Southern California Edison
1996 Commercial
Energy Management Services Program

Load Impact Evaluation

Study ID Number 544

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EXECUTIVE SUMMARY

This report presents the results of an impact evaluation of the Southern California Edison Company's (Edison) 1996 Energy Management Services program for the Commercial sector (CEMS96). This program has been in existence for more than a decade and is generally closely linked to Edison's incentive program in the nonresidential sector, the Energy Management Hardware Rebate Program (EMHRP). The objective of CEMS is to provide, via Edison service representatives and/or account executives, useful information and recommendations concerning energy efficiency potential at commercial sites. Regarding equipment efficiency, then, the EMS (information providing) may be seen as the broader program within which EMHRP (information and financial incentive) operates, or as a delivery program for EMHRP. Beyond equipment changes/replacements, however, EMS is the program offering concrete recommendations on operational or behavioral choices affecting efficiency.

The objective of this study was to estimate cost-effectively the first-year gross and net savings achieved by the program, in terms of the results claimed for 1996. This was accomplished by use of regression billing analyses of savings impacts upon consumption of program participants, combined with a parallel analysis of a nonparticipant sample developed by RER Associates in connection with its impact evaluation of the 1996 Commercial Energy Management Hardware Rebate Program (EMHRP96). Tracking system data, weather data, billing and customer characteristic information from Edison's Customer Data Base, and survey data pertaining to participant and nonparticipant site changes were brought to bear on the estimation problem. In addition, under the California Measurement Protocols, estimates were required for end uses HVAC, Lighting, and "Other," in each case distinguishing between equipment-related and operational or "practice" measures.

The 1996 program claimed a total of 3268 distinct results, when the locations of unique measures performed under "chain account" program delivery and tracking strategies are taken into consideration.

Study results include quite small gross and net realization rates for the program, as the following extract from study Table 4.3B suggests.

Enduse/activity	Gross RR	Standard Error, Gross_rr	Net RR	Standard Error, Net_rr	Net-to-Gross Ratio	Standard Error, NTGR
HVAC/EQUIP	0.0304	.0207	0.0297	0.0207	0.9800	0.1390
HVAC/PRAC	0.0000	--	0.0000	--	--	--
HVAC/TOTAL	0.0176	.0120	0.0173	0.0807	0.9800	0.1390
LIGHT/EQUIP	0.1975	.0209	0.1572	0.0275	0.7960	0.1108
LIGHT/PRAC	0.1788	.1750	0.1423	0.1407	0.7960	0.1108
LIGHT/TOTAL	0.1971	.0207	0.1569	0.0274	0.7960	0.1108
OTHER/EQUIP	0.1602	.0476	0.0000	--	--	--
OTHER/PRAC	0.0091	.0566	0.0000	--	--	--
OTHER/TOTAL	0.0562	.0417	0.0000	--	--	--
EQUIP, ALL	0.1165	.0146	0.0736	0.0752	0.6319	0.6463
PRACTICE, ALL	0.0067	.0363	0.0015	0.0012	0.2268	0.1766
TOTAL	0.0711	.0087	0.0438	0.0749	0.6160	0.6344

The implication of the table is that with the exception of lighting equipment and practices, and "Other equipment" measures, the apparent impact of the program on billing consumption is indistinguishable from zero. There are reasons to consider these results an understatement of the efficiency benefits produced by the EMS program in the commercial sector:

- Practice measures are very often ongoing maintenance procedures, for which a clear consumption delta, associated with a specific startup or "implementation date" (in equipment-related modifications or replacements), is not logically to be expected. Rather, the appropriate comparison for practices is the consumption that would have occurred absent the maintenance activity, implying evaluation via engineering simulation rather than a "simple" billing analysis.

- Additionally, practices, as well as some of the rebate-ineligible equipment measures supported by the program, are likely to be applied in circumstances of declining system performance, mitigating inefficiencies that would otherwise have occurred, and essentially filling the role of "deferred load" measures. In these cases as well, a substantial amount of information about the site and its changes, mainly unavailable to this regression study, may be required to make proper adjustments.
- At many sites, EMS measures have a very low "signal-to-noise" ratio, making it less likely that the inexpensive regression approach adopted here would distinguish measure impact from myriad other processes taking place at a site.
- A healthy skepticism toward the Protocol-compliant net-to-gross ratios is warranted, based as they are on a comparison to an unnecessarily small comparison group's measure adoption behavior. In fact, as we argue at points in this report, the adjustments made for general population trends in our gross savings models are probably more consistent with the actual intent of the Protocols. In the case of "Other" measures, some very low-incidence measure taking in the comparison group effectively zeroed out net savings in this study.

Although we stand by the validity of this billing analysis within the limitations imposed by the study design and Protocol requirements (findings are robust over a number of carefully specified alternative models), and believe that we may have been unusually successful in mitigating problems of customer heterogeneity endemic to commercial sector evaluations, we would argue on the basis of this study that more extensive and expensive data collection is required in order to confidently assess program impact, extending perhaps to hybrid engineering/billing analysis models exemplified by many evaluations of California commercial incentives programs. Further, we believe that this is reason enough (coupled with other logical reasons having to do with program delivery realities), to insist that in the future audit and rebate programs in the commercial sector should be evaluated in concert, under one over-arching study design. For relatively low marginal research cost, enough audit program sites could be evaluated under this approach to determine the extent to which efficiency impacts in an audit program differ substantially from (more intensively studied) impacts in its allied rebate program.

1. INTRODUCTION AND BRIEF DESCRIPTION OF CEMS96.

This report presents the results of an impact evaluation of the Southern California Edison Company's (Edison) 1996 Energy Management Services program for the Commercial sector (CEMS96). This "performance adder" program has been in existence for more than a decade and is generally closely linked to Edison's incentive program in the nonresidential sector, the Energy Management Hardware Rebate Program (EMHRP). The objective of CEMS is to provide, via Edison service representatives and/or account executives, useful information and recommendations concerning energy efficiency potential at commercial sites. The issues may involve retrofit/replacement of energy-using equipment, changes in controls on such equipment, or energy efficient "add-ons" (e.g., window film, reflectors, insulation, weatherstripping). Where equipment replacements, modifications, or additions are eligible for Edison incentives, and incentives are deemed necessary to cost-effectively encourage change, the customer in question may be offered a rebate and thereby becomes a participant in EMHRP. Regarding equipment efficiency, then, the EMS (information providing) may be seen as the broader program within which EMHRP (information and financial incentive) operates, or as a delivery program for EMHRP. Beyond equipment efficiency, however, the EMS is the program offering concrete recommendations on operational or behavioral choices affecting efficiency, and it is sometimes mistakenly considered to be wholly concerned with "practices" rather than "installations."

In 1996, the program claimed a total of 3268 distinct results, arrayed across a variety of end uses and measure types, and including both practices and equipment changes/replacements. The delivery of these results to customer sites occurred in three modes, referred to as "account types" hereafter: "regular," "multiple," and "chain." Regular accounts involved specific recommendations and results provided to and recorded for specific sites, meters, and premises. Multiple accounts involved recommendations and results expected to result in savings affecting a number of contiguous sites, meters, or premises—prototypically a shopping mall, with a generalized HVAC or lighting change affecting consumption at a number of meters and/or businesses within. Finally, chain accounts involved recommendations provided to a multiply-sited customer, with results recorded and bill savings expected at an enumerated set of premises. Note that while a major bank or fast food chain would be prototypical, the "chain" designation really concerns the manner in which recommendations were delivered and results expected and verified, rather than the ownership structure (chain, etc.) of an affected business.

Results of Edison recommendations, whether kWh savings or kW reductions, were verified onsite by Edison representatives – i.e., measures were verified to be in effect at the location recorded in the tracking system. In the case of chain accounts, a minimum of 15 percent of affected premises were verified for each measure result. For "multiple" and "regular" delivery strategies, all measures were verified onsite prior to being recorded as program results.

It is the primary task of this analysis to provide estimates of first-year gross and net program impact upon energy use, disaggregated quite simply into impacts of operational or practice versus equipment-related measures, and distinguishing as well between end uses affected by measures (HVAC, lighting, and all other end uses combined). This has been accomplished as cost effectively as possible, relying heavily upon billing, weather, and tracking system data to achieve regression-based estimates of savings. Statistical samples of the paper records supporting tracking system data have been used to establish critical estimates regarding the relationship between "little delta" and "big delta" estimates of savings; that is, between "standards-based" ex ante savings estimates relating to efficiency levels of new equipment and the savings expected to be observed at the meter, relating to the replacement of old equipment. Additionally, customer surveys of participants have been conducted in order to estimate the extent to which additional information about site-specific changes would enhance the impact study beyond its reliance on a very large sample and adjustments for temporal changes occurring in the population. Finally, as a last step in estimating net savings per the California Protocols, we have borrowed and reweighted the comparison group of onsite-surveyed customers used in evaluating the 1996 EMHRP program (data courtesy of Regional Economic Research, Inc. of San Diego; hereafter RER).

1.1 Organization of the Report

The remainder of this report consists of :

- Section 2, combining a statistical description of the program with a discussion of data sources, their development, and an introduction to the regression approaches used to isolate gross and net savings.
- Section 3, combined with some appendicized materials, in which regression-based savings estimates are developed and supported with diagnostic efforts, including but not limited to those listed in the Protocols.
- Section 4, in which regression results and ex ante data are combined to provide savings estimates at the end use level, and "load shape" tables are applied to gross and net savings for disaggregation into season and time of use categories.
- Appendices include:

A:	Selected program guideline information.
B.	Documentation for Streetwalk location building program.
C:	Survey of tracking data to establish measure-level relationship between standards-affected ex ante savings and "big delta" ex antes savings – sources, sampling, examples, and results.
D.	Contents and means, crossectional time series files ANAL1M1, ANAL1M2.
E.	Contents and means, crossectional time series files ANALNP1B, ANALNP1C.
F.	Diagnostics for participant gross savings regression AN010M, Round 1 (OLS).
G.	Parameter estimates for gross savings regression model alternatives, AN010A-10M.
H.	Diagnostics for nonparticipant savings regression AN005A, Round 1 (OLS).
I.	Tables 6 and 7 for the California M&E Protocols.
J.	RER/ADM Onsite Survey Instrument
K.	ASW Engineering's survey of large-variance customers.

2. PROGRAM DETAILS, DATA SOURCES, AND METHODS.

2.1 Program Details.

Prior to a review of data sources, we begin by describing the program in terms of tracking system variables, simply to acquaint the reader with the program, and without embellishment regarding the development (including cleaning of that data).

Critical dimensions to consider in describing the CEMS96 include:

- Accounts vs. locations vs. customers.
- Measures, end uses, activity type (practice vs equipment measures), result type (deferred load versus "original results," etc.).
- Chain vs multiple vs regular delivery methods.
- Standard-affected vs other measures, and the difference in ex ante estimates.
- Characteristics of locations – building type, pre-program participation, etc.

The following discussion involves tables 2.1A through 2.1F.

Table 2.1A places the Commercial sector version of the program in the context of the overall program. Measures were implemented at 1972 distinct locations. Locations are algorithmically defined collections of contiguous premises or meters, defined in more depth below. These locations, and the 3268 distinct measures at the locations, dominate the industrial and agricultural sector EMS activity, although the commecial sector ex ante savings estimates (219 gWh) are rivaled by the savings expected in the industrial sector. It will be noted that the ex ante values for the program are accompanied by corresponding "big delta" savings and kW reductions. These are based on estimation work performed during the evaluation

Table 2.1A: Total customers, location, measure/locations and ex ante values

	Agricultural	Commercial	Industrial	Overall
				609.0
Number locations	73.0	1,972.0	190.0	2,235.0
Number measure/locations	127.0	3,268.0	316.0	3,711.0
Ex ante kwh savings est	17,350,376.0	219,924,021.0	167,200,201.6	404,474,598.6
Ex ante kw reduction est	1,819.6	32,216.5	8,798.6	42,834.7
Big delta ex ante kwhsav	17,350,376.0	278,498,815.6	167,200,201.6	463,049,393.2
Big delta ex ante kw redn	1,819.6	61,331.3	8,798.6	71,949.5

effort, and are a necessary part of the billing analyses to be described later. The "big delta" values are based on intensive sampling of EMS paper data supporting the tracking system, and indicate the savings expected to be observed by the customer, in the event that a particular measure's claimable ex ante value is constrained by state or NEPA standards affecting HVAC, motor, or lighting minimum efficiency requirements. Estimated full customer savings, corresponding to expectations for the billing analysis, exceed claimable savings by approximately 26 percent, with the kW comparison considerably more striking (approximately 90 percent).

Table 2.1B is a lengthy but important enumeration of the nominal measures from the commercial EMS only, divided into 6 categories by the tripartite distinction between HVAC, Lighting, and Other end uses, and the distinction between practices and equipment changes. Within each end use/practice category, measures are given in descending order of their contribution to total savings for the category (e.g., EMS systems contribute 28 percent of the total kWh ex ante for the HVAC-equipment category. Contributions by general category are roughly:

HVAC-EQUIP:	57 gWh
HVAC-PRACTICE:	42 gWh
Lighting-EQUIP:	50 gWh
Lighting-PRACTICE:	1 gWh
Other-EQUIP:	22 gWh
Other-PRACTICE:	48 gWh

HVAC equipment measures are dominated by EMS and ASD applications, and, notably, measure HW11-2, signifying reductions in cooling load linked to lighting efficiencies. Cooling tower maintenance dominates operational HVAC measures. System modifications and system replacements account for most lighting equipment savings, with delamping accounting for all but 14 percent of operational lighting claims. Approximately 20 percent of all commercial program savings claims are based on cleaning condenser coils in refrigeration, an "Other-PRACTICE" measure.

Table 2.1C breaks out commercial EMS activity according to account type. Approximately 2/3 of expected savings are attributed to traditional, regular, "one site per measure" delivery approaches, although a considerably lesser proportion of locations are involved (389 of 1976; note that the 1976 is larger than the earlier-cited 1972 because of a handful of cases in which a given location participated as a local site for a chain measure as well as being a "regular" site for a different measure). Table 2.1C also indicates that only 51 of the 3268 measure results are characterized as "deferred load" per the tracking system, and that these are not disproportionately distributed among account types.

Table 2.1D provides a frequency distribution on the major methods by which ex ante estimates of savings were generated ("Calc type"), by end use/activity. Edison's MARS program, a collection of engineering algorithms covering numerous end uses and applications, is by far the usual calculation method of choice – exceptions in the commercial sector tend to be large and complex facilities. Table 2.1E distinguishes among the various characterizations of measure "result," with "original reductions" accounting for almost all measures, especially in lighting and HVAC end uses.

Finally, Table 2.1F itemizes the building type distribution within commercial EMS locations – schools, offices, food stores, and "miscellaneous" building types, based on facility SIC, account for 76 percent of involved locations. For 1740 of these locations, for which at least 6 months of the 12 months preceding participation were covered by available billing data, average pre-participation year kWh/day and the corresponding standard deviation are provided, indicating average consumption at college, hospital, and miscellaneous locations to be highest (and also most variable between locations).

Table 2.1B: Listing of Measure Totals By Enduse/Activity Type

End use/Activ	Meas code	Description	Measures	Exante kWh	Big Delta	Exante kW	Big Delta	Sav_pct
HV-EQUIP	96-CU1-2C	EMS (SPACE CONDITIONING)	117	16,074,856	16,074,856	1267.6	1267.6	28.0
	96-OS1-1	ADJ SPD DRIVE, (HVAC)	24	14,369,168	14,369,168	0.0	0.0	25.0
	96-HW11-2	RDCE INTERN COOLING-HRDWR	547	10,515,596	10,515,596	2908.5	2908.5	18.3
	96-SC1-3	CHILLER > 300 TONS	8	2,652,198	10,126,652	514.7	1885.6	4.6
	96-CU1-49	ECONOMY CYCLE	11	2,538,599	2,538,599	0.0	0.0	4.4
	96-CU1-15C	MISC (SPACE COND)	16	2,344,034	2,344,034	232.1	232.1	4.1
	96-HW11-4	COOLING TOWER MAINT-AUTO FEEDE	8	1,815,505	1,815,505	0.0	0.0	3.2
	96-SC1-2	CHILLER 150 - 300 TONS	12	1,241,674	37,065,163	914.4	24493.8	2.2
	96-SAX-3	AIR COOLED, SINGLE PKG	19	1,168,762	1,658,954	444.7	574.9	2.0
	96-CU1-60	COOLING TOWER	2	1,012,486	1,012,486	0.0	0.0	1.8
	96-CU1-12C	TIMECLOCK (SP CONDITING)	34	857,638	857,638	4.5	4.5	1.5
	96-SE1-1	EVAP COOLING - DIRECT	1	816,046	816,046	0.0	0.0	1.4
	96-CU1-11C	THERMOSTAT (SP CONDTING)	3	755,985	755,985	0.0	0.0	1.3
	96-OM2-1A	MOTORS - THREE PHASE (SP COND)	2	452,176	904,352	99.7	199.4	0.8
	96-SC1-4	CHLLR>300 TON NON-CFC REF	1	297,147	1,268,259	122.3	522.0	0.5
	96-SI1-1	ROOF INSULATION	18	195,584	195,584	91.3	91.3	0.3
	96-SAX-2	AIR COOLED, SPLIT SYSTEM	5	193,095	365,864	112.4	213.0	0.3
	96-SAX-4	EVAP OR WATER COOLED	3	113,767	722,470	73.1	260.3	0.2
	96-SAX-1	ROOM & WALL	1	33,954	41,295	4.1	5.0	0.1
	96-CU1-5C	INSUL, PIPES (SP COND)	1	26,114	26,114	3.0	3.0	0.0
	96-SC1-1	CHILLER < 150 TONS	2	22,981	98,086	28.4	121.2	0.0
	96-SHX-3	AIR COOLED, SINGLE PKG	1	4,218	14,298	1.2	4.1	0.0
	96-HW11-1	OFF PEAK COOLING	1	0	0	0.0	0.0	0.0
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HV-EQUIP			837	57,501,583	103,587,004	6822.0	32786.3	100.0

Table 2.1B: Listing of Measure Totals By Enduse/Activity Type (continued)

End use/Activ	Meas code	Description	Measures	Exante kWh	Big Delta	Exante kW	Big Delta	Sav_pct
HV-OPERAT	96-OP11-16	COOLING TOWER MAINTENANCE	141	27,071,590	27,071,590	1379.1	1379.1	65.1
	96-OP11-8	CLEAN CONDENSER COIL	728	6,482,270	6,482,270	3823.9	3823.9	15.6
	96-OP11-6	MAKE OP AN EXIST ECON CYC	4	3,733,462	3,733,462	0.0	0.0	9.0
	96-OP11-14	RDCE INT COOLING L-OPTL	29	2,226,551	2,226,551	218.7	218.7	5.4
	96-OP11-10	RESET TIME CLOCK	2	916,823	916,823	0.0	0.0	2.2
	96-OP11-4	RESET THERMOSTAT(S)	4	439,479	439,479	98.9	98.9	1.1
	96-OP11-1	RAISE CHILLED WATER TEMP	4	375,379	375,379	196.1	196.1	0.9
	96-OP11-12	DISCONNECT	1	218,204	218,204	107.1	107.1	0.5
	96-OP11-15	MISC. OPERAT & MAINT	1	102,729	102,729	0.0	0.0	0.2
	96-OP11-3	RESET HOT/COLD DECK TEMP	1	5,370	5,370	4.5	4.5	0.0
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HV-OPERAT			915	41,571,857	41,571,857	5828.3	5828.3	100.0
LL-EQUIP	96-LSM-X	SYSTEM MODIF - INDOOR	525	28,646,847	35,740,572	7370.8	9104.4	57.4
	96-LSR-X	SYSTEM REPLCMNT - INDOOR	125	11,212,673	13,050,977	2535.2	3041.7	22.5
	96-LO1-1	OCCUPANCY SENSOR	75	2,197,101	2,197,101	0.0	0.0	4.4
	96-LSM-8	SYSTEM MODIF-CFL - INDOOR	57	2,018,507	2,018,507	573.8	573.8	4.0
	96-LC-2	ENERGY MGMT SYSTEM	7	1,834,576	1,834,576	0.0	0.0	3.7
	96-LD1-1	DAYLIGHTING SYSTEMS	3	1,114,566	1,114,566	0.0	0.0	2.2
	96-LOR-X	SYSTEM REPLCMNT - OUTDOOR	107	830,919	911,501	12.4	13.2	1.7

Table 2.1B: Listing of Measure Totals By Enduse/Activity Type
(continued)

End use/Activ	Meas code	Description	Measures	Exante kWh	Big Delta	Exante kW	Big Delta	Sav_pct
LL-EQUIP	96-LSR-8	SYSTEM REPLCMNT-CFL - INDOOR	21	809,987	984,530	184.9	207.5	1.6
	96-LC-3	TIMING DEVICE	10	509,994	509,994	0.0	0.0	1.0
	96-LOR-8	SYSTEM REPLCMNT-CFL - OUTDOOR	18	294,103	294,103	28.6	28.6	0.6
	96-LOM-X	SYSTEM MODIF - OUTDOOR	16	237,343	237,343	1.1	1.1	0.5
	96-LC-6	PHOTOCELL	15	172,594	172,594	0.0	0.0	0.3
	96-LC-4	TWIST TIMER	3	11,086	11,086	0.0	0.0	0.0
	96-LOM-8	SYSTEM MODIF-CFL - OUTDOOR	1	2,562	2,562	0.0	0.0	0.0
	96-LC-5	WALL SWITCH	1	0	0	0.0	0.0	0.0
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LL-EQUIP			984	49,892,858	59,080,012	10706.8	12970.3	100.0
LL-OPERAT	96-OP12-1	REMOVE LAMPS	12	835,382	835,382	236.3	236.3	85.7
	96-OP12-7	REWIRE TO IMP LGTNG CNTRL	2	66,907	66,907	0.0	0.0	6.9
	96-OP12-2	RESET TIME CLOCK	2	44,718	44,718	0.0	0.0	4.6
	96-OP12-5	DISCONNECT LAMPS	1	28,123	28,123	0.0	0.0	2.9
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LL-OPERAT			17	975,130	975,130	236.3	236.3	100.0
OT-EQUIP	96-CU1-15A	MISC (PROCESS)	24	8,066,171	8,066,171	1064.4	1064.4	37.0
	96-CU1-34	FLEXIBLE BARRIER	22	2,034,168	2,034,168	309.1	309.1	9.3
	96-OS1-4	ADJ SPD DRVE,(WATER SERV)	22	1,791,146	1,791,146	0.0	0.0	8.2
	96-OM2-3A	MOTORS - THREE PHASE (PROCESS)	8	1,641,101	3,246,095	632.6	1257.6	7.5
	96-OS1-2	ADJ SPD DRIVE, (REFRIG)	3	1,356,562	1,356,562	0.0	0.0	6.2
	96-OM1-3A	MOTORS - SINGLE PHASE (PROCESS	1	1,288,267	2,532,864	141.0	277.2	5.9
	96-CU1-29	VACUUM SYSTEM	1	1,010,104	1,010,104	214.0	214.0	4.6
	96-CU1-55	PUMP SYSTEM EFF IMPROV	1	987,968	987,968	0.0	0.0	4.5
	96-CU1-33	ENCLOSURE	3	586,440	586,440	81.5	81.5	2.7
	96-CU1-10A	PUMP SYS CNTRLS (PROCESS)	3	541,831	541,831	0.0	0.0	2.5
	96-CU1-10D	PUMP SYS CNTRLS (WTR SER)	1	508,141	508,141	0.0	0.0	2.3
	96-OM2-4A	MOTORS - THREE PHASE (WTR SERV	1	468,510	921,138	130.1	255.8	2.1
	96-CU1-61	PUMP REPLCMNT	2	383,093	383,093	48.5	48.5	1.8
	96-CU1-54	IRRIG EFF IMPROVEMENTS	1	268,915	268,915	0.0	0.0	1.2

Table 2.1B: Listing of Measure Totals By Enduse/Activity Type (continued)

End use/Activ	Meas code	Description	Measures	Exante kWh	Big Delta	Exante kW	Big Delta	Sav_pct
OT-EQUIP	96-CU1-11A	THERMOSTAT (PROCESS)	1	234,887	234,887	0.0	0.0	1.1
	96-OS1-3	ADJ SPD DRIVE, (PROCESS)	2	210,271	210,271	0.0	0.0	1.0
	96-CU1-19	COMPRESSED AIR SYSTEM	3	170,923	170,923	55.1	55.1	0.8
	96-CU1-12D	TIMECLOCK (WTR SERVICES)	1	122,640	122,640	0.0	0.0	0.6
	96-CU1-15D	MISC (WATER SERVICES)	1	60,351	60,351	16.8	16.8	0.3
	96-CU1-13A	TIMING DEVICE (PROCESS)	1	46,454	46,454	0.0	0.0	0.2
	96-CU1-15B	MISC (REFRIGERATION)	1	26,095	26,095	0.0	0.0	0.1
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OT-EQUIP			103	21,804,038	25,106,257	2693.1	3580.0	100.0
OT-OPERAT	96-OP14-1	CLEAN CONDENSER COILS	389	43,546,738	43,546,738	5774.0	5774.0	90.4
	96-OP15-6	REPAIR COMP AIR LEAKS	5	2,379,051	2,379,051	0.0	0.0	4.9
	96-OP15-2	RESET TIMECLOCK	2	987,776	987,776	0.0	0.0	2.1
	96-OP15-17	COOLING TOWER MAINT-MANL FEEDE	1	761,940	761,940	0.0	0.0	1.6
OT-OPERAT	96-OP17-4	DISCONNECT	1	218,223	218,223	60.6	60.6	0.5
	96-OP14-15	MISC. OPER MAINTENANCE	12	210,088	210,088	91.0	91.0	0.4
	96-OP17-9	RESET PUMPING SYS CNTRLS	1	38,799	38,799	4.4	4.4	0.1
	96-OP17-15	MISC. OPERAT & MAINT	1	35,940	35,940	0.0	0.0	0.1
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OT-OPERAT			412	48,178,555	48,178,555	5930.0	5930.0	100.0
			=======	==========	==========	=======	=======	======
			3268	219,924,021	278,498,816	32216.5	61331.2	600.0

Table 2.1C: Breakout of Program Activity By Account Type

Account type	Ex ante kWh	Big delta kWh	Ex ante kW	Big delta kw	Deferred ld. meas	Number locns
CHAI	74,311,081	74,690,554	12022.2	12097.4	11	1526
MULT	5,467,440	6,005,366	659.1	769.3	0	61
REG	140,145,500	197,802,895	19535.2	48464.6	40	389
	219,924,021	278,498,816	32216.5	61331.2	51	1976

Table 2.1D: Ex Ante Calculation Type By End use/Activity Type

TABLE OF Calc type by End use/activity

Calc. Type / Frequency / Col Pct	End use/Activity: HVAC Equip	HVAC Operatn	Lighting Equip	Lighting Operatn	Other Equip	Other Operatn	Total
MARS	702	812	756	17	70	396	2753
	83.87	88.74	76.83	100.00	67.96	96.12	
Engineering Anal	60	101	188	0	27	15	391
	7.17	11.04	19.11	0.00	26.21	3.64	
Other	75	2	40	0	6	1	124
	8.96	0.22	4.07	0.00	5.83	0.24	
Total	837	915	984	17	103	412	3268

Table 2.1E: Measure Result Category By End use/Activity Type

TABLE OF RESLT_T BY EU_ACT

RESLT_T(Result type, trkg-based) EU_ACT

Frequency Col Pct	HVAC Equip	HVAC Operatn	Lighting Equip	Lighting Operatn	Other Equip	Other Operatn	Total
Original Reductn.	800 95.58	906 99.02	964 97.97	17 100.00	79 76.70	412 100.00	3178
HVAC - Early Replacement	3 0.36	1 0.11	0 0.00	0 0.00	0 0.00	0 0.00	4
HVAC - Replace On Burnout	3 0.36	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	3
Deferred Load	30 3.58	0 0.00	18 1.83	0 0.00	3 2.91	0 0.00	51
Reestablished Results	1 0.12	8 0.87	1 0.10	0 0.00	21 20.39	0 0.00	31
Load Shift	0 0.00	0 0.00	1 0.10	0 0.00	0 0.00	0 0.00	1
Total	837	915	984	17	103	412	3268

Table 2.1F: Building Type Data for Participant Locations

Building Type	Locs.	Billing Locs.	Mean pre-kwh/day	Std, pre-kwh/day
01 office	426	387	3972.4	15889.7
03 rest	107	99	1158.3	627.3
04 retail	96	82	2321.4	2859.8
06 food	218	215	5440.6	1258.9
07 warehouse	36	23	5778.1	5542.6
09 schools	616	594	916.5	1276.3
10 colleges	43	41	21091.2	48769.3
11 hospitals	50	42	19988.3	26015.6
13 hotels	26	23	8398.0	7848.7
14 misc/uncla	252	152	11408.0	63700.0
99 noncommerc	98	82	7489.3	16271.1
	=====	=====		
Overall	1968	1740	4560.3	22720.2

2.2 Data Sources and Development

Figures 2.2A and 2.2B are flowcharts describing data development for participants and nonparticipants, and may be helpful to the reader throughout this section.

2.2.1 The "target" – analysis data sets. In order to better describe the process of data development, it may be helpful to very briefly review the data sets that were produced at or near the end of development, and which figured in the actual impact analysis. They will be revisited later.

- Files anallm1, anallm2 (n=78469, each). These are cross-sectional/time series files pertaining to participants, containing a combination of tracking-based ex ante data, tracking data adjustments based on paper review, program overlap information, weather data, billing usage data, SIC/consumption level-specific population consumption figures, and historical participation rates. These files are used in the gross impact regressions for nonparticipants. They contain monthly time series records for up to two years prior to the onset of the most liberal of three "deadband periods" bracketing customer participation in the CEMS96, and through November 1997 as available. Although the 78469 monthly records pertain to a total of 1793 CEMS-affected locations for which some billing data was retrievable, only 1459 were usable in the regressions which were the core of the gross analysis, under the definition of eligibility to be explained later. Files anallm1 and anallm2 differ primarily in the way that kWh and kWh-related ex ante variables are normalized.
- File sumbilp5 (n=1793). This location level file contains summary data, including pre- and post-participation consumption means, various eligibility flags, flags and totals summarizing participation levels, and counts on valid billing months available for the location. It is basically a "keep track" file which was occasionally refreshed from it inception as file sumbill through various discoveries regarding eligibility issues during the gross impact analysis preparation. Taken together, sumbilp5 and either anallm1 or anallm2 are sufficient to carry out a gross impact analysis for the CEMS program.
- Moving back slightly, files chnmea2(n=2318), multmea2(n=234), and regmea2(n=1159), are files which contain unique combinations of each unique measure identified in the original tracking data, and location identifiers. These files maintain data for all three sectors (commercial, industrial, agricultural). Measures for chain and multiple account types are thus "flattened out" or disaggregated into locations at which they are expected to have impacts. These files were staging data sets for building the cross-sectional time series files, and retained all of the ex ante kWh savings and kW reductions in the original tracking data. They also store the results of the effort to "back into" billing savings expectations or "big delta" ex antes in the case of standards-affected measures. In the case of chain accounts (file chnmea2), there are 60 "false locations" involving 90 chain measures, all commercial sector, for which it was impossible to develop identifiers sufficient to link a measure and "parent customer number" to service account information necessary to either assign a true location identifier or link to Edison customer data bases including billing files. These identifier problems, discussed later as well, account for 3,199,597.41 or 1.45 percent of the original commercial sector 219,924,021 tracking system ex ante, and 607.6 kW of the original tracking total of 32,216.5.
- Moving back and stopping for now, files meas_c8c(n=3374), meas_m8d(n=318), and meas_r8c(n=1159) are direct ancestors of chnmea2, etc., but represent a disaggregation to the level of the individual service account or premise. Essentially, each measure is linked to every service account which the tracking system files originally designated as influenced by the measure, but also to "sibling" accounts sharing locations with the original service account. The situation is slightly more complicated in the case of "multiple" account types (meas_m8d), where a "lead service account" was used in the tracking system, with its own set of sibling service accounts, and the assignment of location identifiers to the service accounts could thereby spawn multiple locations connected with lead and sibling service accounts. In

practice, this complexity arose on only a handful of occasions. In general, the meas_ series files should be considered the "anchor files" maintaining, from the earliest phases of tracking system cleanup to final analysis file building, an increasing connection between the measure data, surveys of paper records, customer data base information, etc.

- Turning briefly to nonparticipant files, analnp1 and analnp1c (each n=12814) contain billing data, eligibility flags, weather data, sic-level population data, program overlap information, sic-level population consumption time series and program participation rates, data on building changes and measure taking by nonparticipants, and analysis weights. These cross-sectional time series files are sufficient to estimate the concomitant changes among nonparticipants in order to develop net-to-gross ratios by end use, via billing analysis. As in the case of anallm1 and anallm2, these files differ only in the normalization method used. Also paralleling participants, file sumbiln2 (n=298) serves as a "keep track" file, containing flags, pre and post consumption means, etc. It will be noted that the 298 locations area subset of 308 selected by RER for use as a comparison group in its analysis of EMHRP96 impacts; the data on changes at facilities are an invaluable and cost effective addition to the current analysis. However, we have removed 10 locations from the billing analysis for nonparticipants, due to their participation in the CEMS96 program (which has no implications whatsoever for the validity of their use as "controls" in the RER analysis).

With the above information about the relatively "analysis-ready" files providing context, we may now move relatively rapidly through a narrative of the major portions of the data development process. Topics included are:

- Location building, via location identifier variable grpid2x.
- Tracking system data cleaning, building linkages, "big delta" paper survey work.
- Weather data
- Participation rates per SIC/size group.
- SIC2PROP (aggregate consumption histories in SIC "niches" pertaining to participant customers)
- Nonparticipant data development, weights.
- Billing data processing.
- Overlapping efficiency impacts.
- Data integration, final normalization.
- Data attrition summary.
- The ASW Engineering "checkup survey."
- General approach to impact estimation.

FIGURE 2.2A

HIGH LEVEL CHART OF PARTICIPANT DATA DEVELOPMENT

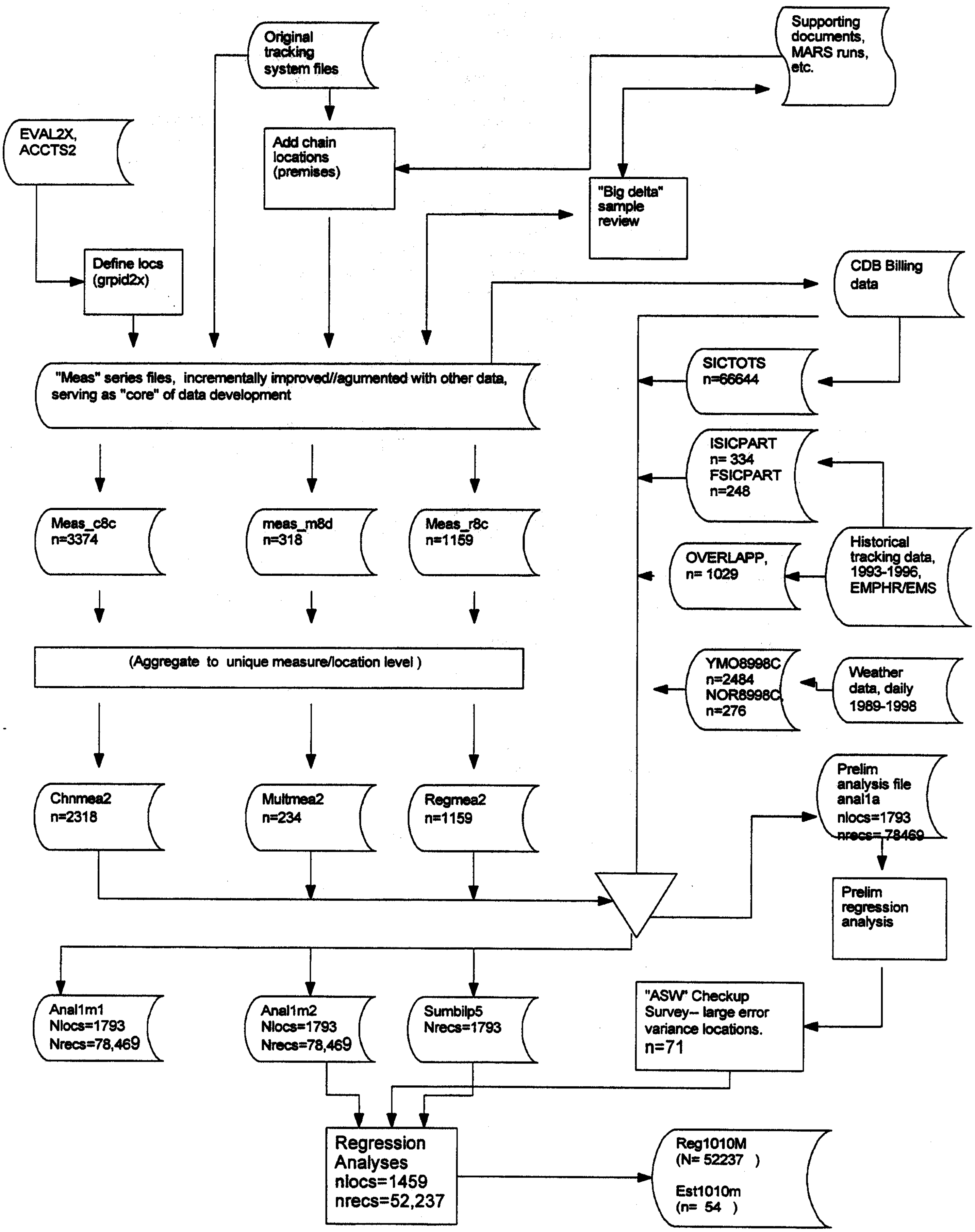
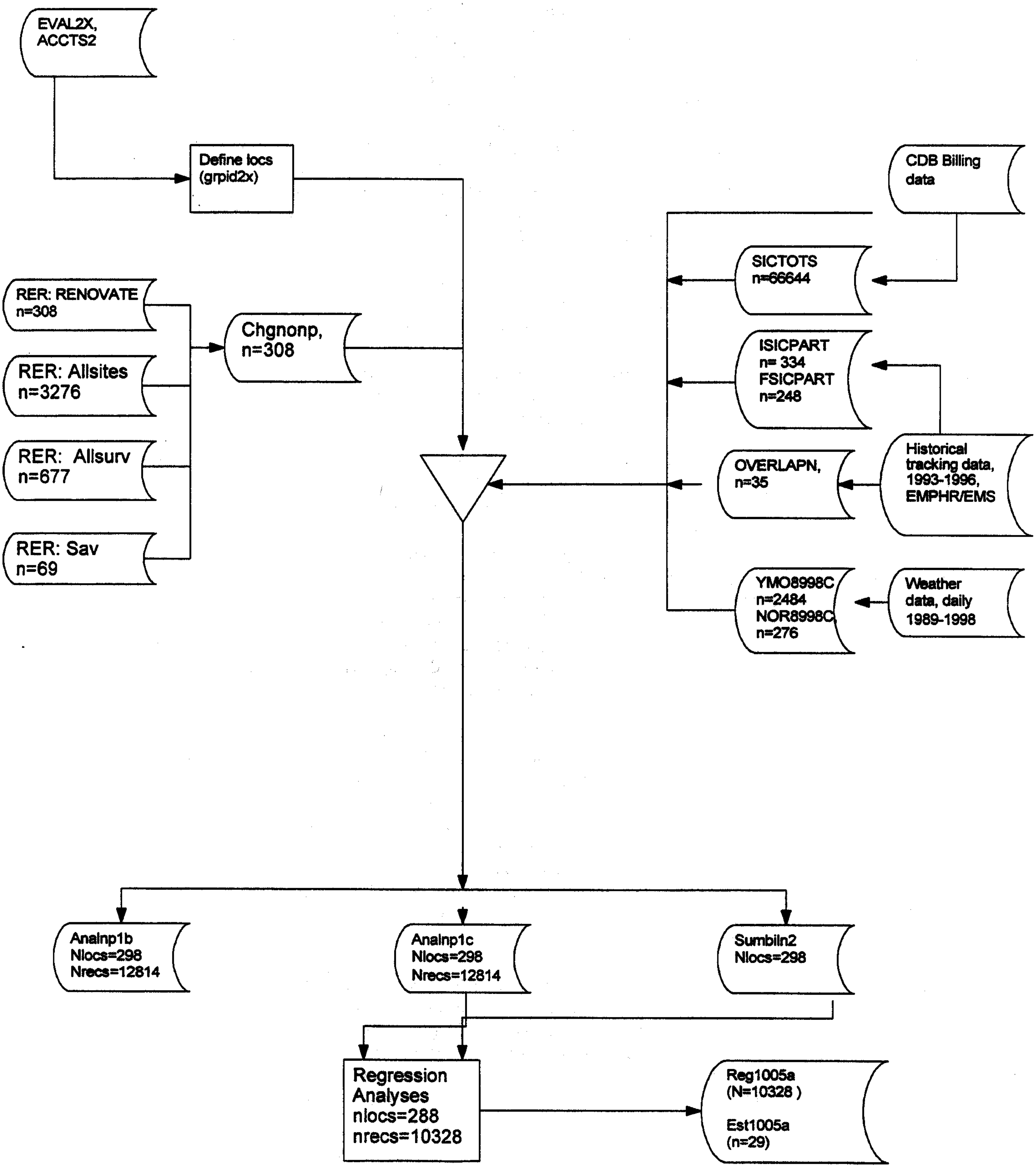


FIGURE 2.2B

HIGH LEVEL CHART OF NONPARTICIPANT DATA DEVELOPMENT



2.2.2 Location building, via location identifier variable grpid2x. Edison's Measurement and Evaluation group has for some time relied on account matching algorithms to agglomerate physically contiguous, similarly named premises and meters into "locations," particularly in the development of commercial sector sample frames for saturation surveys and impact evaluations. In early 1997, Athens Research sought to produce a more generalized routine for M&E, allowing for various "parameter settings" regarding name similarity, address contiguity, and providing the capability of "going around the corner" to agglomerate based on transformer number in addition to street address. In general, such account matching allows for impacts expected throughout a facility or location to be observed in connection with a measure, rather than lost due to the attribution of the measure impact to the wrong meter, and it at least theoretically allows for better handling of "secondary" or interactive effects between, say, lighting-centered and HVAC-centered accounts at the same location. The 1997 memorandum explaining "Streetwalk," the account matching routine, is contained in Appendix B. The parameter settings used in building the frame files EVAL2X and ACCT2, which served the EMHRP96 evaluation and Edison's 1997 Commercial and Industrial Market Effects study, and provided a basis for connecting EMS96 tracking data to locations and service accounts, were as follows:

- Name similarity: depunctuated and devowelled customer name. Name differences beyond this level prompt agglomeration stoppage.
- Compare customer names using all characters of the shorter of any two names (once deconstructed as above).
- Street address gap: agglomeration stops if gap is less than 31 street numbers.
- Transformer pole number: similar names on different streets sharing same transformer number are eligible for further agglomeration.

As indicated in the appendix, commercial sector results are average location sizes of 1.27 meters, slightly higher than previous routines used by Edison had achieved. The location identifier developed in this process has been referred to as "GRPID2X" in both this study and the RER effort.

2.2.3 Tracking system data cleaning, linkage building, "big delta" paper survey work. In building toward the files meas_c8c, meas_m8d, and meas_r8c (described above), which are fully cleaned tracking data records, disaggregated to unique combinations of measure, location, and service account, we began with separate measure files provided by Tina Cheung of Edison staff. Chain and regular/multiple account measure files were maintained separately, and were linked via various fairly reliable keys to other files providing physical service accounts. Considerable work was done by Measurement and Evaluation staff and Athens Research to improve the coverage of chain account measures. Briefly, a number of chain measures were attached only to a Customer Service System (CSS) Parent Customer Number, with no indication in the tracking system of the service accounts at which said measures were expected to have impact. By dint of considerable key punching, computer-aided verification, and repunching, we were able to effectively link all but 60 chain measures to service accounts, resulting, as indicated earlier, in a coverage deficit of 1.45 percent of claimed kWh. The effort involved keying paper records of either CSS service accounts or CIS (Customer Information System) account numbers, and going against a number of M&E frame files and/or CSS or CDB (Customer Data Base) sources, in order to locate the desired CDB service account ("premno9"). With premno9 keys in hand (and in the case of "multiple account" measures, premno9 values for "sibling" accounts), it was then possible to visit Streetwalk files EVAL2X and ACCT2 to obtain GRPID2X values, and to gather other service accounts connected to these locations but not, of course, given in the tracking system.

A basic issue for the impact analysis was the lack, in either the tracking system or an independent survey, of the <u>two</u> ex ante values necessary to evaluate savings on standards-affected measures. For HVAC units of various types and sizes, motors, and many fluorescent light changes, either State or National Energy Policy Act (NEPA) standards apply, and the tracking system carries only the smaller, claimable number. To carry out an appropriate billing analysis, it is necessary to explain billing changes, quite possibly with a "big delta" ex ante reflecting the full kWh savings expected, and then to adjust the savings using the ratio of the claimable savings to the "big" ex ante. In short, what was needed for these three types of measures, was an "inverse MEAF" (Minimum Efficiency Adjustment Factor, per California Protocols Appendix G) – a method of backing out of the standards-adjusted tracking delta to obtain a supplementary, larger number for analysis purposes. In most cases, the data needed to develop this adjustment factor is in the paper files for the program, in the form of output from Eidson's Measure Analysis and Reporting System (MARS) or other engineering calculation documents.

In the case of HVAC and motors, we used a combination of (a) a census review of all paper documentation for MARS and engineering data in order to establish the overall and standards-adjusted kW and kWh pieces, (b) programming from lookup tables in program guidelines when it was clear that the tracking system already contained a "previous efficiency" estimate (COP, EER, kW/ton) and an intermediate "standards-consistent" value was needed, (c) a handful of cases where neither (a) or (b) obtained, so that a previous efficiency was imputed from information established over other measures in the tracking data.

For lighting measures, on the other hand, it was necessary to perform an intensive sample survey of the MARS and engineering analyses in the supporting paper documents. The sample was constructed by stratifying all the lighting measures in CEMS96 by measure type, and, within many measure types, ex ante savings size. A sampling plan was developed to intensively cover each stratum, optimizing on the variance of ex ante kWh within strata. The sampled measures were then examined, and in the process CEMS96 claimable savings were separated into those parts of complex lighting measures that were and were not standards affected, and the former compared to the larger savings reported on paper as the expected "savings" the customer could expect on the bill. With the sample survey completed, it was possible to estimate for each measure and measure size substratum an "inverse MEAF" serving to return the "big delta" savings. With this strategy, it was possible to accomplish the correction for even relatively omnibus measures (see for example lighting system replacements "LSR-X" in Table 2.1b). Fuller details on the "inverse MEAF" work are provided in Appendix C.

2.2.4 Weather Data. Daily weather data covering 1989 through November, 1997 were obtained through the kind assistance of Michael Redding, Edison staff. Data for Edison's 23 weather stations were quite straightforwardly aggregated to monthly statistics of various types, meant to give the impact analysis latitude in developing an appropriate statement of the relationship between weather, consumption, and certain end uses. Statistics included average daily heating degree days (65 degree base) and average daily cooling degree days (74 degree day base), as the primary candidates for eventual analysis use, but also such statistics as average temperature, average minimum daily temperature, number of days reaching certain temperature thresholds, and the like. The monthly data were stored in file YMO8998C (n=2484 monthly records). Normal weather was approximated by aggregating YMO8998C into file NOR8998C (n=276), providing like statistics per normal month.

2.2.5 Participation Rates per SIC/Size Group. As a cost-effective alternative to the "selectivity correction" approaches that have amassed over the past few years of California DSM evaluation, we opted to use as aggregate "covariates" terms reflecting the participation rate in Edison rebate/audit programs for the two digit SIC code/size group to which a given analysis sample customer belongs. Using the population frame of GRPID2X's (locations from file EVAL2X), we determined, relying upon CDB service account and CSS service accounts as keys, the locations which had participated in Edison's EMS or EMHRP program during 1993-1995. Aggregating by industrial and then facility "SIC2", and within these kwh size terciles, rates of participation were created and stored in files ISICPART and FSICPART, ready for attachment, using keys "ISIC2" or "FSIC2," to analysis records. Variables AUDRATI and AUDRATF refer to rates of EMS program participation, while PARTRATI and PARTRATF provide overall EMS/EMHRP participation rates. The advantage of this approach is in its straightforwardness, in that (a) many participation models consider business type and size to be determinants of both program participation and savings-proneness, and (b) providing an actual participation-proneness indicator may overcome some of the causal distance between a sample customer's business type/size and his likelihood of participating. Those concerned about the "contextual fallacy" risked through the use of these rates in individual regressions, or those true believers in "simultaneity" in savings (savings begetting participation, rather than one or any number of predetermined variables, including utility policies, essentially impacting both savings and participation recursively), may be less optimistic about the meaning of such adjustment terms. The contextual fallacy critics should not, logically, include proponents of the adjustment documented in the following section.

2.2.6 Sic2prop.

In order to adjust for naturally occurring changes in the commercial population, billing histories for all Edison nonresidential accounts, 1992 through December 1998, were aggregated to the 4 digit SIC code level, and the consumption totals stored by year, month, and SIC code in files SICTOTS (n=73501) and SICTOTS2 (n=66644). Later, when applied in regression, the data were first aggregated to the 2 digit SIC-by-year/month level, and attached to customer records by SIC2 and year/month keys. In use, the gWh totals were converted to proportions of the total population gWh occurring during the billing months being analyzed for the customer in question – a radical normalization required to avoid having the billing analysis entirely distorted by the relative magnitudes of various SIC groups, when the naturally occurring changes within a particular customer's "niche" are the actual adjustments sought.

2.2.7 Nonparticipant data development, and weights. We requested and received from RER several small files identifying locations (GRPID2X) for their nonparticipant sample, and containing useful information on changes occurring since January 1995. File ALLSITES (n=3276) identified all sample frame members, and for nonparticipant sample points, included ...

- Square footage at time of audit.
- Establishment construction date
- Square footage changes and year/month of occurrence
- Amount and date of occurrence for operating hours changes
- Percentage of square footage currently heated, cooled, or both.

File ALLSURV (n=577) provided contact information not required in this study. File RENOVATE (n=308) provided information as follows (extracted from RER communication of December 17, 1997):

ARETHERE	Changes in building=T / No=F
DDELTCOL	Date of change in cooling system
DDELTHET	Date of change in heating system
DDELTHRS	Date of change in operating hours
DDELTLIT	Date of change in lighting system
DDELTOKW	Date of change in other item
DDELTSFT	Date of change in sqft of building
DELTACHR	Amount change in hours of cool system
DELTACKW	Amount of change in KW in cooling system
DELTAHHR	Amount of change in hours of heat system
DELTAHKB	Amount change in KW/BTU in heat system
DELTAHKW	Amount change in KW in heating system
DELTALHR	Amount change in hours in light system
DELTALKW	Amount KW change in lighting system
DELTAOPH	Amount change in operating hours
DELTASQF	Amount change in sqft of building
DELTOHRS	Other change in hours
DELTOTXT	Any other type of change
RER_SITE	RER Site ID

Finally, file SAV (n=69) identified energy efficiency savings due to program-eligible actions occurring at nonparticipant sites, and contained the following variables (RER's December 17, 1977 communication).

RER_SITE	RER Site ID
MONTH	Calendar month
CHVACSV	HVAC savings for eligible measures
AJCSTKWH	Overall adjusted lighting savings including secondary effects for eligible measures
REFRIG	Refrigeration savings
IMPTD_1	Implementation date

These data were merged and combined into file CHGNONP (n=308), in essentially "ready mode" for mixing into the cross sectional time series format. Ultimately, 10 of the 308 were eliminated prior to building the cross-sectional time series file, because their GRPID2X location identifiers appeared among the CEMS96 participants. Another 10 were excluded from the billing analysis because of their lack of full billing data for the time periods of interest to this evaluation (12 months pre and post May 1996, which is the median implementation date for the CEMS 1996 program).

In order to place the weighting of nonparticipants in context, it is necessary to look ahead slightly. In the impact analysis, the remaining 288 nonparticipant locations were used in a regression developed, specified, and estimated separately from the participant gross savings regression. The nonparticipant regression results (kWh savings normalized on pre-program consumption) required weighting to be appropriate "controls" on the participant results. The 1459 eligible participants were accordingly stratified by a constructed variable NEWSTRAT, a combination of information on location building type and median pre-participation daily consumption within building types. The 288 nonparticipants were allocated to levels of the variable NEWSTRAT, and weights for nonparticipants developed accordingly. Weights KWHWT1 and LOCWT1 are expansion weights returning total daily average consumption of participants and total locations of participants, respectively. Relative weights RKWHWT1 and RLOCWT1 were also constructed, and return, over the whole nonparticipant sample, its mean pre-May 1996 daily consumption, and the total of 288 respectively. In fact, only expansion weight KWHWT1 was found useful in the estimation of net savings. Table 2.2A gives the relationship between stratification variable NEWSTRAT, building type, and the median daily consumption used to substratify some building types.
Total participant and nonparticipant sample sizes per NEWSTRAT are provided, with the KWHWT1 value assigned to nonparticipants.

TABLE 2.2A -- PART/NONPART DISTRIBUTION ON NEWSTRAT, WEIGHTS

NEWSTRAT	BUILDING TYPE		MEDIAN KWH/DAY	PARTICP SAMPLE	NONPART SAMPLE	Exp. wt. KWHWT1
100	01	office	522.6	172	51	9.45
101	01	office	522.6	158	45	4.42
300	03	rest	1167.5	43	8	11.01
301	03	rest	1167.5	43	1	57.23
400	04	retail	1150.2	69	62	3.45
400	13	hotels	6028.6	20	1	3.45
600	06	food	5261.1	58	12	11.07
601	06	food	5261.1	67	10	7.29
700	07	warehouse	3366.3	18	12	11.19
900	09	schools	469.3	251	13	30.07
901	09	schools	469.3	281	18	10.18
1000	10	colleges	4128.3	32	10	24.96
1100	11	hospitals	11230.9	33	10	4.04
1400	14	misc/uncla	101.0	71	13	7.60
1401	14	misc/uncla	101.0	74	13	52.62
9900	99	noncommerc	2859.9	69	9	24.95

2.2.8 Processing of billing data. For the 298 nonparticipant locations which survived the screen of CEMS96 participation, and for the 1793 participant locations with adequate service account information, billing data were sought for the period 1992 through November 1997, for every premise at a given location. Usage and kW data were calendarized from billing period format, and aggregated over all active accounts at a location for a given month, with kWh consumption stored as kWh/day. The calendarized and aggregated billing data for this six year period were stored in location-year-month files LOCBILLP(n=129096) and LOCBILLN(n=21456). Flags were developed and recorded in the "SUMBIL series" summary files regarding the following data quality issues:

- kWh/day less than 3.33.
- For participants, absence of the service account associated with the CEMS tracking record, for a particular month of usage (indication that the service account given in CEMS was not established or active at that point).
- Evidence of a customer change (customer number within service account) occurring at any point in a location's stream of consumption year/months.
- Availability of 24 good pre-participation billing months, 12 good pre-participation billing months, 12 good post-participation billing months, and 9 good post-participation billing months, where "good" reflects the criteria just mentioned, and three distinct ways of defining pre- and post-program periods were used.

The definitions of pre and post-program periods depend on deadbanding alternatives, reflecting different levels of sensitivity to the issue of avoiding transitional periods in the billing analysis. Deadbanding definitions are as follows, for participants:

- Definition 1. The period inclusive of the first and last CEMS96 measure implementation dates is deadbanded; "pre" predates the first implementation, "post" follows the last.
- Definition 2. Definition 1, but the deadband is extended by 1 month in either direction.
- Definition 3. Definition 1 amended, with "pre" reduced by two months, and "post" commencing after the later of either the implementation or the Edison representative's verification date.

The majority of billing analysis work used definition 1, with definition 3 participating in a "check" run to discern the sensitivity of results to the definitions. By eligibility criteria set 1, stored as binary ELIG1 on files SUMBILP5 and various billing analysis files, participant locations were eligible for analysis if conditions for billing quality were met for all months during the pre- and post- 12 month periods under definition 1: i.e., sufficient kWh, no changes in customers within location, presence of CEMS-designated service account in active status. This admitted 1459 locations into analysis. As indicated earlier, 288 of the original 308 nonparticipant locations "borrowed" from RER were eligible based on valid billing data available throughout the pre and post periods.

2.2.9 Overlapping efficiency impacts. In order to properly attribute consumption impacts to CEMS96 measure installations, it was necessary, for nonparticipants and participants, to adjust for their co-participation in other programs. Therefore, tracking systems data for the 1996 EMHRP and 1995 EMS (1995 EMHRP was never implemented) were processed, and ex ante savings for results in either program stored for inclusion in the building of analysis data sets. Files OVERLAPN (nonparticipants, n=35) and OVERLAPP(participants, n=1029) were stored in GRPID2X-by-YEAR-MONTH format, with tracking system exantes for the two "competing programs" stored per end use and in summary form for the months in which implementation occurred. With this structure, it was later an easy matter to include "overlap" ex antes as competing cumulative indices of expected impact in the cross sectional time series analysis file format.

2.2.10 Data integration and final normalization. With the anchor files MEAS_C8C, MEAS_M8D, and MEAS_R8C containing all necessary ex ante terms as well as the necessary GRPID2X, SIC2, and weather station keys, it was possible to create the following billing analysis files by dint of the various merges illustrated in the flowchart in Figures 2.2A and 2.2B.

- ANAL1M1 (participants, normalization 1, n=78,649)
- ANAL1M2 (participants, normalization 2, n=78,649)
- ANALNP1B (participants, normalization 1, n=12,814)
- ANALNP1C (participants, normalization 2, n=12,814).

As shown in Appendix D (contents and means, files ANAL1M1, ANAL1M2), the participant files contain

- Location identifier GRPID2X
- kWh/day, per month
- flags for various billing data problems described above
- building type categorical variables and regression-amenable dummies
- CEC weather zone categorical variable and a set of regression-amenable dummies
- a number of monthly weather terms, prominently featuring CDD65A, HDD74A
- SIC2PROP, the proportion of SIC2-specific GWH expressed as a fraction of that in the customer's 12 preprogram months, as described above
- Partrati, audrati, partratf, and audratf, the SIC2-participation rate terms used for selectivity adjustment
- a number of time-cumulative savings terms, for the CEMS program and otherwise (overlap with other programs), and in dummy variable, "claimable," and "big delta" form
- "period variables" sufficient to use in selecting customer-months to include a given analysis
- year, month, and season terms
- SIGNRATE - a variable categorizing locations in terms of the ratio of customer ex ante savings to customer consumption (1= less than 5 percent, 2=5-49.99 percent, 3=50-99.99 percent, 4=100 or more percent), and affiliated regression-amenable dummies SIGN1-SIGN4. The variable plays a heavy role in the impact analysis, allowing for differential savings impacts where measures are more or less dominant (or more or less credible).
- Normal weather terms paralleling the actual weather terms mentioned above.
- M1_2412, M1_1212, M1_1200: average daily consumption over (a) 24 months of pre-participation and 12 months of post, (2) 12 months pre and 12 months post, (3) 12 months of pre. The latter figures heavily in the analysis.
- ELIG1, a binary reflecting a location's eligibility for analysis under definition 1 of eligibility, discussed above, which allows 1459 locations into the regression study.

Basically, ANAL1M1 and ANAL1M2 differ only in their treatment of consumption and consumption-related terms in the regression. Both provide access, for example, to SIC2-specific proportions and rates, identically treated across files. Both treat binaries as true binaries. However, while ANAL1M1 <u>scales all consumption related variables</u> – savings terms, overlap impacts, actual consumption – to a metric of kWh/day, ANAL1M2 goes further, expressing all consumption related terms as <u>proportions of pre-program consumption average variable</u> M1_1200. In other words, an ex ante term reflecting savings per annum in kWh is first scaled to kWh/day savings (file ANAL1M1), and then scaled to reflect a proportional decrease in savings over the average of the preprogram 12 months (file ANAL1M2). In fact, the latter, more radical approach to mitigating the degrading impact of heterogeneity in the commercial sector was the one used in the impact analysis, so that file ANAL1M1 has not been opened since its creation.

Appendix D (means and contents on files ANALNP1B, ANALNP1C) reveals that these nonparticipant billing files analysis parallel participant files ANAL1M1, ANAL1M2, with terms reflecting changes observed in the EMHRP onsite surveys, and measures taken outside of programs, essentially replacing ex ante variables pertaining to CEMS96 participation. To review a few selected variables ....

- ELIG1212 reflects eligibility for analysis in the 12 month pre/12 month post cross sectional time series model.
- ELIGHV, ELIGRF, and ELIGLIT are SAE terms indicating RER judgments, based on DOE-2 modeling at these sites, of the expected savings per day due to extra-program performance of efficiency measures.
- Weight KWHWT1, as explained earlier, is an expansion weight used to "equate" nonparticipants and participants on pre-program consumption characteristics.

2.2.11 Data attrition summary. As indicated earlier, nonparticipant locations from RER's EMHRP evaluation were diminished by 10 due to their participation in CEMS96, and by another 10 locations due to failure to meet the billing data criteria imposed for this study (12 "good" months, before and after May, 1996).

Turning to participants (Table 2.2B), note that our failure to completely link chain measures to valid service accounts while cleaning the tracking data results in a mere 1.45 percent drop in ex ante kWh "covered" by the impact regression, with the remaining drop to 61 percent of ex ante kWh, and 74 percent of locations consisting of valid billing data availability criteria.

Table 2.2B: Attrition of Locations, Ex Ante kWh

	LOCS	LOCS %	EX ANTE KWH	KWH %
Commercial locations	1968	100.00	219,924,021	100.00
Unable to form true location from CSS or CDB Service Acct.	-76	-3.86	-3,199,597	-1.45
Unable to locate 12 months pre, 12 months post good bills	-220	-11.18	-32,715,382	-14.87
Customer changes within location	-150	-7.62	-20,669,139	-9.40
CEMS measure- implementing service account not active at location during 12 pre, 12 post	-63	-3.20	-29,075,010	-13.22
Remaining study locations	1459	74.14	134,264,893	61.05

2.2.12 The ASW Engineering "checkup survey."

During preliminary modeling work, we developed a sample of locations with considerable unexplained variance in consumption. This sample of locations were investigated in structured telephone surveys carried out by ASW Engineering of Tustin, California, in an attempt to determine what changes at these sites would account for residual variation. Although we eventually found that these sites' inclusion or exclusion from the impact analysis model made little difference for either coefficient estimates or savings estimates, we did look into the extent to which change information (at the approximately 25 percent of high variance sites where changes were reported) might make impact models more efficient. The results of the effort are contained in Appendix K, along with a fuller description of the sample selection and survey approach.

2.2.13 General approach to impact estimation. The regression specifications introduced in the next section meet several general considerations, so that there is some "theory," or at least a general measurement framework applying to the specification. There is an absolute necessity, due to Protocol reporting requirements for this program, that terms distinguishing between equipment and practices, and end uses HVAC, Lighting, and Other be retained in the model regardless of performance. The first general consideration is the extreme heterogeneity of consumption in the commercial sector, and the problems DSM impact studies have encountered in trying one or another approach to the issue. The second consideration is the possible unreliability of some program ex ante values, based in part on the relationships observed between ex ante total location savings estimates and total annual consumption. A third issue is the importance of adjusting both participant and nonparticipant "savings regression" for predetermined predilections to use more or less energy and to participate in Edison DSM programs. Last, "ecological" or economic forces varying over time should be adjusted for as explicitly as possible, especially insofar as they connect with energy use.

Heterogenity. In order to deal effectively with the extreme heterogeneity of the nonresidential sectors, a number of strategies may be invoked. One is the radical choice of estimating a very small number of coefficients, including perhaps one indicating program effect, on an essentially per-customer basis. For a program of any size, this makes each customer an ill-understood "adventure," uses up an extraordinary number of degrees of freedom relative to independent data points, and generally prohibits the kinds of coefficient estimates required to arrive at estimates of a number of parameters required to satisfy, say, the California Protocols' end use-specific savings estimate requirements. Another popular approach, within the tradition of "pooled analyses," is to extract from each customer's consumption stream the mean for that customer (or specify an intercept per customer). This leaves a great deal of heterogeneity in the variance of consumption, allowing large customers to dominate a pooled regression solution, and also allowing effects of theoretically size-unrelated variables to be mercilessly confounded by their interaction with the consumption variance across customers. An extension of this "LSDV" approach within (usually) ordinary least squares regression is to very explicitly attack not only heterogeneity across customers but across time, with dummy variables representing years, seasons, and/or months, thereby "fixing" the variance in separate instruments. In the non-residential sectors, however, this still does not guarantee that a coefficient on, say, a tracking system kWh ex ante estimate for HVAC, will not essentially have its meaning distorted by virtue of incidental association between the ex ante estimate and the residual consumption variance across customers. Admittedly, this very much "applied" discussion thus far ignores a number of elegant alternatives in the literature (random coefficient models, switching models, GLS approaches, etc.), which might be particularly applicable in settings containing fewer cross sections, and, especially, less cross-sectional heterogeneity!

A favorable alternative to the choices thus far discussed is normalization of data. In the commercial sector, square footage is generally the denominator of choice, and each customer, when participating in an unweighted regression, is on an essentially equal footing in the pooled analysis. Further, the calibrated savings model is relatively easily used in producing point estimates, simply by reweighting customer-specific savings by customer square footage values. Possible weaknesses of this otherwise very sensible approach are (a) the necessity of survey data, (b) the easily degrading effects of measurement unreliability, and (c) the building type-specific "meaning" of such normalization.

In this evaluation, we adopted the philosophy of normalization wholeheartedly, but turned to easily obtained and reliably measured alternative to square footage – the customer's own average daily consumption during the year preceding participation. While less useful than square footage for some purposes (e.g., when savings models have forecast-related application as well), the "pre- mean" certainly compares favorable on cost of collection and reliability of measurement. With regression results accounting for "savings per pre-program kWh" in hand, it is a simple matter to retrieve kWh savings through reweighting.

<u>Large and small relative ex ante values</u>.

In analysis of the tracking data sets, it emerged that in some cases a large percentage of customer pre-participation consumption is identified as impact year savings. The reasons may include our failure to identify the entire location(s) at which such large savings may really obtain, optimistic service representative estimates, or very effective savings recommendations. Table 2.2C outlines the dimensions of the issue. The impact regressions are kept flexible by interacting ex ante terms with the four categories of "signal to noise" displayed in the table, allowing each to have its own slopes reflecting identifier problems, optimism, and perhaps effectiveness differences. This is an important modeling feature allowing savings to be found where they are in fact reliably predicted by Edison's program.

Table 2.2C: savings ex antes as percentages of pre-participation consumption

Ex ante as % of usage	Number locations	%
0-4.99 %	724	40.4
5-49.99 %	869	48.5
50-99.99 %	79	4.4
100+ %	121	6.7

Selectivity. Both participants and nonparticipants select themselves into these statuses, each year in which the program runs, or are "selected for" by utility strategies for marketing and delivery of DSM. To the extent that we can cheaply adjust for either customer or utility predilections by relying on recent history as a guide, recent participation rates by two digit SIC group seem a very good modeling bargain.

Naturally occurring change. By adjusting for population level changes in production, and tailoring the measures of these changes to fit the individual customers' consumption trajectories, we effectively "detrend" consumption. Under some reasonable definitions of the EMS program's mission, inclusion of SIC2PROP in fact makes the regression a net savings regression. In any case, SIC2PROP belongs in the specification on theoretical grounds.

In the development of savings models, a fairly specific framework of regressors was decided upon a priori, and fit to the normalized consumption data for nonparticipants and participants (i.e., in which every expression of consumption is as a proportion of average pre-program consumption). It will be noted that the models are being run in "levels" rather than, say, 12 month differences or "changes." Setting aside a number of issues on which this decision could be debated, note that the deadbanding approach required for a program in which multiple result implementation dates could be expected made such differencing intractable, in that the deadband period itself would have to be included in any differencing approach.

Operationally, for a given model run, an OLS version of the model is first fit, and a number of post-calibration diagnostics regarding heteroscedasticity, leverage, multicollinearity, omitted variables, and autocorrelation are produced. Savings identified by the model are then collected. Next, a GLS re-estimation is an option, using squared residuals as case weights. In practice, the GLS results were always extremely close to the OLS results, at least in part due to the advance normalization work. Finally, SAS output data sets containing predicted values and residuals, as well as SAS estimate data sets containing parameters and parameter covariances, were produced and optionally saved to permanent disk storage.

3. SAVINGS MODELS.

3.0 Context: zero order results.

The savings model results to follow may be more meaningful in light of the simple "zero-order" results reported in Table 3.0A. This table is based on the same "core study sample" that is used in estimating gross savings, with seven locations experiencing deferred load measures eliminated (they are included in the savings model with appropriate terms to identify them). We have grouped locations according to the end use/activity which dominates their ex ante savings totals, and compare pre-implementation to post-implementation consumption (based on tracking system information on implementation). As an example, 132 locations at which HVAC equipment measures dominated CEMS participation consumed 300 mWh in their pre-implementation years, and dropped by 1.6 mWh post-implementation (a drop of 0.53 percent). This drop constitutes 42 percent of the ex ante savings in HVAC equipment associated with these locations, suggesting a "zero order realization rate" of 0.42. This is of course an ambiguous quantity without a number of adjustments for competing causes of consumption change (i.e., a multivariate regression model like that performed for this study and/or an engineering model). Finally, although there was a small drop in overall consumption, 63.6 percent of these locations experienced a pre-post increase in consumption.

In addition to the "omitted variable" problem just mentioned, the zero-order comparison method used here also fails to account for the impacts of multiple types of measures on individual customers, in that we have strictly grouped customers based on their dominant measure type. These are both straightforward arguments for multivariate savings models.

However, Table 3.0A does suggest that, unless there are strong competing determinants of consumption that can be identified in our savings model, it will be difficult to identify positive savings at sites involved in HVAC practices (cooling tower maintenance, condenser coil cleaning, etc.), as the simple consumption increase for these locations is nearly half the ex ante value for expected decrease. Note also that the difficulty is not particularly "outlier-driven" in that 74 percent of these locations (and 70 percent of practice-dominated locations overall) experience a pre-post consumption increase.

Table 3.0A: Zero-Order Changes in Consumption, Pre-post for Core Regression Study Group of 1459 Locations
(Each location allocated to end use/activity dominating its ex ante savings)

End use/activity	Locs	Pre-part. year mWh	Diff: post-pre	% Diff	'Realizn Rate'*	Pct Incr.**
HVAC/EQUIP	132	300.0	-1.6	-0.53	0.42	63.6
HVAC/PRAC	561	900.9	18.8	2.08	-0.45	74.0
HVAC/TOTAL	693	1200.9	7.2	0.59	-0.10	72.0
LIGHT/EQUIP	472	339.6	-7.7	-2.27	0.30	36.7
LIGHT/PRAC	40	257.6	-35.0	-13.60	2.33	40.0
LIGHT/TOTAL	512	597.2	-42.7	-7.15	1.05	36.9
OTHER/EQUIP	56	70.2	1.0	1.43	-0.10	53.6
OTHER/PRAC	191	321.7	3.2	1.01	-0.12	65.4
OTHER/TOTAL	247	391.9	4.3	1.09	-0.12	62.8
EQUIP, ALL	660	709.9	-11.6	-1.63	0.29	43.5
PRACTICE, ALL	792	1480.2	-13.0	-0.88	0.16	70.2
TOTAL***	1452	2190.0	-31.2	-1.43	0.21	58.1

* Simple zero order change divided by total ex ante savings for end use/activity category.

** Percentage of locations experiencing an increase in consumption (regardless of change in category total kWh).

*** Excludes seven locations at which deferred load measures were taken (these are included in savings modeling).

3.1 Participant Gross Savings Model.

We will begin by describing the final savings model estimated for participant gross savings, in order to make shorter work of describing the development process. Table 3.1A provides both the specification and the estimation results, but requires some narration. The model is estimated over the 1459 locations identified earlier as meeting eligibility criteria under program deadband definition 1. Twelve months of post-program data are included, and from 12 to 24 months of preprogram months, depending upon the availability of acceptable consumption data in the period 13-24 months prior to participation. As to the regressors included:

- MEANKWH is a "centering" or customer intercept term, equal to the mean of the normalized kWh variable over the customer's trajectory. It is equivalent to entering individual customer intercepts in an LSDV format.
- SEAS9401-SEAS9704 are dummy variables providing "seasonal intercepts" under the LSDV philosophy, for January-March 1994 through October-December 1997.
- PARTRATI is a term representing SIC2-specific participation rates in 1993-1995, for EMS and EMHRP programs.
- SIC2PROP is the monthly consumption in the population, for the customer's SIC2, expressed as a proportion of its mean value during the customer's 12 month preprogram period.
- OV_TU is an SAE term representing, cumulatively, any participation in CEMS95 or EMHRP96, outside of the current program. It is based on tracking system data from these other programs.
- CDD74A, HDD65A are mean daily cooling and heating degree days for the month in question, with 74 and 65 degree bases respectively.
- INT1141—INT1089 are terms specifying EMS96 ex ante values (corrected to "big delta" status), for HVAC equipment, HVAC practices, Lighting equipment, Lighting practices, Other equipment, and Other practices, each interacted with a dummy representing the location's status in terms of "signal to noise"— total EMS96 savings represent from 0 to 49.99 percent of the location's preprogram consumption.
- INT3141—INT3089: as above, interacted with dummy SIGNAL3 representing savings totaling 50-99.99 percent of preprogram consumption.
- INT4081—INT4089: as above, using SIGNAL4 representing savings in excess of preprogram consumption.
- DHV_EQB: deferred load HVAC savings term, indicating that the customer results are considered deferred load, and "savings" are expected for HVAC equipment.
- DHV_PRAB: deferred load HVAC practices term.
- IAHV018, IAHV017: interactions between weather and HVAC ex antes.

Substantive anomalies or unexpected findings in the results include:

- A strong positive coefficient for HVAC practices, indicating an increase, adjusted for various factors, in consumption after implementation.
- Weaker positive coefficients for HVAC practices, lighting equipment, other practices, in the 50% plus ex ante/consumption brackets.

The final portion of table 3.1A provides summary information about the model results. Regarding multicollinearity (maximum condition index=27.2), the collinearity is isolated in two reasonable portions: the logical multicollinearity one would expect from a set of dummies representing categorical variable year-season, and in the relationship between customer intercept term MEANKWH and variable SIC2PROP. The Goldfeld/Quandt test as well as the correlation between MEANKWH and absolute residuals indicate that there is still some heteroscedasticity in model errors, albeit much less than would have been encountered if raw consumption data were involved. Among reasonably-entertained alternative or additional regressors (ex ante by weather interactions, alternative weather variables, alternative participation rate variables, additional deferred load-by-ex ante terms), there was no evidence of correlation with model residuals, providing some evidence that specification error is not a problem. Finally, as would be expected in undifferenced data, there is, on average, moderate positive autocorrelation in the individual customer trajectories, as evidenced by the median Durbin-Watson value of 0.72. This value, which varies widely between customers, was not judged serious enough to warrant the risks

encountered by customer-specific fixes, and in any case was not technically feasible given the deadbanding approach adopted.

Table 3.1A: Estimates for Model An010M

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|	Standardized Estimate	Variable Label
MEANKWH	1	0.830452	0.01046255	79.374	0.0001	0.80461498	
SEAS9401	1	-0.091490	0.01122543	-8.150	0.0001	-0.01123063	
SEAS9402	1	-0.108378	0.00890237	-12.174	0.0001	-0.02339913	
SEAS9403	1	-0.127552	0.00895129	-14.250	0.0001	-0.03331550	
SEAS9404	1	-0.089523	0.00861318	-10.394	0.0001	-0.02431248	
SEAS9501	1	-0.112794	0.00844428	-13.357	0.0001	-0.03120532	
SEAS9502	1	-0.138129	0.00833664	-16.569	0.0001	-0.03822746	
SEAS9503	1	-0.121932	0.00891738	-13.673	0.0001	-0.03354244	
SEAS9504	1	-0.119581	0.00844701	-14.157	0.0001	-0.03276155	
SEAS9601	1	-0.117494	0.00856173	-13.723	0.0001	-0.03211401	
SEAS9602	1	-0.119501	0.00861100	-13.878	0.0001	-0.03262783	
SEAS9603	1	-0.119757	0.00909573	-13.166	0.0001	-0.03251171	
SEAS9604	1	-0.115789	0.00869481	-13.317	0.0001	-0.03097626	
SEAS9701	1	-0.110920	0.00885313	-12.529	0.0001	-0.02779093	
SEAS9702	1	-0.114846	0.00979782	-11.722	0.0001	-0.01982008	
SEAS9703	1	-0.052945	0.01411346	-3.751	0.0002	-0.00476186	
SEAS9704	1	-0.075627	0.02138426	-3.537	0.0004	-0.00388838	1997 Fall Binary
SIC2PROP	1	0.320924	0.00934679	34.335	0.0001	0.31188186	Prop of pre12 sic2gwh avg
PARTRATI	1	0.015365	0.00590642	2.601	0.0093	0.00439836	Isic2 partcpn rate,reb+aud 93-95
OV_TU	1	-0.000350	0.00011808	-2.964	0.0030	-0.00314062	Overlap kwh, any
CDD74A	1	0.008441	0.00052388	16.112	0.0001	0.02358113	Mean of daily cdd74
HDD65A	1	-0.009674	0.00039141	-24.717	0.0001	-0.06420146	Mean of daily hdd65
INT1141	1	-0.038506	0.02274078	-1.693	0.0904	-0.00178992	Signl1,2*HV_EQB
INT1081	1	0.402701	0.04528853	8.892	0.0001	0.00975010	Signl1,2*HV_PRAB
INT1144	1	-0.231687	0.02361102	-9.813	0.0001	-0.01105812	Signl1,2*LL_EQB
INT1084	1	-0.147190	0.18117830	-0.812	0.4166	-0.00082603	Signl1,2*LL_PRAB
INT1149	1	-0.178738	0.05808568	-3.077	0.0021	-0.00316646	Signl1,2*02_EQB
INT1089	1	-0.013635	0.05921663	-0.230	0.8179	-0.00024659	Signl1,2*02_PRAB
INT3141	1	0.018612	0.02089563	0.891	0.3731	0.00091627	Signl3*HV_EQB
INT3081	1	0.066859	0.04162979	1.606	0.1083	0.00187848	Signl3*HV_PRAB
INT3144	1	0.068190	0.02546132	2.678	0.0074	0.00274544	Signl3*LL_EQB
INT3084	1	-1.062315	0.16891580	-6.289	0.0001	-0.00639538	Signl3*LL_PRAB
INT3149	1	-0.138875	0.03198672	-4.342	0.0001	-0.00446679	Signl3*02_EQB

Table 3.1A: Estimates for Model An010M
(continued)

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|	Standardized Estimate	Variable Label
INT3089	1	0.078953	0.08969889	0.880	0.3788	0.00100431	Signl3*02_PRAB
INT4141	1	0.021925	0.00184817	11.863	0.0001	0.01607664	Signl4*HV_EQB
INT4081	1	-0.000578	0.00572321	-0.101	0.9196	-0.00014070	Signl4*HV_PRAB
INT4144	1	-0.025322	0.00508136	-4.983	0.0001	-0.01409295	Signl4*LL_EQB
INT4149	1	-0.002465	0.00333875	-0.738	0.4602	-0.00075254	Signl4*02_EQB
INT4089	1	0.089282	0.03824542	2.334	0.0196	0.00237953	Signl4*02_PRAB
DHV_EQB	1	0.225685	0.05244064	4.304	0.0001	0.01213700	Defload x hv_eqb
DHV_PRAB	1	0.456386	1.26304357	0.361	0.7178	0.00036767	Defload x hv_prab
IAHV018	1	0.002148	0.00083590	2.570	0.0102	0.00346565	cdd74a x HV_EQB
IAHV017	1	0.001058	0.00257057	0.412	0.6806	0.00057729	cdd74a x HV_PRAB

Model Summary:

Billing months	52237
Rsquare:	0.9462
Maximum condition index:	27.2
Goldfeld Quandt test:	F(20843,20843)=17.90, p=0.0000
Major model correlates of abs(residual):	MEANKWH (0.22)
Major non-model correlates of residual:	None
Median Durbin Watson d:	0.72

Notes: Multicollinearity limited to interplay among seasonal dummies, and between centering term MEANKWH and SIC2 population consumption variable SIC2PROP.

3.11 A brief review of the model development process. The following discussion is based on logs kept during model estimation, leading up to the reported model AN010M.

- Model AN010A is specified like AN010M, with the following differences: additive year terms and additive season terms instead of year-by-season terms, lack of CDD65A, and inclusion of terms representing higher order deferred load-by-HVAC measure-by CDD effects.
- Model AN010B moved to a year-by-season set of intercept terms, with no evident impacts on substantive coefficients due to the greater complexity of the seasonal adjustment.
- Model AN010C investigated and discarded the notion that nonlinear ex antes would be more appropriate for the high "savings/consumption" cases. For example, there was very little difference in standardized betas. Note that we are working in a very high Rsquare context, given the levels modeling, so that alternative bases for decision are important.
- Model AN010D investigated and discarded, based on failure to identify significant interaction, season-specific lighting ex ante terms.
- Model AN010E added a "main effect" CDD65A term, without impact on other variables' coefficients, and thereby became the "standard."
- Model AN010F downweighted the customers having the largest DFFITS values (case influence indices) in the data set (5). With very little coefficient change or savings changes (change of 0.04 in standardized beta for SIC2PROP), AN010E was retained.
- Model AN010G downweighted a larger number of such customers (adding only one more even though a DFFITS criterion of 1/20 that of AN010F was invoked), with the same result.
- Model AN010H experimentally dropped theoretically required variable SIC2PROP, in order to demonstrate that intercept term MEANKWH was behaving correctly (with removal of its correlate, MEANKWH moves back toward the 1.00 value that would normally obtain).
- Model AN010I experimentally dropped MEANKWH-correlated variable PARTRATI, from the specification AN010E, with an expectedly less pronounced effect on the MEANKWH coefficient.
- Model AN010Jextended the experiment to both SIC2PROP and PARTRATI taken together, with the expected return to 1.00.
- AN0107K With model AN010E still the "standard," a set of locations were identified for which very preliminary models, run weeks earlier, had revealed very high internal variability. These preliminary models ran the gamut of specifications, and used raw kWh/day. Retrieving these, we severely downweighted them, and found that AN010E coefficients and savings estimates still obtained without any appreciable changes.
- AN0010L: modify deadbanding definition used in AN010E, applying more conservative definition, with trivial impact on coefficients and savings.
- AN0010M: investigate whether higher order terms representing deferred load-by-HVAC measure-by CDD effects may be eliminated without impact on either model coefficients or savings. With no appreciable impact, AN010M replaces AN010E as the final model.

Appendix F contains diagnostics produced in the initial OLS "round" of AN010M's estimation, while Appendix G presents, without significant commentary, the parameter estimates for models AN010A—AN010M.

3.2 Nonparticipant "concomitant savings" model.

In order to establish net savings in accord with CADMAC Protocols, it is necessary to estimate "gross savings" occurring for a comparison group during the same period. Model AN005A, given in Table 3.2A, is the final model chosen for this purpose. It is estimated over 10328 monthly records distributed over the 288 nonparticipants eligible for "12 pre/12 post analysis," but makes use of valid billing months in the 13-24 month "pre-period" when available. The model contains some of the same "staple" terms as in participant model AN010E, with the following problem-specific terms:

- ELIGHV, ELIGRF, ELIGLIT are RER-supplied SAE terms representing savings on measures taken outside of Edison programs by nonparticipants. They are normalized upon nonparticipants average pre-May 1996 daily consumption.
- CDDHV, HDDHV, and CDDRF interact the above SAE terms with cooling and heating degree days.

The final portion of table 3.1B provides summary information on model results. Multicollinearity again only surfaces as an issue involving interplay among seasonal dummies, MEANKWH, and SIC2PROP. The Goldfeldt/Quandt test and the MEANKWH-absolute residual correlation suggest significant but very much moderated heteroscedasticity of error. No appreciable correlations between residuals and omitted variables were uncovered. The median Durbin-Watson value suggests an average positive serial correlation resembling that of participants, with similar variability of this result among customers.

Given the results of the diagnostics, the only alternative model considered (not presented in this report) was a variant of AN005A removing year x season terms and replacing them with additive year and season dummies. As this change only impacted some "logical multicollinearity," with no change in substantive coefficient estimates, the current year x season specification was kept.

Appendix H gives estimate and diagnostic information for nonparticipant model AN005A (round 1, OLS, only).

Table 3.2A: Parameter Estimates for Model An005a

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|	Standardized Estimate	Variable Label
MEANKWH	1	0.992446	0.03357559	29.559	0.0001	0.98760932	
SEAS9402	1	-0.381104	0.04413107	-8.636	0.0001	-0.08480152	
SEAS9403	1	-0.334349	0.04584634	-7.293	0.0001	-0.09207117	
SEAS9404	1	-0.431723	0.04320654	-9.992	0.0001	-0.11958271	
SEAS9501	1	-0.434983	0.04249293	-10.237	0.0001	-0.12076558	
SEAS9502	1	-0.425509	0.04326781	-9.834	0.0001	-0.11806689	
SEAS9503	1	-0.335580	0.04612633	-7.275	0.0001	-0.09316789	
SEAS9504	1	-0.449388	0.04370101	-10.283	0.0001	-0.12476490	
SEAS9601	1	-0.456077	0.04290641	-10.630	0.0001	-0.12662180	
SEAS9602	1	-0.379708	0.04458247	-8.517	0.0001	-0.10541935	
SEAS9603	1	-0.320398	0.04655128	-6.883	0.0001	-0.08895288	
SEAS9604	1	-0.432273	0.04387421	-9.853	0.0001	-0.12001306	
SEAS9701	1	-0.439229	0.04323565	-10.159	0.0001	-0.12194423	
SEAS9702	1	-0.409531	0.04528539	-9.043	0.0001	-0.06564433	
SIC2PROP	1	0.389759	0.02675665	14.567	0.0001	0.37792469	Prop of pre12 sic2gwh avg
PARTRATI	1	-0.005296	0.01419427	-0.373	0.7091	-0.00091678	Isic2 partcpn rate,reb+aud 93-95
CDD74A	1	0.011540	0.00083562	13.810	0.0001	0.03866064	Mean of daily cdd74
ELIGHV	1	0.597554	0.73008946	0.818	0.4131	0.00308597	Elig hv savings /day
ELIGRF	1	-0.500021	0.47443565	-1.054	0.2919	-0.00293232	Elig rf savings /day
ELIGLIT	1	-0.752784	0.18757449	-4.013	0.0001	-0.00793885	Elig nonp light savgs, kwh/day
CDDHV	1	-0.021873	0.01678549	-1.303	0.1926	-0.00297718	Cdd74a x elighv
HDDHV	1	-0.012916	0.00746734	-1.730	0.0837	-0.00599333	Hdd65a x elighv
CDDRF	1	-0.025522	0.02251023	-1.134	0.2569	-0.00315256	Cdd74a x eligrf

Table 3.2A: Parameter Estimates for Model An005A
(continued)

Model Summary:

Billing months	10328
Rsquare:	0.9610
Maximum condition index:	52.1
Goldfeld Quandt test:	F(4090,4147)=12.07, p=0.0000
Major model correlates of abs(residual):	MEANKWH (0.2
Major non-model correlates of residual:	None
Median Durbin Watson d:	0.68

Notes: Multicollinearity limited to interplay among seasonal dummies, and between centering term MEANKWH and SIC2 population consumption variable

4. FINAL SAVINGS CALCULATIONS.

This section contains a summary and evaluation of the savings identified by the models estimated and described in the previous section. The section covers much of the ground required by Table 6 of the California Protocols (Appendix I). It will be noted, in general, that (1) appreciable first year gross savings are identifiable for lighting equipment, lighting practices, and "other" equipment only, (2) positive net savings are identifiable for lighting measures only.

4.1 Procedures and calculations. In advance of the presentation of findings, we briefly review the procedures and calculations underlying the findings.

4.11 Gross savings of participants. Based on the gross savings model estimated over participants, savings experienced by participants are accumulated over the entire impact year (i.e., each customer-year-month of impact year, for each end use/activity), along with the corresponding ex ante savings estimates. With this accumulation procedure, and recalling that each savings estimate per customer month is expressed as a proportion of a locations pre program mean kWh/day (PREMEAN), gross savings are first retrieved in model post-processing as

$$S = \Sigma (PREMEAN_i * ESTSAV_{i,m})$$

where ESTSAV is the savings proportion from the model results (savings attributed to presence of model variables representing measure impacts), and customers are indexed by "I" and months by "m." Similarly, the "big delta" ex ante is calculated as

$$E = \Sigma (PREMEAN_i * \text{ex ante}_{i,m})$$

We have thus partially "undone" the normalization performed for the regression, weighting up so that monthly savings and ex ante values are expressed in kWh/day, and summing to obtain total average daily savings per customer over impact year months (S) and total average daily savings expected over the same customer months (E). This may not be the most natural metric in which to consider savings, but it is suitable for moving to gross realization rates per end use/activity and associated standard errors. For calculation of net savings of participants, it is also helpful to consider gross savings "per pre-program kWh" for straightforward comparison to nonparticipants. From a simple arithmetic standpoint, this second approach requires accumulating, over all participant impact year months, the average daily pre-program consumption – a total to be divided into S.

Note that there is no requirement, logical or otherwise, that participant gross savings be either negative or positive, or less or more than the ex ante "predictions."

4.12 Concomitant savings of nonparticipants. We carry out some very similar procedures to obtain competing savings estimates for the comparison group, based on the effects attributable to measure-taking among nonparticipants. We accumulate model savings as before but include customer weight kWhwt1 to equate participants and nonparticipants with respect to the consumption and the relative share of consumption within strata:

$$S = \Sigma (PREMEAN_i *kWhwt1_I * ESTSAV_{i,m})$$

We also accumulate, over all "impact year" customer months, a weighted total of daily pre-impact year daily consumption averages – a total to be divided into S.

These calculations are carried out for nonparticipant end uses HVAC, Lighting, and Other. Note that there is no logical requirement that nonparticipant "concomitant savings" be positive or negative, or constrained to less than observed among participants.

4.13 Net savings of participants. Normalized on pre-impact year daily kWh, net savings are calculated as

$$N = S_p/A_p - S_n/A_n$$

Where Sp and Sn are model-based savings totals as described above, and Ap and An are totals over customer months of pre-program daily consumption averages. End use specific net-to-gross ratios are calculated (and applied to both equipment and practice measures within end uses) as

$$NTGR = (S_p/A_p - S_n/A_n)/ (S_p/A_p)$$

4.14 Precision of gross savings, net savings, and ratios. In all of what follows, no allowances have been made for the finite population correction factor (which some analysts would apply in order to magnify the precision of estimates from the partial census of program locations), or the slight gains in precision likely to have come from post-stratification of the nonparticipant sample obtained from RER. The precision levels adopted here are quite conservative. It might well be argued that in the case of the program participant analyses (where the RER sample is not involved in any calculation), the results are essentially population figures, in which the only real errors at issue are a combination of specification error and measurement error (reasonably assumed to be minimal with the possible exception of the expansion of "fixed" Edison ex antes to "big delta" ex antes). We proceed in order to satisfy the Protocols.

The standard error for "big delta savings" is calculated by standard use of the parameter covariance matrix C from the model run – i.e., the sum of all savings relevant regressors (including substitution of normal weather terms wherever appropriate), are placed in end use/practice-specific vector M corresponding to all regressors, weighted as S above, with irrelevant regressors left at 0, and the standard error for the total savings is thus:

$$se\_gross = (MCM')^{1/2}$$

This standard error for total sample gross savings is scaled by the appropriate divisor when gross savings are normalized on preprogram average daily consumption, or upon ex ante savings in the case of the gross realization rate. In neither of these cases of ratio calculations involving gross savings do we adjust for correlation between the dividend and the divisor, because the gross savings estimates are already based upon a regression model containing the divisor in one form or another.

The end use-specific standard error for net savings per preprogram average daily kWh is calculated as the square root of the sum of two error variances:

$$se\_net = (se\_part^2 + se\_nonpart^2)^{1/2}$$

where se_part is the standard error for gross savings/preprogram kWh, and se_nonpart is the standard error for concomitant nonparticipant savings/pre-impact year kWh. We debated the logic of two calculations for the standard error re. the net/gross ratio:

$$se\_ntgr\_1 = ((1/gross^2) (se\_net^2 + NTGR^2 \cdot se\_gross^2 - 2\ NTGR\ r_{net,gross} \cdot se\_net \cdot se\_gross))^{1/2}$$

$$se\_ntgr\_2 = ((1/gross^2) (se\_net^2 + NTGR^2 \cdot se\_gross^2 - 0)^{1/}$$

Here,

gross = gross savings/preprogram kWh

se_net= standard error for net savings/preprogram kWh
se_gross=standard error for gross savings/preprogram kWh.

The second calculation assumes no correlation between net and gross savings, and in the normal case will enlarge the ratio's standard error. The first makes that adjustment, using a correlation obtained from the regression output file REG1010M, supplemented by end use-specific calculations of predicted net savings. We opted for the first calculation, but also present the second to illustrate the sensitivity of the calculation to this judgment.

At this point, we have developed standard errors for an end use/activity (-practice and end use-equipment) gross realization rate, and for an end use level net-to-gross ratio. In order to make appropriate use of the two commodities (gross realization rate x NTGR), an end use/activity level standard error for this product is required:

$$se\_netrr = (gross\_rr * NTGR) * ((se\_grossrr/gross\_rr)^2 + (se\_NTGR/NTGR)^2)^{1/2}$$

The standard error for the overall realization rate is thus a function of the two constituent ratios and their coefficients of variation.

4.15 Extension to demand. Extension of gross and net savings estimates to demand reduction is a highly derivative exercise in which factors borrowed from RER's EMHRP96 evaluation were applied at the end use level. Specifically, RER estimated gross kWh savings and kW reductions as follows:

	Gross kWh savings	gross kW reductions
HVAC	13,392,281	684
Lighting	17,492,988	4,569
Other	2,704,338	174

End use level "RER factors" (coincident peak reduction/gross kWh savings) were applied to gross and net kWh savings estimates to obtain coincident peak demand reduction estimates. These are compared to tracking system totals in order to obtain kW-specific gross and net realization rates, and kW-specific NTGRs.

4.16 Expansion to all participants. Simple multiplicative techniques are used to calculate gross and net savings for the entire participant population, including the entire 1968 locations in the program, rather than the 1459 studied locations. These are described in section 4.3 as they are invoked to produce tabled estimates.

4.2 Sample estimates. The following are estimates developed from the 1459 participant and 288 participant locations. These are commodities necessary in order to develop full population estimates (see section 4.3).

Table 4.2A provides model savings estimates and "big delta" ex ante totals, in the metric of kWh/day, accumulated, as earlier described, over impact year customer months. Significant positive gross realization rates are identified for lighting equipment measures (0.1975), lighting overall (0.1971), "other end use" equipment (0.1602), and equipment measures overall (0.1209). Lighting practices results (0.1788) are similarly effective in terms of gross savings, but the estimate is based on so few instances that the standard error for the realization rate is equally large. While the table shows lower positive rates than those prevailing in reports on non-residential efficiency programs (particularly incentive programs), there is nonetheless evidence that the program has made efficiency inroads in commercial lighting. More disappointing is the failure to isolate positive savings for HVAC practices. These measures, of which 90 percent of ex ante savings are accounted for by (1) cooling tower maintenance, (2) condenser coil cleaning, (3) making operative an existing economizer, (4) reducing lighting-induced cooling load, receive a "realization rate" of -0.39 – a figure which remains stable through a number of different specifications of the gross savings model.

Table 4.2B restates gross savings in terms of pre-program consumption. For better visibility, savings per preprogram kWh and its standard error are multiplied by 1000. As an example of interpretation, for every mWh of preprogram consumption, approximately 3.33 kWh appear to have been saved through lighting equipment measures.

Table 4.2A: Modeled Gross Savings, Realization Rate, Standard Errors

End use/activity	Model savings	Model s.e.	Gross RR	RR s.e.
HVAC/EQUIP	34,846.873	25789.74	0.0304	.0207
HVAC/PRAC	-387,312.562	43189.95	-0.3963	.0442
HVAC/TOTAL	-349,465.683	51035.86	-0.1572	.0230
LIGHT/EQUIP	239,765.327	25444.46	0.1975	.0210
LIGHT/PRAC	3,871.203	3789.91	0.1788	.1750
LIGHT/TOTAL	243,636.530	25625.69	0.1971	.0207
OTHER/EQUIP	80,496.179	23924.98	0.1602	.0477
OTHER/PRAC	7,604.179	47428.04	0.0091	.0567
OTHER/TOTAL	88,100.358	54069.47	0.0562	.0404
EQUIP, ALL	358,108.385	43783.31	0.1209	.0148
PRACTICE, ALL	-375,837.181	64155.60	-0.2047	.0349
TOTAL	-17,728.796	83701.65	-0.0037	.0174

Table 4.2B: Modeled Gross Savings: Per Pre-program kWh, Standard Errors

End use/activity	Savings/prekwh (x1000)	Savings/prekwh s.e. (x1000)
HVAC/EQUIP	0.5261	0.3584
HVAC/PRAC	-5.3830	0.6003
HVAC/TOTAL	-4.8570	0.7093
LIGHT/EQUIP	3.3323	0.3536
LIGHT/PRAC	0.0538	0.0527
LIGHT/TOTAL	3.3861	0.3562
OTHER/EQUIP	1.1188	0.3325
OTHER/PRAC	0.1057	0.6592
OTHER/TOTAL	1.2245	0.7515
EQUIP, ALL	4.9771	0.6085
PRACTICE, ALL	5.2235	0.8917
TOTAL	-0.2464	1.1633

The low and sometimes negative realization rates identified by the gross savings model are (a) consistent with "zero-order" differences between pre- and post-program consumption, and (b) robust under different model specifications. One might reasonably ask whether they have been strongly affected by our efforts to adjust tracking system ex ante estimates to "big delta" estimates where standards have affected the former. However, the "inflation" in the sample from tracking system to "big delta" is certainly not of a magnitude accounting for significant diminishment of positive realization rates – HVAC, Lighting, and

Other equipment inflation rates for standards adjustment are 1.36, 1.17, 1.19 respectively, in the sample of 1459 locations.

Nonparticipant savings captured by model run AN005A are displayed in table 4.2C. For better visibility, savings per pre-impact year kWh and its standard error are multiplied by 1000.

Table 4.2C: Modeled Nonparticipant Savings, Standard Errors

End use	Model savings	Model s.e.	Savings/prekwh (x1000)	Savings/prekwh s.e. (x1000)
HVAC	-7174.584	7,491.836	-0.0969	0.2362
LIGHT	51,157.556	12,747.149	0.6909	0.1721
OTHER	427,329.933	405,464.384	5.7710	5.4770
TOTAL	471,312.905	405,996.716	5.4289	5.4829

From a "difference of differences" standpoint on net savings, the "Other" results pose obvious problems for the CEMS program, in that the savings rate for nonparticipants is several times larger than than for participants, albeit based on a small set of nonparticipants adopting "Other" measures.

Table 4.2D presents net savings based on the "difference of regression-adjusted differences" outlined in section 4.1. Credible net/gross ratios, with credible standard errors, are obtained for HVAC and Lighting. We present standard errors accounting for the correlation between gross savings and net savings (vers. 1) and the somewhat larger standard errors resulting when this correlation is ignored (set to 0). We go forward with Version 1 standard errors, providing Version 2 only as evidence that the covariance term is of modest import.

Table 4.2D: End Use Specific Net Savings

End use	Savings/prekwh (x1000)	Standard error (x1000)	NTGR	SE_NTGR Vers. 1	SE_NTGR Vers. 2
HVAC	-4.7601	0.7476	0.9800	0.1390	0.2102
LIGHT	2.6953	0.3956	0.7960	0.1108	0.1437
OTHER	-4.5465	5.4858	-3.7130	3.7387	4.5922
TOTAL	-6.6114	5.6049	26.8320	123.9987	128.7068

In Table 4.2E we present estimated gross and net realization rates per end use and practice, developed as per section 4.1 above.

Table 4.2E: Gross and Net Realization Rates, Per End Use and Practice

End use/activity	Gross_rr	Std Err, Gross_rr	Net_rr	Std Err, Net_rr
HVAC/EQUIP	0.0304	0.0207	0.0297	0.0207
HVAC/PRAC	-0.3963	0.0442	-0.3884	0.0701
HVAC/TOTAL	-0.1572	0.0230	-0.1540	0.0309
LIGHT/EQUIP	0.1975	0.0210	0.1572	0.0275
LIGHT/PRAC	0.1788	0.1750	0.1423	0.6244
LIGHT/TOTAL	0.1971	0.0207	0.1569	0.0274
OTHER/EQUIP	0.1602	0.0477	-0.5948	0.6244
OTHER/PRAC	0.0091	0.0567	-0.0337	0.2131
OTHER/TOTAL	0.0562	0.0404	-0.2442	0.2879
EQUIP, ALL	0.1209	0.0148	3.2432	14.9932
PRACTICE, ALL	-0.2047	0.0349	-5.4922	25.3986
TOTAL	-0.0037	0.0174	-0.0990	0.6545

To complete our review of model-based sample estimates, and prior to moving on to expansion of these results to the entire program population, we note:

- Only lighting (equipment, and with less significance, practices), show appreciable positive net savings.
- The results are based on carefully specified and tested models, and results were robust over a number of specification alternatives.
- "Other equipment," and effectively "all equipment" have small yet significant gross savings which do not survive comparison to RER's nonparticipant customer consumption/measure adoption trajectories (i.e., under Protocol compliant net savings estimation).
- A healthy skepticism toward the Protocol-compliant net-to-gross ratios is warranted, based as they are on a small-n comparison group's measure adoption behavior. The Protocols have long been myopic about the instabilities that these small (and yet expensively captured) comparison (not control) groups introduce when putatively "correcting" gross to net.
- Additionally, it is reasonable to consider what we are here calling "gross savings" as "net savings." Essentially the "detrending" involved in "sic-niche" consumption adjustment of the gross savings model is entirely consistent with the underlying logic of the "difference of differences" net savings approach required by the Protocols. When the required content of the Protocols' comparison group is considered, it becomes obvious that the de facto definition of the program according to Protocols makes the general population, and thus the "sic-niche" adjustment, a reasonable basis for comparison. This de facto definition implies a proactive utility intervention in the commercial sector at large, in which there are myriad opportunities for efficiency enhancement, and militates for a natural extension of the comparison group requirement to a more straightforward adjustment for consumption occurring in the general population of generally CEMS-eligible customers. In other words, the logic of the Protocols' identification of the comparison group for net savings ironically suggests the sic-niche approach as a better approach to net savings estimation. The appropriate inclusion of sic-level population consumption trajectories, coupled with use of the comparison group, produces an error-ridden double jeopardy situation with respect to net savings, particularly for information programs.

- There are logical/methodological reasons to distrust billing analysis as a viable way of evaluating operational measures or practices. Practice measures are often essentially ongoing maintenance procedures, for which a clear consumption delta about a single implementation date is not to be expected. Additionally, there may be selection practices at work which produce an association between declining system performance, and the probability of a maintenance measure within the audit program. This is particularly likely to be the case to the extent that an incentive program is drawing off customers willing to make more effectual equipment modifications or replacements. The upshot may be a positive association between practices and system inefficiency, which should not be interpreted as a causal impact of the practice measures. The appropriate comparison case for practices, based on either the "ongoing maintenance" or the "selection effect" argument, is the consumption that would have occurred absent the maintenance: e.g., an engineering simulation rather than a simple billing analysis approach. This is also an argument for an integrated single-study evaluation approach to information and incentive programs, particularly in situations like Edison's, where the rebate program is essentially an "information+assistance" subset of the audit program.

- In expanding to the population in the next section (and in completing Table 6), we are faced with the question of how to handle negative gross and net savings. We calculate, per end use (HVAC, lighting, other) and activity (operational or practice vs equipment) savings where sample estimates indicate positive savings, and set "dissavings" to zero. This includes presenting positive gross savings for an end use/practice and zero net savings. It also means parting company with aggregate results for, say, "all equipment," as such results were reported in this section, and moving to a summing up of positive savings only, with an associated recalculation of precision.

- The standard errors calculated in these (and like efforts involving small comparison groups and somewhat overdone Protocol requirements for ratio estimates) would profit from re-estimation/ verification by bootstrapping techniques. These would be highly computation-intensive efforts involving random sample re-reselection for both participant and nonparticipant models – work at least initially appropriate only to large-budget incentive program evaluations.

4.3 Expansion to program population.

Tables 4.3A and 4.3B summarize the expansion of energy savings results for the participant study group of 1459 locations, to the population of program participants. Here, the gross and net realization rates (gross_rr and net_rr) are applied to end use/activity combinations, resetting the relevant ratios to zero wherever negative (per the California Protocols). The expansion is in terms of claimed savings (tracking system) rather than "big delta" savings, so that we are applying, per the Protocols, billing analysis-based realization rates to only the standards-independent portion of expected customer savings – i.e., the tracking system estimate. Note also that where a particular end use/activity combination is reset to zero, the sample estimate of aggregate ratios involving that end use/activity are no longer consistent with the overall implied savings, so that they must be recalculated during expansion. Finally, note that the lighting equipment claimed savings have been downwardly adjusted, prior to application of gross and net realization rates, by a total of 499,856 kWh, reflecting the proper allocation of credit for energy efficient lamp installation associated with subsequent to EMHRP-incented delamping ("hard delamping" involving fixture rewires). Table 4.3A provides the energy savings estimates, while Table 4.3B provides derivative ratios and their standard errors.

Table 4.3A: Gross and Net Savings, Expanded to Participating Population

End use/activity	Gross_rr	Net_rr	Claimed ex ante kWh	Gross kWh savings	Net kWh savings
HVAC/EQUIP	0.0304	0.0297	57,501,583	1,744,472	1,709,671
HVAC/PRAC	0*	0*	41,571,857	0	0
HVAC/TOTAL	**	**	99,073,440	1,744,472	1,709,671
LIGHT/EQUIP	0.1975	0.1572	49,393,002	9,752,500	7,762,707
LIGHT/PRAC	0.1788	0.1423	975,130	174,335	138,766
LIGHT/TOTAL	0.1971	0.1569	50,368,132	9,926,835	7,901,473
OTHER/EQUIP	0.1602	0*	21,804,038	3,492,680	0
OTHER/PRAC	0.0091	0*	48,178,555	437,606	0
OTHER/TOTAL	0.0562	0*	69,982,593	3,930,286	0
EQUIP, ALL	**	**	128,698,623	14,989,651	9,472,378
PRACTICE, ALL	**	**	90,725,542	611,941	138,766
TOTAL	**	**	219,424,165	15,601,592	9,611,144

* set to zero based on negative value.
** sample estimate of this aggregate ratio made irrelevant by setting ratios for one or more end use/activity groups to zero.

Table 4.3B: Derived Population Level Ratios and Standard Errors, Energy Savings

End use/activity	Gross_rr	Stderr, Gross_rr	Net_rr	Stderr, Net_rr	NTGR	Stderr NTGR
HVAC/EQUIP	0.0304	.0207	0.0297	0.0207	0.9800	0.1390
HVAC/PRAC	0.0000	--	0.0000	--	---	
HVAC/TOTAL	0.0176	.0120	0.0173	0.0807	0.9800	0.1390
LIGHT/EQUIP	0.1975	.0209	0.1572	0.0275	0.7960	0.1108
LIGHT/PRAC	0.1788	.1750	0.1423	0.1407	0.7960	0.1108
LIGHT/TOTAL	0.1971	.0207	0.1569	0.0274	0.7960	0.1108
OTHER/EQUIP	0.1602	.0476	0.0000	--	--	
OTHER/PRAC	0.0091	.0566	0.0000	--	--	
OTHER/TOTAL	0.0562	.0417	0.0000	--	--	
EQUIP, ALL	0.1165	.0146	0.0736	0.0752	0.6319	0.6463
PRACTICE, ALL	0.0067	.0363	0.0015	0.0012	0.2268	0.1766
TOTAL	0.0711	.0087	0.0438	0.0749	0.6160	0.6344

Table 4.3C invokes the end use specific findings from Edison's EMHRP 1996 Commercial sector evaluation to extend the kWh savings results to coincident peak demand reductions. This is a highly derivative exercise, suggesting modest but positive demand reductions in lighting overall and for equipment related measures in general – closely paralleling the findings for energy savings. Given the number of steps already encountered in properly calculating non-bootstrap standard errors for the energy-related ratios, and the fact that the "RER factors" come complete with their own sampling error, we have opted not to strain our credulity or the reader's by providing superfluous precision estimates for demand reductions.

Table 4.3C: Gross and Net Coincident Peak Reductions

End use/activity	Tracking kW ex ante	Gross Reductn	Net Reductn	Gross_rr	Net_rr	NTGR
HVAC/EQUIP	6,822	89.10	87.32	0.0131	0.0128	0.9800
HVAC/PRAC	5,828	0.00	0.00	0.0000	0.0000	0.0000
HVAC/TOTAL	12,650	89.10	87.32	0.0070	0.0069	0.9800
LIGHT/EQUIP	10,707	2547.26	2027.54	0.2379	0.1894	0.7960
LIGHT/PRAC	236	45.53	36.24	0.1929	0.1536	0.7960
LIGHT/TOTAL	10,943	2592.79	2063.79	0.2369	0.1886	0.7960
OTHER/EQUIP	2,693	224.72	0.00	0.0835	0.0000	0.0000
OTHER/PRAC	5,930	28.16	0.00	0.0047	0.0000	0.0000
OTHER/TOTAL	8,623	252.88	0.00	0.0293	0.0000	0.0000
EQUIP, ALL	20,222	2861.08	2114.86	0.1415	0.1046	0.7392
PRACTICE, ALL	11,994	73.69	36.24	0.0061	0.0030	0.4918
TOTAL	32,216	2934.77	2151.11	0.0911	0.0667	0.7330

Table 4.3D disaggregates gross and net kWh savings and kW reductions into season and costing periods, using an allocation table maintained by Edison for annual DSM reporting. The commercial portion of that table relates percentage savings/percentage peak kW reductions to measures at a disaggregate end use/technology code level. The disaggregation proceeded by (a) linking the allocation table elements to individual tracking system measures pertaining to each customer, (b) aggregating over customers and end use/activity combinations in order to well represent the program's measure mix within end use/activity, (c) application of the resultant twelve-row (six end use-by activity categories, three end use totals, two activity totals, overall) allocation table to the data of tables 4.3A and 4.3C.

Table 4.3D: Season and Costing Period Allocation of Savings

End use/activ	PARAMETER	SUMMER ON PK	SUMMER MID PK	SUMMER OFF PK	WINTER MID PK	WINTER OFF PK	kWH TOTAL
HVAC/EQUIP	GROSS kWh	441608.43	349161.50	190743.94	618040.34	144917.80	1744472.00
	NET kWh	432798.65	342195.97	186938.73	605710.87	142026.79	1709671.00
	GROSS kW	89.10	82.95	51.14	69.11	42.78	
	NET kW	87.32	81.30	50.12	67.73	41.93	
HVAC/PRAC	GROSS kWh	0.00	0.00	0.00	0.00	0.00	0.00
	NET kWh	0.00	0.00	0.00	0.00	0.00	0.00
	GROSS kW	0.00	0.00	0.00	0.00	0.00	
	NET kW	0.00	0.00	0.00	0.00	0.00	
HVAC/TOTAL	GROSS kWh	475904.19	334409.59	198545.56	622223.64	113389.02	1744472.00
	NET kWh	466410.24	327738.35	194584.71	609810.71	111126.99	1709671.00
	GROSS kW	89.10	81.68	56.31	72.16	47.70	
	NET kW	87.32	80.05	55.19	70.72	46.75	
LIGHT/EQUIP	GROSS kWh	1047075.38	1170300.00	903424.62	4583675.00	2048025.00	9752500.00
	NET kWh	833441.62	931524.84	719099.78	3648472.29	1630168.47	7762707.00
	GROSS kW	2547.26	2547.26	1707.49	2547.26	2158.60	
	NET kW	2027.54	2027.54	1359.11	2027.54	1718.18	
LIGHT/PRAC	GROSS kWh	31380.30	19176.85	12203.45	99370.95	12203.45	174335.00
	NET kWh	24977.88	15264.26	9713.62	79096.62	9713.62	138766.00
	GROSS kW	45.53	45.53	22.76	40.07	22.76	
	NET kW	36.24	36.24	18.12	31.89	18.12	
LIGHT/TOTAL	GROSS kWh	1079614.98	1189317.24	915266.80	4684642.01	2057993.97	9926835.00
	NET kWh	859342.24	946662.06	728525.85	3728839.29	1638103.56	7901473.00
	GROSS kW	2592.79	2592.79	1728.48	2586.07	2177.73	
	NET kW	2063.79	2063.79	1375.82	2058.44	1733.41	

Table 4.3D: Season and Costing Period Allocation of Savings
(continued)

End use/activ	PARAMETER	SUMMER ON PK	SUMMER MID PK	SUMMER OFF PK	WINTER MID PK	WINTER OFF PK	kWH TOTAL
OTHER/EQUIP	GROSS kWh	465986.37	512878.13	426219.56	1307375.96	780219.99	3492680.00
	NET kWh	0.00	0.00	0.00	0.00	0.00	0.00
	GROSS kW	224.72	218.09	200.72	204.75	179.91	
	NET kW	0.00	0.00	0.00	0.00	0.00	
OTHER/PRAC	GROSS kWh	27101.44	48136.66	78272.41	114411.10	169684.40	437606.00
	NET kWh	0.00	0.00	0.00	0.00	0.00	0.00
	GROSS kW	28.16	28.16	28.00	28.12	28.00	
	NET kW	0.00	0.00	0.00	0.00	0.00	
OTHER/TOTAL	GROSS kWh	330945.20	477447.87	633397.01	1165778.95	1322716.97	3930286.00
	NET kWh	0.00	0.00	0.00	0.00	0.00	0.00
	GROSS kW	252.88	250.55	243.48	245.63	236.16	
	NET kW	0.00	0.00	0.00	0.00	0.00	
EQUIP, ALL	GROSS kWh	2647834.75	2401394.69	1574391.77	6031114.94	2334914.86	14989651.00
	NET kWh	1673240.54	1517508.19	994902.01	3811229.52	1475497.74	9472378.00
	GROSS kW	2861.08	2783.23	1909.70	2610.62	2052.07	
	NET kW	2114.86	2057.32	1411.61	1929.72	1516.85	
PRACTICE, ALL	GROSS kWh	105429.49	86941.57	92233.01	189654.15	137682.78	611941.00
	NET kWh	23907.58	19715.19	20915.10	43006.67	31221.46	138766.00
	GROSS kW	73.69	70.11	62.01	68.09	58.43	
	NET kW	36.24	34.48	30.50	33.49	28.74	
TOTAL	GROSS kWh	2727887.19	2382752.66	1932733.49	5682439.98	2875778.67	15601592.00
	NET kWh	1680477.01	1467861.67	1190633.62	3500588.21	1771583.50	9611144.00
	GROSS kW	2934.77	2831.53	2149.03	2690.52	2187.60	
	NET kW	2151.11	2075.44	1575.18	1972.08	1603.46	