056	1	Misc. Food and Kindred Products
226	0.0056	1	Textile Finishing, except Wool
227	0.0282	5	Carpets and Rugs
251	0.0113	2	Household Furniture
265	0.0056	1	Paperboard Containers and Boxes
267	0.0395	7	Misc. Converted Paper Products
271	0.0169	3	Newspapers
272	0.0169	3	Periodicals
275	0.0226	4	Commercial Printing
281	0.0113	2	Industrial Inorganic Chemicals
282	0.0226	4	Plastics Materials and Synthetics

283	0.0113	2	Drugs
285	0.0056	1	Paints and Allied Products
308	0.1412	25	Miscellaneous Plastics Products, Nec
322	0.0056	1	Glass and Glassware, Pressed Or Blown
323	0.0056	1	Products Of Purchased Glass
324	0.0056	1	Cement, Hydraulic
331	0.0282	5	Blast Furnace and Basic Steel Products
335	0.0113	2	Nonferrous Rolling and Drawing
339	0.0113	2	Miscellaneous Primary Metal Products
341	0.0113	2	Metal Cans and Shipping Containers
342	0.0056	1	Cutlery, Handtools, and Hardware
344	0.0056	1	Fabricated Structural Metal Products
346	0.0113	2	Metal Forgings and Stampings
347	0.0113	2	Metal Services, Nec
349	0.0113	2	Misc. Fabricated Metal Products
354	0.0056	1	Metalworking Machinery
355	0.0056	1	Special Industry Machinery
356	0.0282	5	General Industrial Machinery
357	0.0226	4	Computer and Office Equipment
359	0.0226	4	Industrial Machinery, Nec
362	0.0113	2	Electrical Industrial Apparatus
364	0.0056	1	Electric Lighting and Wiring Equipment
367	0.0734	13	Electronic Components and Accessories
369	0.0113	2	Misc. Electrical Equipment & Supplies
371	0.0169	3	Motor Vehicles and Equipment
372	0.1299	23	Aircraft and Parts
376	0.0282	5	Guided Missiles, Space Vehicles, Parts
381	0.0169	3	Search and Navigation Equipment
382	0.0226	4	Measuring and Controlling Devices
384	0.0169	3	Medical Instruments and Supplies
394	0.0056	1	Toys and Sporting Goods
733	0.0056	1	Mailing, Reproduction, Stenographic

8.7 Gross Impact Observations

AESC's results varied from the base impact values (kWh savings) in all but 24 of the 230 measures that were evaluated. AESC results were less than the base impact value in 147 measures and higher in 59 measures. The gross energy savings calculations were affected by several factors. The most significant factors resulting in changes to the base impact estimates include:

1. Baseline equipment changes/issues,
2. Variations in actual versus estimated hours of operation,
3. Differences in estimated versus equipment load and/or operating speeds observed at the time of the site visit,
4. Errors in the original calculations, and
5. Reduction of deferred load due to CADMAC survey responses (discussed previously).

Baseline equipment changes resulted in the elimination of all of the base impact savings associated with 17 of the 230 measures. In each case, it was determined that the high efficiency equipment installed under the program represented the baseline for this industry and/or application. Approximately 8.6 million kWh of impact savings were eliminated in this fashion.

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. Variations in the assumed operating profile for measures involving variable speed drives was another area on-site inspections (observed operating speeds) resulted in changes to the impact estimates. In many instances, the ESR had inappropriately used the HVAC default profile for equipment that was found to be operating at a fixed speed (i.e., air handlers for clean rooms).

AESC found a variety of errors in the original calculations that were usually minor. Leaving out the equipment load factor or leaving out the equipment power factor (for calculations involving 3-phase current and voltage estimates) resulted in significant savings reductions.

9. Results of Net Impact Analysis

In this section, the net NTGRs for kWh and kW will be presented at the measure, end-use, and program levels. Before presenting the impact results, however, a brief description of the reliability of the core measure of the NTGR will be provided. After that, the results of the standard NTGR analysis will be presented followed by the results of the custom NTGR analysis.

9.1 Standard NTGR Results

9.1.1 Reliability Analysis of Core NTGR Measure

In the evaluation of the 1996 IEEI Program, three new core questions were added to the decision-maker survey. Prior surveys had included only two core questions. The new core items were added to increase the reliability of the central measure of the NTGR. All other things being equal, reliability is increased with the addition of items to a scale. Before using the new items, an assessment of the internal consistency reliability was performed. In the evaluation of the 1996 Program, Cronbach's alpha for the five items in the sample was 0.93, well above an acceptable level of internal consistency reliability. In the evaluation of the 1997 Program, Cronbach's alpha was .89, well above an acceptable level of internal consistency. Deleting any of the items would not result in any significant improvement in the reliability of the measures, indicating that all items contribute to reliability. One of the items, if removed, would not have diminished the reliability. However, for the sake of consistency over time and projects, this item was included in all analyses.

9.1.2 Measure-Level Standard NTGRs

The standard NTGR was calculated for the 230 rebated and evaluated measures. The standard NTGR was based *solely* on the responses to the five NTGR questions on the decision-maker survey and when required, Question 13. The unweighted standard NTGR for this group is 0.503 with a standard deviation of .28.

9.1.3 End-Use Level Standard NTGR Results for kWh and kW

The standard NTGR for each end-use was calculated in a way that accounts for the magnitude of each measure's net kWh and kW. Table 9-1 presents these results.

Table 9-1. Evaluated Gross Savings, Net Savings, and Net-to-Gross Ratios by End-Use Using Standard NTGRs.

Group	Measure	kWh	kW
Total			
	No. of Measures	230	230
	Evaluated Gross Savings	145,228,969	15,238.2
	Evaluated Net Savings	92,879,752	9,019.8
	Net-to-Gross Ratio	0.639	0.592
Process			
	No. of Measures	111	111
	Evaluated Gross Savings	81,798,396	10,409.7
	Evaluated Net Savings	54,435,814	6,321.1
	Net-to-Gross Ratio	0.665	0.607
Lighting			
	No. of Measures	72	72
	Evaluated Gross Savings	45,035,218	4,164.4
	Evaluated Net Savings	26,017,583	2,360.1
	Net-to-Gross Ratio	0.578	0.567
HVAC			
	No. of Measures	35	35
	Evaluated Gross Savings	17,831,400	625.9
	Evaluated Net Savings	12,027,431	313.8
	Net-to-Gross Ratio	0.675	0.501
MISC			
	No. of Measures	12	12
	Evaluated Gross Savings	563,954	38.2
	Evaluated Net Savings	398,925	24.7
	Net-To-Gross Ratio	0.707	0.647
The above results are based solely on the standard results and are not the final results.			

As one can see, the kWh NTGR for Miscellaneous is the largest, followed by HVAC, Process, and Lighting. Miscellaneous has the largest kW NTGR, followed by Process, Lighting, and HVAC.

Table 9-2 repeats the standard NTGRs at the end-use level and also presents the overall NTGRs for each end-use. For the *overall* NTGRs for each end-use, the kWh and kW have been weighted by the marginal costs. The 80 percent and 90 percent confidence intervals are not presented here. However, they are presented for the final, custom NTGRs in Tables 9-5, 9-6, and 9-7, and, of course, in Table 2-1.

Table 9-2. Standard NTGRs for Each End-Use

	Process N=106	**Lighting N=72**	**HVAC N=35**	**MISC. N=17**
Standard kWh NTGR	0.665	0.578	0.675	.707
Standard kW NTGR	0.607	0.566	0.501	.647
Overall NTGR	0.663	0.577	0.673	.706

9.1.4 Program-Level Standard NTGR Results

Across kWh and kW for the process, lighting, HVAC, and Miscellaneous end-uses, the standard NTGR is estimated to be .637 +/- .008 at the 80 percent confidence level and +/- .010 at the 90 percent confidence level.

9.2 Custom NTGR Results

9.2.1 Measure-Level Custom NTGRs

A custom NTGR was calculated for 26 coupons covering 38 measures. The custom NTGR was based not only on the responses to the core NTGR questions on the decision-maker survey but also included additional information and processing (see Section 7.1.4 for details). The unweighted standard NTGR for the 38 custom measures was 0.650, and the corresponding custom NTGR was 0.627, a decrease of 2.3 percentage points. The average unweighted NTGR for all measures in all four strata, after customization of those measures in the top two strata, was 0.499. This average is very close to the average for the standard unweighted NTGR of 0.503 presented in Section 9.2.1.

The NTGR customization for the 38 measures in strata three and four resulted in only 12 changes covering nine coupons. Of these, 4 were increases and 8 were decreases. The average increase was 0.186 while the average decrease was 0.268. Table 9-3 shows the frequency distribution of the changes produced by the customization process.

Table 9-3. Level and Frequency of NTGR Change From Customization

NTGR Change from Customization	Frequency of Change
-0.279	6
-0.238	1
-0.235	1
0.0	26
+0.105	1
+0.120	1
+0.260	2

The case studies provide information supporting changing of the standard NTGR as well as the magnitude of any changes. Rationales are also given for retaining the standard NTGRs. These case studies are presented in Appendix C.

9.2.2 End-Use-Level Custom NTGRs for kWh and kW

Table 9-4 summarizes the customized NTGRs by end-use. When comparing Table 9-4 to Table 9-1, one can see that customization has only minor effects at the end-use and program-levels. The biggest impact is on the Lighting end-use where the kW NTGR increases by 3.6 percentage points and the kWh NTGR increases by 1.3 percentage points. With respect to Process end use, the kWh NTGR increases by .4 percentage point while the kW NTGR decreases by .2 percentage point. For the HVAC end-use, the kWh NTGR decreases by .5 percentage point and the kW NTGR remains unchanged. For the Miscellaneous end-use, the kWh NTGR increases by .6 percentage point and the kW NTGR increases by 1.8 percentage points. Finally, the program-level kWh NTGR increases by .5 percentage point and the kW NTGR increases by .9 percentage point.

Table 9-4. Evaluated Gross Savings, Net Savings, and Net-To-Gross Ratios by End-Use Using Custom NTGRs

Group	Measure	kWh	kW
Total	No. of Measures	230	230
	Evaluated Gross Savings	145,228,969	15,238.2
	Evaluated Net Savings	93,660,921	9,147.7
	Net-to-Gross Ratio	0.644	0.600
Process			
	No. of Measures	111	111
	Evaluated Gross Savings	81,798,396	10,409.7
	Evaluated Net Savings	54,699,101	6,300.3
	Net-to-Gross Ratio	0.669	0.605
Lighting			
	No. of Measures	72	72
	Evaluated Gross Savings	45,035,218	4,164.4
	Evaluated Net Savings	26,607,184	2,508.2
	Net-to-Gross Ratio	0.591	0.602
HVAC			
	No. of Measures	35	35
	Evaluated Gross Savings	17,831,400	625.9
	Evaluated Net Savings	11,952,781	313.9
	Net-to-Gross Ratio	0.670	0.501
MISC.			
	No. of Measures	12	12
	Evaluated Gross Savings	563,954	38.2
	Evaluated Net Savings	401,854	25.4
	Net-to-Gross Ratio	.713	.665

Tables 9-5, 9-6, and 9-7 present the custom NTGRs for each end-use for kWh and kW for the end-use as a whole. Both kWh and kW have been weighted by the marginal costs in order to produce the NTGRs for each end-use as a whole. These tables also present the 80 percent and 90 percent confidence levels.

Table 9-5. Custom kWh NTGRs for Each End-Use

	Process N=111	Lighting N=72	HVAC N=35	MISC. N=12
Custom NTGR	0.669	0.591	0.670	0.713
80% Confidence Interval	+/- 0.013	+/- 0.015	+/- 0.023	+/- 0.045
90% Confidence Interval	+/- 0.016	+/- 0.019	+/- 0.030	+/- 0.058

Table 9-6. Custom kW NTGRs for Each End-Use

	Process N=111	Lighting N=72	HVAC N=35	MISC. N=12
Custom NTGR	0.605	0.602	0.501	0.665
80% Confidence Interval	+/- 0.015	+/- 0.022	+/- 0.023	+/- 0.053
90% Confidence Interval	+/- 0.019	+/- 0.028	+/- 0.030	+/- 0.068

Table 9-7. Custom NTGRs for Each End-Use

	Process N=111	Lighting N=72	HVAC N=35	MISC. N=12
Custom NTGR	0.666	0.591	0.668	0.712
80% Confidence Interval	+/- 0.013	+/- 0.015	+/- 0.023	+/- 0.045
90% Confidence Interval	+/- 0.016	+/- 0.019	+/- 0.029	+/- 0.058

9.2.3 Program-Level Custom NTGR Results

Across the Process, Lighting, HVAC, and Miscellaneous end-uses, the program-level custom NTGRs for both kWh and kW and for the program as a whole were estimated along with the 80 percent and 90 percent confidence intervals. Table 9-8 presents these results.

Table 9-8. Custom NTGRs for Program-Level kWh and kW and for the Overall Program

	kWh	kW	Overall
Custom NTGR	0.644	0.600	0.643
80% Confidence Interval	+/- 0.008	+/- 0.011	+/- 0.008
90% Confidence Interval	+/- 0.011	+/- 0.013	+/- 0.011

Appendix A: Individual Measure Results

Appendix B: Individual Measure Analysis

Appendix C: Customized NTGR Analysis Case Studies

Appendix D: NTGR Survey Forms

Appendix E: On-Site Survey Forms

Appendix F: Program Evaluation Databases

Appendix G: References