EVALUATION OF FIRST YEAR LOAD IMPACTS OF SOUTHERN CALIFORNIA EDISON'S 1994 AGRICULTURAL AUDIT AND REBATE PROGRAMS

STUDY ID # 518 A AND 518 B

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I. INTRODUCTION

This impact evaluation study attempts to estimate gross and net savings achieved by customers performing measures in Southern California Edison's Agricultural Incentives and Agricultural Surveys programs, limiting attention to customers who installed pumping (or water service) measures as part of the 1994 programs. Rebater, audit (non rebater), and non-participant populations are delineated, and samples drawn for telephone surveys, in order to complete a billing analysis in accord with the California Measurement and Evaluation Protocols.

Results include negligible or negative gross realization rates, with a self report-based free ridership rate of approximately 50 percent. The effort to uncover gross savings has been particularly frustrating, in that a great deal of effort was expended in developing a survey which would provide adequate covariates to adjust for changes in level of service. Apparently, our regressions were not as informative about changes in service, or about changes in priority among pumps, as would be necessary to identify gross savings.

The result is that the results of this estimation process are not credible. It is quite possible that the gross savings from installing higher efficiency equipment may have been overestimated, but it is not believable that the gross savings were zero. Increasing energy consumption after implementation of a known energy efficient measure is a clear sign that something else is occuring. It appears that, despite our best attempts to design precise questions (see Appendix D), we have not been able to get sufficiently precise information from customers about what is occurring with equipment attached to specific meters. While we attempted to incorporate that information into the regression analysis of bills, it has been impossible to correctly apportion the resulting usage increases so that the countervailing efficiency-based reductions could be detected.

From this failure, we draw two conclusions. First, we are forced to reject the results of the statistical analysis as a reasonable representation of program achievement. Instead, we must fall back on the verified engineering estimates of gross program savings contained in the program tracking system. These were developed using approved engineering algorithms and on-site data collection by Edison employees for every site. For a net-to-gross ratio, we use analysis of customers' survey responses to questions about program influence on their decisions.

Second, different methods should be used to estimate program savings next time. We suspect that, as in the industrial sector, year-to-year variations in production may make it quite unlikely that we can develop reliable savings estimates from a statistical analysis of three particular years of energy consumption data. We are forced to recommend that the next evaluation use engineering estimates calibrated and verified with a small sample of sites metered for flow and energy use.

II. PROGRAM ACTIVITY

Based on program tracking system records, summary data on participation in Edison's Agricultural Surveys (audit) and Agricultural Incentives (rebate) program are presented in Tables 1 and 2. Table 1 presents summary information on measure adoptions by 3 digit SIC code (or Major SIC), within program categories. Audit participants have been separated into those performing at least one water services (pumping related) measure, labeled "AuditWs," and those agricultural customers who performed no such measures ("AuditNws). Note that although some data is reported at various points throughout this study for the "AuditNws" customers, there has been no attempt to evaluate their savings. They were originally included in the design, per Protocol Table C-6, however a lack of survey data (one completed response) meant that there was no useful way to proceed with analysis.

Turning to Table 1, note that approximately two thirds of rebate activity, as measured in terms of trackings system reports of ex ante saving estimates, occurs in the water supply/irrigation systems SIC groupings. A total of 290 measures, involving 246 distinct service accounts, were performed by these customers. Among AuditWs customers, there is also a concentration of participants, measures, and particularly ex ante kWh savings in water supply/irrigation. Table 2 details measures, water service and otherwise, performed by program participants. Leading water service measures are pump replacements and pump system efficiency improvements, and adjustable speed drives.

In analyzing the gross impacts of measures taken within these programs, as reported in the next section, we concentrate on the very simple distinction between water services measures taken within the program, and non-water services measures taken by the same customers.

III. GROSS EFFECTS ANALYSIS

The approach adopted for the gross effects analysis was to estimate per-customer regressions of the following form for participants and non-participants:

For audit or rebate participants:

$$KWHMO(i,t) = \alpha(i) + \beta1*S\_water(i,t) + \beta2*S\_nonw(i,t) + \beta3*Srsaew(i,t) + \gamma1*Adjust(i,t) + e(i,t)$$

where i indexes customers, t indexes months, kWHMO is monthly consumption, S_water and S_nonw are cumulative monthly estimates of annual savings for water service and non-water service measures taken in the program, Srsaew is estimated savings for cumulative self reported measures taken outside of the program (and reported by customers as influenced by the program), Adjust is a variable (or variables) adjusting for changes likely to compete with measure-taking in explaining consumption.

Table 1
Distribution of Program Activity
By Major SIC Group

Rebate Participants

SIC3	SIC DESCRIPTION	ACCOUNTS	MEASURES	REBATES	CUST. INVESTMENTS	EX ANTE SAVINGS, kWh
11	CASH GRAINS	5	5	$ 9,220	$ 58,922	160,927
13	FIELD CROPS, OTHER	28	29	$ 52,680	$ 366,639	1,173,387
16	VEGETABLES	4	4	$ 8,026	$ 35,644	179,161
17	FRUITS AND TREE NUTS	52	59	$ 162,083	$ 2,447,084	5,314,146
18	HORTICULTURAL SPEC.	5	5	$ 30,135	$ 150,399	954,479
19	GENERAL CROP FARMS	16	17	$ 46,380	$ 312,438	1,295,710
24	DAIRY FARMS	7	7	$ 6,106	$ 88,909	195,142
25	POULTRY	2	2	$ 1,233	$ 4,110	58,608
27	ANIMAL SPECIALTIES	1	1	$ 440	$ 6,164	17,476
494	WATER SUPPLY	122	155	$ 571,288	$ 6,465,585	20,602,270
497	IRRIGATION SYSTEM	4	6	$ 20,956	$ 137,378	805,268
	TOTAL	246	290	$ 908,547	$ 10,073,272	30,756,574

Audit Participants AuditWS - (At Least One Water Svc. Measure)

SIC3	SIC DESCRIPTION	ACCOUNTS	MEASURES	EX ANTE SAVINGS, kWh
13	FIELD CROPS, OTHER	17	17	672,779
16	VEGETABLES	1	1	11,386
17	FRUITS AND TREE NUTS	21	22	963,666
19	GENERAL CROP FARMS	10	10	251,430
21	LIVESTOCK	2	2	34,107
92	FISH HATCHERIES	2	3	1,021,103
494	WATER SUPPLY	92	108	13,778,376
497	IRRIGATION SYSTEMS	1	1	26,035
	TOTAL	146	164	16,758,882

Table 2

Distribution of Program Activity

By End Use & Measure Description

Rebate Participants With at Least One Water Service Measure

ENDUSE	MEASURE	MEASURE DESCRIPTION	COUNT	REBATES	CUST. INVEST.	EX ANTE SAVINGS, kWh
HV	94-SAX-2	AIR COOLED SPLIT SYSTEM AC	1	$ 22	$ 2,180	444
HV	94-SW1-1	WINDOW TREATMENT	1	$ 90	$ 622	3,012
LI	944-L01-1	OCCUPANCY SENSOR	1	$ 320	$ 4,654	10,584
L1	94-LSM-X	INDOOR LIGHTING SYS. MOD.	3	$ 1,673	$ 10,274	76,084
L1	94-LSR-X	INDOOR LIGHTING SYS REPLACEMT.	1	$ 994	$ 3,312	40,476
PR	93-0M2-EA	3 PHASE TEFC MOTOR, PROCESS	3	$ 270	$ 1,745	6,339
PR	94-CU1-8A	PRE-COOLING EQUIPMENT, PROCESS	1	$ 767	$ 22,482	25,550
PR	94-0S1-3	ADJUSTABLE SPEED DRIVE, PROCESS	4	$ 60,275	$ 2,304,523	2,448,846
RE	94-CU1-1B	CONDENSER COIL (REFRIGERATION)	1	$ 22,406	$ 80,504	746,864
RE	94-CU1-12B	TIME CLOCK (REFRIGERATION)	1	$ 888	$ 2,961	141,180
RE	94-CU1-15B	MISC. (REFRIGERATION)	2	$ 26,000	$ 158,143	866,679
RE	944-CU-42	COLD STORAGE INSULATION	1	$ 899	$ 97,278	29,969
RE	94-0S1-2	ADJ . SPEED DRIVE	1	$ 11,191	$ 41,329	373,043
WS	93-0M2-4A	MOTOR (WTR SVC) 3 PHASE (ODP)	22	$ 13,822	$ 301,899	452,933
WS	93-0M2-48	MOTORS (WTR SVC) 3 PHASE (TEFC)	10	$ 7,118	$ 147,487	122,404
WS	94-CU1-10D	PUMP SYS. CONTROLS (WATER SVC)	2	$ 33,980	$ 391,416	1,132,688
WS	94-CU1-15D	MISC (WATER SERVICES)	1	$ 4,020	$ 16,598	133,986
WS	94-CU1-54	IRRIG EFF IMPROVEMENTS	15	$ 43,279	$ 1,173,830	1,442,706
WS	94-CU1-55	PUMP SYSTEM EFF IMPROVEMENT	6	$ 23,370	$ 890,870	820,572
WS	94-CU1-61	PUMP REPLACEMENT	56	$ 220,655	$ 1,207,553	9,473,158
WS	94-CU2-54	IRRIG EFFCY IMPROVEMENT	3	$ 14,292	$ 629,362	204,655
WS	94-CU2-55	PUMP SYS EFF IMPROVEMENTS	6	$ 50,347	$ 191,137	555,621
WS	94-CU2-61	PUMP REPLACEMENT	115	$ 221,115	$ 1,500,567	4,697,465
WS	94-OP1-1	PUMP ADJUSTMENT	12	$ 660	$ 18,938	544,173
WS	94-0S1-R	ADJ SPD DRVE, (WATER SVC)	21	$ 150,094	$ 873,608	6,407,143
	TOTAL		290	$ 908,547	$ 10,073,272	30,756,574

Table 2 (con't.)

Distribution of Program Activity

By End Use & Measure Description

Audit Participants AuditWS - (At Least One Water Svc. Measure)

ENDUSE	YEAR MEASURE	MEASURE DESCRIPTION	COUNT	EX ANTE SAVINGS, kWh
WS	93-OM2-4A	MOTORS (WTR SVC) 3 PHASE (DDP)	3	16,224
WS	93-OM2-4B	MOTORS (WTR SVC) 3 PPHAASE (TEFC)	4	92,458
WS	94-CU1-55	PUMP SYSTEM EFF IMPROV	12	5,134,105
WS	94-CU1-61	PUMP REPLACEMENT	81	4,697,472
WS	94-CU2-61	PUMP REPLACEMENT	11	555,770
WS	94-0P1-1	PUMP ADJUSTMENT	26	1,230,637
WS	94-OP17-15	MISC. OPERAT & MAINT	5	887,173
WS	94-0P17-8	ADJUST IMPELLER CLEARANCES	14	488,845
WS	94-0P17-9	RESET PUMPING SYS CNTRLS	1	120,208
WS	944-0S1-4	ADJ SPD DRVE, (WATER SERVICE)	7	3,535,990
	TOTAL		164	16,758,882

Audit Participants AuditNWS - (No Water Service Measures)

ENDUSE	YEAR MEASURE	MEASURE DESCRIPTION	COUNT	EX ANTE SAVINGS, kWh
HV	94-CU1-5D	INSUL, PIPES (WTR SERVICE)	1	10,752
HV	94-0P11-14	REDUCE INT COOLING LL-OPTL	1	12,000
HV	94-DP11-8	CLEAN CONDENSER COIL\TWIST TIMER	1	50,580
LI	94-LC-4	TWIST TIMER	1	22,956
LI	94-LSM-X	INDOOR LGTING SYS MODIFICATINO	1	1,680
RR	94-LSR-X	INDOOR LGTING SYS REPLACE	2	101,400
RE	94-CU1-15A	MISC. (PROCESS)	2	4,113,146
	944-0P14-1	CLEAN CONDENSER COILS	1	22,716
			10	4,335,230

Similarly, for non-participants, the general form of the equation estimated is

$$KWHMO(i,t) = \alpha(i) + \beta 1 * Post1\ (i,t) + \beta 3 * Srsaew(i,t) + \gamma 1 * Adjust\ (i,t) + e(i,t)$$

Where Post1 is a binary reflecting pre-post June 1994 status, and in this case Srsaew includes all self reported measure-taking by nonparticipants, whether or not influenced by an Edison program.

Note that in principle these equations could be used to identify both gross and net savings, as well as address participant spillover. The fundamental reason for this per-customer approach was our distrust of any specification which risked cross-sectional contamination of impact estimates, given the extreme heterogeneity of the population. We viewed this as a conservative approach which made fewer assumptions about the individual determinants of consumption.

Three variants of these equations were entertained, each treating the final adjustment variable differently.

Approach 1 (for participants and nonparticipants) adjusted for two variables. First, adjusting for changes in factors global to individual customers, the variable Sicupmwh, the total monthly consumption in the customer's 2-digit SIC group, was entered as a covariate. Secondly, a "level of service" variable, KVAR, was constructed. Where available, it contained the customer's self report of total water usage for the current year. As a backup, customer reports of changes in average hydraulic lift for the pumps on the account were placed in KVAR. In the case of farmers, annual self reports of months of planting and acres planted and affecting the account in question were multiplied, to form a crude index of water demand. Finally, if all these variables were

unavailable, KVAR was set equal to the mean monthly temperature for the customer's weather station.

Approach 2 simply eliminated KVAR from consideration, and used monthly mean temperature as the temporal adjustment variable. Approach 3 used the product of mean monthly temperature and aggregate (SIC2) consumption as the adjustment variable. Approach 3's appeal lies in its inclusion of two highly collinear variables in a form which does not damage the regression, and in fact offers complementary monthly information about local conditions (weather) and global territorial conditions (SIC2 consumption). We stopped with these three specifications, since the number of data points (a maximum of 36 per customer) would not support a complex model.

Prior to considering our findings, we display means, standard deviations, and number of valid cases for a panoply of variables relevant to consumption, including the variables mentioned above as candidate regressors. Table 3 treats rebaters, audit recipients, and non-participants separately, and compares time periods defined by first measure-taking (June 1994 in the case of non-participants). Among the variables whose Table 3 descriptions may be unclear, IC_PUMP indicates that a 200 HP internal combustion pump is working in concert with an electric pump or pumps on the service account. PCTWTR, PCTLIF, PCTWK are annual variables describing the year in question as a percentage of the total water pumped, the average lift applied, or the work performed (total water x lift) for the year 1994 on a particular account. LOGDROP is a logit attached to each customer's records, and indicates, based on a separate attrition analysis, the odds of that customer being excluded from the final sample of 388 accounts. K_WATER is a scaling of S_WATER, the ex ante estimate of water services savings, as a percentage of mean monthly KWH. SRSAEW is a complex variable based on self reports of water services efficiency measures. To calculate it, intra-program ex ante variables were considered as

Table 3

Relevant Variables for Gross Effects Analysis
Means, Standard Deviations, and Valid n's
By Participation Group and Pre/Post

Variable	Description	Statistic	Rebaters Pre	Rebaters Post	Audits Pre	Audits Post	Non Participants <6/94	Non Participants >=6/95
KWHMO	kWh for month	MEAN:	38482.04	44623.74	25224.87	23856.91	12356.10	13217.49
		STDEV	141494.9	149973.3	30534.50	29666.74	39240.52	41107.25
		N:	1575.00	1595.00	606.00	595.00	4649.00	4685.00
KWHMOPCT	kWh month/customer avg kWhmo	MEAN:	94.28	105.67	103.21	96.73	99.19	100.80
		STDEV	100.62	118.31	97.67	85.02	117.49	118.63
		N:	1575.00	1595.00	606.00	595.00	4649.00	4685.00
MCDD60	Mean CDD, 60 degree base	MEAN:	5.91	7.32	5.88	7.23	6.00	7.33
		STDEV	5.96	7.41	6.04	7.38	6.26	7.63
		N:	1575.00	1595.00	606.00	595.00	4649.00	4685.00
MEANTMP	Mean monthly temperature	MEAN:	61.13	63.17	60.83	62.87	61.05	63.06
		STDEV	10.74	11.69	10.69	11.59	11.00	11.88
		N:	1575.00	1595.00	606.00	595.00	4649.00	4685.00
MULTPUMP	Dummy, for multiple pump acct	MEAN:	0.43	0.42	0.22	0.22	0.39	0.39
		STDEV	0.53	0.53	0.43	0.43	0.52	0.52
		N:	1575.00	1595.00	606.00	595.00	4649.00	4685.00
PUMPHP	Calculated total pump hp/acct	MEAN:	325.89	323.67	202.69	204.89	132.03	132.17
		STDEV	498.67	494.40	279.71	282.20	248.61	248.33
		N:	1575.00	1595.00	606.00	595.00	4649.00	4685.00
IC_PUMP	Dummy, non backup I.C Pump	MEAN:	0.01	0.01	0.00	0.00	0.01	0.01
		STDEV	0.11	0.11	0.00	0.00	0.08	0.08
		N:	1575.00	1595.00	606.00	595.00	4649.00	4685.00
PCTWTR	Pct of 1994 water usage	MEAN:	112.49	110.93	192.88	198.82	142.09	141.03
		STDEV	61.33	62.41	323.45	338.99	730.52	725.81
		N:	985.00	995.00	392.00	389.00	2645.00	2683.00
PCTLIF	Pct of 1994 average lift	MEAN:	99.89	99.94	99.45	97.25	99.86	99.67
		STDEV	9.75	9.14	8.47	14.90	11.07	11.65
		N:	1392.00	1400.00	480.00	475.00	3878.00	3908.00
PCTWK	Pct of 1994 calculated work	MEAN:	113.50	111.47	189.33	197.63	146.06	144.11
		STDEV	65.06	65.11	304.97	321.32	758.00	752.24
		N:	949.00	959.00	338.00	337.00	2451.00	2492.00
MOXAC	Annual months x acres planted	MEAN:	1001.40	1054.22	1229.92	1275.28	3668.27	3638.29
		STDEV	1266.62	1314.52	1151.34	1188.74	51313.90	51006.28
		N:	592.00	603.00	303.00	292.00	2551.00	2582.00
WELPCT	Percentage of water from well	MEAN:	99.98	98.24	100.51	108.30	99.89	97.42
		STDEV	1.64	12.37	3.56	63.91	12.82	20.52
		N:	1461.00	1473.00	553.00	548.00	4344.00	4387.00
MOXACP	Moxac as percentage of 1994	MEAN:	95.73	98.55	97.84	98.63	265.73	99.21
		STDEV	16.41	11.12	7.72	13.92	2514.43	14.15
		N:	592.00	603.00	303.00	292.00	2551.00	2582.00
SICUPPCT	Monthly SIC2 consumption/totl	MEAN:	94.58	105.37	93.82	106.29	96.12	103.85
		STDEV	41.69	47.56	39.30	45.36	45.61	52.02
		N:	1575.00	1595.00	606.00	595.00	4649.00	4685.00
LOGDROP	Logit, odds of attrit to 388	MEAN:	-2.05	-2.05	-2.09	-2.09	-2.01	-2.01
		STDEV	0.44	0.44	0.38	0.39	0.39	0.39
		N:	1575.00	1595.00	606.00	595.00	4649.00	4685.00

Table 3
(continued)
Relevant Variables for Gross Effects Analysis
Means, Standard Deviations, and Valid n's
By Participation Group and Pre/Post

Variable	Description	Statistic	Rebaters Pre	Rebaters Post	AuditWs Pre	AuditWs Post	Non Participants <6/94	Non Participants >=6/95
N_WATER	Number water measures, pgm	MEAN:	0.22	1.21	0.11	0.95	0.00	0.00
		STDEV	0.60	1.15	0.33	0.33	0.00	0.00
		N:	1575.00	1595.00	606.00	595.00	4649.00	4685.00
N_NONW	Number non water measures,pgm	MEAN:	0.00	0.04	0.00	0.00	0.00	0.00
		STDEV	0.07	0.21	0.00	0.00	0.00	0.00
		N:	1575.00	1595.00	606.00	595.00	4649.00	4685.00
S_WATER	Ex ante, water measures, pgm	MEAN:	17292.18	88690.37	3839.32	65563.48	0.00	0.00
		STDEV	94432.16	177247.5	20394.78	73486.87	0.00	0.00
		N:	1575.00	1595.00	606.00	595.00	4649.00	4685.00
S_NONW	Ex ante, non water meas, pgm	MEAN:	686.74	10578.18	0.00	0.00	0.00	0.00
		STDEV	10491.76	88460.67	0.00	0.00	0.00	0.00
		N:	1575.00	1595.00	606.00	595.00	4649.00	4685.00
K_WATER	Scaled S_WATER (pct KWMEAN)	MEAN:	525.04	2160.34	31.46	276.70	0.00	0.00
		STDEV	6338.84	12947.32	118.69	210.09	0.00	0.00
		N:	1575.00	1595.00	606.00	595.00	4649.00	4685.00
K_NONW	Scaled S_NONW (pct KWMEAN)	MEAN:	2.17	12.69	0.00	0.00	0.00	0.00
		STDEV	33.14	77.66	0.00	0.00	0.00	0.00
		N:	1575.00	1595.00	606.00	595.00	4649.00	4685.00
D_WATER	Dummy, water measures, pgm	MEAN:	0.19	0.95	0.11	0.92	0.00	0.00
		STDEV	0.42	0.23	0.33	0.28	0.00	0.00
		N:	1575.00	1595.00	606.00	595.00	4649.00	4685.00
D_NONW	Dummy, non water meas, pgm	MEAN:	0.00	0.00	0.00	0.00	0.00	0.00
		STDEV	0.00	0.00	0.00	0.00	0.00	0.00
		N:	1575.00	1595.00	606.00	595.00	4649.00	4685.00
SRSAEW	S.R. SAE, water meas	MEAN:	6136.06	3803.35	1091.99	2502.56	1192.58	7632.52
		STDEV	56970.97	145510.0	9540.63	22162.22	16620.41	43630.45
		N:	1575.00	1595.00	606.00	595.00	4649.00	4685.00
KRSAEW	Scaled S.R. SAE, water meas	MEAN:	18.14	3.96	5.04	8.78	9.43	65.86
		STDEV	126.72	42.65	39.74	61.87	70.66	179.58
		N:	1575.00	1595.00	606.00	595.00	4649.00	4685.00
DSAEW	Dummy for S.R. water meas	MEAN:	0.04	0.02	0.03	0.03	0.04	0.28
		STDEV	0.21	0.14	0.16	0.18	0.20	0.47
		N:	1575.00	1595.00	606.00	595.00	4649.00	4685.00
TOTWTR	Total acre footage for year	MEAN:	9143.25	9541.01	427.68	434.32	534.92	517.37
		STDEV	50653.42	51564.41	352.44	365.03	1982.44	1928.77
		N:	985.00	995.00	392.00	389.00	2645.00	2683.00
AVLI3	Average hydraulic lift for year	MEAN:	206.35	206.50	250.83	248.07	171.09	171.21
		STDEV	174.13	175.62	137.61	141.05	526.29	524.21
		N:	1404.00	1435.00	480.00	475.00	3884.00	3925.00
SICUPMWH	Total MWH in SIC2, monthly	MEAN:	78401.21	89682.81	84579.26	98519.44	65877.29	73126.95
		STDEV	43210.77	53481.82	41188.58	51091.51	40883.86	50215.80
		N:	1575.00	1595.00	606.00	595.00	4649.00	4685.00

proportions of average monthly consumption, and the median proportion of ex ante savings to consumption was calculated from the data set. This median proportion was then applied to customer mean monthly consumption when applicable self report measures were encountered.

Table 4 indicates the correlations among KWHMO and the various regressors discussed above. Note the high correlation between temperature and aggregate SIC2 consumption. Also note the strong positive correlations between measure-taking within the program and consumption -- correlations which indicate that powerful adjustments from level of service covariates must be forthcoming in order to produce gross savings estimates.

Results of the regressions are presented below, in Table 5. Over participants and nonparticipants, mean values of coefficients other than intercepts have been calculated, applying relative weight rwt_c in the process. Note that coefficients on ex ante variablesrarely exceed their standard errors, implying that realization rates are not significantly non zero. Often, the coefficients are positive, indicating that measure-taking serves as more of a signal of greater usage than a determinant of reductions, and that realization rates are if anything negative.

Clearly, we have failed to adequately adjust for changes in production coincident with measure-taking in the agricultural pumping sector, despite our efforts to collect good information on changes in level of service, and to include in individual customer models information that would serve to isolate program impacts.

Table 4: Correlations Among Model Variables

Pearson Correlation Coefficients / N = 13705

	KWHMO	S_WATER	S_NONW	SRSAEW	SICUPMWH	KVAR	POST1	MEANTMP	PRODUCT
KWHMO monthly consumption	1.00000	0.13008	0.53398	0.17655	0.19643	-0.00423	0.01422	0.09587	0.19408
S_WATER sae for water measures, ex ante	0.13008	1.00000	-0.00767	0.01219	0.13106	-0.00915	0.14028	0.02936	0.11888
S_NONW sae for non-water, ex ante	0.53398	-0.00767	1.00000	0.22155	0.02294	-0.00319	0.03634	0.00497	0.02178
SRSAEW self reported water measure sae	0.17655	0.01219	0.22155	1.00000	0.00719	0.00019	0.04639	0.00310	0.00542
SICUPMWH regional totmwh for sicup	0.19643	0.13106	0.02294	0.00719	1.00000	0.01047	0.10782	0.51796	0.96989
KVAR journeyman level of svc var	-0.00423	-0.00915	-0.00319	0.00019	0.01047	1.00000	-0.02407	-0.00297	0.00672
POST1 Dummy for after per1	0.01422	0.14028	0.03634	0.04639	0.10782	-0.02407	1.00000	0.09484	0.12018
MEANTMP mean temperature	0.09587	0.02936	0.00497	0.00310	0.51796	-0.00297	0.09484	1.00000	0.67709
PRODUCT meantmp * sicupmwh	0.19408	0.11888	0.02178	0.00542	0.96989	0.00672	0.12018	0.67709	1.00000

Table 5

Regression Results
With Three Approaches,
Rebaters, AuditWs, and Non participant

Rebaters

	Approach 1		Approach 2		Approach 3	
Coefficient	Mean	S. E.	Mean	S. E.	Mean	S. E.
B-Water	0.041	0.073	0.164	0.059	-0.064	0.082
B-NonW	0.073	0.2997	0.180	0.458	0.097	0.345
B-SRSAEW	-0.193	0.090	-0..053	0.052	-0.102	0.055
B-SICUPWH	0.385	0.054	-	-	-	-
B-Kvar	34850.6	3927.8	-	-	-	-
B-MeanTMP	-	-	1369.4	264.8	-	-
B-Product	-	-	-	-	0..004	0.001
Number Accts.	90		90		90	
Root MSE:						
Median	4400.9		4889.7		4531.8	
Mean	12212.9		13358.0		12869.9	

AuditWs

	Approach 1		Approach 2		Approach 3	
Coefficient	Mean	S. E.	Mean	S. E.	Mean	S. E.
B-Water	0.035	0.104	0.032	0.067	0.000	0.064
B-NonW	-	-	-	-	-	-
B-SRSAEW	0.018	0.221	-0..033	0.215	-0.035	0.214
B-SICUPWH	0.232	0.063	-	-	-	-
B-Kvar	213.6	136.3	-	-	-	-
B-MeanTMP	-	-	943.7	203.1	-	-
B-Product	-	-	-	-	0.003	0.001
Number Accts.	34		34		34	
Root MSE:						
Median	5682.2		6264.6		5820.8	
Mean	8601.3		9178.7		9119.0	

Non-Participants

	Approach 1		Approach 2		Approach 3	
Coefficient	Mean	S. E.	Mean	S. E.	Mean	S. E.
B-Post1	0.023	944.2	171.22	686.41	-386.21	633.011
B-SISAEW	0.266	0.126	0.248	0.108	0.300	0.111
B-SICUPMWH	0.292	0.183	-	-	-	-
B-Kvar	100.1	78.1	-	-	-	-
B-MeanTMP	-	-	943.7	203.1	-	-
B-Product	-	-	-	-	0.005	0.005
Number Accts.	264		264		264	-
Root MSE:						
Median	1562.0		1775.6		1575.1	
Mean	4971.2		5348.9		5110.2	

Adopting regression approach 1 as our model of choice, if only because of the slightly better fit suggested by average root mean square error values, we may calculate, for the sake of completion, gross realization rates for water measures in the rebate and audit program. These are based on calculating the weighted sum of customer-specific products B_water(i)*S_water(i) over all customers, and dividing by the sum of S_water over sampled customers.Since B_water varies over customers, there is no direct linear relationship between it and the aggregate realization rate. The standard error for the ratio involves the variances and covariances of both customer specific "realizations" and customer specific ex ante estimates:

$$SE(R) = \{1/n*E^2\}*\{Var(c) + R^2*Var(E) - 2\,R*Cov(E,c)\}$$

where c = customer realization
E = ex ante savings estimate
R = ratio

We provide realization rates and their standard errors in Table 6 below.

Table 6

Gross Realization Rates
and Their Standard Errors

Water Services Measures

	Rate	Standard error
Rebaters	-0.12884	0.0048
AuditWs	0.12408	0.0026

The reader is referred to Appendix B for further information and diagnostics on regression approach 1.

IV. FREE-RIDERSHIP ANALYSIS

Free-ridership analysis is aimed to adjust the gross savings estimate for "naturally occurring savings" to arrive at net savings - the savings that are directly attributed to the program. The net-to-gross analysis uses self-reported information to estimate a free rider ship rate. This self-reported information was elicited through a telephone survey asking various questions about measure taking decisions. The general methodology for estimating free ridership values to customer responses to these questions is explained here.

Free Ridership Scoring Mechanism:

The scoring mechanism basically takes responses of the customers and based on these responses, credits the program for being influential in the customer's decision about measure taking behavior. In this scoring scheme we take into account responses to more than one question in order to have a built-in consistency check operating when relying on the self-reported information. The following "types" of questions pertaining to measure taking decisions, were asked in the telephone survey of the rebate and audit programs participants.

Q1. If there was no Edison rebate/audit available, do you think your company would have made the same efficiency-enhancing changes?

Q2. Without the Edison rebate/audit, how many additional months do you think your company would have waited to make these changes?

Q3. How strongly you agree or disagree that your company:

i. Decided what changes to make before you knew there was an Edison rebate/audit available.

ii. Would have paid the whole cost of equipment without Edison's rebate.

iii. Would have accepted some additional long term costs if you hadn't had the energy efficient work done.

iv. Edison rebate/audit was a significant factor in shaping your company's decision.

A customer responses to these questions was assumed to be indicative of the customer's inclination to be a free rider. We first started with assigning arbitrary values to the responses to combinations of questions. This arbitrariness was tested by changing these values. The range of the assigned values was set between 0 and 1, where 0 means a free rider and 1 means a truly influenced participant. The final scoring was accomplished such that it reflects the interaction of responses to a set of primary questions. From the above list of questions, responses to Q1 and Q2 were combined because Q2 is attached to response to Q1 (See Appendix D). Next, Q3(ii) and Q3(iii) were judged to be not clear enough to yield a reliable response. Also these types of questions were not asked in the Audit participants survey. In order to be consistent in the usage of self reported information from Audit and Rebate participants, we decided to exclude these two questions in our analysis. Hence the analysis used responses to Q1, Q2, Q3(i) and Q3(iv) as drivers to the estimation of {1-free ridership ratio}. The scoring scheme consisted of the following steps in the assignment of values to customer responses.

i. The assignment started with Q3 (iv) and assigned extreme values (0 or 1) to the responses.

ii. As a next level of assignments the interaction of Q3 (iv) response with rest of the selected questions was considered.

In this way we tried to relax the extreme value assignments used in level one and at the same time include more than one questions in the scoring scheme. For instance a

customer exhibiting tendency to be a free rider in Q3 (iv) was assigned a value of 0. However, when this customer was found to be a true participant, then the value assignment was incremented to 0.5 from 0[1].

The following table gives the results of the scoring scheme.

Table 7A
Influence Scoring

Q3iv	Q1&2	Q3(i)	Influence	Frequency
F	F	F	0	24.80
F	F	P	0.5	7.60
P	DK	DK	1.0	0..80
P	DK	F	0.5	1.60
P	DK	P	1.00	1.60
P	F	F	0.5	22.50
P	F	P	0.5	16.20
P	P	F	0.5	8.20
P	P	P	1.0	16.70

F= free rider, P= participant, DK= don't know Influence = Influence of the program on measure-taking behavior.

The above scoring scheme shows that when a customer shows free ridership tendencies in his responses to any of the selected survey questions, we have credited the program only partially. In the analysis, we also attempted hierarchical values that gave Q2 and Q3(i) lower values compared to Q3(iv) and Q1. However, we found that this only had a marginal effect on the end results (See Appendix C). Using this procedure, we then calculate the weighted average of the a total score. This weighted average gives the value of {1-free ridership} rate = 0.47 for Rebate program and 0.74 for Audit program. To get

some sense of the validity of this procedure, we attempted to estimate a free ridership rate with an different approach to responses on questions 1, 3 and 6. In this alternative method, which bears some similarity to the "Stated Intentions" approach used elsewhere in California nonresidential impact evaluations, we scored questions 1, 3, and 6 as follows: 0 if clear free rider, 1 if clear participant, 0.5 if unknown or equivocal. Then the questions were given weights reflecting their face-value salience for free ridership, as follows: question 1 - 0.4, question 3 - 0.2, and question 6 - 0.4. A weighted index of these items was calculated, and a weighted mean estimated over rebate program survey respondents, i.e., an estimate of 1 - the free ridership rate. The result, a mean of 0.48, is nearly identical to the 0.47 value obtained through the free ridership scoring scheme that we have chosen to use.

Table 7 B gives the program-induced conservation rate={1-free ridership rate} for Rebate and Audit programs and the standard errors.

TABLE 7 B

Program-Induced Conservation Rate
{1 - Free Ridership Rate}

	Rate	Standard Error [2]
Rebaters	0.47	0.031
Audit(Ws)	0.74	0.051

[1] Other values that were tested were 0.2 and 0.8. However, we decided 0.5 to be a reasonable value to be used in the analysis.

[2] Formula for the Standard error calculation used was:

$$SE=\sqrt{\{\Sigma\ RWT\ (INF613 - \overline{INF613})^2\}/n}$$

where RWT is the sample weight
INF613 = influence

APPENDIX E

Protocol Tables 6 and 7

Southern California Edison
M&E Protocols Table 6
First Year Load Impact Evaluation
Agricultural Incentives (Rebate) and Agricultural Services (Audit), 1994
Water Services End Use

1. Average Participant Group and Average Comparison Group.

1.1 Over regression sample of 388 accounts, without regard to availability of acre footage (D.U.M.) data:

1.1.A. Pre-install	Rebate	Net Audit	Non-participant
Mean kWh	463,393	277,447	77,426
n	90	34	264
s.e.	(census)	(census)	8,831.6
90% confid			
lower	(census)	(census)	62,898.02
upper	(census)	(census)	91,953.98
80% confid			
lower	(census)	(census)	66,103.88
upper	(census)	(census)	88,748.11

1/1.B. Post-install			
Mean kWh	485,424	227,405	72,065
n	90	34	264
s.e.	(census)	(census)	8,860.9
90% confid			
lower	(census)	(census)	57,488.82
upper	(census)	(census)	86,641.18
80% confid			
lower	(census)	(census)	60,705.33
upper	(census)	(census)	83,424.67

Notes:
a. Rebate group and net audit group (audit participants that are not rebaters) are both attempted censuses.
b. Non participant standard errors calculated based on stratification by MAJCAT5A (see text).

1.2 Over regression sample of accounts, where square footage (D.U.M.) data are available.

1.2.A Pre-install	Rebate	Net Audit	Non-participant
n	23	11	92
Mean kWh	136,104	257,204	52,983
s.e.	(census)	(census)	5,402.30
90%lower			44,096
90%upper			61,870
80%lower			46,057
80%upper			59,909
Mean acre ft.	123.02	232.33	673.11
s.e.	(census)	(census)	387.00
90%lower			36.50
90%upper			1309.73
80%lower			176.98
80%upper			1169.24
kWh/acre ft.	1106.394	1107.06	78.73
s.e.	(census)	(census)	4.29
90%lower			71.67
90%upper			85.79
80%lower			73.23
80%upper			84.23

Notes:

a. Rebate group and net audit group (audit participants that are not rebaters) are both attempted censuses.

b. Non participant standard errors calculated based on stratification by MAJCAT5A (see text).

c. Standard error of ratio calculated as

1.2 Over regression sample of accounts, where square footage (D.U.M.) data are available (continued).

1.2.B. Post-install	Rebate	Net Audit	Non-participant
n	23	11	92
Mean kWh	117,974	200,076	48,863
s.e.	(census)	(census)	4,993.59
90%lower			40,648
90%upper			57,077
80%lower			42,461
80%upper			55,265
Mean acre ft.	115.45	173.66	852.38
s.e.	(census)	(census)	506.17
90%lower			19.73
90%upper			1685.03
80%lower			203.47
80%upper			1501.29
kWh/acre ft.	1021.85	1152.13	57.33
s.e.	(census)	(census)	3.30
90%lower			51.90
90%upper			62.76
80%lower			53.10
80%upper			61.56

2. Average Net and Average Gross End Use Load Impacts. Over regression analysis cases, without regard to availability of acre footage information.

	REBATE		AUDIT	
	Gross	Net	Gross	Net
2.A.ii.				
Mean kWh	89,174	41,912	74,432	55,080
n	90	90	23	23
s.e.	na	2,764	na	3,796
90%lower		37,365		48,835
90%upper		46,459		61,325
80%lower		38,360		50,216
80%upper		45,456		59,947
2.D.A.ii.				
Realization rate	1.00	0.47	1.00	0.7
4				
n	90	90	23	23
s.				
e.	na	0.031	na	0.0
51				
90%lower		0.419		0.656
90%upper		0.521		0.824
80%lower		0.430		0.675
80%upper		0.510		0.805

Note:

a. Gross figures are weighted means of ex ante estimates.

b. Gross realization rates of 1.00 are consistent with SCE's position that verified savings estimates from Edison tracking system are superior to the estimates obtained from the Protocol-compliant estimates from the impact study.

c. Net savings standard errors are of merely heuristic value, given that these are partial census data rather than samples.

2.D.B.ii.

For subset of accounts with acre footage data (D.U.M.), load impacts/d.u.:

	REBATE		AUDIT	
	Gross	Net	Gross	Net
kWh/acre foot	713.26	335.23	296.89	219.70
n	23	23	11	11
s.e.	na	22.11	na	15.14
90%lower		298.86		194.79
90%upper		371.61		244.61
80%lower		306.89		200.29
80%upper		363.58		239.11

3. Net-to-Gross Ratios.

	Rebate	Net audit
	0.47	0.74
90%lower	0.419	0.656
90%upper	0.521	0.824
80%lower	0.430	0.675
80%upper	0.510	0.805

Note:

Net savings standard errors are of merely heuristic value, given that these are partial census data rather than samples.

4. Designated Unit Intermediate Data.

A. Pre-install	Rebate	Net Audit	Non-participant
Mean acre ft.	123.02	232.33	673.11
s.e.	(census)	(census)	387.00
90%lower			36.50
90%upper			1309.73
80%lower			176.98
80%upper			1169.24

B. Post-install	Rebate	Net Audit	Non-participant
Mean acre ft.	115.45	173.66	852.38
n	23	11	92
s.e.	(census)	(census)	506.17
90%lower			19.73
90%upper			1685.03
80%lower			203.47
80%upper			1501.29

6. Measure Count Data -- Water Services Measures.

	Rebate	Net Audit	
Participant study group (regression study):	108	35	(unweighted counts)
All program participants:	269	164	
Comparison group:	(0, by definition)		

7. Market Segment Data.

	Rebate	Net Audit
Number participating accounts:	246	146

Southern California Edison
M&E Protocols Table 7
First Year Load Impact Evaluation
Agricultural Incentives (Rebate) and Agricultural Services (Audit), 1994
Water Services End Use

A. Overview Information.

1. Study Title and Study ID.

Evaluation of First Year Load Impacts of Southern California Edison's 1994 Agricultural Audit and Rebate Programs.

ID: 518a, 518b

2. Program, year, description.

1994 Energy Management Services Program -- an audit/information program. 1994 Energy Management Hardware Rebate Program --a retrofit incentives program.

3. End uses or measures covered.

Pumping/water services.

4. Methods and models used.

Incentives program, audit program: per-account regression on a monthly consumption series, where regressors included (a) the ex ante estimate of water services savings cumulated by that point in time, (b) the cumulative non-water services savings ex ante, (c) estimated self-reported water services measure savings, (d) the ubiquitous "trend" variable containing SIC-specific mWh consumption, (e) a level of service "adjustment" variable constructed as described on page 4 of the text. Pages 4-5 and Table 5 of the text describe alternative models as well.

5. Participant and comparison group definition.

Incentive participant group. An attempted census of service accounts with agricultural SIC codes which performed measures rebated under Edison's 1994 Hardware Rebate Program. Accounts whose inclusion in the sample would entail duplication of respondents were eliminated at random within "clusters," primarily by use of Edison's corporate account numbers. See Appendix A.

Audit participant group. An attempted census of service accounts with agricultural SIC codes which performed at least one water service measure under Edison's 1994 Energy Management Services Program, implemented in 1994. Accounts which also participated in the Hardware Rebate Program of 1994 were eliminated, making the population to which the study generalizes "net audit accounts." Accounts whose

inclusion in the sample would entail duplication of respondents were eliminated at random within "clusters," primarily by use of Edison's corporate account identifiers. See Appendix A.

Non-participant group definition. Stratified sample of non-participant (no 1994 audit or rebate program activity) Edison service accounts in the agricultural sector, drawn in order to represent the SIC and size distribution of audit and rebate accounts. Stratification included as a primary element a distinction between accounts according to their participation in Edison's Hydraulic Services program. See Appendix A.

6. Analysis sample size. The following tabulation shows the customer (service account), measure, and observation (service account month, or n x t) counts by study group.

	Accounts	Measures	Cust. months
Rebaters	90	108	3170
Audit only	34	35	1201
Pump test only	142	0	5007
Nonparticipant	122	0	4327

B. Database management

1. Describe .....

Please see Appendix A text, Figure A-1.

2. Identify ....

See Appendix A text, and figure A-1.

3. Diagram and describe the data attrition ....

See Appendix A text, and figure A-1.

4. Describe the internal/org. ....

This item, as written, appears to require an explanation of the basis and perhaps the details of the effort to match (merge?) various kinds of data needed in the analysis. In general, note that the keys involved in file building were PREM9FIN (service account), METER number, ID (California Survey Research Identifier). If further details along this remarkably open-ended line of inquiry are needed, the reader is referred to the enclosed diskette containing all programs written in connection with file building and analysis.

5. Provide a summary ....

Not applicable. All data collected for analysis figured in analysis, either through inclusion in the estimation or in case selection.

C. Sampling

1. Sampling procedures and protocols ....

This information is contained in Appendix A. Note also that both the rebate and audit "samples" are in fact attempted censuses, so that sampling precision issues (with respect to annual consumption !) are irrelevant. On the other hand, pump test-only and non-participant strata were developed for combined use as a comparison group. Targets of 130 and 192 (summing to 332) were established for these two parts of the comparison group, respectively. This is a great deal larger than either the target or the acheived census sizes for rebaters or audit only customers. Therefore, on the appropriate precision issue -- the precision of estimated differences between comparison group and participant group -- the comparison group sample size is well above the point at which returns to sample size begin to vanish, particularly given that the comparison group sample has been disproportionately stratified. However, in the process of sample design, it was determined based on population data that the approximate 90% confidence level relative precision on consumption was 14%. For reference, the program responsible for this estimate (AG015B) is displayed immediately below, followed by the key results.

AG015B

```
000013 data all;  set xxtemp.pmpboth xxtemp.nonboth;
000014 * programming              testn ;
000015  if freq=. then freq=0;
000016  testn=freq; if testn < 2 then testn=2;
000017  if GROUP='PUMPTEST' then do;  * adjustments from initial design.;
000018     * subtract;
000019        if stratum3= 6 then testn +  -4;
000020        if stratum3= 10 then testn + -7 ;
000021        if stratum3= 24 then testn + -11;
000022        if stratum3= 25 then testn +  -3 ;
000023         if stratum3 in (1,2,3) then testn=0;
000024   end;
000025   if group='NONPART' then do;
000026        if stratum3=29 then testn + -2 ;
00027   end;
000028     diff=testn-freq;
000029
000030  vh = var; if var=. then vh =varpop;
000031  *   vh=varpop;
000032   subtot=freqpop * (freqpop-max(1,testn)) ;
000033    subtot=subtot*vh/max(1,testn);
000034
000035 proc means noprint sum data=all; var subtot freqpop testn freq;
000036    output out=totvar sum=totvar freqpop testn freq;
000037
000038
000039 proc means noprint  data=all; var meanpop; weight freqpop;
000040   output out=meanpop mean=meanpop;
000041
000042 title3 "------ old and new quotas, modified quota precision implicns";
000043 data result;
000044  merge meanpop totvar;
000045   semean=   ((1/freqpop**2)) * totvar;
000046  semean = semean ** 0.5;
000047   t=1.646;
000048  precis    = t*semean/meanpop;
000049   file print;
000050   put _all_; run;
```

AG015B RESULTS

```
000001 1AGO015B-- LOOK AT PRECISION FROM NP/PUMPTEST SAMPLE
000002    ============================================================
000003  ------ old and new quotas, modified quota precision implicns
000004_FREQ_=49 MEANPOP=30096.08 TOTVAR=2.77E15 FREQPOP=20265
000005  TESTN=322 FREQ=331 SEMEAN=2599.5393431 T=1.646
000006  PRECIS=0.1421727228 _ERROR_=0  _N_=1
```

2. Survey information: survey instruments should ....

Re. survey instruments, see Appendix D. Re. response rates, see Appendix A, Table A-2. Re. non-response bias, see Appendix A -- discussion on pages 3-4, and Table A-3.

3. Statistical descriptions ...

See text, Tables 3 and 4.

D. Data screening and analysis.

1. Describe procedures used ...

See discussion of the "hierarchical" filling of the variable KVAR, pages 3-4.

2. Describe what was done to control for the effects of background variables ...

See discussion of SICUPMWH, text pages 4-6. Note that we included this ecological covariate in regressions at the same time that (a) we intended to use a comparison group, and (b) net impacts were measured using self report. This is consistent with the current confusion within CADMAC and its consultants regarding "trend," "adjusted gross," and "net." There are quite legitimate reasons, based on an extrapolation from the content of the Protocols, particularly regarding comparison groups, to argue that this "detrending" specification is in fact capturing what CADMAC de facto defines as net.

3. Describe procedures, including those identified ...

See Appendix A, pages 4-5, and Table A-1. Also see Appendix B, discussion of LOGDROP, indicating that case exclusion from the final regression data set is unrelated to either the SAE coefficient estimated for the customer or to the savings estimate finally calculated for the customer.

4. Regression statistics ...

See Table 5, on pages 7-8.

5. Specification.

Generally, see pages 4-9 and Appendix B.

a. Describe ... ("heterogeneity")

Heterogeneity is addressed radically, by estimating "seemingly unrelated" or individual customer time series.

b. Describe ... ("changes over time")

Self reported actin taking, ecological (SIC) consumption, level of service (KVAR), and

weather are imbedded in the various per-customer specifications that were estimated - see Table 5.

c. Describe ... ("self-select")

In the recursive sense of selectivity, bias is in theory reduced by the inclusion of level of service and consumnption variables from the pre-program period. In the CADMAC-popularized nonrecursive sense that "consumption change causes participation," the analysis strategy is vulnerable, assuming such phenomena exist. The vulnerability may be in an unexpected direction, in that pumping efficiency modifications are, according to knowledgeable practicioners, signals for ("caused by?") future usage increases.

d. Discuss the factors ....

Not applicable/unclear request.

e. Describe how the model ...

In light of the unrealistic gross savings results in this study, SCE has opted to calculate net impacts by multiplied "verified savings estimates" by the "program-induced conservation rates" given on page 13.

6. Error in measuring variables ...

As described throughout the text, and as is evident in the latter sections of the survey instruments, strong efforts were made to obtain reliable account-level information on temporal changes in level of service (water production). Additionally, specifications of the content of "KVAR" were varied to obtain the best direct or proxy indicator of level of service.

7. Autocorrelation: ...

See Appendix B, "Autocorrelation."

8. Heteroskedasticity (sic.): ....

See Appendix B, "Heteroscedasticity."

9. Collinearity: ...

Unclear request. See Appendix B, "Multicollinearity."

10. Influential data points: ...

See Appendix B, "Observation influence."

11. Missing data: ...

See discussion of the "hierarchical" filling of the variable KVAR, pages 3-4.
Also see Appendix B, discussion of LOGDROP, indicating that case exclusion from the

final regression data set is unrelated to either the SAE coefficient estimated for the customer or to the savings estimate finally calculated for the customer.

12. Precision: ...

Re. gross realization rate: see page 8. Re. net to gross ratio, see footnote 2, page 13.