AB 970, AB 29X and SB 5X PEAK LOAD REDUCTION PROGRAM

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Prepared by:
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Prepared By:
Nexant
Terry Fry
San Francisco, California
Contract No. 400-00-070

Prepared for:
California Energy Commission

John Sugar
Contract Manager

Monica Rudman
Project Manager

John Sugar
Manager
Public Programs Office

Valerie Hall
Deputy Director
Renewables, Efficiency and Demand Analysis Division

Scott W. Matthews
Acting Executive Director

Section 4 ECAA Loan Program

4.1 BACKGROUND OF PROGRAM ELEMENT

The California Energy Commission's Energy Conservation Assistance Act (ECAA) has been in existence since 1979. In April 2001, AB29X provided $50 million to the ECAA account for low-interest rate loans and grants to fund the installation of energy saving projects, and for technical assistance to identify energy saving opportunities. Since ECAA was established, over 500 loans have been issued, of which 65 are from AB29X funding. The interest rate for the AB29X-funded projects is fixed at three percent for the term of the loan, which is up to 11 years.

Projects with proven energy (kWh or therm) and/or electrical demand (kW) savings are eligible for loan funding, as are energy audits and feasibility studies. Energy efficiency projects funded by ECAA involve lighting efficiency and controls; heating, ventilating, and air-conditioning (HVAC) measures; light-emitting diode (LED) traffic signals; and other energy saving technologies.

Participants must repay loans (including principal and interest) for audits and studies within two years. Equipment loans (principal and interest) must be repaid within 11 years; the loan cannot exceed the useful life of the loan-funded equipment. Repayment of the loan is accomplished through reduction in utility bills due to the installed measures. This can occur through a reduction in energy savings, or through peak-demand savings, if the loan recipient is subject to a utility rate that charges for peak-demand usage.

Loan applications are accepted on a first-come, first-served basis until the funds are exhausted, or until a new notice is issued. Eligible loan applicants include cities, counties, special districts, public or non-profit schools, and public or non-profit hospitals and care facilities. Priority consideration was given to applicants who completed and installed their projects before May 1, 2002, and thereby provided quantifiable energy savings for the summer of 2002. Those who completed the installation of their projects by May 1, 2002 were eligible for a service contract rebate of between three and 15 percent of the loan funds drawn, depending on the actual project completion date.

The maximum loan amount is $2 million per application and $5 million per entity (for example, a school district). There is no minimum loan amount. In most cases, no matching funds are required to receive an ECAA loan. The Energy Commission reviews loan applications. Projects must demonstrate technical and economic feasibility in addition to meeting minimum energy efficiency criteria as established by the Energy Commission. Only project-related costs that are paid for after approval by the Energy Commission may be included in the loan request, preventing pre-existing projects from receiving loans.

4.2 STATUS OF PROGRAM ELEMENT

As of July 31, 2003, loans totaling $38.2 million have been committed through AB29X. The Energy Commission will approve more loans when funds become available as a result of project cancellations or repayments, or when final project costs are less than the original budgeted amount. The number of project loans varies over time as some loan participants drop out and others are added.[1]

At this time, there are 65 approved loans in various stages in this program element. The projects funded by AB29X are listed below in Table 4-1. As shown in the table, some loan recipients have more than one loan. A loan application may include multiple projects (energy efficiency measures), such as a lighting project that saves electrical energy (kWh) combined with an HVAC project that saves gas (therms). The 65 approved loans represent a total of 87 distinct projects. If all loan-funded projects in Table 4-1 are installed, the estimated demand savings would be 10.6 MW. As of July 31, 2003, the total reported demand savings of installed projects funded from AB29X, indicated as “Complete” in Table 4-1, is 9.8 MW.

Table 4-1: ECAA Projects as of July 31, 2003

Loan Recipient	Project Type(s)	Loan Amount	Reported kW Savings	Reported kWh Savings	Reported Therm Savings	Project Status
Alameda County	Miscellaneous	$1,071,000	515	823,330	0	Complete
Antelope CCD	HVAC	$544,680	109	475,000	0	Complete
Antelope CCD	Lighting	$1,090,020	230	1,040,000	0	Complete
Antelope CCD (Solar Heating)	Miscellaneous	$61,628	0	0	12,700	Complete
Apple Valley USD	Lighting	$199,261	190	238,236	0	Complete
Barstow Unified School District	Lighting	$119,696	46.2	284,008	0	Complete
Burbank USD	Lighting	$121,000	13.7	103,000	0	In progress
Capistrano USD	Lighting	$185,885	39.8	275,771	0	Complete
Capistrano USD	Lighting	$901,306	52.2	549,090	0	Complete
City & County of San Francisco	LED traffic signals	$1,765,014	313	2,737,772	0	Complete
City & County of San Francisco	LED traffic signals	$1,627,203	402	3,524,111	0	Complete
City of Auburn	LED traffic signals	$112,060	11	97,150	0	Complete
City of Bellflower	LED traffic signals	$128,502	77	673,498	0	Complete
City of Belmont	LED traffic signals	$20,000	11	95,635	0	Complete
City of Culver City	LED traffic signals	$279,078	90	786,645	0	Complete
City of El Centro	LED traffic signals	$74,857	29	251,808	0	Complete
City of Fairfield	Lighting, HVAC	$2,002,821	274	1,818,820	282,950	Complete
City of Fresno - Water Division	Miscellaneous	$276,915	107	751,437	0	Complete
City of Indio	LED traffic signals	$144,309	45	393,867	0	Complete
City of Manteca	Misc. (2), LED traffic signals	$1,991,717	521	3,892,000	456,782	Complete
City of Manteca	Lighting, Misc.	$648,780	230	670,252	0	Complete

[1] For example, at the end of the third quarter of 2002, the program had 72 project loans funded through AB 29X, totaling $47.8 million of committed funds.

Loan Recipient	Project Type(s)	Loan Amount	Reported kW Savings	Reported kWh Savings	Reported Therm Savings	Project Status
City of Modesto	LED traffic signals	$191,836	82	721,242	0	Complete
City of Napa	LED traffic signals	$42,353	15	131,935	0	Complete
City of Oakland	Lighting, HVAC, Misc.	$438,100	228	650,000	-507	In progress
City of Redlands	Miscellaneous	$1,500,000	970	8,072,340	0	Complete
City of Redlands	LED traffic signals	$253,272	97	851,981	0	Complete
City of San Buenaventura	LED traffic signals	$255,654	79	687,938	0	Complete
City of San Carlos	HVAC	$657,303	16	383,923	40,447	Complete
City of San Juan Capistrano	LED traffic signals	$75,693	16	140,701	0	Complete
City of Santa Rosa	Miscellaneous	$1,090,567	350	4,000,000	0	Complete
City of Sausalito	Lighting	$31,000	14	38,000	0	Complete
City of Susanville	Miscellaneous	$150,000	74	360,000	0	In progress
City of Westlake Village	LED traffic signals	$190,986	34	295,976	0	Complete
Clovis USD	Lighting	$388,533	133.7	685,980	0	Complete
Contra Costa County	HVAC	$384,881	50	525,000	9,000	Complete
Contra Costa County	HVAC	$315,119	50	303,000	8,700	Complete
County of Mendocino	Lighting, HVAC	$96,884	44	130,620	260	Complete
County of Merced	Lighting, HVAC	$1,900,345	353	1,090,000	7,000	Complete
County of Orange	Lighting	$805,117	396	1,747,551	0	Complete
County of Orange	Miscellaneous	$643,408	400	1,527,716	0	Complete
County of Riverside	LED traffic signals	$526,229	268	2,349,562	0	Complete
County of Solano	Lighting, HVAC	$1,027,088	130	1,727,048	0	Complete
Dameron Hospital	HVAC	$348,338	75	599,333	0	In progress
Del Mar Union SD	Lighting, HVAC	$750,000	82	630,000	4,288	Complete
Fuller Theological Seminary	Lighting, HVAC	$250,000	6.3	209,534	0	Complete
Kerman Unified School District	Lighting, HVAC, Misc.	$270,000	25.3	158,794	0	Complete
Latrobe School District	Lighting	$22,300	2.8	13,744	0	In progress
Los Angeles Valley College	Lighting, HVAC	$1,600,000	655.5	1,306,799	0	Complete
Loyola Marymount University	Lighting	$1,125,000	210	1,142,400	0	Complete
Middletown USD	Lighting, Miscellaneous	$131,559	21.7	109,739	0	Complete
Mt. San Antonio College	Lighting	$962,617	335	1,702,393	0	Complete
Mt. San Antonio College	Miscellaneous	$647,134	400	0	0	Complete
O'Connor Medical Center	Lighting, HVAC	$791,200	131	588,560	0	In progress
Piner-Olivet USD	Lighting, HVAC	$261,930	20.9	182,716	0	Complete
Rio Linda USD	Lighting	$730,000	103.2	917,970	0	In progress
San Francisco General Hospital	Lighting	$970,626	311	2,452,988	0	Complete
Sierra College	HVAC	$1,261,583	104	913,403	48,141	Complete
Sierra College (Lighting)	Lighting	$116,727	59	575,092	0	Complete
Sierra View District Hospital	Lighting, HVAC	$140,000	60.5	268,600	0	Complete
Southwestern CCD	Lighting, HVAC, Misc. (2)	$1,210,000	345	767,344	48,154	Complete
State Center CCD	Lighting	$1,308,913	260.5	1,880,317	0	Complete
Sutter Extension Water District	Miscellaneous	$96,300	66	75,600	0	Complete
Torrance Unified School District	Lighting, HVAC	$471,411	43	682,404	4,520	Complete
Town of San Anselmo	LED traffic signals	$82,756	22	190,483	0	Complete
Washington Township Hospital	Miscellaneous	$300,000	120	945,774	24,320	In progress

Loan Recipient	Project Type(s)	Loan Amount	Reported kW Savings	Reported kWh Savings	Reported Therm Savings	Project Status
Totals		**$38,178,494**	**10,567**	**62,215,930**	**946,755**	

4.3 MV&E APPROACH

Nexant's general approach to verifying savings for the ECAA program element involves calculating the difference between the equipment energy use before and after an energy efficiency retrofit. A sample of projects is chosen for analysis, and the findings from that sample are extrapolated to the population as a whole. The sample population must be large and diverse enough to meet the statistical confidence and accuracy levels required by the Energy Commission.

For those projects not already installed before the start of Nexant's evaluation activities, Nexant visits the sample sites to establish baseline conditions by confirming (a) the presence and type of existing equipment, (b) the energy use and/or the load (kW demand) of the existing equipment, and (c) the hours of operation of the existing equipment. Many projects were already installed, however, and for these projects, Nexant was not able to verify baseline equipment and operating conditions.

After a sample project has been reported complete, Nexant visits the site to confirm: (a) the completion of the project, (b) the energy use and/or load of the new equipment, and (c) the hours of operation of the new equipment. Using the baseline and post-installation data, the baseline energy and peak demand and post-installation energy and demand, respectively, are calculated. The difference between the two is the verified energy and peak demand savings.

4.4 PROGRAM ELEMENT MONITORING AND VERIFICATION

To meet the Energy Commission's goal of reporting program savings within an 80 percent confidence interval at a 20 percent precision interval (80/20), Nexant completed M&V activities on 12 randomly selected projects. For sampling purposes, Nexant broke down the 87 projects into four general categories: lighting, HVAC, LED traffic signals, and miscellaneous. Table 4-2 shows the total and sampled populations for these categories.

Table 4-2: Summary of ECAA Projects

Project Type	AB29X Population	Projects for M&V Analysis
Lighting (efficiency & controls)	32	4
HVAC (efficiency & controls)	20	3
LED traffic signals	17	3
Miscellaneous	18	2
Total	**87**	**12**

Nexant has completed its M&V analysis for the 12 sampled projects. M&V plans for each project are located in the Appendix to this report. Results for the sampled projects, which are organized into the four previously defined project types, are discussed in the sections that follow.

4.4.1 M&V Activities for Sampled Lighting Projects

Table 4-3 below shows the results of the four sampled lighting projects. Specific details about each project on which M&V was performed follows after the table.

Table 4-3: Results of Sampled Lighting Projects

Project	Reported kWh Savings	Verified kWh Savings	Realization Rate (kWh)	Reported kW Savings	Verified kW Savings	Realization Rate (kW)
Capistrano USD	549,090	445,574	0.81	52.2	50.6 ± 27.2	0.97
Del Mar USD	135,761	165,158	1.22	28.4	43.0 ± 19.0	1.51
Piner Olivet USD	124,707	128,109	1.03	20.9	20.7 ± 5.6	0.99
SF General Hospital	2,452,988	2,388,054	0.97	311.0	231.5 ± 105.0	0.74
Totals for Lighting	3,262,546	3,126,895	0.96	412.5	345.8	0.84

4.4.1.1 Capistrano Unified School District

The Capistrano Unified School District replaced T-12 fluorescent lamps and magnetic ballasts with high efficiency T-8 fluorescent lamps and electronic ballasts at three schools—R.H. Dana Elementary School, Dana Exceptional Needs Facility, and San Clemente High School. Incandescent fixtures were also replaced with compact fluorescent fixtures. Simultaneously, skylights were installed at the three schools to provide natural lighting and to supplement the existing fixtures in the classrooms, gymnasium, and multipurpose rooms. The daylighting measure is analogous to a lighting controls measure, as it effectively reduces the number of hours the fluorescent lamps operate in the middle of the day.

Nexant's representative visited the Capistrano Unified School District on five separate occasions: August 26, 2002 and November 7, 2002 (discussion of M&V work with facility manager), November 13, 2002 (equipment installation for Dana Elementary), November 18, 2002 (equipment installation for San Clemente High School), and January 14, 2003 (equipment removal). During those site visits, Nexant surveyed and inspected the counts and fixture types of the installed equipment. Time-of-use lighting loggers were also deployed and retrieved to measure the actual lighting usage at the facilities. The data from the lighting loggers were analyzed by Nexant by time-of-use period to determine the estimated electrical energy and peak-period demand savings for the project.

During the post-installation audit inspections, a random sample of retrofitted fixtures were visually inspected to confirm the retrofit work was properly and thoroughly completed. Fixture type and quantity inaccuracies found during the inspections were documented, and the lighting tables were updated to accommodate the modifications. A significant portion of the retrofit work was not performed as originally planned due to a lack of funding for the project, and this is reflected in the energy savings modifications last submitted to Nexant on April 29, 2003.

For combined lighting efficiency and lighting controls projects such as this one, energy savings are calculated using the difference between the pre-installation energy usage and the post-retrofit energy usage. Energy usage is determined by multiplying the wattage of the fixtures by the number of hours the fixtures operate per year. Equation 1 was used to calculate the annual energy savings for the usage groups in which daylighting measures were installed—Classrooms and Gymnasium.

$$(1) \qquad kWh_{saved} = (kW_{pre\text{-}retrofit} * Hours_{pre\text{-}retrofit}) - (kW_{post\text{-}retrofit} * Hours_{post\text{-}retrofit})$$

For the remaining usage groups, in which daylighting measures were not installed, it is assumed that the pre-installation hours of operation are equal to the post-installation hours of operation. Equation 1, upon making this substitution, then simplifies to Equation 2, which is used for all usage groups that do not have savings from daylighting.

$$(2) \qquad kWh_{saved} = (kW_{pre\text{-}retrofit} - kW_{post\text{-}retrofit}) * Hours_{post\text{-}retrofit}$$

The wattages of the pre-retrofit lighting equipment and post-retrofit lighting equipment were taken from the manufacturer ratings, as indicated on the Equipment Data Sheets or listed on the fixtures themselves. Fixture wattages were confirmed during the post-installation inspection, when randomly selected points were verified. Post-installation hours of operation are determined by directly monitoring the run-time of a sample of the fixtures using lighting loggers. Since pre-installation hours of operation could not be obtained for use in Equation 1, the class schedule hours of 8 AM to 4 PM were used for the pre-installation hours of operation.

CMS Viron, the lighting retrofit contractor for this project, submitted lighting survey tables for the three facilities in the project. Of the more than 20 usage groups in the project, only four usage groups were selected for Measurement and Verification, as they provided the majority of the energy savings in the project – Classrooms, Restrooms, Offices, and Other. The “Other” usage group included the gymnasium. Using the 80 percent confidence/20 percent precision statistical guidelines specified by the California Energy Commission, Nexant randomly selected a statistically-valid sample of lines for each M&V usage group, as stated in the project’s original M&V plan.

The sample was monitored over a one-month period to accurately assess the actual usage hours of operation by time-of-use period (peak period, part-peak period, and off-peak period). The monitored hours of operation were annualized and applied by usage group to either Equation 1 or Equation 2, depending on whether or not the usage group contained daylighting measures. The resulting energy savings by usage group were then aggregated across the entire project, and the result is the verified energy savings for the project. Both electrical peak demand and energy savings were achieved in this project. Verified peak demand savings are calculated by dividing the verified energy savings in the peak-demand period by the total number of hours in the peak period (1,008 hours – Weekdays, 2-6 PM, excluding 8 main holidays).

The monitoring results gathered by Nexant, given in Table 4-4, indicate that there are some discrepancies in the hours of operation reported by Capistrano Unified School District (CMS Viron) and those monitored by Nexant. Some hours reported by CMS Viron were more than what was monitored by Nexant, so the annual energy savings reported by Capistrano were somewhat aggressive. The actual energy savings are lower than what was expected primarily because part of the original scope of work was removed; originally, an EMS was to automatically open and close louvers based on the time of the day and the amount of sunlight a classroom received. Thus, the daylighting measure would have replaced the use of lights in the classrooms, multipurpose rooms, and gymnasium during the bulk of the operating hours of the schools. However, due to complaints from the occupants of the classrooms, the automated feature was removed from the project scope in favor of manual switches. This has caused the energy savings from the daylighting measure to be reduced, as greater occupant control has allowed for greater use of artificial lighting.

Two sets of realization rates were calculated, one for peak-period demand savings and one for annual energy savings. The peak-period realization rate was calculated by dividing the verified peak demand savings by the reported peak demand savings. Similarly, the energy realization rate was determined by dividing the verified energy savings by the reported energy savings. Table 4-5 lists the project savings and corresponding realization rates for this project. The realization rates indicate that the energy savings calculations submitted by CMS Viron were somewhat aggressive. The reported peak demand savings, however, were very accurate, since the realization rate is 97 percent.

Table 4-4: Capistrano USD Monitoring Results by Facility

School	Reported kWh Savings	Verified kWh Savings	Verified Peak kW Savings
Dana Exceptional Needs	89,840	81,459	8.1
Dana Elementary	138,849	121,265	16.8
San Clemente High	293,293	242,850	25.7
Totals	**549,090**	**445,574**	**50.6**

Table 4-5: Capistrano USD Project Results

Savings	Reported	Verified	Realization Rate
Energy (kWh)	549,090	445,574	0.81
Peak Demand (kW)	52.2	50.6	0.97

Statistical results are presented in Table 4-6. The errors given are reported at an 80 percent confidence level. Measurement error was minimal, but was still included in the evaluation. Measurement uncertainty resulted from errors associated with the lighting loggers, which have an error of a minute per week, or 0.0001 of the collective monitoring time period. Also included in the measurement uncertainty is the equipment "box time," or the period of time between when the loggers are deployed until when they are installed, and the time between when they are removed until when the data from the logger is downloaded to the computer, which is approximated to be 1 percent.

The largest source of error is from sampling error, which is calculated using the standard deviation of the realization rates of the monitored points, as summarized below. Taking into account the resulting uncertainty of the project, the total verified savings for this project are 445,574 kWh of annual energy, and 50.6 +/- 27.2 kW of peak demand.

Table 4-6: Capistrano USD Statistical Results

Sampled lines	30 of 509 lines
Measurement error	0.0005
Standard deviation	0.4197
Sampling error	0.5379
Total project error	53.8%

4.4.1.2 Del Mar Hills Elementary School

The Del Mar Hills Elementary School replaced T-12 fluorescent lamps and magnetic ballasts with high efficiency T-8 fluorescent lamps and electronic ballasts. The school also replaced incandescent fixtures with compact fluorescent fixtures. Of the original 999 lines of fixtures, 719 lines of fixtures were removed and replaced.

Nexant's representative visited the Del Mar Hills School District on three separate occasions for the lighting retrofit portion of this project - October 14, 2002 (equipment installation), December 9, 2002 (equipment removal), and December 11, 2002 (equipment verification). During the post-installation audit inspections, a random sample of retrofitted fixtures were visually inspected to confirm the retrofit work was properly and thoroughly completed. Fixture type and quantity inaccuracies found during the inspection were documented, and the lighting tables were updated to accommodate the modifications. No significant errors were found during the inspections. Time-of-use lighting loggers were also deployed and retrieved to measure the actual lighting usage at the facility. The data from the lighting loggers were analyzed by Nexant by time-of-use period to determine the estimated electrical energy and peak-period demand savings for the project.

For projects that contain lighting efficiency measures such as this one, energy savings are calculated using the difference between the baseline lamp wattage and post-retrofit lamp wattage, multiplied by the annual hours of operation.

$$kWh_{saved} = (kW_{pre\text{-}retrofit} - kW_{post\text{-}retrofit}) * \text{Hours of Operation}$$

The wattages of the pre-retrofit lighting equipment and those of the post-retrofit lighting equipment were taken from the manufacturer ratings, as indicated on the Equipment Data Sheets or listed on the fixtures themselves. Fixture wattages were confirmed during the post-installation inspection, when randomly selected points were verified. Post-installation hours of operation are determined by directly monitoring the run-time of a sample of the fixtures. It is assumed that the pre-installation hours of operation will be the same as the post-installation hours for calculating the lighting efficiency savings.

Baker Electric (a subcontractor of Cal-Air), the lighting retrofit contractor for this project, submitted a survey table of 999 fixtures in the pre-retrofit stage and 719 fixtures in the post-retrofit. Only three usage groups were selected for monitoring purposes, because they provided the majority of the project energy savings – Classrooms, Closed Corridors, and Portables. Using the 80% confidence/20% precision statistical guidelines specified by the California Energy Commission, Nexant randomly selected a statistically-valid sample of lines for each M&V usage group, as stated in the project's original M&V plan. The sample was monitored over a one-month period to accurately assess the actual usage hours of operation by time-of-use period (peak period, part-peak period, and off-peak period).

The monitored hours of operation were used to calculate verified energy savings using the lighting efficiency equation. The verified peak-period demand savings were then calculated by dividing the energy savings during the peak-demand period by the total number of hours during the peak-period. Monitoring results are presented in Table 4-7. The monitoring results gathered by Nexant indicates that there are some discrepancies in the hours of operations reported by Del Mar Hills School District and those monitored by Nexant. However, the hours reported by Del Mar Hills were less than what was monitored by Nexant, so the results submitted by Del Mar Hills were conservative.

Two sets of realization rates were calculated, one for peak-period demand savings and one for annual energy savings. The peak-period realization rate was calculated by dividing the verified peak demand savings by the reported peak demand savings. Similarly, the energy realization rate was determined by dividing the verified energy savings by the reported energy savings. Table 4-8 lists the project savings and corresponding realization rates for this project. The high realization rates indicate that the assumptions going into the reported savings calculations (such as estimated hours of operation) are conservative.

Table 4-7: Del Mar USD Monitoring Results

Usage Group	Hours Submitted by Del Mar Hills	Hours Monitored by Nexant	Percentage Difference

Classroom	1,860	2,324	19.97
Closed Corridor	1,860	3,086	39.73
Portables	1,860	1,641	-13.35

Table 4-8: Del Mar USD Project Results

Savings	Reported	Verified	Realization Rate
Energy (kWh)	135,761	165,158	1.22
Demand (kW)	28.4	43.0	1.51

Statistical results are presented in Table 4-9. The errors given are reported at an 80 percent confidence level. Measurement error was minimal, but was still included in the evaluation. Measurement uncertainty resulted from errors found in the lighting data-monitoring device, which has an error of a minute per week, or 0.0001 of the collective monitoring time. Also included in the measurement uncertainty is the equipment “box time,” or the period between when the loggers are deployed and when they are installed, and the time between when they are removed and when the data from the logger is downloaded to the computer, which is approximated to be 2 percent.

The largest source of error is from sampling error, which is calculated using the standard deviation of the realization rates of the monitored points, as summarized below. The third source for error resulted from not performing pre-installation monitoring. The pre-installation operating hours was assumed identical to the operating hours of the facility during the post-installation for simplicity, as is usually assumed. However, variations in usage patterns may vary from month to month, which introduces a degree of error into the results. Thus, to add consideration for this error, a 7 percent error was assumed for the variation in hours between pre- and post-installation monitoring. Taking into account the resulting uncertainty of the project, the total verified savings for this project are 165,158 kWh of annual energy and 43.0 +/- 19.0 kW of peak demand.

The uncertainty for this project could be minimized if the lines in the LE table were separated out for each room. A more comprehensive statistical analysis could be performed if a more detailed LE survey table of the pre- and post-retrofit lighting equipment was submitted.

Table 4-9: Del Mar USD Statistical Results

Sampled lines	18 of 72 lines
Measurement error	0.0065
Standard deviation	0.3456
Sampling error	0.4429
Pre-monitoring error	0.00002
Total project error	44.3%

4.4.1.3 Piner Olivet Union School District

The Piner Olivet Union School District replaced T-12 fluorescent lamps and magnetic ballasts with high efficiency T-8 fluorescent lamps and electronic ballasts. Incandescent fixtures were also replaced with compact fluorescent fixtures, and occupancy controls were installed. A total of 135 lines of fixtures in the three schools—Piner, Olivet, and Schaefer—were included in the lighting efficiency and controls project.

Nexant's representative visited the Piner Olivet Union School District on six separate occasions: July 19, August 2, November 7, 2002; January 3, January 8 and February 14, 2003. During the post-installation audit inspections, a random sample of 34 lines (out of 134 total) of retrofitted fixtures were visually inspected by Nexant to confirm the retrofit work was properly and thoroughly completed by Chevron Energy Services. Fixture type and quantity inaccuracies found during the inspection were documented, and the lighting tables were updated. No major errors were found during the inspections.

Time-of-use lighting loggers were also deployed and retrieved for three separate monitoring periods to ensure an accurate assessment of the actual lighting usage at the facilities. The data from the lighting loggers were analyzed by Nexant by time-of-use period to determine the estimated electrical energy and peak-period demand savings for the project.

For projects that contain lighting efficiency and controls measures such as this one, energy savings are calculated by subtracting the post-installation energy usage from the baseline energy usage, as in Equation 1 below:

$$(1)\ kWh_{saved} = (\text{Operating Hours}_{pre\text{-}retrofit} * kW_{pre\text{-}retrofit}) - (\text{Operating Hours}_{post\text{-}retrofit} * kW_{post\text{-}retrofit})$$

For fixtures with only lighting efficiency, Equation 1 simplifies to:

$$(2)\quad kWh_{saved} = (kW_{pre\text{-}retrofit} - kW_{post\text{-}retrofit}) * \text{Operating Hours}$$

For lighting controls:

$$(3)\quad kWh_{saved} = (\text{Operating Hours}_{pre\text{-}retrofit} - \text{Operating Hours}_{post\text{-}retrofit}) * kW$$

The wattages of the pre-retrofit lighting equipment and those of the post-retrofit lighting equipment were taken from the manufacturer ratings, as indicated on the Equipment Data Sheets or listed on the fixtures themselves. Nexant confirmed fixture wattages during the pre- and post-installation inspections, when randomly selected points were verified. Monitoring of a sample of fixtures was performed to determine the pre- and post-installation hours of operation. Fixtures were monitored for both the in-session and out-of-session periods for the three usage groups with the highest amount of energy savings and greatest amount of variation in the pre- and post-installation periods: Classrooms, Office, and Restrooms. The usage hours for the other areas are assumed to have similar usage patterns for both in-session and out-of-session periods (i.e. Hallways). For the classroom, office, and restroom usage groups, the annualized hours are proportional to the total number of days during the in-session to out-session days per year. Since the school is in-session for approximately 75 percent of the year and out-of-session for approximately 25 percent of the year, the results are weighted accordingly.

Chevron Energy Services, the lighting retrofit contractor for this project, submitted a survey table of 135 lines of fixtures, organized into 18 usage areas at the campus sites. The six usage groups with the highest amounts of energy savings were monitored during the in-session time period and only the classroom, offices, and restroom usage groups were monitored during the out-of-session time periods. This is because of the low utilization of the other usage groups in the out-of-session period. The results for the three usage groups with low usage hours were pro-rated based on the results of the monitored usage groups. Using the 80 percent confidence/20 percent precision statistical guidelines specified by the California Energy Commission, Nexant randomly selected a statistically valid sample of lines for each M&V usage group. The selected sample was monitored over a one-month period in the in- and out-of-session periods in order to assess accurately the lighting usage of the project.

Table 4-10 summarizes the findings of Nexant's monitoring efforts for this project. The summary compares the monitoring results gathered by Nexant with the energy savings estimates submitted by Piner Olivet.

Table 4-10: Piner Olivet USD Monitoring Results

M&V usage group	Submitted Average (Hrs)	Nexant Measured (Hrs)	Difference (Hrs)	Difference (%)	Project Savings (kWh)	Project Savings (%)*
Classroom	1,985	1,601	383.65	23.96	63,191	53.28
Office	2,376	1,504	872.07	57.99	6,363	5.37
Restroom	2,923	763	2,160.39	283.29	1,135	0.96
Hallway	3,926	1,033	2,892.94	280.04	509	0.43
Kitchen	1,531	1,756	-225.04	-12.81	518	0.44
Multipurpose	3,569	2,358	1,210.92	51.35	20,600	17.37

*The other 12 usage areas, which make up the other 22.15% of the energy savings of this project, were not monitored.

The monitored hours of operation were used to calculate verified energy savings using Equation 1. Verified peak-period demand savings were then calculated by dividing the energy savings during the peak-demand period by the total number of hours during the peak-period. The monitoring results gathered by Nexant indicates that there are some discrepancies in the hours of operations reported by Piner Olivet Union School District and those monitored by Nexant. However, the differences in the usage groups average each other out in yielding a similar total energy savings amount for the entire project. The end result is that the energy savings estimates submitted by Piner Olivet Union School District were close to the true energy savings for the project.

Two sets of realization rates were calculated—one for peak-period demand savings and one for annual energy savings. The peak-period realization rate was calculated by dividing the verified peak demand savings by the reported peak demand savings. Similarly, the energy realization rate was determined by dividing the verified energy savings by the reported energy savings. Table 4-11 lists the project savings and corresponding realization rates for this project. Realization rates were very close to 1.0, indicating that Piner Olivet's assumptions and estimates were extremely accurate.

Table 4-11: Piner Olivet USD Project Results

Savings	Reported	Verified	Realization Rate
Energy (kWh)	124,707	128,109	1.03
Demand (kW)	20.9	20.7	0.99

Statistical results are presented in Table 4-12. The errors given are reported at an 80 percent confidence level. Measurement error was minimal, but was still included in the evaluation. Measurement uncertainty resulted from errors found in the lighting data-monitoring device, which has an error of a minute per week, or 0.0001 of the collective monitoring time period. Also included in the measurement uncertainty is the equipment "box time," or the period between when the loggers are deployed and when they are installed, and the time between when they are removed and when the data from the logger is downloaded to the computer, which is conservatively approximated to be 2 percent.

The largest source of error is from sampling error, which is calculated using the standard deviation of the realization rates of the monitored points, as summarized below. The pre-installation operating hours were assumed identical to the operating hours of the facility during the post-installation for simplicity, as is usually assumed. However, variations in usage patterns may vary from month to month, which introduces a degree of error into the results. Taking into account the resulting uncertainty of the project, the total verified savings for this project are 128,109 kWh of annual energy, and 20.7 +/- 5.6 kW of peak demand.

Table 4-12: Piner Olivet USD Statistical Results

Sampled lines	35 of 134
Measurement error	0.02
Standard deviation	0.2116
Sampling error	0.2712
Pre-monitoring error	0.066
Post-monitoring error	0.066
Total project error	27.2%

4.4.1.4 San Francisco General Hospital

The San Francisco General Hospital replaced T-12 fluorescent lamps and magnetic ballasts with high efficiency T-8 fluorescent lamps and electronic ballasts. Incandescent fixtures were also replaced with compact fluorescent fixtures, and incandescent Exit signs were replaced with light-emitting diode (LED) Exit signs. A total of 5,816 lines of fixtures in 14 buildings were included in the lighting efficiency project.

Nexant's representative visited the S.F. General Hospital facility on four separate occasions – September 9, October 4, November 7 and December 6 2002. During the post-installation audit inspections, a random sample of 140 lines (out of 5,816 total) of retrofitted fixtures were visually inspected to confirm the retrofit work was properly and thoroughly completed by S.F. General Hospital's contractors. Fixture type and quantity inaccuracies found during the inspection were documented, and the lighting tables were updated to accommodate the modifications. During the inspections, 16 errors were found, which is well within the error tolerance for 80% confidence/20% precision.

Time-of-use lighting loggers were also deployed and retrieved for three separate monitoring periods to ensure an accurate assessment of the actual lighting usage at the facility. The data from the lighting loggers were analyzed by Nexant by time-of-use period to determine the estimated electrical energy and peak-period demand savings for the project.

For lighting efficiency projects, such as this one, energy savings are calculated using the difference between the post-retrofit and baseline lamp wattages, multiplied by the monitored hours of operation.

$$kWh_{saved} = (kW_{pre\text{-}retrofit} - kW_{post\text{-}retrofit}) * \text{Hours of Operation}$$

The wattages of the pre-retrofit lighting equipment and those of the post-retrofit lighting equipment were taken from the manufacturer ratings, as indicated on the Equipment Data Sheets or listed on the fixtures themselves. Fixture wattages were confirmed during the post-installation inspection, when randomly selected points were verified. Post-installation hours of operation are determined by directly monitoring the run-time of a sample of the fixtures. It is assumed that the pre-installation hours of operation will be the same as the post-installation hours for the purpose of calculating the lighting efficiency savings.

Digital Energy, the lighting retrofit contractor for this project, submitted a survey table of 5,816 lines of fixtures, organized into 55 usage groups in 14 buildings. As many of the 55 usage groups contained only a few lines and/or represented only a small proportion of the total project savings, Nexant reorganized the usage groups into six manageable M&V usage groups. Using the 80% confidence/20% precision statistical guidelines specified by the California Energy Commission, Nexant randomly selected a statistically-valid sample of lines for each M&V usage group, as given in Table 4-13. The sampling requirements are separated into two monitoring sites—main hospital and other hospital buildings—and are stratified (weighted) based on the projected savings of each M&V usage group. The sample was monitored over a one-month period to accurately assess the actual usage hours of operation by time-of-use period (peak period, part-peak period, and off-peak period).

Table 4-13: San Francisco General Hospital Monitoring Points

Usage Group	Main Hospital	Other Hospital Buildings
Interior Hall, restrooms	8	8
Laboratory, exam rooms	8	8
Office, storage normal	8	8
High	5	5
Medium	5	5
Low	5	5
Totals	**39**	**39**

Table 4-14 summarizes the findings of Nexant's monitoring efforts for this project. The summary compares the monitoring results gathered by Nexant with the energy savings estimates submitted by S.F. General Hospital. The high error percentages in three of the usage groups may be due to Nexant's grouping of the many S.F. General Hospital usage groups.

Table 4-14: San Francisco General Hospital Monitoring Results

M&V Usage Groups	Submitted Average (Hrs)	Nexant Measured (Hrs)	Difference (Hrs)	Difference (%)	Project Savings (%)
High	8,482	6,547	1,935	-29.6	22.2
Interior Hall, Restroom	6,388	5,972	416	-7.0	23.6
Laboratory, Exam	3,200	5,244	2,044	39.0	18.1
Low	1,777	1,696	81	-4.8	9.7
Medium	3,470	1,732	1,738	-100.3	3.3
Office, Storage Normal	2,499	2,854	355	12.4	21.4
Exit Signs (unmonitored)	8,760	8,760	0	0	1.7

The monitored hours of operation were used to calculate verified energy savings using the lighting efficiency equation. Verified peak-period demand savings were then calculated by dividing the energy savings during the peak-demand period by the total number of hours during the peak-period. The monitoring results gathered by Nexant indicates that there are some discrepancies in the hours of operations reported by San Francisco General Hospital and those monitored by Nexant. However, the differences in the usage groups average each other out in yielding a similar total energy savings amount for the entire project. Thus, the energy savings estimates submitted by San Francisco General Hospital were close to the measured energy savings for the project.

Two sets of realization rates were calculated—one for peak-period demand savings and one for annual energy savings. The peak-period realization rate was calculated by dividing the verified peak demand savings by the reported peak demand savings. Similarly, the energy realization rate was determined by dividing the verified energy savings by the reported energy savings. Table 4-15 lists the project savings and corresponding realization rates for this project. The high realization rate for energy savings indicates that the assumptions going into the reported savings calculations (such as estimated hours of operation) are accurate. The lower realization rate for demand savings indicates that the estimated peak-period hours of operation were somewhat aggressive.

Table 4-15: San Francisco General Hospital Project Results

Savings	Reported	Verified	Realization Rate
Energy (kWh)	2,452,988	2,388,054	0.97
Demand (kW)	311.0	231.5	0.74

Statistical results are presented in Table 4-16. The errors given are reported at an 80 percent confidence level. Measurement error was minimal, but was still included in the evaluation. Measurement uncertainty resulted from errors found in the lighting monitoring device, which has an error of a minute per week, or 0.0001 of the collective monitoring time period. Also included in the measurement uncertainty is the equipment “box time” or the period between when the loggers are deployed to when they are installed, and the period between when they are removed to when the data from the logger is downloaded to the computer, which is approximated to be 2 percent.

The largest source of error is from sampling error, which is calculated using the standard deviation of the realization rates of the monitored points, as summarized below. The third source of error resulted from not performing pre-installation monitoring. The operating hours of the pre-installation lamps was assumed identical to the operating hours of the facility during the post-installation for simplicity, as is usually assumed. However, variations in usage patterns may vary from month to month, which introduces a degree of error into the results. Thus, to add consideration for this error, a 7 percent error was assumed for the variation in hours between pre- and post-installation monitoring. Taking into account the resulting uncertainty of the project, the total verified savings for this project are 2,388,054 kWh of annual energy, and 231.5 +/- 105.0 kW of peak demand.

The uncertainty for this project could be minimized if the monitoring sample is increased. However, considering that this project contained 5,844 rooms/lines of fixtures, selecting a representative random sample of fixtures is the only cost-effective way to estimate the energy savings for the project.

Table 4-16: San Francisco General Hospital Statistical Results

Sampled lines	78 of 5,844
Measurement error	0.0201
Standard deviation	0.3492
Sampling error	0.4475
Pre-monitoring error	0.07
Total project error	45.3%

4.4.2 M&V Activities for Sampled HVAC Projects

Table 4-17 below shows the results of the three sampled HVAC projects. Specific details about each project on which M&V was performed follows after the table.

Table 4-17: Results of Sampled HVAC Projects

Project	Reported Savings (kWh)	Verified Savings (kWh)	Realization Rate (kWh)	Reported Savings (kW)	Verified Savings (kW)	Realization Rate (kW)
Contra Costa County	303,000	149,193	0.49	50.0	40.0 ± 23.2	0.80
Del Mar USD	494,239	568,598	1.15	53.6	89.5 ± 29.1	1.67
Piner Olivet USD	58,009	54,876	0.95	0	92.5 ± 50.0*	--
Totals for HVAC	**855,248**	**772,667**	**0.90**	**103.6**	**129.5**	**1.25**

*Savings for this project are not counted in verified savings results

4.4.2.1 Contra Costa County

Contra Costa County (CCC) installed similar energy saving HVAC measures in four buildings. The measures include removing pneumatic controls equipment (Alerton DDC controls system); controlling hot water pumping via Alerton DDC; replacing variable inlet vanes on air-handling unit (AHU) fans with variable frequency drives (VFDs); decreasing chiller usage due to the VFDs and other energy savings control algorithms; and reducing heating gas usage due to VFD control and OSA temperature reset. All measures were installed before the start of the M&V activities. Since the enhanced DDC control system and the decreased chiller usage measures required pre-installation monitoring to establish an accurate baseline, these could not be included in the M&V activities. Only the hot water pumping controls and the replacement of the variable inlet vanes with VFDs were included in the M&V analysis since these did not require pre-retrofit monitoring to establish the baseline.

Nexant staff visited the four CCC facilities on August 8, 2002, to conduct a post-installation site visit. At each facility, information was gathered, power draw measurements were made, and equipment installation was verified. Information collected includes equipment nameplate data and pre-retrofit time-of-use schedules. Power draw measurements were made with a Powersite Energy Analyzer. Equipment installation was visually verified. In addition, Nexant requested that the CCC use their energy management system to trend a number of parameters. The trending period began September 3, 2002, and lasted for one month. The energy management system collected data every 10 minutes during the trending period. Nexant used the trend data to complete its analysis and determine the estimated electrical energy and peak-period demand savings resulting from the two measures.

The M&V process focused on two energy conservation measures at each facility: (1) the control of hot water pumps with Alerton energy management system and (2) the replacement of variable inlet vanes on air-handling unit fans with VFDs. For the pump controls measures, Nexant calculated energy and peak demand savings using Equation 1 below; for the VFD measures, Nexant used Equation 2 below. The equations relate energy usage to the hours of operation of the equipment multiplied by the power consumption of the equipment. Efficiency savings are the result of a reduction in equipment power consumption, with hours of operation remaining constant (Equation 2). Control savings result from a reduction in the hours of operation, with the equipment power consumption remaining constant (Equation 1). Peak demand savings are calculated by dividing the energy savings during the peak-demand time-of-use period by the total number of hours in the peak-demand period. For the peak demand savings calculation, the analysis was conducted only for weekdays between the hours of 2 pm and 6 pm.

$$\text{(1)} \quad \text{Savings (kWh)} = (\text{Hours}_{\text{pre-retrofit}} - \text{Hours}_{\text{post-retrofit}}) * \text{kW}_{\text{post-retrofit}}$$

$$\text{(2)} \quad \text{Savings (kWh)} = \Sigma(\text{kW}_{\text{pre-retrofit}} - \text{kW}_{\text{post-retrofit}})_i * \text{Hours}_{\text{post-retrofit, i}}$$

Where:

Savings	are energy savings, expressed in units of kWh
$\text{Hours}_{\text{pre-retrofit}}$	are pre-installation hours of operation
$\text{Hours}_{\text{post-retrofit}}$	are post-installation hours of operation
$\text{kW}_{\text{pre-retrofit}}$	is pre-installation power consumption in units of kW
$\text{kW}_{\text{post-retrofit}}$	is post-installation power consumption in units of kW
i	refers to a specific temperature bin

The hours of operation in Equation 1 come from trended data, and the power consumption of the water pumps was measured during the site visit. The efficiency savings in Equation 2 are calculated using a temperature bin analysis, where the average fan power after installation is subtracted from the average fan power before installation for each temperature bin *i*. The difference in power consumption is multiplied by the number of operating hours from weather data within each temperature bin *i*. Then the energy savings from all the temperature bins are added to result in the savings over the entire range of operating temperatures.

The savings estimated from the M&V analysis (verified savings) were divided by the savings reported on the ECAA loan application (reported savings) to arrive at the realization rates, reported by building for each of the two analyzed measures. The loan recipient's calculation spreadsheet, which was broken down building-by-building, indicated a total peak-demand savings of 128 kW, while the reported aggregate demand savings from the loan application was reduced to 50 kW. Thus, Nexant normalized the peak-demand savings attributed to each building by a ratio of 50/128. These results are presented in Table 4-18 and Table 4-19 for electrical energy savings and peak-period demand savings, respectively.

Low realization rates for the VFD measure are due to: (1) low on-site power measurements when VFD was at full speed; (2) low VFD speed variability in trend data; and (3) assumption that VAV system was properly commissioned in the pre-retrofit condition. This last assumption means that, in order to approximate the baseline conditions of the project, Nexant had to assume that the HVAC equipment, such as the inlet vanes, was operating at the original design conditions. Some of these assumptions may be in error due to degradation of the equipment. For example, according to observations made by the Energy Commission, the HVAC equipment controlled by the existing pneumatic control was experiencing problems prior to the energy management system retrofit. These included: (1) building air pressure imbalance caused by uneven ventilation and (2) inlet vane malfunction in the air handling units. As a result, the HVAC equipment would operate more than needed to keep the building occupants comfortable.

The strengths of the M&V process include: (1) separate analysis for each piece of equipment; (2) power draw based on site visit measurements; and (3) time-of-use analysis (in the post) based on temperature-binned trend data. The M&V analysis weaknesses include: (1) baseline schedule based on interview and not directly verifiable; and (2) trend data only captured part of outside air temperature operating range. For outside air temperature bins not covered by the trend data, a correlation between pump duty cycle and outside air temperature had to be made. In some cases, this correlation was difficult to estimate and may be a significant cause of error.

Table 4-18: Contra Costa County Summary of M&V Results—Energy Savings

	Pump Controls			VFDs			
Building	Reported Savings (kWh)	Verified Savings (kWh)	Realization Rate	Reported Savings (kWh)	Verified Savings (kWh)	Realization Rate	Total Realization Rate
10 Douglas	1,371	1,239	0.90	24,327	10,336	0.42	0.45
50 Douglas	1,904	1,961	1.03	56,143	29,623	0.53	0.54
1980 Muir	4,114	1,849	0.45	26,556	8,660	0.33	0.34
597 Center	1,143	4,855	4.25	40,832	18,481	0.45	0.56
Totals	**8,532**	**9,904**	**1.16**	**147,858**	**67,100**	**0.45**	**0.49**

Table 4-19: Contra Costa County Summary of M&V Results—Peak-Demand Savings

Building	Pump Controls			VFDs			Total Realization Rate
	Reported Savings (kW)	Verified Savings (kW)	Realization Rate	Reported Savings (kW)	Verified Savings (kW)	Realization Rate	
10 Douglas	0.19	1.43	7.48	3.39	2.36	0.70	1.06
50 Douglas	0.48	0.78	1.64	9.38	5.66	0.60	0.65
1980 Muir	0.57	1.13	1.99	3.70	2.06	0.56	0.75
597 Center	0.16	0.58	3.65	5.97	4.95	0.83	0.90
Totals	**1.40**	**3.93**	**2.81**	**22.44**	**15.03**	**0.67**	**0.80**

Using the results from the two analyzed measures, the total project savings are then estimated. The overall project results are given in Table 4-20. The total verified project savings are 149,193 kWh of annual energy, and 40.0 +/- 23.2 kW of peak-period demand.

Table 4-20: Contra Costa County Project Results

Savings	Reported	Verified	Realization Rate
Energy (kWh)	303,000	149,193	0.49
Demand (kW)	50.0	40.0	0.80

Statistical results are shown in Table 4-21. The errors in the tables are reported at an 80 percent confidence level. The standard deviations reported were calculated using realization rates for the four pumps and 14 fans, respectively. The sampling error for both measures is equal to zero because the entire population was sampled. The measurement error is a combination of equipment measurement error and calculation error. A 2 percent measurement error is associated with the one-time equipment power draw measurement. Another source of error common to both analyses results from correlating pump duty cycle and average VFD speed to outside air temperature and then using the correlation to extrapolate to outside air temperature bins that were not captured by the trend. The other significant error in estimating energy and demand savings for the pump's controls was an assumed 10 percent error associated with the pre-retrofit operating schedule filled out by building staff. This error component is the driving error for the project, and ultimately contributes 35 percent to the project uncertainty. Other sources of error for the VFD measures include the standard error associated with averaging VFD speeds for each temperature bin and the error, assumed to be 2 percent, associated with using ASHRAE curves to correlate percent flow to percent power draw for both pre (inlet guide vanes) and post (VFD) retrofit conditions.

Table 4-21: Contra Costa County Statistical Results

Equipment Measured	Statistical Measure	Result
Pump Controls	Sampled pumps	4 of 4
	Standard deviation	0.31
	Sampling error	0.00
	Measurement error	0.44
	Total error	44%
VFDs	Sampled fans	14 of 14
	Standard deviation	0.083
	Sampling error	0.00
	Measurement error	0.38
	Total error	38%
Total project error		**58%**

4.4.2.2 Del Mar Hills Elementary School

The original design of the Del Mar Hills (DMH) elementary school facility was very inefficient in terms of energy usage and, according to district records, the school once held the distinction of having the highest energy usage per pupil in the state of California. Cognizant of this situation, the school's facility manager manually deactivated many of the HVAC components affected by the upgrade project. Time clocks originally intended to regulate the AC systems were disabled and electric heating elements would frequently operate simultaneously with cooling equipment. The AC unit serving the administrative office area would operate continuously and a lack of walls separating zones served by the original AC systems contributed to the excessive HVAC energy usage. Baseline HVAC equipment included seven rooftop AC units that provided a total of 165.5 tons of cooling with an accompanying 288.5 kW of electric heating elements.

Included with the ECAA loan application was an analysis performed by Cal Air, the project's vendor, wherein the baseline HVAC consumption was identified as 1,165,530 kWh per year. Assisted by Del Mar Hills Union School District staff, Nexant researched the specifications of the original equipment and enhanced the model developed by Cal Air. Based on the refined HVAC component data, Nexant developed a baseline estimate of 764,968 kWh per year including Cal Air's original estimate of 299,252 kWh attributable to electric heating.

Nexant staff visited the school several times beginning on December 9, 2002 to conduct a post-installation site visit. During a site visit on December 11, 2002, Nexant identified the priorities and instrumentation required to perform the M&V analysis for the project. After the seven original AC units were removed, 29 new units were installed to provide a total of 141 tons of cooling and gas-fired heat to the facility. True power measurements were recorded for a statistically valid sample of the new units based on the tonnage rating for each system. Furthermore, these measurements were recorded when the units were in full cooling mode and economizer mode. A total of 24 data loggers were installed in 19 of the units starting on January 8, 2003 and were removed on February 20 in an effort to record operational characteristics for the systems during active academic sessions. The following table summarizes the populations and sample sizes for each category of AC unit monitored.

Table 4-22: Del Mar USD HVAC Equipment

Manufacturer & Model No.	Quantity	Tons Each.	Sample Size
Carrier 48HJD004	7	4	5
Carrier 48HJD005	13	5	6
Carrier 48HJD006	4	6	3
Carrier 48HJD007	3	7	3
Carrier 40QKB024	2	1.5	2
Totals	**29**	**141**	**19**

As indicated in the M&V Plan, Nexant relied upon monitoring data collected from the new AC units in comparison with the modeled baseline in order to derive a savings estimate for the project. Continuous monitoring of the 19 sampled units was performed for 42 days and an average consumption profile for each size of AC unit was developed from the data. While the monitoring was performed in January and February, unseasonably high temperatures were experienced for two weeks of the session and provided significant opportunities to monitor heavy AC operations during the academic year. Of the 24 total data loggers deployed at the site, 14 units were able to record variable load data at 1-minute increments. This load data was calibrated by referring to the true power measurements recorded for each unit at the time of the logger installation. Pursuant to the M&V Plan, the following formula was used to calculate the savings attributable to the project.

> Verified Savings (kWh/year) = Modeled Baseline (kWh/year) – Post-Installation Usage (kWh/year)
>
> Where: Post-Installation Usage = (Fan-only demand [kW] x Annualized fan-only operational hours) + (Fan and cooling demand [kW] x Annualized fan and cooling operational hours) + (Fan and heating demand [kW] x Annualized fan and heating operational hours)

The savings estimate derived from the M&V analysis (verified savings) was divided by the savings reported on the ECAA loan application (reported savings) to arrive at the realization rate. The following table summarizes these values for both the energy and demand components of the project.

Table 4-23: Del Mar USD Project Results

Savings	Reported	Verified	Realization Rate
Energy (kWh)	494,239	568,598	1.15
Demand (kW)	53.6	89.5	1.67

Factors affecting the realization rates include the modifications to the baseline that were enabled by Nexant's research into the detailed performance specifications of the original AC systems and the exclusion of demand savings attributable to the decommissioning of the electric heating system. Interviews with Del Mar Hills staff indicated that the heating elements had been disconnected for two to three years before the project's implementation and, subsequently, did not contribute to the current savings values. Furthermore, the vendor's original estimate of post-installation energy consumption identified in the ECAA loan application was higher than the actual consumption determined from the monitoring process. The verified energy savings for this project is 568,598 kWh, and the peak-demand savings is 89.5 ± 29.1 kW.

The strengths of the M&V process include: (1) statistically valid sampling and detailed monitoring of each type of affected AC unit in the post-installation period; (2) post-installation demand values are based on detailed true power measurements; and (3) access to site-based facilities personnel with hands-on familiarity of all pre- and post-installation equipment affected by the project. The M&V analysis weaknesses include: (1) baseline was developed prior to Nexant's presence at the site and was not verified via monitoring or measurements; (2) monitoring data was not collected during all seasons of facility operation and only captured brief periods of high ambient air temperature operating characteristics; and (3) several original HVAC components were either disabled or not functioning properly during the baseline and resulted in artificially low utility consumption data. Ultimately, uncertainties with the baseline will function as the most significant cause of error in the analysis.

With the transition of seven AC systems to 29 new AC systems of differing sizes, the development of a conventional standard deviation of pre-and post-installation consumption values is challenging. Subsequently, a standard deviation reported for the project was calculated using data obtained from the monitoring session wherein performance data from similar-sized units is compared for consistency. This standard deviation value of 0.112 was further used to calculate the standard error. The sampling error for the project is based on a sample size (n) of 19 out of a population (N) of 24 and is adjusted with the finite population multiplier. A measurement error of 1.02 percent for the project is based on the manufacturer's specifications for the Fluke Model 41B true power meter used to record the demand measurements for the selected AC units. Furthermore, all of the Onset data loggers have a 5 percent error factor for the measurement of amperages versus time. This error factor was added as a separate item in addition to the measurement error for the demand samples. Modeling error is based on assumptions indicated in the baseline consumption estimate submitted with the loan application that were further modified during the M&V process using original equipment specifications.

Table 4-24: Del Mar USD Statistical Results

Statistical Measure	Results
Sampled AC units	19 of 29
Standard deviation	0.112
Sampling error	0.0257
Modeling error – baseline	0.300
Measurement error – demand	0.0102
Measurement error – amps vs. time	0.050
Total project error	32.5%

4.4.2.3 Piner Olivet Union School District

Chevron installed three HVAC measures at the Piner Olivet Union School District for the ECAA Loan Program. The measures include: installing 23 new gas-pack units on the school buildings (11 of which were funded by the program), replacing the manual thermostats controlled by six-hour timers with programmable thermostats throughout the classrooms; and the installation of a new HVAC control system at Schaefer Elementary.

Nexant staff visited the three schools in the Piner Olivet Union School District on six occasions – July 19, August 2, November 7, 2002; January 3, January 8 and February 14, 2003. At each facility, nameplate information was gathered, power draw measurements were made, equipment installation was verified, and data loggers were installed to measure the performance of the equipment before and after the retrofit. Information collected includes equipment nameplate data and pre-retrofit time-of-use schedules. Power draw measurements were made with a Powersite Energy Analyzer. Nexant staff verified equipment installation visually. In addition, current data loggers were also installed to monitor the performance of the HVAC equipment for a 1-month period in the summer and winter (due to the different usage patterns of the units based on the climate at the facility). The data was taken in 2- to 5-minute increments to monitor the cycling patterns of the gas-packs in various times during the year. Nexant used the trend data to complete its analysis and to determine the estimated electrical energy and peak-period demand savings resulting from the programmable thermostat and gas-pack replacement measures.

The M&V process focused on two major energy conservation measures (ECMs) at each facility: (1) control of the new gas-packs using programmable thermostats with preset schedules, and (2) replacement of the old gas-packs with new high-efficiency Bard gas-packs. An additional HVAC control measure was also installed at Schaefer Elementary, but because of the low energy savings resulting from the project, no M&V activities were performed for that measure.

Information collected during the site visits and trend weather data for the Santa Rosa area were used to calculate energy and peak demand savings with Equation 1 below for HVAC controls, and with Equation 2 below for HVAC efficiency. The equations relate energy usage to the hours of operation of the equipment multiplied by the energy consumption of the equipment.

Efficiency savings are the result of a reduction in equipment power consumption, with hours of operation remaining constant (Equation 2). Control savings result from a reduction in the hours of operation, with the equipment power consumption remaining unchanged (Equation 1). Peak demand savings are calculated by dividing the energy savings during the peak-demand time-of-use period by the total number of hours in the peak-demand period. For the peak demand savings calculation, the analysis was conducted only for weekdays between the hours of 2 PM through 6 PM.

(1) $\text{Savings (kWh)} = (\text{Hours}_{\text{pre-installation}} - \text{Hours}_{\text{post-installation}}) * \text{kW}_{\text{post-installation}}$

(2) $\text{Savings (kWh)} = \Sigma(\text{kW}_{\text{pre-installation}} - \text{kW}_{\text{post-installation}})_{\text{i}} * \text{Hours}_{\text{post-installation, i}}$

The pre-installation hours of operation in Equation 1 is calculated from the monitoring data, the post-installation hours of operation is calculated from the monitoring data and supported by the time schedules programmed into the thermostats by the Piner Olivet staff. The difference in hours is multiplied by the average power consumption of the unit at each temperature bin interval taken during the post-installation measurements. The energy savings at each temperature interval is totaled over the range of temperature between 50 to 90 degrees for the HVAC controls measure. The efficiency savings in Equation 2 are calculated using a temperature bin analysis, where the average power drawn by the gas-pack after installation is subtracted from the average power drawn by the gas-pack for each temperature bin i. The difference in power consumption is multiplied by the number of annual hours within each temperature bin (i) extracted from the weather data, and from the duty cycle of the units within those temperature bins. The energy savings from all the temperature bins are added to result in the total savings over the temperature range of 50 to 90 degrees for the HVAC efficiency measure.

The savings estimated from the M&V analysis (verified savings) were divided by the savings reported on the ECAA loan application (reported savings) to arrive at the realization rates, given in Table 4-25. The strengths of the M&V process include: (1) separate analysis for each piece of equipment; (2) power draw based on site visit measurements; and (3) time-of-use (in the post) based on temperature-binned trend data. The M&V analysis weaknesses include a small monitoring sample selection, which resulted in a large fluctuation in data.

Table 4-25: Piner Olivet USD Project Results

Savings	Reported	Verified	Realization Rate
Energy (kWh)	58,009	54,876	0.95
Demand (kW)	0	92.5	--

Statistical results are shown in Table 4-26. The errors in the tables are reported at an 80 percent confidence level. The total verified project savings are 54,876 kWh of annual energy, and 92.5 ± 50.0 kW of peak-period demand. Since, for this project, the loan recipient claimed no peak-period demand savings, the savings are ignored for the purposes of calculating a program element realization rate.

The standard deviations reported for HVAC efficiency and controls were calculated using realization rates from three of the sampled heat pumps in the population of 11 funded by the CEC. The sampling error is slightly high for the measures due to the small sample size and the high variation in the data results. For HVAC efficiency and controls, a 2 percent measurement error is associated with the one-time equipment-power-draw-measurement. Another source of error common to both analyses results from the gas-pack duty cycle, since measurements were taken at 5-minute intervals and the cycling behavior of the gas packs operate at unknown intervals.

Table 4-26: Piner Olivet USD Statistical Results

	HVAC Efficiency	HVAC Controls	HVAC Combined
Sample size	3 of 11	3 of 11	3 of 11
Standard deviation	0.4656	0.4407	0.4282
Sampling error	0.5968	0.5560	0.5403
Measurement error	0.0002	0.0003	0.0003
Total project error	59.7%	55.6%	54.0%

4.4.3 M&V Activities for Sampled LED Traffic Signals Projects

Table 4-27 below shows the results of the three sampled LED Traffic Signal projects. Specific details about each project on which M&V was performed follows after the table.

Table 4-27: Results of Sampled LED Traffic Signals Projects

Project	Reported Savings (kWh)	Verified Savings (kWh)	Realization Rate	Reported Savings (kW)	Verified Savings (kW)	Realization Rate
City of Redlands	851,981	765,937	0.90	97.0*	87.4 ± 63.2	0.90
County of Riverside	2,349,562	2,091,110	0.89	268.0	241.0 ± 46.2	0.90
City of Westlake Village	295,976	249,668	0.84	34.0	28.5 ± 2.6	0.84
Totals for LED Traffic Signals	**3,497,519**	**3,106,715**	**0.89**	**399.0**	**356.9**	**0.89**

* Corrected value (refer to project description below)

4.4.3.1 City of Redlands

The City of Redlands replaced red, amber, and green main signals and turn signals, as well as pedestrian “Walk/Don’t Walk” signals with LED traffic signal modules at 49 intersections. Nexant staff visited a randomly selected sample of 13 intersections within the City of Redlands during the post-installation site visit on July 3, 2002. During the inspection, it was verified that the signals had been replaced with LED traffic signal modules. Lamps at each intersection were counted by type (main signal, turn signal, pedestrian signal) and color (red, amber, green, pedestrian orange, pedestrian white). The counts were compared to the Intersection Inventory Spreadsheet submitted to the Energy Commission by the loan recipient. No errors were observed during the inspection. Utility bill results were submitted to Nexant by the City of Redlands for the same 13 randomly selected intersections to complete the billing analysis specified in the approved M&V plan.

For each of the 13 intersections in the sample, utility bill results for several months before the retrofit and for several months following the retrofit were submitted. Nexant performed a billing analysis to compare the savings expected—based on the Intersection Inventory Spreadsheet and using assumed use factors—to the savings actually achieved based on the utility bill analysis. Table 4-28 lists the incandescent wattages, LED traffic signal module wattages, and assumed use factor used by the loan recipient for each lamp type in the project. The loan recipient estimated the use factors. These values are used, along with the counts of the lamps, to calculate the expected energy and demand savings for each of the 13 sampled intersections. For LED traffic signals projects, demand savings and peak demand savings are synonymous, since usage does not vary by time of day. Nexant discovered an error in the loan recipient’s demand savings calculation methodology. The loan recipient had not included the use factors in their calculations. As Nexant does not believe this error is common within projects of this type, the calculation was corrected using the use factors. The energy saving calculations were correct as submitted.

Table 4-28: City of Redlands Signal Specifications

Signal Type	Pre-installation Wattage	Post-installation Wattage	Assumed Use Factor
Red 12” Main Signal	135	11	0.5
Red 8” Main Signal	60	7	0.5
Red 12” Turn Signal	135	7.5	0.5
Amber 12” Main Signal	135	15	0.07
Amber 8” Main Signal	60	10	0.07
Amber 12” Turn Signal	135	8	0.07
Green 12” Main Signal	135	12	0.43
Green 8” Main Signal	60	7	0.43
Green 12” Turn Signal	135	7	0.43
Pedestrian Signal–Orange	135	14	0.8
Pedestrian Signal—White	135	10	0.2

The average energy usage of each intersection *after* the retrofit, as indicated by the utility bill results, is subtracted from the average energy usage of the intersection *prior to* the retrofit, as indicated by the utility bill results, to calculate verified energy savings for the intersection. Energy savings are calculated on a per-day basis, to account for differences in billing periods. The expected energy savings for the 13 intersections are compared to the verified energy savings from the billing analysis to calculate the realization rate for each intersection. Two realization rates are calculated—one for demand savings and one for energy savings.

The savings resulting from the M&V utility billing analysis (verified savings) were divided by the savings reported on the ECAA loan application (reported savings) to arrive at the realization rates shown in Table 4-29. The energy and demand realization rates, both 90 percent, are typical for LED traffic signals projects.

Errors in the calculated expected savings might be due to the use factors assumed by the loan recipient. In particular, typical use factors for red turn signals are usually much higher than 0.5, and typical use factors for green turn signals are usually much lower than the value of 0.43 assumed by the loan recipient. Assumed use factors that are significantly different from the actual use factors (which have not been measured for this project) can result in large errors due to the propagation of small errors over large numbers of intersections. In this project there were 115 red arrow LED modules (for which reported savings were probably under-predicted, resulting in increased realization rates), and 154 green arrow LED modules (for which reported savings were probably over-predicted, resulting in decreased realization rates). It is likely that any errors from green turn signals will propagate since there are 33 percent more green turn signals than red turn signals.

Table 4-29: City of Redlands Project Results

Savings	Reported	Verified	Realization Rate
Energy (kWh)	851,981	765,937	0.90
Demand (kW)	97.0 (corrected)	87.4	0.90

Statistical results are presented in Table 4-30. The errors given are reported at an 80 percent confidence level. Measurement error was minimal, but was still included in the evaluation. Measurement uncertainty resulted from errors in the utility revenue meters from which the utility bills are obtained, and are conservatively estimated to be 1 percent for the purpose of the calculations. The largest source of error is sampling error, which is calculated using the standard deviation of the realization rates of the 13 intersections. For this project, three of the intersections had large variations between the expected savings and the verified savings, resulting in a large standard deviation in the intersection realization rates. The large standard deviation is the cause of the high uncertainty value of 72 percent for this project. Taking into account the resulting uncertainty of the project, the total verified savings for this project are 765,937 kWh of annual energy, and 87.4 +/- 63.2 kW of peak demand.

Table 4-30: City of Redlands Statistical Results

Statistical Measure	Results
Sampled intersections	13 of 49
Standard deviation	0.5639
Sampling error	0.7228
Measurement error	0.0271
Total project error	72.3%

4.4.3.2 County of Riverside

The County of Riverside replaced red, amber, and green main signals and turn signals, as well as pedestrian "Walk/Don't Walk" signals with LED traffic signal modules at 128 intersections. Nexant staff visited a randomly selected sample of 13 intersections within the County of Riverside during the post-installation site visit on July 3, 2002. During the inspection, it was verified that the signals had been replaced with LED traffic signal modules. Lamps at each intersection were counted by type (main signal, turn signal, pedestrian signal) and color (red, amber, green, pedestrian). The counts were compared to the Intersection Inventory Spreadsheet submitted to the Energy Commission by the loan recipient. No errors were observed during the inspection. Utility bills were submitted to Nexant by the County of Riverside for the same 13 randomly selected intersections to complete the billing analysis specified in the approved M&V plan.

For each of the 13 intersections in the sample, utility bill results for several months before the retrofit and for several months following the retrofit were submitted. For three intersections, only one bill was received either before or subsequent to the retrofit. These three intersections were excluded from the billing analysis due to a lack of confidence in results from a single utility bill. For the remaining 10 intersections, Nexant performed a billing analysis to compare the savings expected—based on the Intersection Inventory Spreadsheet and using assumed use factors—to the savings actually achieved based on the utility bill analysis. Table 4-31 lists the incandescent wattages, LED traffic signal module wattages, and assumed use factor for each lamp type in the project. The loan recipient estimated the use factors. These values are used, along with the counts of the lamps, to calculate the expected energy and demand savings for each of the 10 sampled intersections. The loan recipient did not retrofit any amber turn signals, and all of the retrofit amber main signals were in flashing intersections (where amber and red flash on and off). For LED traffic signals projects, demand savings and peak demand savings are synonymous, since usage does not vary by time of day.

Table 4-31: County of Riverside Signal Specifications

Signal type	Pre-installation Wattage	Post-installation Wattage	Assumed Use Factor
Red 12" Main Signal	150	11	0.59
Red 8" Main Signal	116	8	0.59
Red 12" Turn Signal	150	9	0.81
Amber 12" Main Signal	150	22	0.5
Amber 8" Main Signal	116	13	0.5
Amber 12" Turn Signal	N/A	N/A	N/A
Green 12" Main Signal	150	15	0.38
Green 8" Main Signal	116	12	0.38
Green 12" Turn Signal	150	13	0.16
Pedestrian Signal	69	10	0.9

The average energy usage of each intersection after the retrofit, as indicated by the utility bills, is subtracted from the average energy usage of the intersection prior to the retrofit, as indicated by the utility bills, to calculate verified energy savings for the intersection. Energy savings are calculated on a per-day basis, to account for differences in billing periods. The expected energy savings for the 10 intersections are compared to the verified energy savings from the billing analysis to calculate the realization rate for each intersection. Two realization rates are calculated—one for demand savings and one for energy savings.

The savings resulting from the M&V utility billing analysis (verified savings) were divided by the savings reported on the ECAA loan application (reported savings) to arrive at the realization rates shown in Table 4-32. The energy and demand realization rates, 89 and 90 percent respectively, indicate that the assumptions going into the reported savings calculations (such as use factors) are accurate.

Table 4-32: County of Riverside Project Results

Savings	Reported	Verified	Realization Rate
Energy (kWh)	2,349,562	2,091,110	0.89
Demand (kW)	268.0	241.0	0.90

Statistical results are presented in Table 4-33. The errors given are reported at an 80 percent confidence level. Measurement error was minimal, but was still included in the evaluation. Measurement uncertainty resulted from errors in the utility revenue meters from which the utility bills are obtained, and are conservatively estimated to be 1 percent for the purpose of the calculations. The largest source of error is sampling error, which is calculated using the standard deviation of the realization rates of the 10 intersections. Taking into account the resulting uncertainty value of 19.2 percent, the total verified savings for this project are 2,091,110 kWh of annual energy, and 241.0 +/- 46.2 kW of peak demand.

Table 4-33: County of Riverside Statistical Results

Statistical Measure	Results
Sampled intersections	10 of 128
Standard deviation	0.1477
Sampling error	0.1893
Measurement error	0.0293
Total project error	19.2%

4.4.3.3 City of Westlake Village

The City of Westlake Village replaced red, amber, and green main signals and turn signals, as well as pedestrian “Walk/Don’t Walk” signals with LED traffic signal modules at 15 intersections, which included two intersections operated by CalTrans. Nexant staff visited a randomly selected sample of eight intersections within the City of Westlake Village during the post-installation site visit on June 27, 2002. During the inspection, it was verified that the signals had been replaced with LED traffic signal modules. Lamps at each intersection were counted by type (main signal, turn signal, pedestrian signal) and color (red, amber, green, pedestrian). The counts were compared to the Intersection Inventory Spreadsheet submitted to the Energy Commission by the loan recipient. One error was found during the inspection, three modules were missed at one intersection. Nexant does not believed the error to be a global error, nor is it a significant error. Therefore, the results will not be adjusted to account for it. Utility bills were submitted to Nexant by the City for all 13 intersections controlled by Westlake Village to complete the billing analysis specified in the approved M&V plan. One intersection, Agoura Road and Terrace Avenue, was found to have a problem with the utility meter, and the results were excluded from the analysis.

For each of the 12 intersections analyzed, utility bill results for several months before the retrofit and for several months following the retrofit were submitted. Nexant performed a billing analysis to compare the savings expected—based on the Intersection Inventory Spreadsheet and using assumed use factors—to the savings actually achieved based on the utility bill analysis. Table 4-34 lists the incandescent wattages, LED traffic signal module wattages, and assumed use factor for each lamp type in the project. These values are used, along with the counts of the lamps, to calculate the expected energy and demand savings for each of the 12 intersections. The loan recipient did not have any eight-inch signals to retrofit. For LED traffic signals projects, demand savings and peak demand savings are synonymous, since usage does not vary by time of day.

Table 4-34: City of Westlake Village Signal Specifications

Signal Type	Pre-installation Wattage	Post-installation Wattage	Assumed Use Factor
Red 12” Main Signal	135	10.5	0.59
Red 8” Main Signal	N/A	N/A	N/A
Red 12” Turn Signal	135	9.3	0.81
Amber 12” Main Signal	135	15	0.03
Amber 8” Main Signal	N/A	N/A	N/A
Amber 12” Turn Signal	135	9	0.03
Green 12” Main Signal	135	11.8	0.38
Green 8” Main Signal	N/A	N/A	N/A
Green 12” Turn Signal	135	9	0.16
Pedestrian Signal	135	9.4	0.9

The average energy usage of each intersection *after* the retrofit, as indicated by the utility bills, is subtracted from the average energy usage of the intersection *prior to* the retrofit, as indicated by the utility bills, to calculate verified energy savings for the intersection. Energy savings are calculated on a per-day basis, to account for differences in billing periods. The expected energy savings for the 12 intersections are compared to the verified energy savings from the billing analysis to calculate the realization rate for each intersection. Two realization rates are calculated—one for demand savings and one for energy savings.

The savings resulting from the M&V utility billing analysis (verified savings) were divided by the savings reported on the ECAA loan application (reported savings) to arrive at the realization rates shown in Table 4-35. The energy and demand realization rates, both 84 percent, are reasonable for a typical LED traffic signals project.

The realization rates may be less than 1.0 because of errors in the calculated expected savings that come about as a result of the use factors assumed by the loan recipient. The use factors used in the calculations are standard values and do not appear to be inaccurate. However, large variations in use factors can be found from city to city, and even from intersection to intersection within the same city. Without actually measuring the real use- factors, it is impossible to know how accurate the assumed use-factors are. Moreover, any small error in use factor can propagate into a large error over a population of intersections.

Table 4-35: City of Westlake Village Project Results

Savings	Reported	Verified	Realization Rate
Energy (kWh)	295,976	249,668	0.84
Demand (kW)	34.0	28.5	0.84

Statistical results are presented in Table 4-36. The errors given are reported at an 80 percent confidence level. Measurement error was minimal, but was still included in the evaluation. Measurement uncertainty resulted from errors in the utility revenue meters from which the utility bills are obtained, and are conservatively estimated to be 1 percent for the purpose of the calculations. The largest source of error is sampling error, which is calculated using the standard deviation of the realization rates of the 12 intersections. Taking into account the resulting uncertainty value of 9.3 percent, the total verified savings for this project are 249,668 kWh of annual energy, and 28.5 +/- 2.6 kW of peak demand.

Table 4-36: City of Westlake Village Statistical Results

Statistical Measure	Results
Sampled intersections	12 of 15
Standard deviation	0.0680
Sampling error	0.0872
Measurement error	0.0309
Total project error	9.3%

4.4.4 M&V Activities for Sampled Miscellaneous Projects

Table 4-37 below shows the results of the two sampled Miscellaneous ECAA projects. Specific details about each project on which M&V was performed follows after the table.

Table 4-37: Results of Sampled Miscellaneous Projects

Project	Reported Savings (kWh)	Verified Savings (kWh)	Realization Rate	Reported kW Savings	Verified kW Savings	Realization Rate
Antelope Valley College – Solar Heating	12,700 Therms	11,814 Therms	0.93	0	0	--
Mount San Antonio – Thermal Energy Storage	0	0	--	400.0	218.9 ± 41.6	0.55
Totals for 12 Sampled Projects	7,615,313 kWh	7,006,277 kWh	0.92	1,315.1 kW	1,051.1 kW	0.80

4.4.4.1 Antelope Valley College – Solar Heating

The AVCC project has one energy conservation measure (ECM), which adds solar heating capacity to an existing pool boiler system. The modified boiler pipe distribution system has valves and piping added to direct pool water flow to 64 solar panels. It is anticipated that the solar heating system will provide all needed pool heating from April to September. However, due to changes in the sun's position throughout the year, the solar panels will not be able to provide sufficient heating at all times, and the boiler will often need to supplement the solar panels. Savings will result from the reduced operation of the existing boiler. The existing boiler will be used as backup heating for times of the year when the heat generated by the solar collectors is not adequate to maintain pool water at 86 degrees, the temperature desired by the school. As reported in the approved ECAA loan application, this project is expected to save 12,700 therms/year.

The loan recipient to calculate the boiler energy offset by the solar panels used an analysis program called "Heliocol Commercial Pool Energy Savings Analysis". Before installation of this measure, the boiler contributed 100 percent of the heating requirement of the pool water. After the solar panels were installed, the boiler can contribute anywhere from zero to 100 percent of the heating requirement, with the rest of the heating requirement met by the solar panels. The energy savings are determined from that portion of the heating requirement that is met by the solar panels. The heating contribution of the solar panels effectively offsets the heating requirement of the boiler, saving natural gas energy, expressed in units of therms.

A post-installation inspection was conducted on September 9, 2002 to confirm the installation of the solar panels and associated valves and piping. Nameplate information of the boiler was recorded, and the pump was verified as a constant-flow system. The pre- and post-installation control methodology for system operation was also confirmed by interviewing site staff.

Monitoring during a three-month period was completed to provide an operational profile of the solar collectors and to characterize periods when the boiler is needed and when it is not needed to maintain 86-degree pool water. Temperature loggers recorded temperatures in 5-minute intervals at two locations: pool water leaving temperature, and solar collector water leaving temperature. The system controller engages the pump motor whenever it estimates, based on measurements from a rooftop light intensity meter, that the collectors can contribute at least six degrees to the pool water. The collectors are in four parallel arrays of sixteen panels to reduce the total flow and increase the temperature change, which is on average eight to 15 degrees. The flow rate was balanced across the system at 200 GPM during system commissioning.

The change in water temperature from the pool exit to the solar collector exit, along with the known constant flow rate of the water, was sufficient to determine the energy savings of the boiler. Results are reported in one-hour intervals. The following equation was used to compute the project energy savings for each hour of operation:

Equation 1:

$$\text{Energy Saving (Therms)} = \frac{(200\ \text{GPM})(8.34)(\text{SPWLT-PWL})(60)}{100{,}000 * (\text{Boiler Efficiency})}$$

Where:	PWLT	Pool Water Leaving Temperature (°F)
	SPWLT	Solar Panel Water Leaving Temperature (°F)
	8.34	Conversion from gallons to pounds
	60	1 Btu per pound-degree Fahrenheit * 60 minutes/hour conversion
	100,000	Btu per therm conversion

The monitoring occurred during January, February, and March of 2003. Monitoring was to occur during the summer months; however, problems with sensor installation prevented the monitoring until the winter-spring period. As per the approved M&V plan, the data was analyzed and results recorded to yield the hourly therm savings, calculated from Equation 1, and aggregated for the entire month. When the pump was not operating, the temperature difference was minimal, so the hourly savings were automatically assigned zero therm savings. The monthly results were compared to the program-predicted results.

Several variables were tested to determine the effect on energy consumption at AVCC. Nexant reviewed national weather data records, the utility bill data, and enrollment to demonstrate what, if any, correlation exists. Enrollment records show that winter-spring sessions, which began and ended about the same time each year, had similar number of students during the performance period as in the summer session, so these are not major factors and can be ignored in the analysis. The last major variable tested for effect on energy consumption is the normal and actual weather used by the Heliocol program during the actual performance period.

The monthly results were compared to the program-predicted results. The calculated energy savings for the three months of collected data were compared to the energy savings for the same three months as reported by the Heliocol program. The Heliocol program uses average monthly temperature values and solar angles of incidence, as well as engineering assumptions, to estimate the baseline. The Heliocol program is not adjusted based on actual results; therefore, the baseline is constant, and no adjustments need to be made for weather or other variables. The results from the three monitored months were used to extrapolate the results for the remainder of the year.

Savings estimated from the M&V analysis (verified savings) were divided by the savings reported on the ECAA loan application (reported savings) to arrive at the realization rate, shown in Table 4-38. The realization rate for the solar pool heating system may be affected by: (1) abnormal weather patterns, such as less sun, during the performance period; (2) possible changes in operation, such as maintaining the pool to a higher tolerance around the desired 86 degree target during the performance period, thus requiring more boiler heating and; (3) the assumption that the boiler/solar heating control system was properly commissioned in the post-retrofit period. Additionally, Nexant suspects that much of the heating occurred early in the morning, during the coldest part of the day and before there is much daylight. If this is the case, the boiler will provide the majority of the heating before the sun rises, after which the solar collectors are needed only to maintain the 86-degree water temperature throughout the remainder of the day.

The strengths of the M&V process include: (1) use of actual measured temperature data and results; (2) verification of how the solar panel usage depends on solar conditions. The M&V analysis weaknesses include: (1) the assumption that sensors were placed in the best location for measurement; and (2) the ability of sensors to respond quickly enough to the cycling water flow. This would have a direct effect on the recorded volume of water flow. It was anticipated that the pumps would not short-cycle in response to transition times of clouds to sunny periods. The boiler delay and solar controller delay will be adjusted to correct for these transient conditions. It is still anticipated that these conditions will not exist in the summer periods.

Using the results from the analysis, the total project savings were estimated. The overall project results are given in Table 4-38. Statistical results are shown in Table 4-39. The errors in the tables are reported at an 80 percent confidence level. The total verified project savings are 11,814 +/- 2,975 therms.

Table 4-38: AVCC Solar Heating Project Results

Savings	Reported	Verified	Realization Rate
Therms	12,700	11,814	0.93

The sampling error for the solar heating project is equal to zero because the entire population was sampled. The error associated with the utility billing meters is set at three percent. The measurement error reported is actually a combination of measurement error and calculation error. There is an assumed 15 percent measurement error—a conservative value—associated with the flow meters. Another significant error in estimating therm savings for the project is an assumed 20 percent error associated with the monthly insolation (sun) data for the stations closest to AVCC.

Table 4-39: AVCC Solar Heating Statistical Results

Sampling error	0.00
Billing error	0.03
GPM flow error	0.15
Insolation	0.20
Project error (percent)	25.20

4.4.4.2 Mount San Antonio College – Thermal Energy Storage

Mt. San Antonio College (Mt. SAC) replaced two eutectic salt thermal energy storage (TES) systems with ice-storage TES systems. For the two years before project installation, the thermal energy capacity of the existing system was zero, as it was not operational. Instead, chilled water was simply pumped into the holding tanks and distributed to the buildings with no additional benefit of energy storage. This required the chillers to run during peak operational periods. The new TES system relies on air-cooled chillers to charge the holding tanks nightly from 11 PM to approximately 8 AM, depending on cooling needs.

Thermal energy storage systems are effective at reducing or eliminating peak-period demand usage. The TES system allows a facility to generate cooling capacity—generally cold water—during the off-peak nighttime hours, and then circulate this stored cooling capacity during the on-peak daytime hours. Electrical energy usage may increase or decrease, depending on the system chosen. For example, since the cold water produced during the night will continuously increase in temperature as the day goes by, it is usually necessary to produce more cold water, or to chill it to lower temperatures, than would be necessary if the water was immediately circulated after leaving the chiller. This has the effect of requiring additional energy usage. However, chilling water at night, when the ambient temperature is lower, rather than during the day may increase equipment efficiencies. This has the effect of reducing the electrical energy consumption. Mt. SAC chose not to claim electrical energy savings, and Nexant did not investigate changes in energy consumption for this project.

The new TES systems utilize the existing pipe distribution network, storage tanks (with new heat exchangers), existing building pumps, and air-distribution and control systems. As reported in the approved ECAA loan application, this project was expected to save 400 kW peak-demand with no energy (kWh) savings. The measure was installed before the start of M&V activities, so analysis focused on available post-installation data.

A post-installation inspection was conducted on September 9, 2002. The chillers, pumps, glycol storage tanks, energy management system, and chilled water distribution systems are all installed and operational. In the baseline configuration, each building, except Building 11, had its own water-cooled chiller. Building 11 had swamp coolers previously and this is additional cooling capacity; however, the space is nominal (approximately 500 square feet) and offset by the removal of the swamp coolers. The existing chillers remain as back-ups to the central plant, and are connected with three-way valves.

The M&V process focused on comparing actual measured results to the results predicted by the engineering calculations contained in the loan recipient's spreadsheet. An analysis spreadsheet was used by the loan recipient to calculate the peak kW savings resulting from installation of the new TES systems. The spreadsheet relies on engineering calculations, projected hours of operation, adjusted chiller efficiencies, and average yearly weather data to estimate savings. It is based on average values, rather than actual results; thus, the baseline is fixed. Nexant compared the actual energy use, from the monthly utility bills, to the predicted energy use supplied by the project sponsor, so the methodology amounts to verifying the peak kW reduction that was achieved by installation of the TES system. A reality check indicated that the 400 kW reported peak-demand savings is greater than twenty percent of the average peak-hourly demand at Mt. SAC, so it appeared that a billing analysis methodology is appropriate. It is generally accepted that billing analyses should not be performed if the expected project savings are less than 20 percent of the average energy usage.

Nexant carried out the methodology to estimate the actual energy demand saved by using the TES systems during representative periods and compared to the spreadsheet results. The TES plant performance evaluation consists of two subtasks: (1) choose weather correction parameters, and (2) evaluate user-defined variables such as campus population changes.

As reported in the approved ECAA loan application, this measure is primarily to shift kW demand from the peak-demand time-of-use (TOU) period, (weekdays 12 PM to 6 PM), to the off-peak TOU period, (weekdays 11 PM to 8 PM). Utilities provide monthly billing data segmented for on-peak usage during the summer months only; therefore the representative periods are baseline, summer 2000, and performance summer 2002. Enron Energy Marketing Corporation serviced Mt. SAC during the summer of 2000 with rate schedule I-6-DA (direct access), and for summer 2002 Southern California Edison serviced Mt. SAC with rate schedule TOU – DA. The billing month starts approximately on the twenty-first for Enron and the ninth for Edison, so a direct monthly comparison is not possible. Instead, Nexant compared the summer seasonal usage for baseline to performance period with correction parameters to account for influences by other variables on energy usage.

To calculate the average hourly demand during peak periods, Nexant used Equation 1 to normalize the billing data. First, the energy usage is adjusted to count only non-holiday weekdays, and the seasonal usage is normalized by day. Next, Nexant divided the daily usage by the six hours during the peak period to yield the average peak-hourly demand.

Equation 1:

$$\text{Savings } (kW_{\text{peak-period}}) = \Sigma(kWh_{\text{pre-installation}} - kWh_{\text{post-installation}})_i \,/\, (\text{Days}_{\text{summer peak}} * \text{Hours}_{\text{summer peak}})$$

Several variables were tested to determine their effect on energy consumption at Mt. SAC. Nexant reviewed school records, national weather data records, and the utility bill data to demonstrate what, if any, correlation exists. Enrollment records show that summer sessions, which began and ended about the same time each year, had seven percent more students during the performance period, so these are not major factors and can be ignored in the analysis. In addition, the campus buildings affected by the retrofit are not significantly changed in size, class usage and schedule, or population; therefore, these are also not major factors and can be ignored in the analysis. The last major variable tested for effect on energy consumption is the normal and actual weather during both the baseline and performance periods.

Weather effects were characterized by cooling-degree days (CDD) for local stations to best approximate the actual weather experienced by the campus during monitoring periods. A CDD is defined as the cumulative number of degrees in a month or year by which the mean temperature is above the balance-point temperature of a building (generally around 65°F). The National Climatic Data Center (NCDC) publishes CDD figures for both the current monthly averages and the historical monthly averages (1971 to 2000). Analysis of these figures and the utility billing data surprisingly shows no strong correlation between the monthly CDD data and the energy consumption during the baseline or performance periods; however, the summer season has fourteen percent fewer CDDs during the performance period indicating a potential for reduced demand savings. Due to there being no data correlation, it is not possible to quantify this variable. Thus, the billing analysis was performed by directly comparing the per-day average energy usage during the baseline peak-period to the per-day average energy usage during the performance peak-period.

Nexant arrived at the realization rate by estimating savings from the M&V analysis (verified savings), which were then divided by the savings reported on the ECAA loan application (reported savings). These results are in Table 4-40 below.

Low realization rates for the TES project may be due to: (1) fourteen percent fewer CDDs during the performance period; (2) possible changes in operation, such as lowering the average room temperature during the performance period, thus requiring more peak cooling; and (3) assumption that the TES system was properly commissioned in the post-retrofit period.

The strengths of the M&V process include: (1) use of actual billing data and results; (2) consideration of measured CDD data for local stations; and (3) examination of published campus records for enrollment and class schedules. The M&V analysis weaknesses include: (1) the assumption that plug-loads (e.g. computers, toasters, etc.) are constant; and (2) actual room temperatures, baseline and performance period, are not verifiable. This would have a direct effect on the required cooling.

Using the results from the billing analysis, the total project savings were estimated. The overall project results are given in Table 4-40. The statistical results are in Table 4-41. The errors in the tables are reported at an 80 percent confidence level. The total verified project savings are 218.9 +/- 41.6 kW of peak-period demand.

Table 4-40: Mount San Antonio College TES Project Savings

Savings	Reported	Verified	Realization Rate
Demand (kW)	400	218.9	0.55

The sampling error for the TES measure is equal to zero because the entire population was sampled. The measurement error reported is actually a combination of measurement error and calculation error. There is a 1 percent measurement error—a conservative value—associated with the utility revenue meter. Other significant errors in estimating demand savings for the TES are an assumed 5 percent error associated with the monthly CDD data for the stations closest to Mt. SAC, and a 15 percent plug-load error associated with undocumented equipment added to

Table 4-41: Mount San Antonio College TES Statistical Results

Sampling error	0.00
Measurement error	0.11
Plug-load error	0.15
CDD error	0.05
Project error (percent)	**19.0**

4.5 PROGRAM ELEMENT EVALUATION

Table 4-42 summarizes the status of the program element as of July 31, 2003.

Table 4-42: ECAA Loan Program Summary

Statistical Measure	Results
Number of current projects (loans)	65
Number of sampled projects for M&V	12
Reported savings from sampled projects	1.32 MW
Verified savings from sampled projects	1.05 MW
Realization rate (kW) from sampled projects	0.80

The results from the 12 sampled projects were applied to all 87 projects in the ECAA Loan Program. The realization rates determined through the M&V efforts were applied to the reported savings for each of the four project types. Results were then aggregated for the entire program element. Table 4-43 gives the results of the ECAA Loan Program element evaluation.

Table 4-43: Results of ECAA Loan Program Element Evaluation

Population category	Reported Savings (kWh)	Verified Savings (kWh)	Realization Rate	Reported Savings (kW)	Verified Savings (kW)	Realization Rate
Lighting	19,437,991	18,655,322	0.96	3,543	2,975	0.84
HVAC	7,712,263	6,943,980	0.90	1,689	2,203	1.25
LED traffic signals	14,139,988	12,578,513	0.89	1,609	1,434	0.89
Miscellaneous	20,925,689	19,251,634	0.92	3,726	2,880	0.80
ECAA program element	**62,215,930**	**57,429,449**	**0.92**	**10,567**	**9,492**	**0.90**

4.6 PROGRAM ELEMENT COST-EFFECTIVENESS

Cost-effectiveness for the ECAA program element is calculated from the levelized costs of the state’s 2001 program investments, as explained below. The ECAA program element cost effectiveness is determined to be $32.65/kW-year. Final results are given by project in the

Appendix for two different indicators of levelized costs—both peak power and electrical energy impacts are calculated, and are expressed in units of dollars per kilowatt-year ($/kW-year) and dollars per kilowatt-hour ($/kWh), respectively. The program element cost effectiveness for energy impacts is $0.0056/kWh.

The general equation for calculating levelized cost of impacts is taken from the Energy Commission's Standard Practice Manual: Economic Analysis of Demand-Side Management Programs, (1987). The terms are modified slightly to reflect Energy Commission, rather than utility, implementation, but otherwise remain unchanged. The formula for levelized cost at the project level is:

$$LC_{CEC} = LC/IMP$$

Where: LC = total Energy Commission costs used for levelizing

IMP = total discounted demand and energy impacts of the project

These terms are further defined as follows:

$$LC = \sum_{t=1}^{N} \frac{Principal_t - Payments_t + Grants_t}{(1 + d)^{t-1}}$$

$$IMP = \sum_{t=1}^{N} \frac{(\Delta kW_t) \text{ or } (\Delta kWh_t) \text{ or } (\Delta therm_t)}{(1 + d)^{t-1}}$$

Where: Principal = amount of project loan from CEC to project host in year *t*

$Payment_t$ = amount of loan repayment from project host to CEC in year *t*

Grants = amount of ECAA service contract in year *t*

ΔkW_t = summer peak demand impact in year *t*, measured in kW

ΔkWh_t = electrical energy impact in year *t*, measured in kWh

d = State Pool Money Investment Account (PMIA) rate of 4.1 percent. (The 4.1 percent interest rate was in effect in 2001 when the CEC made its decision to fund AB29X.)

N = loan repayment period including principal and interest

Loan repayments are discounted over the lifetime of the project loans, which vary in duration, and are limited to no more than eleven years. Energy and peak demand impacts are levelized over equipment lifetimes, which is an estimate of the median number of years that installed measures are still in place and operable. The September 25, 2000, CALMAC report, Procedures for the Verification of Costs, Benefits, and Shareholder Earnings from Demand-Side Management (DSM) Programs (MA&E Protocols), will be used to identify average equipment lifetimes. By discounting to the common denominators noted above, the overall cost effectiveness can be derived by weighting and combining project impacts.

The Appendix contains the cost-effectiveness indicators for each project within the ECAA Loan Program. The effective subsidy represents the present value of the difference between payments on the below-market loan at 3 percent and baseline financing at the April 2001 PMIA rate. It includes the service contract payment for projects completed before May 1, 2002, and any technical assistance cost spent to date. Projects analyzed in the sample all have attractive cost-effectiveness metrics from the perspective of the magnitude of demand and energy savings achieved per dollar of loan subsidy delivered through the program.

4.7 PARTICIPANT AUDITS

Nexant conducted participant audits for the ECAA program to evaluate participants' compliance with the program rules and requirements such as program eligibility, the application process, program reporting, and repayment of loans. As an adjunct, the audits also provided some indication of the level of satisfaction with the program process and design. All participant audits for the ECAA program were conducted by telephone from December 2002 to mid-January 2003.

Nexant selected to perform participant audits on the 10 participants that constituted the 12 projects that were randomly chosen for the M&V activates. Of the original 10 telephone surveys, seven participants were reached while three were not, even after repeated attempts over a one-month time period. Due to the nature of the ECAA program, it was not necessary for Nexant to perform any administrator audits because of the maturity of the program, now in its 24 year of implementation under Energy Commission administration.

Table 4-44: Audit Participants

Number	Participant Sampled	Loan Project
1	Capistrano USD	Lighting
2	City of Westlake Village	LED Traffic Signals
3	San Francisco General Hospital	Lighting
4	Contra Costa County	HVAC
5	County of Riverside	LED Traffic Signal
6	Piner-Olivet USD	Lighting and HVAC
7	City of Redlands	LED Traffic signals

Nexant developed a collection of 20 structured interview questions to ask program participants. The survey questionnaire was designed to fully cover the necessary research questions while at the same time not unduly keep respondents on the telephone. Of the 20 questions, participants responded to all of them, except for Questions 4, 6, 10, 14, and 17, which one respondent declined to answer, and Question 13, which two respondents declined to answer. Participants did not answer these questions because they either felt the questions were not relevant to their project or they could not recall enough detail to feel confident about their response.

The questions were broken down into specific categories, each covering a different aspect of the program and/or a participant's experience. Questions 1 through 8 ask participants about various aspects of the program such as program marketing, communication, reporting, and verification of results. Table 4-45 lists questions and survey responses regarding program communications. Responses indicate effective outreach and marketing, as well as the importance of the financial assistance. Table 4-46 provides additional detail that highlights the influence of the financial assistance among factors motivating program participation.

Table 4-45: Participant Responses to Program Communication Questions

Questions 1—8 focus on program aspects such as marketing, communication, reporting and verification		
Question Number	**Question**	**Response**
1	How did you find out about the ECAA program element?	4 respondents found out through the Energy Commission; 2 mention the website. 1 answered for each: word of mouth, consultant, and the utility
2*	Why did you participate in the program?	Financial incentives was the most frequent response Second highest responses were between (a) energy savings and (b) the financial benefit of obtaining low-interest rate loans to perform previously scheduled retrofits. One participant answered because of local political pressure.
3	Did you participate in any other similar peak load reduction programs?	4 said no, 3 said yes. Yes answers included: (a) a program with PG&E, (b) ECAA Loan Program battery backup system with the LED traffic signals project, and (c) installation of occupancy sensors.
4	Rate the overall quality of communication with the Energy Commission (5=thorough; 3=sufficient; 1=inadequate)	The average was 4.3 with three responding with 5, two with 4 and one with 1. The frequency of communication between the Energy Commission and participants varied from once, to weekly, to whenever a question arose.
5	By what means did you most often communicate?	Phone and e-mail were the most frequent responses. The only different response was in-person meetings in conjunction with e-mail.
6	Rate the reasonableness of the required reporting requirements (5=very reasonable; 3=somewhat reasonable; 1=very unreasonable)	The average was 4.7 with five responses of 5 and one response of 3. One said there were no reporting requirements; others mentioned progress reports that were due throughout the project implementation.
7	How long did it take for you to be notified about the status of your application after submittal?	Two said two weeks; 1 said four weeks; 2 said one to two months; 1 said less than a week; 1 did not remember
8	Did anyone from the Energy Commission visit your project to verify project completion?	Four said yes, 2 said an auditor visited and 1 could not remember

* More than one answer available for this question

Table 4-46: Participant Motives

Source	No. of Responses
Save energy	2
Rebate	4
Retrofit	2
Political pressure	1
Total	**9**

Questions 9 through 14 ask about how the program went over time and what effects the program had on participants' willingness to undertake efficiency upgrades. Responses listed in Table 4-47 indicate that program procedures pose no significant obstacles to participation, with all participants indicating that they would apply to the same or a similar program in the future.

Table 4-47: Participant Responses to Project Application and Development Process

Questions 9—14 are about the application process and what effect the program had on participants' willingness to undertake energy efficiency upgrades		
Question Number	**Question**	**Response**
9	Did you achieve your peak demand savings goals?	Five said yes; 2 were not sure because final savings numbers were not yet available
10	Rate how significant the obstacles were that you encountered implementing the project (5=no significant obstacles; 3=obstacles were significant, but would do project again; 1=obstacles were prohibitive).	The average was 4.2, with four 5s, one 4, and one 1 (Redlands). Two respondents noted "hang-ups", one with CalTrans and one with a part of the project that never got completed
11	Did you need approvals before project implementation? If yes, did this interfere with or delay the application?	All respondents had to get approval: three from a city/county council and two from a school board. No delays were noted.
12	Do you anticipate having any difficulties in repaying the loan within the time period?	All answered no
13	What is the likelihood that you would have performed peak load-reducing actions without the ECAA program? (5=definitely yes, 3=yes but under different circumstances; 1=definitely no)	The average was 2.7 with five participants responding.
14	From your experience, would you participate again in a similar program? (5=definitely yes; 3 =yes, though under different circumstances; 1=definitely no)	The average was 4.8 with five participants responding with a rating of 5 and one responding with a 4.

Questions 15 through 20 are questions with quantifiable responses offering the respondent a range of 1 to 5 to describe the level of satisfaction around the various program aspects such as about the administrator, the application, and the timeline. Table 4-48 tabulates the survey results. Responses indicated a high level of satisfaction with all program attributes, averaging 4 or higher to each question. Contra Costa County was the only respondent that gave consistently low ratings to program components. It rated the overall program and the Energy Commission both 3, the application and verification processes both 2, and the payment process a 1. Piner-Olivet Unified School District also rated the program a three, attributing that to the different people they had to deal with at Chevron. Riverside County rated the implementation timeline a three.

Table 4-48: Program Attribute Satisfaction Rankings (frequency of response)

Question No.	Question Focus	Low	Ranking			High	Average
		1	2	3	4	5	
15	Overall program	0	0	2	2	3	4.1
16	Administrator	0	0	1	2	4	4.4
17	Application process	0	1	0	3	2	4.0
18	Payment process	1	0	0	3	3	4.0
19	Verification process	0	1	0	1	5	4.4
20	Timeline	0	0	1	2	4	4.4

4.7.1 Non-participant Audits

Nexant performed non-participant audits on those program participants that had not finished either their application or their project after starting the process. The purpose of these audits was to try to discover why participants left the program, if they continued with their energy retrofit projects, and how the program might be altered to accommodate their participation in the future. The audit was composed of five questions:

1. How did you find out about the program?
2. At what point in the application or participation process did you choose to withdraw your application?
3. Why did you withdraw your participation in the CEC Peak Load Reduction Program?
4. Did you perform peak load-reducing actions without this program?
5. Would you participate in a similar program if it met your needs?

Question 1 was open-ended, two and three were multiple choice, and four and five were yes/no questions with room for explanation.

Of the 11 non-participants contacted by Nexant, only one completed the non-participant audit. The San Jose Unified School District withdrew its application because: (1) the process appeared more involved than expected; (2) there was a belief that cheaper money was available elsewhere; (3) and it could participate in a similar program if it found a no-interest loan program.

4.8 CONCLUSIONS

Most of the AB29X-funded projects in the ECAA Loan Program element have been installed and are saving energy and/or peak-demand. At this time, loan recipients have reported 9.8 MW of installed demand savings. Since its inception in 1979, the ECAA Loan Program element has funded energy efficiency projects, load reduction projects, and projects with both energy and demand savings. Since the program is not exclusively focused on peak-demand savings, Nexant has examined results for both peak-demand and energy savings. For this program element, Nexant reports two sets of realization rates—one for peak-demand and one for energy.

Nexant completed M&V activities on 12 randomly selected projects with the AB29X-funded projects. Projects were selected randomly to ensure a diverse range of projects was examined. The results of the M&V analyses indicate that most of the loan recipients have been accurate in reporting energy savings and, to a slightly lesser degree, peak-period demand savings. Nexant's results indicate a program element realization rate of 92 percent for energy savings, and a realization rate of 90 percent for peak-period electrical demand savings. Nexant has verified an ECAA program element annual energy savings of 57,429,449 kWh. Additionally, the verified peak demand savings for the ECAA Loan Program is 9,492 kW ± 1,905 kW. The error analysis for this program element, given in the Appendix, indicates that Nexant's analysis resulted in an 80 percent confidence at a 20 percent precision level, which is the exact level that was specified by the California Energy Commission.

Nexant believes that, at least in some cases, the loan recipients have not been advised of the correct way to calculate peak demand savings. Nexant has reviewed several project applications where the loan recipient has simply subtracted the total demand of the new equipment from the total demand of the old equipment to calculate demand savings. For projects where the equipment does not operate continuously, such as typical lighting projects, this is not reporting peak-demand savings, but rather the maximum-possible coincidental demand savings. As these calculations do not take into account the actual operating schedules of the equipment, the demand savings may be greatly overstated. Compounding this is the fact that, in general, peak-demand savings are more difficult for the loan recipient to accurately predict, and more difficult for the Energy Commission's loan application reviewers to fully and accurately assess. Nexant believes that the ECAA Loan Program is an important and cost-effective means of achieving peak-demand savings, but greater emphasis should be placed on ensuring that loan applications have accurately reported peak-demand savings.

The ECAA program element cost effectiveness has been determined for two indicators—peak-period demand and electrical energy. The program element results are $32.65/kW-year and

$0.0056/kWh, respectively. Cost effectiveness at the project level varied from $2.14/kW-year to over $500/kW-year for peak demand savings.

The participant audits have been completed, and the results are positive for the ECAA Loan Program element. Seven participants were contacted, and the results indicate that they are generally satisfied with the ECAA Loans and Grants Program. Results from the participants were almost all positive, including their experience with Energy Commission staff, the application process, the invoicing process, and the MV&E process. When asked if they would participate in a similar program based on their experience with the ECAA Loan Program, the response was overwhelmingly positive, indicating strong satisfaction with the ECAA program element and a desire to participate in similar programs. Most did not think they would have performed peak-load reduction actions if it were not for the ECAA Loan Program.

Section 5 Innovative Peak Load Reduction Program Element — 2003 Supplemental Report

5.1 BACKGROUND OF PROGRAM ELEMENT

First created by AB 970 with a budget of $8 million and a savings goal of 32 MW, the Innovative Peak Load Reduction (IPLR) program element was continued under SB 5X with an additional budget of $41 million. A funding reallocation in March 2002 ultimately raised the final budget to approximately $51 million. The corresponding savings goal for the SB 5X portion of the IPLR program is 120 MW.

The IPLR offers incentives for a broad range of peak demand reduction projects that are not provided for in the other SB 5X program elements. This program element pays participants up to $250 per kW saved, plus a bonus to grant recipients for any savings that were attained in time to help alleviate the peak shortage anticipated for the summer of 2001.

Funding for IPLR projects is provided via three mechanisms: (1) small grants, (2) large grants, and (3) third-party administrator contracts. Each mechanism represents a segment, or sub-element, of the program. Eligible projects generate peak demand savings through a variety of means, including: energy-efficient equipment retrofits, process improvements, installation of generation equipment, building envelope improvements, and curtailment programs.

5.2 STATUS OF PROGRAM ELEMENT

Under AB 970, ten projects were contracted and completed; representing 32.0 MW of verified demand savings and expending a total of $5,410,940 in funds. Under SB 5X, there are 255 projects under contract, some of which are complete, representing a total verified savings of 105.1 MW and a total expenditure of $25,366,833 in SB 5X funds.

Table 5-1 compares each sub-element's reported savings—that is, the total operational demand savings reported by program participants to the Energy Commission as of March 31, 2003—with the verified savings, which Nexant calculated, based on the results of the analysis of samples of program projects. It also shows the corresponding weighted realization rate, or the relationship between the verified savings and the reported savings.

Table 5-1: Peak Load Reduction Capability by Program Segment

Segment	Reported savings (MW)	Verified savings (MW)	Realization rate (weighted)
Large	54.4	53.3	98.1%
Small	27.6	27.3	98.9%
Third	67.9	56.4	83.0%
Totals	**149.9**	**137.0**	**91.4%**

Table 5-2: Peak Load Reduction Capability by Funding Source

Funding	Program goals (MW)	Reported savings (MW)	2001 Verified savings (MW)	2002 Verified savings (MW)	Realization rate (2002) (weighted)
AB970	32.0	35.6	23.6	32.0*	89.7%
SB5X	120.0	114.3	NA	105.1	91.9%
Totals	**152.0**	**149.9**	**23.6**	**137.0**	**91.4%**

* Peak demand savings from AB 970-funded projects have been adjusted for persistence of savings.

Table 5-2 shows the association of verified savings to funding source. Details on Nexant's method for determining savings verification and associated findings are discussed later in this chapter.

Of the 39[1] projects in the original sample set, three dropped out during the fourth quarter of 2002: Fleetwood Travel Trailer, Fresno Veterans Administration Medical Center, and Victoria's Secret. These projects represent a lost potential demand reduction of 30 kW, 203 kW, and 1,710 kW, respectively. Nexant intentionally over-sampled subpopulations to assure that the precision of the calculated verified savings was not affected by any dropouts and/or missing data. The loss of these projects does not affect the precision of the verified savings.

Of the eight AB 970 projects included in the sample set, all but one reported that their projects are still installed and operational, and are delivering the same level of savings as at the end of 2001. More details are provided in the Persistence Verification discussion, provided in Section 5.7.4.

Table 5-3 shows the contracted peak demand savings for each of the program's five defined customer types: commercial, government, industrial, institutional, and residential. The commercial customers represent the largest portion of contracted peak demand savings in the program element. These customers include corporations, general partnerships, limited liability companies, limited partnerships, and sole proprietors. Table 5-3 also shows that each program segment had one or more business types not participating. This is represented by "NA" in the columns.

Industrial participants represent the second largest portion of contracted demand savings, due to the contributions from a single project, the San Joaquin Valley Energy Partners. With approximately 22 MW of contracted demand savings, this project is the largest individual contributor to the IPLRP.

Nexant based its MV&E activities, including determination of verified savings and cost-effectiveness values, on the subpopulations of project types by technology.

[1] Nexant listed 41 projects in the Third Quarter report sample. This was in error; two listed projects were from AB 970 were not actually in the sample.

Table 5-3: Contracted Demand Savings by Customer Type (MW)

	Program segment			
Business type	**Large grant**	**Small grant**	**Third-party administrator**	**Total**
Commercial	32.5	38.1	46.6	**117.1**
Government	9.2	7.2	NA	**16.4**
Industrial	25.1	0.7	16.5	**42.3**
Institutional	6.7	4.5	NA	**11.2**
Residential	NA	0.1	25.8	**25.9**
Totals	**73.5**	**50.5**	**88.9**	**212.9**

5.3 MV&E APPROACH

Nexant's approach to verifying the demand impact of the program varies by project type. In general, Nexant calculates the difference between peak demand *before* a project is installed (the baseline demand) and the peak demand *after* the project is installed (post-installation demand). Nexant collects data necessary to make calculations from project implementers (during site inspections) and from load metering conducted both before and after installation.

Due to the number and diversity of projects in this program, it has not been feasible to directly monitor and analyze the demand savings and the performance of the entire population of sites. Therefore, Nexant performed direct MV&E activities on a representative sample of projects and then extrapolated these results to estimate the peak demand impacts and program compliance over the entire population.

Sample populations had to be large enough to meet the statistical goal of determining the program’s peak load impacts at 80 percent confidence and 20 percent precision levels. Nexant therefore chose the sample population to achieve results with an 80 percent certainty that the demand savings extrapolated from sampled sub-populations would be within 20 percent of the actual savings for the population-at-large. Generally, the approach for the sampling methodology is to expend analytical efforts in the direction of the greatest demand savings. By performing detailed analysis on large-impact project groups, the greatest degree of precision and confidence can be achieved with the available effort.

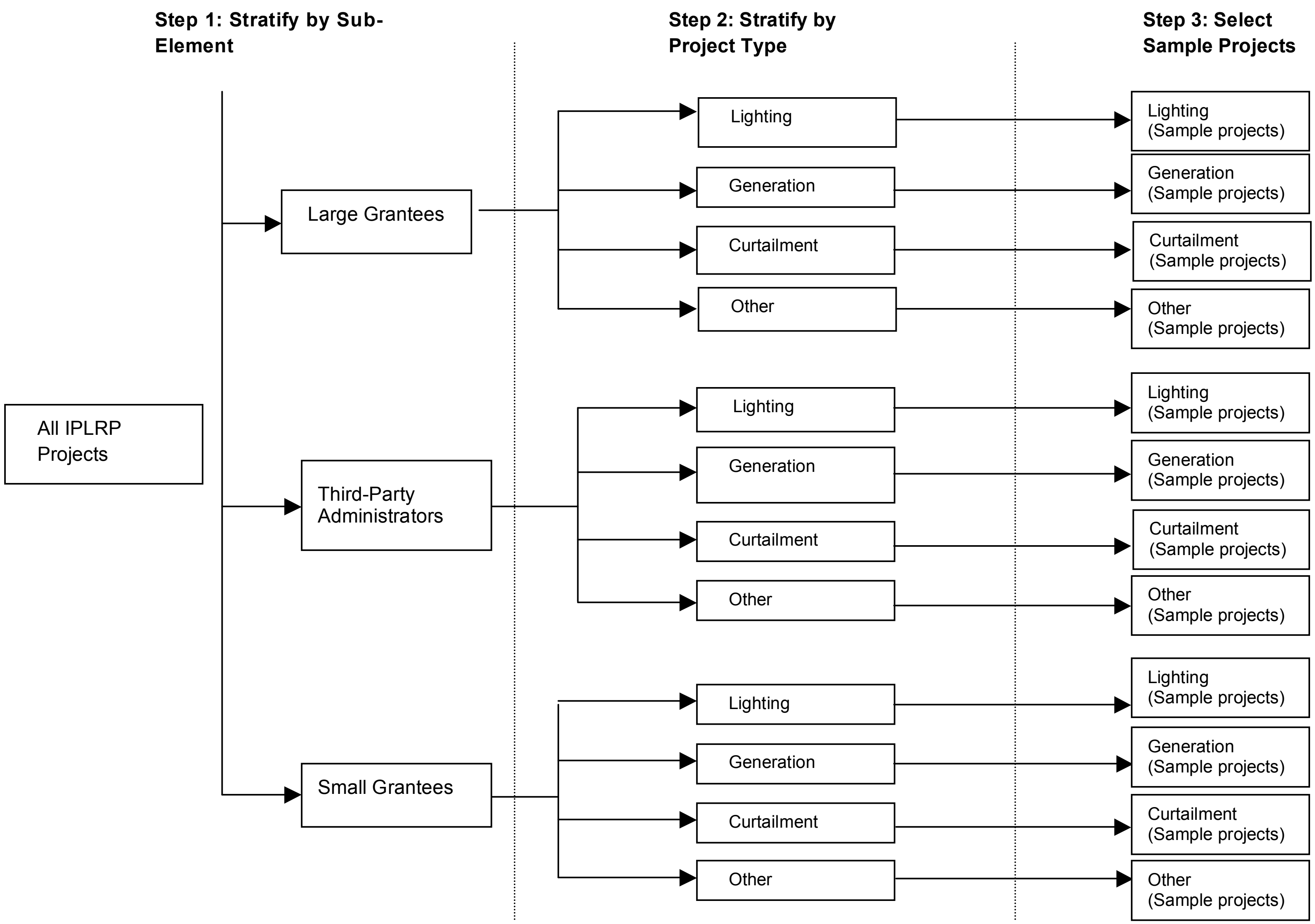
To report on the success of the individual program segments, the sampling plan measured projects from each program segment and addressed two major concerns: (1) that the sample sizes remain at levels to achieve confidence and precision levels as noted above, and (2) that reporting is possible by segment. Nexant derived the sample populations as follows:

1. Divided the total population of projects into the three program segments (small grant, large grant, and third-party).
2. Divided each program segment subpopulation into the four technology types (lighting, generation, curtailment, and other), for a total of 12 sub-populations.

3. Selected sample projects from each of the 12 sub-populations. Projects with large expected impacts, compared to the others in the sub-population, received more attention than those with smaller impacts and a project with more variance received more attention than one with smaller variance. The product of this stratified sampling approach is a specific number of projects, targeted for sampling in each of the 12 sub-populations.
4. Selected appropriate subsamples within sample projects. Some sample projects have multiple sites; in such cases it was necessary for Nexant to select a sample of sites at which to perform direct measurements or calculations of demand impacts. For instance, if a selected lighting project was a large retail store chain implementing efficiency retrofits at all of its California locations, then a sample of stores from the chain would be measured and the results applied to all stores in the chain that were undergoing this efficiency retrofit.

The purpose of this sampling methodology is to provide a comprehensive evaluation of impact at the *program level*, while ensuring that results can be reported at the *segment level*. Accuracy and precision of reported values at the segment level might differ from those of the program level. Actual levels of confidence and precision are determined from the data collected; as a result, they were not known at the program level or the segment level until after the sample was measured. Figure 5-1 illustrates the stratification of project types for sampling.

Figure 5-1: Flow Chart Depicting Project Stratification and Sampling Methodology



To calculate the necessary sub-population sample size to achieve 80 percent confidence at 20 percent precision, Nexant first calculated the sample size for a hypothetical infinite population of projects using the following equation:

$$n^i = \frac{\left[C_v^2 \times z^2\right]}{p^2}$$

Where:

n^i	=	sample size for an infinite population
C_v	=	Coefficient of variation (depends on expected variation of key parameters)
z	=	z-statistic (equal to 1.2817 for an 80 percent confidence level)
p	=	precision level (set at 20 percent for 80/20 reliability)

Then Nexant determined the sample size for a finite population of projects using the following equation:

$$SampleSize = \frac{n^i \times N}{\left(N + n^i\right)}$$

Where:

N	=	size of the actual population to be measured

The coefficient of variance (C_v) is defined as the standard deviation of a group of measurements divided by the mean of that group of measurements. For the sampling plan, an assumed C_v had to be selected, since the actual C_v value cannot be determined until after the project data is gathered and analyzed. The generally accepted value for projects in which no previous measurements exist is 0.5, and this is the value Nexant used for the majority of the calculations in the sampling methodology. Two exceptions exist—first, an assumed C_v of 0.35 was used for the generation sub-populations of each of the three program segments. This is because the kW augmentations are easier to estimate from generation projects, and they are expected to be close to their projected kW augmentations. The second exception, associated with choosing a sample of sites within a single project, was assumed to also have a C_v of 0.35. This is because it is expected that sites within the same project will achieve similar realization rates.

Tables 5-4 and 5-5 show the subpopulation sample sizes for both SB 5X (28 projects) and AB 970 (8 projects). The sample population size is 36 projects.

Table 5-4: SB 5X Subpopulation Sample Sizes

	Program segment			
Technology	**Large grant**	**Small grant**	**Third-party**	**Total**
Lighting	2	4	1	7
Generation	3	0	1	4
Curtailment	3	4	3	10
Other	1	1	5	7
Totals	**9**	**9**	**10**	**28**

Table 5-5: AB 970 Subpopulation Sample Sizes

Technology	Large grant
Lighting	3
Generation	3
Curtailment	2
Other	0
Total	**8**

Reported savings for projects in the AB 970 sample represent 99 percent of total reported savings for the population of AB 970 projects (35.2 MW of 35.6 MW). Reported savings for projects in the SB 5X sample represent 68 percent of total reported savings for the population of SB 5X projects (77.6 MW of 114.3 MW). A high degree of confidence in the evaluation results is directly attributable to the large shares of reported savings that were represented in sampled projects.

5.4 PROGRAM ELEMENT MONITORING AND VERIFICATION

For all sample projects, Nexant performed pre-installation inspections to verify the presence or absence of proposed equipment. Where construction was started or was substantially completed before the inspection, inspectors made an effort to determine which equipment was in place before the retrofit. For each sample project, Nexant also performed post-installation inspections to verify the actual and proper implementation of the project.

For all sampled projects, Nexant calculated the difference between peak demand *before* a project was installed (baseline demand) and *after* the project was installed (post-installation demand). Demand savings were calculated using the following equation:

$$kW_{saved} = \frac{\sum_{2p.m.}^{6p.m.} kWh_{baseline} - \sum_{2p.m.}^{6p.m.} kWh_{post-retrofit}}{4}$$

Where:

kWh = the average energy consumption per day of the affected building(s) or system(s), June through September, between 2 pm and 6 pm on a non-holiday, weekday.

Nexant collected necessary data in several ways, depending on the type and complexity of the project. Overviews of the various data collection approaches are summarized below; the exact procedures used for each project in the sample populations can be found in the appendices to this program element.

In cases where direct-metering data was necessary, Nexant used metering equipment that included portable data loggers, which recorded measurements such as electrical current (amps), light levels, and equipment on/off status, (usually at 15-minute intervals). Additional equipment, such as true-power meters, was sometimes needed to calibrate the data loggers and measure various performance aspects of affected equipment.

5.4.1 Lighting Efficiency and Lighting Controls

Lighting inspections were performed on a sample of the sites to verify the installation of new equipment. The procedure was to use data loggers to determine operating hours and equipment time of use. Standard lighting table information was then used to supply pre- and post-retrofit fixture wattages. These results were then extrapolated and applied to the balance of the sites based on how much old equipment was removed and new equipment installed. For any project, sufficient loggers were installed to achieve an 80 percent precision at 20 percent confidence level, assuming the C_v of the measurement was 0.5.

5.4.2 Deemed Savings Projects

This method was used only for simple measures where savings did not warrant methods that are more rigorous. For a sample of sites, inspections were performed to verify installation of equipment. Where appropriate, data loggers were installed to determine equipment-operating times. Pre-established values (such as watts/square foot) were used to determine baseline and post-retrofit savings. Results from sampled sites were extrapolated to the balance of the sites based on an inventory of installed equipment.

5.4.3 Nameplate Information/Engineering Equations/Spot Measurements

This method was used for simple measures (i.e., equipment with constant load) or when enough onsite energy management system (EMS) data was available to accurately estimate demand from engineering equations. It was also used if equipment had been modified or replaced before alternative M&V strategies could be implemented.

Equipment performance was established using inventories of equipment affected by the measure. For many pieces of equipment, the demand was determined from nameplate information, manufacturer’s specification sheets, or similar sources. Operating hours were taken from EMS or time clock schedules. At a sample of locations, operating hours were measured to verify schedule accuracy and time-of-use allocations.

5.4.4 Performance, System, or Equipment Curves

In this calculation method, standard performance curves were used to determine the demand savings associated with a retrofit or installation project. These performance curves establish a relationship between demand use and equipment operating conditions (CFM, temperature, etc.) affecting equipment load. Spot measurements or short-term monitoring were performed to verify the accuracy of the curves.

For equipment subject to variable-load applications, published performance curves were used to establish equipment demand. Field measurements at multiple operating loads were used to verify the accuracy of the curves. After verifying the accuracy of the curves, the equipment load parameter (temperature, CFM, etc.) was measured directly and the demand was calculated from the performance curve. The post-retrofit demand was either measured directly or estimated through a performance curve or regression analysis. Equipment nameplate information and engineering equations were used to supplement available information.

5.4.5 Regression Analysis

When information was available, regression analysis was used to track equipment electric demand (kW) as a function of one or more independent parameters. To estimate equipment demand, a relationship between the demand use and the independent parameter was established.

For equipment subject to a variable load, regression models of demand as a function of independent variables were used to estimate pre-retrofit demand. The post-retrofit demand was either measured directly or estimated through a performance curve or regression analysis. Equipment nameplate information and engineering equations were used to supplement the available information.

5.4.6 Continuous Direct Monitoring

Where possible, continuous direct metering, using logging equipment, was used to measure the pre- and post-retrofit performance of projects. Many of the projects that involve generation equipment had dedicated utility-grade revenue meters installed on them. From these meters, power and energy, either consumed or produced by equipment, was determined.

5.4.7 Simulation Analysis

Simulation analysis uses computer software (e.g., DOE-2 or similar) to create a model that simulates the energy impact of measure(s) or curtailment strategy. Nexant used this strategy when the energy efficiency measures were too complex or costly to analyze with the traditional M&V methods, such as projects with multiple measures that contain interactive effects.

5.5 PROGRAM ELEMENT EVALUATION

Nexant's findings on the demand impacts of the 36 projects in the sample are presented in Table 5-6. The table lists: a) the sample project, b) the contracted demand impacts, c) Nexant's verified demand impact, and d) a description of the project.

Table 5-6: Measurement and Verification Findings for the Sample Population

Segment	Technology	Name	Reported savings (MW)	Realization rate (Percentage)	Verified savings (MW)	Project description	Status
Funding SB 5X							
Third party	Other	Novatia	2.361	175.7	4.148	Solar-shade window screens	M&V complete
Third party	Generation	SCS Engineers	1.000	71.7	0.717	Landfill-gas-fueled generators	M&V complete
Third party	Curtailment	ECS Energy, Inc.	4.098	100.0	4.097	Lighting and HVAC controls	M&V complete
Third party	Other	ConSol	4.891	57.9	2.830	Comfortwise efficient-home design	M&V complete
Third party	Curtailment	Quantum Consulting	1.345	26.1	0.352	Waste-water treatment plant pump controls	M&V complete
Third party	Other	BOMA of Los Angeles	14.200	117.9	16.739	Lighting and HVAC retrofit	M&V complete
Third party	Other	Proctor Engineering - Commercial	22.319	81.1	18.094	Air-conditioner tune-ups	M&V complete
Third party	Other	Proctor Engineering - Residential	7.789	81.1	6.315	Air-conditioner tune-ups	M&V complete
Third party	Curtailment	SCE Electrodrive	9.260	29.7	2.746	Electric forklift and golf cart battery charger controls	M&V complete
Third party	Lighting	Solatube	0.618	51.0	0.315	Daylighting with skylights	M&V complete
Large	Lighting	Tenet Health Systems	1.816	72.5	1.316	Lighting retrofit	M&V complete
Large	Generation	Los Angeles Valley College	0.433	100.0	0.433	Chiller replacement	M&V complete
Large	Curtailment	East Bay MUD - WWTP	0.090	100.0	0.090	Storage expansion	M&V complete
Large	Curtailment	East Bay MUD - Aqueduct	2.163	88.6	1.917	Process modifications	M&V complete
Large	Lighting	State Center Community College District	0.480	121.2	0.582	Lighting retrofit	M&V complete
Large	Curtailment	Smart & Final	2.188	265.8	5.815	Lighting, HVAC, and refrigeration controls	M&V complete
Large	Other	Johns Manville International Inc	0.923	100.0	0.923	Air-compressor controls	M&V complete
Large	Generation	USA Waste of California	2.500	100.0	2.500	Landfill-gas-fueled generators	M&V complete
Large	Generation	Pure Power	3.600	96.1	3.460	Ethanol microturbines	M&V complete

Segment	Technology	Name	Reported savings (MW)	Realization rate (Percentage)	Verified savings (MW)	Project description	Status
Funding AB 970							
Large	Generation	County of Alameda	0.222	100.0	0.222	Photovoltaic panels on county jail	M&V complete
Large	Curtailment	Lost Hills Water District	1.500	101.5	1.523	Reservoir expansion	M&V complete
Large	Lighting	Mt. San Antonio College	0.500	67.0	0.335	Lighting retrofit	M&V complete
Large	Generation	County of San Diego Public Works	0.225	55.6	0.125	Landfill-gas-fueled generators	M&V complete
Large	Curtailment	Berrenda Mesa Water District	2.600	99.0	2.575	Reservoir expansion	M&V complete
Large	Lighting	County of San Diego	0.414	100.0	0.414	De-lamping	M&V complete
Large	Lighting	Kmart Corporation	7.546	84.5	6.380	Lighting retrofit	M&V complete
Large	Generation	San Joaquin Valley Energy Partners	22.230	90.0	20.000	Biomass-gas-fueled generators	M&V complete
Funding SB 5X							
Small	Lighting	Pilgrim Towers East (L.P.)	0.019	158.4	0.030	Lighting retrofit	M&V complete
Small	Other	City of Lakewood	0.048	100.0	0.048	Thermal energy storage system	M&V complete
Small	Lighting	St. Jude Medical Center	0.101	61.6	0.063	Lighting retrofit	M&V complete
Small	Curtailment	Southern California Water Company	0.216	100.0	0.216	Well rehabilitation and pump retrofit	M&V complete
Small	Curtailment	City of Burbank	0.135	113.3	0.153	Waste-water treatment plant aeration diffusers	M&V complete
Small	Curtailment	City of Fairfield	0.096	162.3	0.155	Lighting retrofit	M&V complete
Small	Curtailment	City of Fremont	0.125	56.9	0.071	Lighting and HVAC retrofit	M&V complete
Small	Curtailment	Ecogate	0.053	49.9	0.026	Dust collection system controls	M&V complete
Small	Lighting	Greater Fresno Area Chamber of Commerce (Phase 2)	0.249	87.3	0.218	Lighting retrofit	M&V complete

Nexant extrapolated the results of the analysis from the sample projects to the entire program population to determine the program-wide demand impacts. The extrapolation methodology involved calculating a realization rate for each sample project. The realization rate is the ratio of verified savings to reported savings. To calculate the realization rate for each project, Nexant used the following equation:

$$RR = \frac{\sum_{j=1}^{n} kW\_verified_j}{\sum_{j=1}^{n} kW\_reported_j}$$

Where:

RR	=	project realization rate
$kW\_verified_j$	=	verified demand savings of site j as determined by Nexant
$kW\_reported_j$	=	demand savings reported for site j by participant
n	=	total number of monitored sites in the project

Nexant then calculated an average realization rate for all sampled projects within a sub-population to determine the subpopulation's realization rate. To do this, the sum of the subpopulation's contracted demand was multiplied by the subpopulation's realization rate to determine the verified demand for that subpopulation. The verified demand for the entire Innovative program element was determined by summing the verified demand for each subpopulation. Nexant used the following equation to calculate the total verified demand for the program element:

$$kW\_reduction = \sum_{k} \left(RR_k \times kW\_reported_k \right)$$

Where:

kW_reduction	=	total verified demand impact for the Innovative program element
RR_k	=	realization rate associated with sub-population k
$kW\_reported_k$	=	total demand reduction reported for sub-population k

Nexant was able to determine the realization rate for each of the 12 subpopulations, with the following exception: Nexant did not include any projects from the small-grant-generation subpopulation, due to the fact that the generation projects were identified and recruited after Nexant had begun its M&V sampling plan. The realization rate for this category is therefore assumed equal to the average of the realization rates from the remaining subpopulations.

Table 5-7 shows the realization rates for each subpopulation, and Table 5-8 shows the verified demand impacts of each subpopulation.

Table 5-7: Subpopulation Realization Rates

	Program segment		
Technology	**Large grant**	**Small grant**	**Third-party**
Lighting	83.9%	100.0%	51.0%
Generation	91.5%	88.0%	71.7%
Curtailment	139.6%	88.3%	48.9%
Other	100.0%	100.0%	93.3%

Table 5-8: Verified Demand Impacts by Subpopulation (MW)

	Program segment			
Technology	**Large grant (MW)**	**Small grant (MW)**	**Third-party (MW)**	**Total (MW)**
Lighting	10.8	18.3	0.3	29.4
Generation	27.0	1.9	0.7	29.6
Curtailment	12.4	0.5	7.2	20.0
Other	3.2	6.7	48.1	58.0
Totals	**53.3**	**27.3**	**56.4**	**137.0**

Tables 5-9 through 5-11 show the application of realization rates to each program segment, broken out by funding source.

Table 5-9: Application of Realization Rates to Large-Grant Segment

	SB 5X		AB 970		Total		
Technology	**Reported (MW)**	**Verified (MW)**	**Reported (MW)**	**Verified (MW)**	**Reported (MW)**	**Verified (MW)**	**Realization rate**
Lighting	4.4	3.6	8.5	7.1	12.8	10.8	83.9%
Generation	6.5	6.4	23.0	20.6	29.5	27.0	91.5%
Curtailment	4.8	8.3	4.1	4.1	8.9	12.4	139.6%
Other	3.1	3.1	0.1	0.1	3.2	3.2	100.0%
Totals	**18.8**	**21.4**	**35.6**	**32.0**	**54.4**	**53.3**	**98.1%**

Table 5-10: Application of Realization Rates to Small-Grant Segment (SB 5X Only)

	SB 5X		
Technology	**Reported (MW)**	**Realization rate**	**Verified (MW)**
Lighting	18.3	100.0%	18.3
Generation	2.1	88.0%	1.9
Curtailment	0.5	88.3%	0.5
Other	6.7	100.0%	6.7
Totals	**27.6**		**27.3**

Table 5-11: Application of Realization Rates to Third-Party Segment (SB 5X Only)

	SB 5X		
Technology	**Reported (MW)**	**Realization rate**	**Verified (MW)**
Lighting	0.6	51.0%	0.3
Generation	1.0	71.7%	0.7
Curtailment	14.7	48.9%	7.2
Other	51.6	93.3%	48.1
Totals	**67.9**		**56.4**

5.5.1 Measurement and Verification Error Analysis

To quantify the level of uncertainty in the program results, Nexant performed an error analysis, using IPMVP guidelines, on the verified demand savings.[2] Nexant determined that the 137.0 MW of overall program verified demand savings had a 5.6 percent precision at the 80 percent confidence level. This level is well within the Energy Commission's goal of 80/20 statistical precision. In other words, Nexant is 80 percent confident that the verified demand savings for the Innovative program are 137.0 ± 7.7 MW.

Nexant first calculated the standard error of individual projects, and then compiled the results to determine the amount of error for the Innovative program as a whole. The sources of uncertainty found in Nexant's analysis come from instrument or measurement error, modeling or calculation error, sampling error, and errors in assumptions and stipulated factors. Nexant's field engineers used professional judgment to establish the magnitude of effects attributable to each potential source of uncertainty, which may vary from project to project. Instrumentation and measurement

[2] Department of Energy, *International Performance Measurement and Verification Protocol, Section 5.10 Calculating Uncertainty*, December 1997.

errors, for example, though typically small in magnitude, can range from as little as 1% to above 5% depending on what type of measurement is required and the precision of the instrument. Other sources of uncertainty (e.g., modeling errors or stipulated values) may have wider ranges, though the process of combining components of uncertainty to derive an expected standard error for an individual project tends to reduce the level of uncertainty around the point estimate of central tendency. Similarly, combining standard error terms for the sampled projects to derive an expected level of precision at the level of the aggregate sample, and so we can reasonably state that program level estimates of precision have a low degree of sensitivity to subjective estimates of error terms at the project level. For this reason, our field engineers typically estimate *larger than expected* ranges of potential error in the project level components of uncertainty. Even with these conservatively large estimates of error terms, the composite level of precision at the 80% confidence interval is comfortably within the Energy Commission's goal.

5.6 COST EFFECTIVENESS

In addition to calculating the demand impacts of each project in the sample population, Nexant also calculated the cost effectiveness of each project in the sample population in order to determine the overall cost effectiveness of the various subpopulations and of the program as a whole.

Program cost effectiveness was calculated in terms of simple costs and levelized costs. The simple cost was calculated by dividing the incentive amount by the verified demand reduction. The levelized cost is expressed as dollars per kilowatt year. The general equation for calculating levelized costs of demand reductions is from the Energy Commission's *Standard Practice Manual: Economic Analysis of Demand-Side Management Programs, (1987).* The formula for levelized cost at the project level is:

$$LC_{project} = IC_{project}/DR_{project}$$

Where:
$LC_{project}$ = levelized cost for individual project ($/kW-yr)
$IC_{project}$ = incentive paid by the Energy Commission for the project ($)
$DR_{project}$ = total discounted demand reduction of the project (kW-yr)

Nexant assumed that because project incentives were distributed as single payments, no discounting of the cash flow was necessary. The demand discount rate was 4.1 percent. Nexant expects project demand reductions to persist from 1 to 25 years, depending on the technology type and the expected operation of the equipment involved. Discounted demand reduction was calculated using the following equation:

$$kW_{disc} = kW_1 + \sum_{i=2}^{t} \frac{kW_i}{(1 + dr)^i}$$

Where

kW_1 = demand reduction for year 1 (kW)
kW_i = demand reduction for year *i* (kW)
dr = discount rate, 4.1%
t = project lifetime in years

The project lifetime of an individual project was based on two factors: (1) the type of technology/equipment installed, and (2) the assumed operational patterns of the equipment. Nexant based a project's lifetime on the effective useful life (EUL) listed in the *California Advisory Council's Master Table of Measure Life Estimates*. This table contains acceptable listings for equipment EULs, given in years, for many different technologies and equipment. EULs from the table were used in the calculation of discounted demand reduction for the majority of projects in this analysis. Where appropriate, Nexant adjusted the EUL up or down based on known or assumed operational patterns of the equipment. For example, an energy-management system used to curtail pump motors may have a listed EUL of fifteen years. If, however, Nexant has reason to believe that the system will be disconnected or disabled within five years, then five years was assumed as the lifetime for that project.

For projects involving more than one measure type, the measure-life for the measure with the most significant demand savings contribution was used.

To determine levelized costs for each subpopulation, Nexant used the following equation:

$$LC_{subpop} = \frac{\sum_{i=1}^{n} IC_{project \cdot i}}{\sum_{i=1}^{n} DR_{project \cdot i}}$$

Where:
LC_{subpop} = levelized cost of subpopulation ($/kW-yr)
$IC_{project\ I}$ = amount of incentive paid by the Energy Commission for project *i* ($)
$DR_{project\ I}$ = total discounted demand reduction of project *i* (kW-yr)
n = number of projects in subpopulation

Tables 5-12 through 5-14 show both the simple cost and levelized cost of the subpopulations of each of the three program segments. Tables 5-15 and 5-16 show the total simple and levelized cost effectiveness.

Table 5-12: Cost Effectiveness for the Large-Grant Segment

Technology	Invoice amount	Verified savings (MW)	Simple cost ($/kW)	Levelized cost ($/kW-yr)
Lighting	$2,857,265	10.8	$265	$24
Generation	$3,640,160	27.0	$135	$36

Technology	Invoice amount	Verified savings (MW)	Simple cost ($/kW)	Levelized cost ($/kW-yr)
Curtailment	$1,779,675	12.4	$144	$19
Other	$702,872	3.2	$220	$21
Totals	**$8,979,972**	**53.3**	**$168**	**$26**

Table 5-13: Cost Effectiveness for the Small-Grant Segment

Technology	Invoice amount	Verified savings (MW)	Simple cost ($/kW)	Levelized cost ($/kW-yr)
Lighting	$4,159,196	18.3	$227	$20
Generation	$526,750	1.9	$284	NA
Curtailment	$89,438	0.5	$192	$19
Other	$1,356,851	6.7	$203	$18
Totals	**$6,132,235**	**27.3**	**$224**	**$20**

Table 5-14: Cost Effectiveness for the Third-Party Segment

Technology	Invoice amount	Verified savings (MW)	Simple cost ($/kW)	Levelized cost ($/kW-yr)
Lighting	$50,000	0.3	$159	$19
Generation	$180,000	0.7	$251	$33
Curtailment	$3,600,661	7.2	$500	$56
Other	$11,834,906	48.1	$246	$34
Totals	**$15,665,567**	**56.4**	**$278**	**$37**

Table 5-15: Cost Effectiveness by Program Segment

Technology	Invoice amount	Verified savings (MW)	Simple cost ($/kW)	Levelized cost ($/kW-yr)
Large-Grant	$8,979,972	53.3	$168	$26
Small-Grant	$6,132,235	27.3	$224	$20
Third Party	$15,665,567	56.4	$278	$37
Totals	**$30,777,773**	**137.0**	**$225**	**$32**

Table 5-16: Cost Effectiveness by Technology

Technology	Invoice amount	Verified savings (MW)	Simple cost ($/kW)	Levelized cost ($/kW-yr)
Lighting	$7,066,461	29.4	$240	$23
Generation	$4,346,910	29.6	$147	$36

Curtailment	$5,469,773	20.0	$273	$34
Other	$13,894,629	58.0	$240	$33
Totals	**$30,777,773**	**137.0**	**$225**	**$32**

5.7 PERSISTENCE VERIFICATION

5.7.1 Introduction

To verify that the AB 970 projects monitored in 2001 were still delivering the same level of demand reductions in 2002, Nexant performed persistence verification activities in the fall of 2002. Persistence verification activities included site visits and phone calls to the original sampled participants inspected as part of the M&V process for the AB 970 projects. Nexant approached persistence verification by trying to find out if: (1) the measure was still in place and operating, (2) there had been any business or operational changes to the project or the site which affected energy savings, (3) the project had performed as planned, and (4) the savings achieved in 2002 were the same as those verified in 2001.

5.7.2 Overview of Activity

Nexant performed persistence verification for the eight projects in the AB 970 M&V sample population. These projects are:

- San Joaquin Valley Energy Partners
- Berrenda Mesa Water District
- County of San Diego
- County of San Diego Public Works
- K-Mart
- Lost Hills Water District
- Mt. San Antonio College
- County of Alameda

To verify persistence, Nexant either did a site visit or performed a phone survey. Nexant determined which projects would be verified via phone or site visit by reviewing project files. If there appeared to be any doubts about a project's implementation, it was added to the site visit list. Participants whose files and reports appeared to be in order received phone calls. Of the eight projects, site visits were used to verify three—San Joaquin Valley Energy Partners, Berrenda Mesa Water District, and County of San Diego. Phone surveys were used to verify the remaining eight.

5.7.3 Summary of Results

All projects were found to still be in place and operating to some extent. Table 5-17 shows the breakdown of responses.

Table 5-17: Persistence Verification Survey Results

	Sampled participant	Project	Project in place and operating?	Changes in operations?	Comments
	Site Visits				
1	San Joaquin Valley Energy Partners	Biomass power plant	Y	Reduced down time	
2	Berrenda Mesa Water District	Reservoir expansion	Y	Yes	
3	County of San Diego	Lighting	Y	N/A	Problems w/ dimming ballasts
	Phone Surveys				
4	County of San Diego Public Works	Landfill gas generation	Y	N/A	
5	K-Mart	Lighting	Y	Decreased store population	
6	Lost Hills Water District	Reservoir expansion	Y	N/A	
7	Mt. San Antonio College	Lighting and HVAC	Y	N/A	
8	County of Alameda	Photovoltaic installation	Y	No	Expanding installation of equipment

During the summer of 2001, the San Joaquin Valley Energy Partners project was able to achieve only 11.0 MW of peak demand impacts, despite having an installed generation capacity of over 24.0 MW. This was primarily due to a high level of facility down time in 2001. For the summer of 2002, San Joaquin Valley Energy Partners, now known as Madera Valley Energy Partners, was able to reduce down time and achieve approximately 20.0 MW of peak demand impacts.

Nexant determined that of the original 134 participating K-Mart stores, 14 had been closed due to bankruptcy, resulting in the persistence of only 90 percent of the verified peak period demand savings. To adjust the peak period demand savings for 2002, Nexant multiplied the verified savings for the K-Mart project from 2001 (7.124 MW) by 90 percent. Nexant originally reported in the 2002 Q4 Innovative Chapter and Appendix that 29 stores had been closed due to bankruptcy. However, only 14 of those stores 29 closed stores participated in original lighting retrofit. Verified peak period demand savings for 2002 were precisely equal to 6.380 MW:

$$(7.124 \text{ MW}) \times (1 - (14/134)) = 6.380 \text{ MW}$$

The San Diego County lighting project reported that more than 100 dimming ballasts have had to be replaced since their installation about a year ago. Of the rooms that Nexant visited, approximately 5-10 percent of the ballasts were not functioning. Our team confirmed that the facility staff replaced ballasts with the same models that were originally installed. Ballast failure should result in lower total demand at the facility; however, in reality equipment failure results in lower savings claims for the project. Because any adjustment to the savings would be small, Nexant did not reduce the verified savings for this project.

For all other projects in our study, the verified savings appear to have persisted at the 2001 level. Table 5-18 compares the 2001 verified savings level with verified savings adjusted for 2002 based on Nexant's persistence verification activities. Only one project, K-Mart, was found to have a drop in savings (0.7 MW) as discussed above.

Table 5-18: Persistence Adjustment to AB 970 Savings

Project	2001 Demand reduction (MW)	2002 Demand reduction (MW)
K-Mart	7.1	6.4
San Joaquin Valley Energy Partners	11.0	20.0
County of San Diego Public Works	0.1	0.1
Berrenda Mesa Water District	2.6	2.6
Lost Hills Water District	1.5	1.5
County of San Diego	0.4	0.4
Mt. San Antonio College	0.3	0.3
County of Alameda	0.2	0.2
Totals (sample)	**23.2**	**31.6**
Totals (AB 970 population)	**23.6**	**31.9**

5.7.4 Persistence Verification Conclusions

The findings of Nexant's AB 970 persistence verification efforts show that the 2001 verified demand savings persisted through 2002 for the sample population. Additionally, several of the projects for which savings have persisted have been expanded, based on the success of the original project. For example, at Mt. San Antonio College the lighting and HVAC project went so well that another phase will be started. Alameda County expanded its photovoltaic solar rooftop system in 2002. Berrenda Mesa Water District notified Nexant that it had increased its water storage capacity. K-Mart had installed more lighting projects, reportedly yielding an additional 1 MW of demand savings. These anecdotal savings are considered as free-drivers that are not direct effects resulting from the program, so they are not included in either reported or verified savings attributable to the program.

5.8 ADMINISTRATOR AND PARTICIPANT AUDITS

5.8.1 Administrator Performance Audits

The purpose of the program administrator audit is to determine the effectiveness of third-party program administration for the Energy Commission's PLRP. In the Innovative program element, there are nine administrators in the third-party administrator sub-element. These administrators are contractors who developed their own plan to recruit participants who implemented a single type (or one of just a few types) of peak load reduction measure. These administrators each have different requirements and different methods of dispersing incentive funds.

The tenth contract is with Xenergy, who is responsible for administering the small-grant sub-element. Xenergy's projects have demand impacts between 20-400 kW. Their administration of this part of the Innovative program is similar to the Energy Commission's administration of grants for those projects with demand reductions greater than 400 kW.

For the Innovative program, Nexant audited Xenergy and their nine third-party administrators:

1. Building Owners and Managers Association of Los Angeles (BOMA)
2. SCS Engineers
3. Southern California Edison Electrodrive
4. ECS Energy, Inc.
5. Solatube
6. Quantum Consulting
7. Proctor Engineering
8. ConSol
9. Novatia

Nexant's administrative audits took place between December 2002 and March 2003 at the administrator's office. All of the administrators allowed Nexant to review a sample of their program files to verify that a proper tracking system was in place, which justified project payments.

Methodology for Audits

Nexant developed a checklist to use for administrator audits. This checklist was based on the administrator requirements defined by Energy Commission contracts, and on key performance indicators such as participant recruitment, customer service, M&V, and delivery of demand savings. Each of the ten administrators, all of the third-party administrators and Xenergy, was evaluated based upon the criteria outlined in this audit checklist. Information for the completion of the checklist was gathered through administrator interviews and onsite audits of administrators' records.

The questionnaire elicited feedback from participants on such criteria as advertisements, the application process, administrator customer service, and administrator M&V. The audit checklist form and participant questionnaire can be found in the appendices to this report.

Administrator Audit Checklist

The administrative audit consisted of six categories, each with its own focus. These categories were:

1. *Participant Recruitment*—determined what methods and materials administrators used to market the program and how successful they were. Criteria considered included use of sales force, communication with vendors, use of flyers and websites, and number of participants and dropouts.
2. *Customer Service*—determined what offerings administrators made to participants to assist them in project implementation. Criteria considered included incentives, equipment, services, and training.
3. *Project Eligibility*—determined whether projects were eligible as defined by the administrator's program guidelines. Criteria considered included demand reduction or supply augmentation, prior project operability, duration of project, measurability of savings, and size of the participants' facilities.
4. *Verification Requirements*—determined the breadth and depth of the administrators' verification process. Criteria included cooperation with third-party verification contractor M&V efforts, method of verification (site visit, data monitoring), and verification sampling plans.
5. *Reporting*—determined the administrators' compliance with program reporting requirements, including participation and savings updates and general communication with contract manager.
6. *Documentation*—determined whether the administrator kept proper records for participating projects. Criteria considered include hardcopy and electronic filing systems, invoices, and incentive payment tracking.

5.8.2 Summary of Results

Below are the 15 questions Nexant used for the administrative audits. The first seven questions cover each area of the administrators' responsibilities throughout the program process. The last six questions investigate administrators' record-keeping practices to discern their level of organization and to check that the procedures and responsibilities required by the Energy Commission have been followed. For questions 1, 2, and 7 the respondents could give more than one answer.

Question 1: How were participants recruited?

The most common answers were through vendors or industry associations and by use of an internal sales force. Specific recruitment efforts include the following:

- ECS Energy worked through the California Hotel and Lodging Association.
- Xenergy had an elaborate marketing plan, which clearly laid out its strategy. Xenergy listed over 30 associations to contact in their plan. Xenergy also held eight statewide informational seminars for potential vendors of the program.

- SCS got in touch with its internal field services group, which already maintained 50 landfill sites that were targets for this program.
- For Electrodrive, SCE account representatives brought in about 50 percent of the business.
- Consol had three sales people placed regionally around the state.
- Solatube exhibited at Edison Electric Institute conferences, and cold-called attendees from the conferences and companies mentioned in *Chain Store Age* magazine.
- Quantum targeted geographic regions and looked at city websites to determine potential customers.

Table 5-19 is a matrix of the administrators and the methods they used to recruit program participants.

Table 5-19: Administrator Recruitment Methods

Administrator	Internal sales force	Existing customers	Vendors/ associations	Tradeshows
Xenergy	X		X	
BOMA			X	
SCS	X	X		
Electrodrive	X	X	X	
ECS			X	X
Solatube	X			X
Quantum	X			
Proctor		X	X	
ConSol	X	X		
Novatia			X	

Question 2: What marketing material did you use to attract participants?

Marketing material to reach prospective customers included: (1) program fliers (2) ads in targeted publications, (3) websites, and (4) direct mailings. Specific responses included the following:

- BOMA used its own newsletter and local newspaper coverage to reach participants.
- A contractor in Proctor's program placed a television spot in Los Angeles; others used print ads.

- Novatia contractors used radio, TV, newspaper, and magazines to advertise the program.
- ConSol assisted at new houses grand openings that used its program.
- Xenergy conducted 13 seminars around the state.

Table 5-20 shows the breakdown of answers to Question 2.

Table 5-20: Administrator Marketing Materials

Administrator	Flyers	Advertisements	Website	Other
Xenergy	X			Direct mail, seminars, telemarketing
BOMA		X	X	E-mail and fax alerts
SCS	X		X	Publish papers
Electrodrive	X		X	
ECS	X	X		
Solatube	X	X		
Quantum	X			
Proctor	X	X	X	Direct mail
ConSol	X	X		At grand openings
Novatia		X	X	
Totals	**8**	**6**	**5**	

Question 3: A two-part question: a) How many participants are participating as of December 31, 2002, and b) How many participants dropped out since September 2000?

Administrators reported the numbers of participants who have completed projects, who committed to projects, and those that dropped out of the program since September 2000 (see Table 5-21). Dropouts are defined as participants who ended their participation prior to project completion. This definition does not include potential participants whose applications were rejected.

- Approximately 50 of Xenergy's participants dropped out. Most of these cited the effects of the weakening economy on their businesses as reasons for leaving the program. According to Xenergy's records, 196 participants either dropped out or were rejected by the administrator. Some of the reasons Xenergy rejected participants were: free riders, non-responsiveness or non-compliance with program guidelines.
- ECS cited post-September 11, 2001 financial struggles for many of their program dropouts. The hospitality industry was hit hard by this event.

Table 5-21: Number of Participants and Dropouts

Administrator	Participant sites	Dropped out
Xenergy	129	50
BOMA	300	0
SCS	2	1
Electrodrive	74	0
ECS	60 hotels; 12,683 rooms	45 hotels
Solatube	3	0
Quantum	6	0
Proctor	35,647	0
ConSol	1,624	N/A
Novatia	15,138	0

Question 4: How has your reported MW changed with the level of participants?

Quantum Consulting noted that based on their research and experience, each of their projects could achieve a 150 kW reduction. As the participant level increased, the baseline savings level was raised to 50-100 kW.

ConSol mentioned that the program was growing, but it takes a while to get participants online.

Xenergy stated that after the initial deadline of July 30, 2001, the program was opened to projects above 400 kW; therefore, savings increased.

Question 5: What equipment and services did you offer to participants?

Program participants received a range of equipment, services, and financial incentives depending on the administrator and the type of proposed project. Table 5-22 shows what each one offered.

Table 5-22: Equipment and Services Offered to Participants

Administrator	Equipment	Services	Incentives
Xenergy	N/A	N/A	$250/kW
BOMA	N/A	N/A	$213/kW
SCS	Turbine and equipment skid	Design, turnkey, O&M contract	$250/kW
Electrodrive	Energy management system; Signage to remind operators of program compliance requirements; Signage to warn operators not to leave batteries connected for long intervals	Training and programming services; Upon request, information on battery charging impacts and battery life; Upon request, electric rate analysis	
ECS	Guest room control systems (motion sensor and door lock switch); Monitors which	Monthly reports and recommendations; Online access to reporting and analysis on ECS website	$62.50/room

Administrator	Equipment	Services	Incentives
	download to ECS database (included in the program)		
Solatube	Skylights; Required to use photo-controllers	Installation partners; assistance with lighting audits, CAD layouts, and payback calculations	$56/unit
Quantum	Process optimization-monitoring and control equipment ranging from timers to EMS (SCADA)	24 hr, 15 minute interval readings	Custom grants
Proctor	N/A	Testing of air conditioner refrigerant charge and airflow; if repairs needed, perform them; then test again after repairs; and finally send a certificate one week after test with educational info about results and maintenance as a 3rd party verification, which includes feedback/satisfaction/problem form and phone number	To contractors: $20 / initial residential run; $30 / residential run after repair; $35 / initial commercial (<5 tons); $75/ commercial (<5 tons) after repair; $35 / initial commercial (>5 tons), $125/ commercial (>5 tons) after repair
ConSol	Plaque for house once certified	Specify highly efficient windows, and mechanical systems; downsize mechanical systems; provide installation specifications-scopes of work for insulation, air conditioning, and windows	N/A
Novatia	Solar Screen	N/A	$1/sq ft

Question 6: Were participants offered training or any other instructional help during any time of their participation?

All the third-party administrators, with the exception of BOMA, offered training to participants. Half of the third party administrators gave participants technical manuals to help them run their projects. Below are some additional offerings:

- Working through its installation contractors, Electrodrive offered their customers systems training.
- SCE provided contractors installation training, program compliance and procedure orientation in late 2001 through early 2002.
- Honeywell provided installation training, program compliance and procedure orientation for contractors in late 2001 and early 2002, and provided data monitoring training for customers.
- Quantum trained operators on how to read data and use it for reducing aeration.
- Proctor had a one-day training for contractors.
- ConSol trained site supervisors and sales people at housing developments.
- Novatia gave contractors marketing training.
- SCS signed operating and maintenance contracts with participants for their projects.

- ECS performed monthly analysis for participants and gave recommendations on how they could further enhance savings

Question 7: How did you evaluate your projects?

Five of the administrators listed eligibility criteria other than size that applicants had to meet. For example, Xenergy had a specific list of eligible project types; Solatube looked at expected lighting levels; and Novatia checked for north-facing windows. Four of the administrators listed feasibility studies and engineering calculations to estimate savings. Three administrators specifically noted size restrictions, usually a minimum standard of building size or energy use. SCS required projects to be at least 60 kW, and ECS had a 75-room minimum for hotel size. This breakdown is displayed graphically in Table 5-23.

Table 5-23: Evaluation Criteria

Administrator	Feasibility study	Size of demand impact	Project type	Calculations
Xenergy			X	X
BOMA				X
SCS	X	X		
Electrodrive			X	
ECS	X	X	X	
Solatube		X	X	
Quantum	X			
Proctor	X			X
ConSol				X
Novatia			X	

In addition to technical criteria, Quantum looked for the presence of any recent code violations and a willingness of the facility staff to make the project a success. Novatia required installers to know the eligibility criteria when visiting a customer. This sometimes led to customers being rejected, after a product was installed, due to the installer's evaluation error. According to Novatia's program guidelines, the installers were also responsible to rectify any problems that developed.

Question 8: A) How did you verify installations?

B) How many participants or sites were verified?

C) Did you use a sampling plan for this?

Fifty percent of the administrators verified every one of their project installations by either site visits, photographs of completed projects, or data collection. The remaining administrators used sampling plans for on-site verification and performed calculations for the rest of the projects. Table 5-24 offers more detailed findings:

Table 5-24: Verification Procedures

Administrator	Verification approach practiced	Number of participants or sites verified	Sampling plan used
Xenergy	Project completion form, invoices, and random and flagged inspections	45 sites were pre-inspected; 13 out of 129 were post-fielded	20% of grant agreement sites pre-inspected; 10% of completed projects post-inspected; all "red flagged" projects inspected
BOMA	Baseline sites, post-installation performance of vendors, and equipment were verified; Contracts and invoices for equipment were reviewed.	300	All
SCS	Turnkey for 2 participants, periodic checks of others; computer system in SCS office gathered all data	2	All
Electrodrive	Count chargers, record nameplate data and verifying the EMS load shift schedules were within program compliance limits; Remote dial-up or internet operational verification performed at completion of installation, 100% monthly by Honeywell DMC Services during summer 2002	11 out of 74 were inspected between Feb and July 2002	SCE verified a sample of Honeywell dial-up data retrievals
ECS	Checked all monitoring systems; cross-checked utility bills with monitored data for commissioning and monitoring; looked at pre- and post-data; if any negative savings occurred then checked with the vendor	60 hotels and 12,683 rooms	All
Solatube	Verify light fixtures ahead; either request photos or physically walk the building after completion	3	All
Quantum	Visited every facility	6	All
Proctor	Tested units before and after service, checked 6 temperature points and 2 pressure points, used digital thermometer; performed statistical tests on data to look for patterns, which might precipitate site visits	Several out of 35,647	Did a random sample of follow-up visits in addition to site visits
ConSol	Inspect and test during building for downsizing; 9 raters in CA	67 out of 1,624	Looked at minimum of 1 in 7 homes; looked at every plan type
Novatia	Nexant onsite inspections; performed some installer audits to confirm that calculations were correct; phone interviews were done with some installers	N/A	Spot-checked applications for rebates over $300; 1 out of every 20 applications spot-checked

Question 9: What method was used to track and report project progress to the Energy Commission and/or the M&V contractor?

All administrators had an electronic list of projects either in Microsoft Access®, Microsoft Excel®, or Microsoft Word®. Proctor Engineering had numerous databases, which were used to analyze data, track charges to the Energy Commission, or generate checks for participants—which was outsourced. Proctor also had a built-in feedback loop with contractors and customers, as well as incidence reports for customers to report problem projects.

ConSol uses a database that mirrors the California Home Energy Efficiency Rating System (CHEERS) registry on the Internet, capturing all the relevant program data. ECS retrieved monitoring data from its sites and stored it on its Los Angeles server. For Quantum, the vendor, BacGen, could dial into the data system; however, all of the data is stored at their facilities.

All administrators prepared a monthly status report for the Energy Commission. For Electrodrive, Honeywell produced weekly tracking and compliance reports. For the ConSol program, the Energy Commission received copies of the CHEERS certificates for homes that complete installation. Regular reports were given to the M&V contractor only when requested.

Record Keeping

Questions 10-15 rate the administrators' record keeping abilities. A 1- to 5-point evaluation scale was developed for each question, 5 being the highest score for any question, while 1 signifies the lowest achievable score. Below each question is a description of how the scale was applied.

The Administrators being evaluated did not have advance notice of the questions that were asked them. Nexant's evaluation procedure was to sample 10 files from each administrator. If there were fewer than 10 completed project files, Nexant reviewed all of the available files. Files were selected randomly from a project list or from filing cabinets at the administrator's site. Files selected were both electronic and hardcopy. When both were available, Nexant staff tried to reconcile between the two forms of information.

Question 10: Are documents available for the sampled projects in question?

On the 5-point scale, 5 = All requested documents were available; 3 = Half of requested documents were available; 1 = No documents were available.

Question 11: Were invoices valid—as shown by proper documentation and consistent with the initial agreements between parties involved and the program requirements?

Where 5 = All invoices were consistent; 3 = Half of the invoices were consistent; 1 = Invoices were completely inconsistent or not available.

Question 12: Was the verification process noted above followed?

Where 5 = Thorough verification process with full documentation; 3 = Nexant observed two or more significant deviations from the verification process, but these were explained; 1 = No verification process or the process was not at all according to plan.

Question 13: Did the installed equipment agree with the invoice?

Where 5 = A complete consistency between invoices and equipment; 3 = Staff observed two or more discrepancies between invoices and equipment; 1 = Invoices were completely inconsistent with equipment or not available.

Question 14: Were participants paid according to the customer agreement?

Where 5 = All payments were made according to customer agreements; 3 = Most payments, with few discrepancies, were made according to customer agreements; 1 = Payments were not made at all, or were not made according to agreements, or all payments were made and were in dispute.

Question 15: Was the tracking/reporting method noted above maintained?

Where 5 = Actual tracking/reported method is consistent with planned method, with data available for all requested participant sites; 3 = A few deviations from the planned method, or half of the records were inadequate or missing; 1 = No effective tracking method observed, or the data was found to be completely inaccurate.

Table 5-25 shows the actual ratings for each administrator for each file component.

Table 5-25: Questions 10-15 Administrator Record-Keeping

	Question 10	Question 11	Question 12	Question 13	Question 14	Question 15
Administrator	**Files**	**Invoices**	**Verification**	**Equipment**	**Payment**	**Tracking**
Xenergy	5	4	4	4	5	5
BOMA	4	3.5	5	3.5	3.5	5
SCS	5	5	5	4	4	5
Electrodrive	5	5	5	5	5	5
ECS	5	5	4	5	5	5
Solatube	5	5	5	4	5	5
Quantum	3	2	2	1	1	3
Proctor	5	5	4	5	5	5
ConSol	4	5	5	4	5	4
Novatia	5	5	4	5	5	5
Averages	**4.6**	**4.5**	**4.3**	**4.1**	**4.4**	**4.7**

Administrator records were in order and administrative processes succeeded except in one case. The lowest average scoring performance attributes (agreement of invoicing and equipment documentation, and documentation of the verification process) was above 4 for the program as a whole, leading Nexant to conclude that the third-party administrators effectively administered the program.

Only one third-party administrator, Quantum, received a rating of three or less for Questions 12-14. No documentation of verification visits was kept; those visits were considered visual inspections. Similarly, because there was neither verification documentation nor other notice of installed equipment, it was difficult to confirm that equipment installed agreed with invoices. The administrator stated that the Energy Commission was conducting an inquiry into the payment process. Nexant contacted the Innovative program manager at the Energy Commission and will defer to the Energy Commission's findings on this matter.

Question 14b: Out of the overall budget, what was the percent allowed for incentives, administration activities, other (specify)?

Five of the administrators took an administrative fee, either based on actual labor and expenses or a flat percent of the overall budget. Four administrators took a commission on each unit or project they completed. SCS and Solatube took no fees from the Energy Commission. They viewed the program as a marketing tool for their product or services. The results are illustrated in Table 5-26.

Table 5-26: Administrator Payment Methods

Administrator	Administrative fee (percent of contract)	Commission	No fee
Xenergy	15.0		
BOMA	15.0		
SCS			X
Electrodrive	20.0		
ECS	Labor costs	X	
Solatube			X
Quantum	6.5		
Proctor		X	
ConSol		X	
Novatia	31.0		

The equipment, services, and rebates administrators offered to participants cover the necessary aspects of project implementation and financing, and are well focused for each of the program's audiences. The administrative processes that have been set up and executed succeeded in: choosing viable candidates while weeding out unsuitable applications; verifying project completion; tracking and reporting project progress; and getting payments out to participants.

5.8.3 Participant Audits

Participant audits were conducted on large and small grant participants as a check on the accuracy of the administrators' records and as a means to determine the degree of participant satisfaction with the administrator's performance. In the Innovative program element, there are three separate types of participants (corresponding with the three program segments):

- Large-grant participants conducted projects at their own facilities. Their grant managers are Energy Commission staff members, and their incentive payments come directly from them.
- Small-grant participants conducted projects at their own facilities; however, their grant managers are staff of Xenergy, Inc. Xenergy forecasts the grant payments they expect to make over six-months or so, and then requests an advance from the Energy Commission to cover the payments. They have been delegated the authority to make grant payments as they determine a project has been successfully completed. No additional signal from the Energy Commission is required.
- Third-party administrator participants have projects whose demand savings vary greatly, as each of the administrators is distributing incentives for different demand reduction measures. Depending on the administrator's program structure, these projects may or may not be managed by the administrator, but in most cases the incentive payment comes from the administrator.

Nexant developed a participant audit survey based on the Innovative program's guidelines and participant contracts and/or grant agreements. The audit survey was administered to a sample of program participants from the large and small grant program segments. Nexant performed program participant surveys over the phone.

The participant audit encompassed five categories, each with its own focus. These categories were:

1. *Application Process*–the participant's compliance with program application guidelines and timeline, and their level of cooperation with application reviewers.
2. *Reporting*–the participant's compliance with program reporting requirements, including timeline, content, and general communication with contract manager.
3. *Project Timeline and Completion*–whether or not the participant upheld the timeline outlined in its agreement. Criteria considered included timeliness and correctness of installation, obstacles to project completion, and communication of delays to the Energy Commission manager.

4. *M&V Requirements*–the level of cooperation with M&V requirements adhered to by the participant. Criteria included cooperation with both administrator and third-party verification contractor M&V efforts, and provision of access to facilities and records.
5. *Miscellaneous*–this category was reserved for unique programmatic requirements, such as insurance requirements and special requirements of the individual participant contract.

Nexant attempted to contact 20 participants—all of whose projects had been included in the M&V sample population—and was successful in completing 15 audits (five participants were never reached despite repeated attempts). Table 5-27 shows the breakdown of audited projects by program segment.

Table 5-27: Participant Surveys and Inspected Projects by Program Segment

	Small grant	Responded	Large grant	Responded
1	St. Jude Medical Center	X	Smart & Final	X
2	City of Lakewood	X	East Bay Municipal Utility District – Waste Water Treatment Plant	X
3	Pilgrim Towers East	X	East Bay MUD - Aqueduct	X
4	City of Burbank	X	USA Waste of California	
5	Fleetwood Travel Trailer	X	Pure Power	X
6	Southern California Water Company	X	City of Fremont	X
7	EcoGate	X	Johns Manville International, Inc.	
8	Fresno Veterans Administration Medical Center		Tenet Health Systems	X
9	Fresno Area Chamber of Commerce		Los Angeles Valley College	X
10	City of Fairfield	X	State Center Community College District	
Totals		**8**		**7**

5.8.4 Summary of Results

Below is a series of charts and discussion categorizing the responses of 15 program participants to each of 17 questions. Seventeen questions were determined to be an appropriate number to cover all categories of interest, while not keeping respondents on the phone longer than was thought reasonable. The first eight questions ask participants about each aspect of the program's process, such as marketing, communication, reporting, and verification. Questions 9-11 inquire about how the process went and what effect the program had on the participants' willingness to undertake an efficiency upgrade. Questions 12-17 ask for ratings of the participants' level of satisfaction with each aspect of the program, such as the administrator, the application, and the program timeline. Not every respondent gave an answer to every question, so total tallies may not always add up to 15 responses.

Question 1: How did you find out about the Energy Commission Innovative Program?

The Energy Commission was the most cited source of information about the program. Four respondents specifically mentioned the Energy Commission's website; one respondent found out through an energy service company (ESCO); one other respondent, Southern California Water Company, said that its consultant monitored the legislative process wherein the Energy Commission was awarded the funds. The breakdown of responses is shown in Table 5-28.

Table 5-28: Source of Program Information

Source	No. of Responses
Energy Commission	8
Utility	2
ESCO	1
Other	1
Total	**12**

Question 2: Why did you participate in the program?

Participants could give more than one answer to this question. As a result, the total number of responses is greater than the number of survey participants. The financial incentive was the most given answer. Two specific responses were (1) funding reduced bottom line costs and subsequent customer costs, and (2) funding saved capital expenditures of a project. Other answers include (1) the fact that the participant wanted to perform a retrofit anyway and decided to get the grant to make it more economical; (2) to demonstrate a new technology; (3) pressure from a city council; and (4) because the program is statewide, different utilities didn't have to be coordinated. The breakdown of answers is shown in Table 5-29.

Table 5-29: Participants' Motives

Source	Number of responses
Rebate/Cost Savings	10
Retrofit	3
Demonstration	1
Statewide	1
Political Pressure	1
Total	**16**

Question 3: Did you participate in any other similar peak load reduction programs?

Eleven respondents answered yes, and four answered no. Programs cited include other state peak load reduction programs being offered by PG&E, SCE, and SDG&E, as well as by the Los Angeles Department of Water and Power and Sacramento Municipal Utility District.

Questions 4, 6, and 13-18 below, ask participants to rate administrators' communication. Each question has a 5-point scale developed by Nexant. A 5 rating is the highest, a 1 the lowest. The exact meaning of the scale is described along with each question.

Question 4: Rate the overall quality of the communication process with your administrator (5=complete; 3=sufficient; 1=absent or inadequate)

All respondents answered and the average rating was 4.6. All Large Grant respondents gave a 5 rating, while the Small Grant average rating was 4.3. Respondents said that communication was generally on a monthly basis, coinciding with status reports.

Question 5: By what means did you most often communicate?

All respondents answered that communication primarily took place either by telephone or email. In addition, one respondent each noted fax, regular mail, and their Energy Service Company as secondary communication methods.

Question 6: Rate the reasonableness of the reporting requirements you were required to fulfill (5=Very reasonable and easy; 3=Somewhat reasonable, with some challenges; 1=Very challenging)

There were 14 responses to this question. The average rating was 4.8. Large Grant respondents gave an average rating of 4.9, while the Small Grant average rating was 4.7. Most respondents listed monthly progress reports as the only requirement. One respondent mentioned pre- and post-installation measurements and efficiency analysis.

Question 7: How long did it take for you to be notified about your application status after you submitted it?

The majority of the respondents said it took from one week to a month to find out about their application status. Three did not recall the length of time. See Table 5-30 for full details.

Table 5-30: Administrator Application Response Time

Metric	No. of responses
Days	3
Weeks	5
Months	3
Not sure	4
Total	**15**

Question 8: Did your program administrator visit your project to verify project completion?

All 15 respondents answered: 11 answered yes, three answered no, and one did not answer because they were still processing the paperwork.

Question 9: Rate the obstacles you encountered and whether you would implement the project again (5 = No significant obstacles; 3 = Obstacles were significant, but would conduct project again; 1 = Obstacles were prohibitive)

Answers were received from all of the respondents. The average rating was 4.1. Large Grant respondents gave an average rating of 4.0, while the Small Grant average rating was 4.3. The following are some specific comments that Nexant recorded:

- Installation was difficult when the HVAC units had to be changed out when the building was occupied, rather than unoccupied as originally planned.
- Sites were sold, closed, and reorganized. Problems were not related to the program.
- Limited time often reduced savings potential.
- Sites with the least savings potential were eliminated due to limited project costs funding.
- Pure Power could not find a customer to contract to purchase the power to be produced. SCE would not purchase under the existing Wind Power contracts.

Question 10: What is the likelihood that you would have taken peak load-reducing actions without the assistance of the Innovative program element?

The responses to Question 10 are in Table 5-31.

Table 5-31: Participants Who Would Have Reduced Load Without Program Assistance

Metric	No. of responses
Never	3
Probably not	3
Maybe	5
Probably	1
Definitely	3
Total	**15**

Question 11: From your experience with this program, would you participate again in a similar program? (5 = without question; 3 = yes, though under different circumstances; 1 = under no circumstances)

For this question, 14 respondents answered. All answers were favorable for participating again, a four, to “yes” without a question they would participate again, a five rating. Two respondents questioned added the following qualifications to their answers:

- They would participate as long as the level of funding ($/kW) was at this program's level or above.
- Maybe if the forms could be made easier to fill out – they were very technical.

Questions 12-17 ask for ratings of the participants' level of satisfaction with each aspect of the program, such as the administrator, the application, and the program timeline. All respondents answered Questions 12, 13, and 17; one skipped 14 and 16, and two skipped 15. The administrator got the highest average rating, followed by the overall program and the verification process. The timeline was the only category to receive an average below four. A number of comments were given regarding the timeline, both negative and positive:

- Working in a hospital and dealing with OSHA drags out the timeline beyond ones control.
- Regulatory requirements complicate the deadline.
- More time would have been helpful.
- Energy Commission deadline was fair, but third-parties made it difficult to achieve.
- Willingness to extend timeline to make program work was appreciated.
- Very accommodating when there were project delays.

Table 5-32 shows each rating for Questions 12-17.

Table 5-32: Program Component Ratings Count

Question	How would you rate	Low	Ranking scale			High	Average	Large average	Small average
		1	2	3	4	5			
12	The program overall	0	0	1	6	8	4.5	4.9	4.1
13	The administrator	0	0	1	1	13	4.8	5.0	4.6
14	The application process	0	0	2	9	3	4.1	4.3	3.9
15	The invoicing, billing, payment process	0	1	0	6	6	4.3	4.8	3.9
16	The verification process	0	0	2	5	7	4.4	4.7	4.1
17	The implementation timeline	2	0	1	6	6	3.9	4.6	3.3

The overall average for the Large Grant Administrator was 4.7, while it was 4.0 for the Small Grant Administrator, with the largest differences coming in rankings of the timeline and the payment process.

5.8.5 Non-Participants

Non-participant audits were also performed on participants that initially applied to the program but then, according to the program database, dropped out. The purpose of this audit was to try to find out when and why participants dropped out; if they went ahead with peak load reduction projects anyway; and how the program could be changed for them to consider participating in the future. Ten non-participants were contacted for feedback, but only one completed a survey. The Pasadena Police Department gave the following feedback:

- They did not remember how they found out about the program.
- They withdrew the application after receiving marketing materials and/or more in-depth program information.
- They withdrew because they felt the process was too much an administrative burden owing to the fact that the application form required the city council approval.
- The police department did complete peak load-reducing actions without the program.
- The police department would participate in a similar program if it met its needs, such as less of a paperwork burden.

5.8.6 Process Evaluation Conclusions

The Energy Commission, and specifically its website, was the best source of information for participants. Rebates appear to be driving participation for the most part. Most participants also are active in other energy efficiency programs. People seemed satisfied with the communication process. Most participants received responses to their applications within a matter of weeks, which seems acceptable to them. Most participants achieved their peak load reduction goals. Participants listed a variety of obstacles to project installation. They seemed unsure as to whether they would have implemented the project without the program. Almost everyone would certainly participate again in a similar program. Participants seemed very pleased with their administrators, and showed the most displeasure with the timeline for project completion.

5.9 CONCLUSIONS

The Innovative Peak Load Reduction Program element has achieved considerable success in reducing summer peak demand for electricity. The program's successes support the following general conclusions, discussed in more detail below:

- The program has substantially realized its goals for peak load reduction.
- Rapid deployment of innovative energy technologies has a demonstrable role in reducing summer peak demand.
- Third-party administrators can provide an effective option for program implementation.
- Cost-effective demand reductions, averaging $32/kW-year, are achievable even in an accelerated timeframe.

5.9.1 Achieving Program Goals

Through December 31, 2002, the program has contracted for 140 percent of its goal. Through its large grant, small grant, and third-party segments, the program has exceeded its 152.0 MW goal by successfully contracting for 212.9 MW. With many projects still pending completion, the program has already achieved documented savings of approximately 137 MW, or 90 percent of the 152 MW goal.

As impressive as the impacts are, the rate at which projects have been recruited and installed has not quite achieved the high expectations embodied in the program's original goals. It became clear as early as the spring of 2001 that expectations for project completion timelines were overly optimistic. Despite the need for demand reductions and the participants' sincere efforts to bring projects on-line by June 1, 2001, unexpected delays inherent in nearly all projects made the deadline impossible for some participants to meet. Nexant recommends that future demand reduction programs should either allow more time for participants to complete their projects, or focus on solicitation of a narrower selection of projects that are able to provide consistent demand savings within a short timeframe.

5.9.2 Role of Innovative Technologies

Equally important as the magnitude of savings is the emerging and plainly evident contribution that innovative energy technologies can play in reducing the State's peak demand for electricity. Successful examples include the following:

- The Berrenda Mesa Water District is able to nearly eliminate its peak demand during summer months by utilizing its Innovative Program-funded reservoir to store water pumped at night for distribution during the peak periods. For most days in the summer of 2001, the district lowered its demand from a summer 2000 baseline demand of 1.5-4.6 MW to just 20 kW (an average reduction of over 99 percent from normal).
- The Alameda County Jail's PV project, implemented in 2001 with a rated capacity of 458 kW, continues to be the largest roof-mounted photovoltaic array in the United States.
- The County of San Diego's and the City of Burbank's landfill-gas generation systems are among the first in the nation to use highly efficient microturbine technology to convert the otherwise wasted energy produced by the landfills' off-gasses into electricity. At the Madera Biomass Power Plant, agricultural and urban waste from no more than 60 miles away is burned to produce electricity. Each of these projects demonstrates the value of an innovative, clean renewable technology that uses local resources to serve local needs.

If promoting innovative, cutting-edge technology demonstrations, such as landfill gas-fired microturbines, is a high priority, the Energy Commission's approach to program implementation can easily be modified. Project completion timelines can be extended to accommodate the extended commissioning and more frequent maintenance required by innovative projects. The two goals of achieving consistent, reliable peak demand savings in the short-term and achieving peak demand savings with innovative (relatively untested) technologies are in potential conflict with one another. Sometimes these goals can be achieved simultaneously, but usually innovative technologies are less reliable in the short-term because they often require a more complex commissioning process.

5.9.3 Program Administration

Use of third-party administrators to implement the program has largely been successful, enabled by an energy industry comprised of capable professionals throughout California. The overall performance in realizing program goals has been exemplary. Participants report satisfaction with the administrative process, and independent examination of program documentation confirms good compliance with administrative procedures. Program impacts appear cost-effective, averaging about $32/kW-yr for the program as a whole, inclusive of retained administrative fees.

Although administrators and participants report that program procedures are effective, refinements in program guidelines could further improve administrative processes. To accommodate the diversity of eligible projects, the Energy Commission established relatively generic program guidelines. Such general guidelines are still needed, but specific guidelines could be developed for some of the more common project types, such as lighting efficiency. For example, guidelines could include (1) pre-approved, stipulated operating hours or coincidence factors for different occupancy types; (2) stipulated lighting fixture wattages; and (3) pre-approved demand savings calculation methodologies. Standardized guidelines could help to improve the accuracy of contracted savings, and would help participants to become more knowledgeable about their projects' potential demand savings.

5.9.4 Cost-Effectiveness of Peak Load Reductions

The Innovative Program has achieved significant peak load reduction impacts at an average cost to the State of about $225/kW (simple cost, or about $32/kW-year in annualized costs). The Berrenda Mesa and Lost Hills Water Districts' reservoir expansion projects are particularly notable for their impact, timeliness, and cost-effectiveness. In general, reservoir expansion projects seem to be a predictable source of demand savings. This type of project is not specific to rural water districts, such as those that participated in the Innovative program element, but can be emulated by any facility that can implement a pumped storage project for the shifting of their load from on-peak to off-peak periods. In the future, when timely and consistent demand savings are desired, an effort should be made to solicit this type of project, which can be brought on-line quickly and provide immediate and consistent demand savings. The market potential of reservoir expansion projects should be investigated for use in future demand conservation efforts.

Contributing to the attractive cost-effectiveness of the program impacts is the persistence of savings. Nexant's persistence verification of the AB 970-funded projects revealed that the level of verified demand savings in 2001 persisted through 2002, leading to the conclusion that the State can reliably depend on the program's peak load reductions now, and in the future.

6.1 BACKGROUND OF PROGRAM ELEMENT

The California Energy Commission's AB970-funded LED traffic signals program element provided grants to public agencies for replacing incandescent traffic lamps with those using light-emitting diodes (LEDs). The grants were designed to pay for part of the material and labor costs associated with installing the LED traffic signal modules. The Energy Commission's initial allocation for the LED program element was $10 million. Any public agency that owns and/or operates traffic signals in California during the summer peak period[1] was eligible to apply for and receive an Energy Commission LED traffic signal grant.

In California, there are an estimated 1.8 million traffic signals operating at approximately 40,000 intersections. Replacing the previously-standard incandescent traffic lamps with LED modules can reduce the energy consumption of the affected signal head by 80 to 90 percent. Before 2001, only a small percentage of traffic signals were equipped with LED technology. It is estimated that by the end of 2001, approximately 30–40 percent of California's traffic signals have had their red, amber, green, and/or pedestrian incandescent lamps replaced with LED modules. The percentage of LED traffic signals in California will continue to rise as prices for the modules drop, energy prices remain relatively high, and California's efficiency standards for traffic signals take effect March 1, 2003. The new standards require traffic signals manufactured after March 1, 2003 and sold in California must not exceed a maximum wattage. Currently, only LED traffic signal modules meet this requirement.

In the past, one major barrier to the widespread use of LED traffic signals has been the high initial capital cost. LED modules are 30 to 80 times more costly than traditionally used incandescent lamps. The Energy Commission's AB970-funded program attempted to help overcome this barrier by providing grants to public agencies up to the amounts listed in Table 6-1. The maximum grant amount per public agency was $3.5 million. There was no minimum grant amount. The grant monies could also be used to supplement incentives from publicly owned utilities. However, the combined incentives could not exceed the total project cost (including materials and installation labor) for each module type. Per the contract scope provided by the Energy Commission, Nexant was not responsible for investigating any potential "double-dipping" (meaning double payments of incentives for the same projects) of incentives associated with any municipal LED traffic signal projects.

Table 6-1: Maximum Grant Amounts for LED Modules

LED Module Type	Grant Amount per Module
Red (8-inch and 12-inch balls and arrows)	$ 50.00
Green (8-inch and 12-inch balls and arrows)	$100.00

[1] Summer peak season is defined as non-holiday weekdays between June 1 and September 30, between the hours of 2:00 p.m. and 6:00 p.m.

Amber (8-inch and 12-inch balls and arrows)	$ 50.00
Pedestrian hand (non-hard wired)	$ 25.00
Combination pedestrian hand/walking person	$ 70.00

The Energy Commission conducted a grant solicitation notifying all appropriate and eligible public agencies, from which applications were accepted on a first-come, first-served basis. As of December 31, 2002, all available LED program element funding had been allocated.

6.2 STATUS OF PROGRAM ELEMENT

A total of 57 grantee projects received monies via the LED traffic signals program element. This number includes 14 projects that were not installed and invoiced until after Nexant's last LED traffic signal program element report in December 2001. In fact, two of the 14 new projects (Chico and San Gabriel) were not complete as of December 31, 2002, which was set as the cut-off date for input to this report, and therefore are not included in this document's statistics. This report provides updates on the original 43 projects reported on in 2001, and incorporates the 12 additional projects that were completed in 2002. Updates on the original 43 projects focus on those that were not completely installed as of Nexant's December 2001 report. In those cases, the demand savings estimates are revised to reflect the completed scope and total project savings.

Table 6-2 presents the verified savings and realization rates for each of the 55 grantee projects represented in this report. No additional M&V activities were performed for this program element subsequent to Nexant's last report; therefore, the project-specific realization rates have remained constant, as well as the overall program element realization rate of 94%.

The demand savings provided to the Energy Commission in each grantee's final report is noted in the column entitled "Reported Demand Savings." The demand savings verified by Nexant are provided in the "Verified Demand Savings" column. The realization rates, which provide an indication of how accurately each grantee predicted their respective project demand savings, were derived by dividing the verified demand savings value by the reported demand savings. If the demand savings reported in the grantee's application is the exact amount verified by Nexant, a realization rate of 1.0 would result. Realization rates may be greater than or less than 1.0. A discussion of how demand savings were documented by Nexant follows in the next section.

The –12 projects added to the program and completed in 2002 are included in the table. None of the -12 projects underwent any M&V activities; they are included in the table to give a more complete summary of the program element, and are noted with a double asterisk (**). For those 12 projects, verified demand savings have been calculated using the program-wide realization rate previously calculated.

Table 6-2: LED Traffic Signals Savings Verification Results as of December 31, 2002

Project	Reported Demand Savings	Verified Demand Savings	Realization Rate
City of Alameda	112 kW	112 kW	100%
City of Anaheim	123 kW	84 kW	68%
Town of Apple Valley	38 kW	38 kW	100%

Project	Reported Demand Savings	Verified Demand Savings	Realization Rate
City of Azusa	24 kW	20 kW	83%
City of Baldwin Park	70 kW	46 kW	65%
City of Bell Gardens	53 kW	35 kW	66%
CalTrans*	1,291kW	1,214 kW	*94%*
City of Carpinteria**	4 kW	4 kW	*94%*
City of Chino Hills	61 kW	37 kW	61%
City of Citrus Heights	28 kW	25 kW	89%
City of Costa Mesa	108 kW	57 kW	53%
City of Cudahy	-13 kW	–8 kW	64%
City of Elk Grove	57 kW	59 kW	103%
City of Escondido	54 kW	49 kW	91%
City of Eureka	31 kW	29 kW	93%
City of Folsom	62 kW	55 kW	88%
City of Glendale*	291 kW	274 kW	*94%*
City of Hesperia	34 kW	33 kW	97%
City of Lancaster**	21 kW	20 kW	*94%*
City of Long Beach #1**	103 kW	97 kW	*94%*
City of Long Beach #2**	166 kW	156 kW	*94%*
Los Angeles Dept of Water & Power*	1,115 kW	1,048 kW	*94%*
City of Maywood*	-14 kW	13 kW	95%
City of Mission Viejo	124 kW	146 kW	118%
County of Monterey**	9 kW	8 kW	*94%*
City of Moorpark*	28 kW	26 kW	*94%*
City of Moreno Valley	100 kW	87 kW	87%
City of Palm Springs	117 kW	70 kW	60%
City of Palo Alto*	124 kW	117 kW	*94%*
City of Paramount	50 kW	46 kW	92%
City of Pasadena	45 kW	68 kW	151%
City of Porterville**	14 kW	13 kW	*94%*
City of Rancho Mirage*	45 kW	42 kW	*94%*
City of Redding	143 kW	96 kW	67%
City of Ridgecrest**	17 kW	16 kW	*94%*
Riverside Public Utilities**	279 kW	262 kW	*94%*
City of Rosemead*	82 kW	77 kW	*94%*
City of Roseville	264 kW	264 kW	100%
County of Sacramento	50 kW	37 kW	74%
City of Sacramento	178 kW	185 kW	104%
City of San Buenaventura**	37 kW	35 kW	*94%*
City of San Diego	561 kW	506 kW	90%
City of San Marcos	63 kW	49 kW	78%
City of Santa Barbara	124 kW	248 kW	200%
County of Santa Barbara**	30 kW	28 kW	*94%*
City of Santa Clara*	146 kW	137 kW	*94%*
Santa Clara County*	43 kW	40 kW	*94%*
City of Sebastopol	5 kW	4 kW	80%
City of Simi Valley**	54 kW	51 kW	*94%*
City of South Gate	101 kW	127 kW	126%
City of Temecula	169 kW	125 kW	74%
City of Torrance**	31 kW	29 kW	*94%*
City of Victorville	105 kW	85 kW	81%
City of Westminster	29 kW	95 kW	328%
Town of Woodside	0.2 kW	0.3 kW	150%
Total	**7,040 kW**	**6,632kW**	**94%**

* Utility bills were not available for this project; the program realization rate was used to document the demand savings.
** Project included in program element after completion of M&V activities; no verification of savings was performed by Nexant.

6.3 MV&E APPROACH

The purpose of the measurement, verification, and evaluation (MV&E) efforts summarized above in Table 6-2 was to estimate the demand savings (kW) actually achieved for each project in the LED traffic signals program element, relative to the demand savings estimated in the grantee's application. Demand savings were estimated by each grantee based on 1) their counts of each type of lamp, 2) the wattage of each type of lamp, and 3) stipulated load factors that were provided for each lamp type. The grantees would calculate their estimated demand savings by first estimating the energy savings (kWh) resulting from the lamp replacement. For each intersection, energy savings were estimated by multiplying the load reduction (defined as the difference, in kW, between the incandescent traffic lamp wattage and the LED traffic signal wattage) by the number of stipulated hours of operation (in hours) for each lamp type.. Wattage data was pulled from manufacturer specifications, and would vary from one type of fixture to another. Average hourly peak demand savings were then calculated by dividing the energy savings in the peak period by the total number of hours in the peak period.

The above calculation utilized a stipulated load factor that varied by type of traffic signal module (e.g., red ball main signal, green arrow turn control, etc.). The load factor represents the percentage of time that each signal type is assumed to be operating. It was assumed that the replacement LED traffic signal modules load factors (i.e., hours of operation) were consistent with those for the incandescent traffic signal modules being replaced. The stipulated load factors for the different traffic signal types are provided in Table 6-3.

Table 6-3: Traffic Signal Module - Stipulated Load Factors

Traffic Signal Module Type	Stipulated Average Load Factor (percent)
Red Ball Main Signal	59
Red Arrow Turn Control	81
Green Ball Main Signal	38
Green Arrow Turn Control	16
Amber Ball and Arrow	3
Amber Beacons	50
Pedestrian	90

6.4 PROGRAM ELEMENT MONITORING AND VERIFICATION

Nexant collected data through November 21, 2001, for each of the 43 original projects participating in the program element. The project-specific data collected included: 1) an intersection inventory report, 2) LED specifications for the lamps used in the project, and 3) utility bills, where available, for a sample of the project's intersections.[2] The content and role of each of these data sources is noted below.

<u>Intersection Inventory</u>

[2] Traffic signal electric metering is routinely done by intersection, rather than individually metering each given traffic signal device.

The intersection inventory report was provided as part of the grantee's application. This report estimates, by intersection, the energy and demand savings based on a number of factors including, a) the number of lamps at the intersection, b) the wattages of the pre-installation incandescent lamps as compared to the LED traffic signal modules, and c) the stipulated load factor of each type of traffic signal module. Total project energy and demand savings were then summarized. The demand savings from this calculation was identified as the grantee's reported project demand savings.

LED Lamp Specifications

Nexant reviewed the specifications for the LED traffic signal modules that were installed for each project. The specifications noted the wattages of the modules, which were used in the energy savings calculations within the intersection inventory report and in pursuing the utility billing analysis.

Utility Bill Analysis

In order to verify the energy and demand savings associated with a given LED traffic signal project, Nexant pursued performing actual utility bill comparative analyses. This required that the grantees provide their utility bills for a sample of intersections. The results of the utility bill analyses were then used by Nexant to derive the verified demand savings. Nexant then calculated a project specific realization rate based on the sample intersections reviewed in the billing analysis. The realization rate was derived by dividing the grantee reported demand savings by the billing analysis-driven verified savings. This realization rate was then applied to the overall project's inventory of intersections and reported savings to derive the overall project's verified demand savings.

For 33 of the original 43 projects, the grantees submitted pre-installation and post-installation utility bills from a sample of intersections. The 10 original projects for which utility bills were not provided are indicated by single asterisks (*) in Table 6-2. For most of these 10 projects, utility bills were not available because the grantee city owns the utility and does not generate an individual bill for each intersection. In total, usable utility bills were submitted for 63 intersections—an amount that exceeds the suggested sample size designed to satisfy the Energy Commission's 80% confidence / 20% precision statistical goals.

Nexant next took the realization rates from the 33 analyzed projects and developed a weighted (by demand savings) average to yield a program element realization rate of 94 percent. For the remaining projects (i.e., the 10 projects for which utility bills were not provided, as well as those added in 2002), their project-specific verified demand savings were derived by applying the overall program element realization rate (94%) to the grantee reported demand savings. An error analysis was performed on the realization rates, and the results indicate that the program element realization rate of 94 percent has an uncertainty of 57 percent at the 80 percent confidence level. This means that although Nexant estimates the program element realization rate to be 94%, the error bounds are substantial; statistically, there is 80% confidence that the actual realization rate is between 37% and 151%. The 80% confidence / 20% precision statistical goal was not met mainly because of a few projects with very low or very high realization rates, resulting in a large standard deviation.

6.5 PROGRAM ELEMENT EVALUATION

Using the M&V approach described above, Nexant calculated the program element realization rate to be 94%. As of December 31, 2002, the program element had garnered 6.6 MW of peak demand savings, which was derived by applying the program element realization rate to the composite reported savings of 7.0 MW. Errors in the participant reported demand savings could have occurred because of:

- inaccurate lamp counts,
- incorrect recording of lamp wattages, and
- discrepancies between the actual traffic signal load factors and the stipulated load factors.

These potential error types were addressed in the evaluation initiatives as described below.

Potential Lamp Count Error Assessment

To assess whether there were systematic errors made by the grantees relative to inaccurate lamp counts, Nexant performed inspections on a statistically valid sample of approximately 130 intersections across 14 projects. The 80 percent confidence / 20 percent precision statistical standard was used to select an appropriate number of projects, and intersections within projects, to inspect.

The site inspections involved confirming that LED traffic signal modules had been installed; this was found to be the case at all inspected intersections. The visit also included counting the number of lamps installed within each lamp type. Nexant then compared these counts with the application's intersection inventory, which break each intersection down into the number of red lamps, green turn signals, pedestrian signals, etc. that are to be installed.

Of the 14 projects inspected, none had a significant number of lamp miscounts. While lamp count errors were noticed, there did not appear to be any pattern, either in over-counting or under-counting the number of lamps within each lamp type. Since no consistent counting error was found during the inspections, no adjustments to the reported demand savings were made for lamp count errors in any of the projects.

Potential Lamp Wattage Error Assessment

Lamp wattages were verified through manufacturer specification sheets, and no adjustments were made to the reported demand savings for wattage errors. Due to the difficulty in accessing the traffic signal modules, Nexant did not directly confirm lamp wattages.

Potential wattage errors may have occurred for projects that received CEC funding to replace only one color of LED module if they replaced the other colors on their own, either through internal funding or through funding from another source. In Nexant's utility bill analyses, it is assumed that all non-retrofitted signals (as indicated in the Lighting Inventories) contain incandescent fixtures, and the incandescent lamp wattages were used to calculate energy savings. However, it is possible that a city may have received a rebate from the utility company for one color and used the CEC incentive for the other color. The City of Westminster received rebates from SCE for the red lamps, and incentives from the CEC for the green lamps. If the installation of these projects occurred at the same time, the pre- and post-installation utility bill analyses could be skewed due to lamp wattage discrepancies. If this scenario occurred, it could have contributed to the program element error.

Potential Load Factor Error Assessment

The remaining, and most significant, potential source of error resulted from using stipulated hours of operation, or load factors (provided in Table 6-3). When considered as an average value over a large population, such as the number of traffic signals associated with over 9,700 intersections impacted by this program element, the stipulated load factors are generally accurate. This accuracy is highlighted by the fact that the program realization rate is 94 percent. However, for small populations of traffic signals, such as at a given intersection level, or for a relatively small grantee city, there is less certainty in the applicability of the stipulated load factors. This is because intersection configurations vary drastically, from simple two-direction intersections to more complicated ones with multiple left-turn lanes or where more than two roads meet. For a simple intersection, a red lamp may have a load factor of 50 percent, while at a complicated intersection the red lamp load factor may be 75 percent. Estimating the demand savings using the stipulated load factor of 59 percent would not equate to the actual demand savings in either example. For this reason, it is expected that the site-specific actual demand savings will differ from the demand savings estimated using the stipulated load factors.

While these site-specific variances may be small, the collective error at a given project level may reflect an aggregated impact. This is because, at the project level, the types of intersections within a project are often similar (consider a city with many one-way streets that may have very simple intersections with red lamp load factors close to 50 percent versus a suburban town that may have a majority of complicated intersections with multiple turning lanes, where the red lamp load factor is closer to 75 percent). In these situations, the variances become additive, thereby resulting in a significant error. Using the stipulated load factor of 59 percent for red lamps, the red lamp savings would be overestimated for the city example and underestimated for the suburban town example.

One can overcome these error factors by analyzing the utility bills associated with an intersection meter to determine the difference between the actual pre-installation and post-installation energy consumption. However, a complete billing analysis on each of the 9,700-plus intersections in the program is beyond the scope and budget of this program element's MV&E effort. Therefore, billing analyses were completed for a sample of intersections, and the results were applied to calculate the demand savings for each project, and was then rolled up for the overall program element.

These error factors (most specifically, the stipulated load factor variable) led to project level realization rates that varied from 53 percent to 328 percent. Nexant found that these higher and lower realization rates generally occurred in relation to projects where the applicant cities retrofitted predominately red or predominately green traffic signals, since relatively small differences in the stipulated load factor versus actual load factor are exacerbated when only one color lamp is involved. For example, if a city has average load factors equal to 50 percent for red and 50 percent for green (ignoring amber in this case), then actual savings due to red lamps would be less than predicted (since the stipulated load factor for red main signals is 59 percent), and actual savings due to green lamps would be greater than predicted (since the stipulated load factor for green main signals is only 38 percent). If the example city had equal numbers of red and green lamp retrofits, the greater savings due to green lamps and the reduced savings due to red lamps would somewhat balance each other, resulting in a project realization rate closer to 1.0. However, if this city retrofitted only red lamps, the realized savings would be much lower than predicted, since there would be no counterbalancing savings due to green lamps in the calculations. Similarly, if the city retrofitted only green lamps, the realized savings would be much higher than predicted, since only green lamps would be considered in the savings calculations.

A low realization rate implies that the actual load factors are lower than the stipulated load factors. For example, the city of Costa Mesa had the lowest realization rate (53%). The lamps retrofitted in this project are predominately red (1,451 red versus 509 green), implying that the actual load factors for the red lamps in this city were significantly lower than the stipulated load factors. Conversely, cities with high realization rates most likely have traffic signal load factors higher than the stipulated values. For example, Westminster retrofitted only green traffic signals, and this project had the highest realization rate (328%). This would imply that their green traffic signal load factors are actually higher than the stipulated values. The fact that only green signals were replaced magnifies the effect of the delta between the actual and stipulated load factors.

6.6 PROGRAM ELEMENT COST-EFFECTIVENESS

The program element's cost-effectiveness relative to levelized costs was also examined. The appropriate metric for levelized costs is $/kW-year, with monetary terms expressed in nominal 2001 dollars. For these calculations, kW was defined as kilowatts of peak demand reduction. An operational lifetime of five years was assumed for the LED traffic signal modules. This is a conservative estimate; although the life of the LED modules could be as long as 10 years, safety issues would require that the modules be replaced on a regular schedule, and every five years is a reasonable assumption. Other potential indicators of cost-effectiveness, such as net present value or benefit-cost ratios, are not appropriate for the 2001 program, as they require evaluation and monetization of program benefits. During the period when investment decisions were being made, the state was experiencing frequent power outages. Program benefits could not be calculated under these conditions, as avoided supply cost concepts do not apply in conditions of absolute shortages. The methodology for calculating cost-effectiveness is included in the Appendix.

Table 6-4 provides the cost-effectiveness results for each project (51 in total) that had submitted an invoice to the Energy Commission as of December 31, 2002. Project cost-effectiveness values range from $48/kW-year to $857/kW-year. The program element level cost effectiveness was calculated to be $369/kW-year, as shown in Table 6-4. If the LED modules are replaced less frequently than every five years, the cost effectiveness will improve.

Table 6-4: LED Traffic Signals – Project Cost Effectiveness Results

Project	Invoiced Amount	Verified Demand Savings	Cost-Effectiveness per kW-Year
City of Alameda	$196,380	112 kW	$379
City of Anaheim	$289,090	84 kW	$745
Town of Apple Valley	$46,120	38 kW	$263
City of Azusa	$26,270	20 kW	$284
City of Baldwin Park	$81,210	46 kW	$382
City of Bell Gardens	$85,620	35 kW	$529
CalTrans	$2,593,360	1214 kW	$462
City of Carpinteria	$4,870	4 kW	$263
City of Chino Hills	$70,940	37 kW	$415
City of Citrus Heights	$99,070	25 kW	$857
City of Costa Mesa	$78,020	57 kW	$296
City of Cudahy	$28,300	8 kW	$765
City of Elk Grove	$35,990	59 kW	$132
City of Escondido	$144,180	49 kW	$637
City of Eureka	$47,310	29 kW	$353
City of Folsom	$12,223	55 kW	$48
City of Glendale	$416,960	274 kW	$329
City of Hesperia	$40,470	33 kW	$265
City of Lancaster	$35,940	20 kW	$389
Los Angeles Water & Power	$1,444,800	1048 kW	$298
City of Maywood	$29,840	13 kW	$497
City of Mission Viejo	$93,310	146 kW	$138
County of Monterey	$26,050	8 kW	$705
City of Moorpark	$32,680	26 kW	$272
City of Moreno Valley	$60,500	87 kW	$150
City of Palm Springs	$167,890	70 kW	$519
City of Palo Alto	$195,450	117 kW	$361
City of Paramount	$91,880	46 kW	$432
City of Pasadena	$75,710	68 kW	$241
City of Porterville	$7,635	13 kW	$127
City of Rancho Mirage	$59,630	42 kW	$307
City of Redding	$193,920	96 kW	$437
Riverside Public Utilities	$681,630	262 kW	$563
City of Rosemead	$120,910	77 kW	$340
City of Roseville	$358,720	264 kW	$294
County of Sacramento	$44,560	37 kW	$261
City of Sacramento	$115,680	185 kW	$135
City of San Buenaventura	$96,050	35 kW	$594
City of San Diego	$1,420,820	506 kW	$608
City of San Marcos	$135,760	49 kW	$600
City of Santa Barbara	$161,135	248 kW	$141

Project	Invoiced Amount	Verified Demand Savings	Cost-Effectiveness per kW-Year
City of Santa Clara	$147,000	137 kW	$232
Santa Clara County	$118,610	40 kW	$642
City of Sebastopol	$7,550	4 kW	$408
City of Simi Valley	$80,520	51 kW	$342
City of South Gate	$134,070	127 kW	$228
City of Temecula	$140,870	125 kW	$244
City of Torrance	$30,694	29 kW	$229
City of Victorville	$134,890	85 kW	$343
City of Westminster	$69,310	95 kW	$158
Town of Woodside	$750	0.3 kW	$541
Total	**$10,811,147**	**6,335 kW**	**$369**

6.7 PERSISTENCE VERIFICATION

Nexant conducted persistence verification for the LED Traffic Signals program element to verify that projects selected for monitoring in 2001 had been fitted with LED traffic signal modules and to ensure that any defective LED modules had been replaced with additional LED modules. Because the goal of this work was to assess persistence relative to the 2001 participants, Nexant focused on the 43 projects that were included in the M&V sample. Nexant's persistence verification for this program element consisted of: 1) conducting follow-up site visits to retrofitted intersections and 2) making telephone calls or emailing participants whose intersections had been originally inspected. For the follow-up site visits, Nexant chose a sample of approximately 130 participating intersections and noted whether the traffic signals contained LED modules. The telephone survey consisted of the three questions listed in Table 6-5; however, Nexant also solicited comments and program feedback from the participants who were contacted.

Table 6-5: Persistence Verification Survey Responses

Question asked	"Yes" Responses
Were all LED modules installed?	95%
Have any been replaced?	51%
Have you or would you make replacements with LED modules?	95%

Thirteen of the original 43 projects were verified with on-site visits, while the remaining 30 were pursued via telephone or e-mail surveys. All of Nexant's persistence verification activities took place between November 2002 and early January 2003.

All of the respondents, except one, confirmed their project's LED module installations. The only exception involved the City of Westminster, where new staff had been brought on board who were not familiar with the original installation project and were unclear whether all of the LED modules had been installed.[3]

Nexant's surveying also uncovered that 22 of the 43 original projects (51%) had to replace some amount of the originally installed LED modules. All but one of these (that being LADWP) said that the replacements were again LED modules. LADWP was the only entity that expressed doubts about replacing LED modules with LEDs, because, according to the contacted representative, the decision is within the purview of the LA Department of Transportation, which doesn't pay for its energy bills, and therefore has no financial incentive to use the more expensive energy efficient technologies.

All 21of the participants who had not yet had to replace any LED modules said they would use like replacements in the future.

The majority (72%) of those surveyed felt very positively about the program saying that the incentives were helpful, the program worked well, and they would like to see it expanded if possible. One particularly comprehensive and positive comment was provided by the City of Santa Barbara;

"The incredible energy savings is a great topic of conversation. We are looking at any LED light system including street lights for potential use in the City. This particular program is the best ever to come out of the California Energy Commission."

Several of the respondents said they plan on additional retrofits of other intersections. A few participants remarked about the maintenance savings resulting from the longer life of the LED modules. Some of those questioned had received positive comments from local residents regarding the increased light intensity from the new LED lamps. The lone negative participant comment was in relation to the volume of paperwork associated with the program, specifically that it was necessary to separate out the records for LED modules from those that were not part of the program.

Based on the consistency of results from the site visits and telephone surveys, Nexant has concluded that the LED traffic signal program element's demand and energy savings have persisted. Additionally, participants are very pleased with the LED modules and will use them in the future providing the budget is available to absorb the increased cost over the conventional incandescent lamps.

6.8 CONCLUSIONS

The value of the LED Traffic Signals program element goes beyond just reducing peak summer demand. The energy and peak demand savings achieved should persist year round, and the savings are real and are independent of human behavior or actions. In addition, the energy cost

[3] This staffing and awareness issue may help explain the very substantial disconnect between Westminster's recorded estimated demand savings and Nexant's verified demand savings, resulting in the 328% realization rate.

savings from these projects have reduced traffic signal energy costs for public agencies by up to 70 percent, thereby freeing up funds and resources for other public purposes.

In addition, installation of the LED traffic signal modules has enhanced public safety, as they are brighter and easier to see under all weather conditions. They require less maintenance, as they have an expected life of five years or more, and they also allow for installations of battery backup systems so that lights can be operated during power outages.

AB970 has accelerated the deployment of LED technologies and has provided the state with summer peak load reductions and long-term economic savings that would not have otherwise occurred until 2003 or beyond.[4] The grants provided by the program covered about half the project cost, which was about 25 percent lower than the incentives offered by the IOUs. It is unknown whether a lower Energy Commission incentive or grant would have provided the same level of interest, participation, and encouragement to rapidly install the LED modules before June 1, 2001. With a lower incentive, more projects could have been funded, thus increasing the peak load savings, but it may have taken longer to complete the projects due to the need for a greater funding share by public agencies.

Costs have significantly decreased for the LED modules, which now average about $75 each, compared to over $200 in the late 1990s. Despite the cost reductions, LED traffic signal modules remain substantially more expensive than their incandescent counterparts, which still cost less than $3 per lamp[5]. With public agencies facing budget constraints, it is uncertain whether the continued pace of LED installations can be sustained without some financial assistance. Without financial assistance, public agencies may delay indefinitely optional capital expenditures, unless other market forces compel them to make these projects a high priority.

With an estimated 1.8 million traffic signals in California, the potential to save energy is tremendous. Historically, the high cost of LED traffic signal modules has been a barrier to market penetration. Additionally, a lack of market awareness regarding the technology and its specifications have also been factors in low implementation rates. These barriers were addressed, and in many ways conquered, by the AB970 LED traffic signals program element. Public agencies were able to substantially lower their purchase and subsequent installation costs through this program. The program also provides needed visibility and desired familiarity with the LED technology.

The LED traffic signals program element has been at least partially successful in transforming the California market for LED traffic signals. Without the state's involvement, it is doubtful that many of the participants would have spent the capital to retrofit their incandescent traffic signals with LED modules. The modest demand savings resulting from this program and the costs to achieve these savings are high when compared to other program elements. The program cost-effectiveness was calculated to be $369/kW-year, which is not as cost-effective as the other AB970 program elements

[4] Note subsequent discussion regarding the inclusion of LED traffic signals in California's Building Standards effective 2003.

[5] Consortium for Energy Efficiency, January 17, 2000 press release.

Promoting this valuable energy-saving technology should lead to greater availability of the technology at reduced costs. Increasing the awareness of the technology within California is an additional benefit. These benefits should make it easier for other cities and counties to follow in incorporating LED traffic signal technology at possibly a lower cost. Due to program efforts, the availability of technical specifications, and the lower cost of the modules, the Energy Commission has incorporated LED traffic signal modules into its Building and Appliance Standards. Starting in 2003, all traffic signals sold in California must meet the Caltrans specification and maximum wattage requirements. Currently, only LED traffic signals meet the specifications.

When compared to other AB970 program element energy savings, the LED traffic signals element provides one of the most sustainable solutions to the energy crisis. The successful deployment of LEDs has assisted municipalities in their assessment of energy use, while providing a lasting technology that will provide savings year-round for the lifetime of the technology. A persistence verification audit conducted a year after installation confirms the LED modules have remained in place and continue to save energy. The audit also reveals high satisfaction rates with the program element, and indicates that the participants expect to continue using LED traffic signal modules, and perhaps other LED technologies as well. This sustainability factor, combined with the educational and psychological impacts made in urban planning, should both be equally considered when evaluating the success of LEDs, especially in comparison to some of the shorter-term peak load demand solutions.

Section 7 State Buildings and Public Universities Program Element

7.1 PROGRAM ELEMENT INTRODUCTION

This AB 970-funded program element provided funds specifically to state agencies and public universities in order to encourage energy efficiency improvements and demand responsive activities that collectively would reduce demand during the Summer 2001 peak period.[1] As noted in Nexant's December 2001 Annual Report, approximately $5.3M of the program element's $5.5M funding allocation was subscribed during 2001, and resulted in 57.1 MW of demand savings, according to Nexant's revised savings estimation methodology. Four state agencies and one private firm were state building and public university program element grant recipients. These included;

California State University (CSU) system: The CSU system received funds to install efficient lighting systems and controls, variable speed drives, controls on building fans, and the replacement of rooftop air conditioning units with efficient central-plant cooling. The six CSU campuses involved were Fullerton, Long Beach, Northridge, Pomona, San Diego State, and Sonoma State.

University of California (UC) system: Three UC campuses received funds; UCLA used theirs to install efficient lighting (T8 lamps along with electronic ballasts) systems; UC Santa Barbara used theirs to install chiller controls and a portion of a chilled water loop, thereby improving the overall efficiency of the campus cooling plants; and UC San Francisco received funds to install efficient lighting, but opted out of pursuing the project within the timeframe allotted. Subsequent feedback from UC San Francisco indicates that they have completed the lighting project..

Department of General Services (DGS): DGS received funds to develop Peak Load Reduction Plans as well as install various energy efficiency technologies including vending misers, watt stoppers and some automated meter reading equipment that provides real time access to utility meters located at 174 DGS buildings around the state.

Department of Corrections (DOC): costs. DOC received funds to develop demand curtailment plans at 33 prisons. In addition, funds were allocated for the installation of heat pumps on emergency generators, a project not pursued due to high costs and questionable savings.

Grueneich Resource Advocates (GRA): Grueneich received funds to facilitate the aggregation of 31 CSU and UC campuses for participation in a statewide plan for emergency demand curtailment. Actual load aggregation services were to be provided by Infotility, Inc.

As the program element was almost fully subscribed and all the actual projects implemented in 2001, Nexant's measurement and verification activities in this arena were limited to those

[1] As for all other program elements, the summer peak period is defined as non-holiday weekdays between June 1 and September 30, between the hours of 2:00 p.m. and 6:00 p.m.

completed and reported on in the December 2001 report. With limited additional program implementation activity in 2002 (additional projects were installed at UCSF and CDC), the major function to pursue within the state and public universities program element was to perform the requisite persistence verification assessment.

7.2 PERSISTENCE VERIFICATION REPORT

7.2.1 Introduction

Nexant conducted persistence verification activities for the State Buildings and Public Universities program element to verify that all participating projects were still successfully participating in load reduction activities as of December 31, 2002. As noted above, original measurement and verification (M&V) site visits and analysis activities were performed throughout 2001 as the involved projects were completed. For 2002, Nexant focused on verifying the projects' savings persistence via a telephone survey that was conducted with a sample of project participant facility managers. Four basic lines of questioning were pursued as noted below:

- Is the measure still in place and operating?
- Has the project been performing well relative to expectations?
- Have there been any operational changes to the project or the balance of the facility, which would affect energy or demand savings?
- Were the savings achieved in 2002 consistent with those attained in 2001?

Beyond these specific lines of questioning, Nexant also solicited and compiled participant comments and feedback on the program. This survey work was conducted in December 2002.

7.2.2 Overview of Nexant's Persistence Verification Results

In order to retain the comparative nature of the 2001 versus 2002 results, Nexant surveyed the same five participants who had been identified as the program element's M&V sample. The respondents and an overview of their projects and survey results are provided in Table 7-1.

Table 7-1: State Buildings and Public Universities Program Element – Persistence Summary

Participant Site	Project Technology	2001 Verified Demand Savings (kW)	2002 Verified Demand Savings (kW)
CSU-Fullerton	Variable speed drives	392	392
CSU-San Diego	Variable speed drives and lighting retrofits	214	232
UC-Los Angeles	Lighting retrofits	525	525
UC-Santa Barbara	Chilled water loop/ Chiller upgrade	57	57
Dept. of General Services (174 buildings)	Meter network system	22,000	22,000

7.2.3 Summary of Results

CSU-Fullerton

Nexant spoke with CSU-Fullerton's Assistant Director of Projects and Programs – Physical Plant. The campus' variable speed drives are still in place and operating. Energy savings are being realized continuously during their normal operation. In the event of a California ISO curtailment notification, the ability to further reduce demand is still present. According to the Assistant Director, CSU-Fullerton has increased the use of the project's variable speed drives, which has lead to increased *energy* savings in 2002. The increased energy savings have in turn allowed the campus to reduce their baseline demand level by approximately 10 percent. On top of that, when called upon by the ISO, the campus is still able to ratchet down their demand by an additional 10 percent. By combining these two attributes, CSU-Fullerton is able to maintain the approximate 392 kW demand reduction verified for 2001.

CSU-San Diego

Nexant spoke with CSU-San Diego's Manager of Electrical Services. The campus' variable speed drive and lighting projects are still in place and operating, and it noted that savings in 2002 were slightly higher than 2001 because of better than expected results from the lighting controls measures in the two involved parking garages. The Manager of Electrical Services indicated that the voltage reducers on lights in Parking Garage #3 provided 21.8 kW in demand savings as compared to the estimated 6.0 kW that had been anticipated. Likewise, in Parking Garage #4, the savings amounted to 6.3 kW whereas 4.2 kW had been expected. These savings when combined equate to an incremental additional savings of 18 kW above the 2001 verified savings. The project's vast majority of savings are associated with its variable speed drive component, which, per the Manager of Electrical Services, continues to perform as designed, with savings equivalent to those noted for 2001. Therefore, the overall project can be viewed as having increased demand reductions to 232 kW (214 + 18).

UC-Los Angeles

Nexant contacted the University of California System Campus Energy Manager regarding both the UCLA and UC-Santa Barbara projects. According to this contact, the efficient lighting upgrade project at UCLA is still in place and performing satisfactorily. Energy and demand savings are being realized continuously during normal operation. The UC Energy Manager also commented that they are retrofitting other campus buildings with energy efficient lighting systems, based on their positive experience with the project and the lighting technologies. Based upon the positive feedback from the Energy Manager and his staff's confirmation that the operating hours associated with the lighting upgrades have not changed, Nexant concludes that the associated 2001 demand savings of 525 kW remain in place.

UC-Santa Barbara

As noted above, Nexant contacted the UC System Campus Energy Manager regarding this project as well. In the December 2001 report, Nexant noted that the UCSB chilled water loop project was experiencing some commissioning problems related to the level of cooling actually provided. Due to this, (along with addressing that the original application's proposed demand reductions were based upon connected load[2]) Nexant was able to verify only 57 kW of the 190 kW estimate reported by UCSB. In order to improve the cooling water loop's operation, small booster pumps were added in October 2001 to increase the loop's output. That revision along with utilization of the system's heat exchangers and some chilled water plumbing corrections, now allow the more efficient cooling water loop to fulfill its role, according to the UCSB project manager. The project was completed and operational on May 17, 2002 and is now functioning well.

The 57 kW verified demand savings value noted in the December 2001 report took into account that the system appeared to be approaching fully operational status when determining the verified savings. Therefore, based on the May 2002 commissioning work completed and the UCSB level of satisfaction in the system's performance, Nexant concludes that the verified 2002 demand savings for the AB 970 funded portion of UCSB's cooling water loop remains about 57 kW.

Now that the system is fully operational, the Project Manager has indicated that they have increased the number of buildings served off the cooling loop to nine. The Project Manager also indicated that, based upon the system's performance, the campus is looking to extend the loop to other buildings rather than add more chillers. However, while this is good news in terms of market transformation and increased utilization of the efficiency technology, it does not affect the demand savings associated with the equipment funded under this AB 970 program element.

Department of General Services

Nexant spoke with the Business Operations Support Manager in DGS' Energy Management Division. The DGS installed a web-based meter network that allowed remote real-time demand readings of each building's energy use. This system was functional in late 2001 and met expectations, however, they are still learning how to use the system to obtain the maximum benefit. An independent consultant is assisting with further development and refinement of the

[2] When calculating demand reductions from air conditioning changes, the total demand reduction is *not* the sum of the nameplate ratings of the individual units. Air conditioners cycle on and off to meet the cooling load; this reduces the aggregate campus demand and therefore the demand reduction that can be achieved.

system and performance is expected to improve with time. The Building Operations Support Manager confirms that the system is in place and operating with no major confirmable changes relative to its performance in 2001.

The ability to read energy use in real-time does not automatically reduce energy use. Rather, it provides information on building operation that can be used to reduce energy use. This is an ongoing process. Prior to the system's completion, DGS made changes at its facilities to reduce energy use for Summer 2001. As detailed in the December 2001 report, Nexant reviewed two years of utility bills associated with 37 DGS facilities (roughly 21 percent of their participating buildings). The analysis showed that for June through September 2001, they reduced their energy use by more than 13 million kWh, which equates to 25 percent of their 2000 energy use. This result was extrapolated to the remaining facilities on a square-foot basis to obtain the 2001 verified demand reduction. Nexant attempted to obtain similar DGS data for the 2002 summer peak period, but was rebuffed by DGS due to more pressing workloads. . Therefore, based on the DGS responses to the persistence verification survey, and subsequent calls to confirm its results indicating no change in operations or demand reductions, Nexant concludes that the 2001 demand reductions have persisted through 2002.

7.2.3.1 Participant Feedback

All respondents gave constructive comments. The CSU representative said that the program was administered well, but some campuses (particularly Long Beach) were not happy with the M&V premises in the program's reporting, in that the assumptions utilized cast some projects in a negative light. The UC representative stated that the deadline for installation was short, which meant that some projects had to be undertaken without utilizing a competitive bid process. The DGS complained about divergent expectations, which led to initial difficulties in satisfying the needs of the Energy Commission. The problems began with the DGS Project Manager having certain understandings of their responsibilities under the original contract, while Energy Commission staff disagreed. Regarding the original project premises, DGS looked at the program's goal as being based upon shedding load, while concurrently keeping buildings operating as normally as possible. From DGS perspective, they felt that the Energy Commission's goal was to see how far they could push the buildings (and their occupants), even considering a full shutdown. A DGS respondent recommended holding more meetings throughout the process to minimize communication breakdowns and the resultant lack of common expectations on both parties' parts; as is apparent from the feedback received from both parties in this matter, communication could have been improved..

7.2.4 Conclusions/Lessons Learned

The consistency of answers from the phone surveys leads Nexant to conclude that the demand savings from the State program have persisted. The technologies installed at the UC and CSU campuses- T8 efficient lighting and electronic ballasts, variable speed drives, and central plant cooling- all provide similar occupant-sensitive performance to the prior systems and technologies, while reducing the demand associated with the involved end-uses.

Variable speed drives are not trivial to install but can yield significant and continuous savings. They can also play a role in demand reduction systems that are able to respond immediately to curtailment calls. So long as the sensors and control systems that operate the variable speed drives continue to function, the VSDs should continue to reduce demand and provide energy as well as cost savings.

Conversion from roof-mounted air conditioners to central-plant cooling has resulted in persistent savings during the cooling season. However, this type of application is only applicable where a central cooling plant exists and can be used without incurring inordinate expenses.

The addition of remote-monitoring systems allows immediate feedback of building energy use. However, savings are only realized when this information is observed, analyzed, and acted upon. The DGS is learning how to use this tool to monitor and control their buildings. By changing how their buildings operate, they were able to reduce summer energy use by 25 percent in 2001, but further reductions will take more effort. The DGS should be commended for their efforts and encouraged to continue them. If the DGS does not continue to monitor building operation, energy use may increase and savings deteriorate.

8.1 BACKGROUND OF PROGRAM ELEMENTS

8.1.1 AB 970 Water/Wastewater Program Element

The Peak Load Reduction Water/Wastewater program element was funded through Assembly Bill 970 (AB 970). The funding was disbursed in the form of grants to municipalities that installed peak load reduction or electricity supply augmentation projects at their water treatment facilities. Municipal applicants were considered on a first-come, first-served basis as of the funding's availability in 2001. The program's goal was to reduce the state's peak electricity demand by 20 MW as of June 1, 2001, and continue on throughout that summer.

In May 2001, funds from other AB 970 accounts were added to the original program element funding of $5 million, raising the total to $6.663 million. These additional funds allowed for second round of grant applications and funding. Two types of grants were available, focusing on demand reduction and load shedding.

As the name implies, demand reduction grants were available for those projects designed to reduce demand (kW) throughout the peak electricity period—that being non-holiday weekdays from 2:00 p.m. to 6:00 p.m. between June 1 and September 30. The program element provided funding for replacing or retrofitting inefficient pumps (as well as other energy using or energy-recovery equipment) with more energy efficient systems or equipment. Changing control systems, project commissioning and testing, as well as programming changes to the software of control systems were also eligible measures. Grants were available for up to $300/ kW of anticipated peak demand reduction.

Load shedding grants were available for those projects designed to allow applicants to participate in the California Independent System Operator (CAISO) Summer Demand Relief Program, by providing technologies that would enable the facilities to quickly curtail loads in response to Stage II or Stage III emergencies. This program funding also provided monies for water and wastewater pump retrofits in terms of offsetting the costs associated with the necessary telemetry equipment and controls, installation, and associated engineering design work. Grants for load-shed projects were available for up to $200/ kW of peak demand reduction.

8.1.2 SB 5X Water Agency Generation Program Element

With the infusion of $9.75 million in SB 5X funding effective May 2001, the Water/Wastewater program that was previously funded by AB 970 is now called the Water Agency Generation program. This program element, which began receiving project applications in October of 2001, pays municipalities or other eligible governmental entities, up to $300/ kW of new generation or peak period kW reduction for projects completed and operational by May 31, 2002. For those projects expected to be operational by May 31, 2003, the incentive level is capped at $250/kW. Applications were handled on a first come, first serve basis, with a goal of providing 30 MW of demand savings and/or system peak offsetting generation during peak periods. In this case, the peak period is defined as summer non-holiday weekdays (June 1 through September 30) during the hours from 2:00 p.m. to 6:00 p.m.

At its outset in May 2001, the program focused on funding upgrades to existing back-up generators that were within the inventories of water and wastewater agencies. Due to low initial enrollment, the program's funding eligibility was expanded to include peak load reductions (i.e., energy efficiency and load shifting measures), similar to the previous AB 970-funded program element.

is by, HDR, Inc a third party administered the SB 5X-funded program element. The AB 970-funded element had been administered directly by the Energy Commission.

8.2 STATUS OF WATER/WASTE WATER AND WATER AGENCY PROGRAM ELEMENTS

As of December 31, 2002, the combined AB 970 and SB 5X elements have achieved 52.2 MW of verified peak load reduction capability, with an additional estimated 7.8 MW underway and due for completion prior to Summer 2003.

The Energy Commission has reported that 43 projects have been approved and are participating under the AB 970 program element. Based on this reported program activity and Nexant's 2002 persistence verification activities, these projects have a verified peak demand potential of nearly 45.1 MW.

Since December of 2001, according to Energy Commission reports, the AB 970 program element activity has involved the addition of three new projects and the withdrawal of three others. The projects that withdrew are Atwater, a 69 kW efficiency project; Escondido, a 300 kW generation project; and Chino, a 124 kW load shifting project. The new projects are all in the efficiency subpopulation: Ontario, at 408 kW; Mount Vista at 364 kW; and Victor Valley, at 18 kW. Detailed discussions of the AB 970 projects can be found in Nexant's December 2001 report.

Also as of December 31, 2002, the SB 5X program administrator, HDR, Inc., reported that 35 projects have been approved and are participating under the SB 5X program element. Nexant estimates that these projects will have the capability to reduce peak demand by nearly 14.9 MW. HDR reports that of the 35 projects, 17 have been completed; representing nearly 7.1 MW of verified savings.[1] The remaining 18 projects are scheduled for completion by June 1, 2003. Table 8-1 shows the breakdown of the total peak reduction by each of the element sub-populations as well as by the stage completed in the M&V process. The estimated savings are based on SB 5X realization rates as applied to the projects in progress.

Table 8-1: Peak Load Reduction by Sub-population

Sub-population	Number of Approved Projects	Verified AB 970 Savings	Verified SB 5X Savings Installed	Estimated SB 5X Savings in-Progress	Total SB 5X and AB 970 Savings
Generation	22	2.13 MW	4.96 MW	3.59 MW	10.67 MW
Efficiency	30	3.22	0.5	0.75	3.93
Load Shifting	24	1.88	1.63	3.45	6.97

[1] Two of the 17 completed projects are still waiting for air quality permits, and another two have not completed their final report.

Sub-population	Number of Approved Projects	Verified AB 970 Savings	Verified SB 5X Savings Installed	Estimated SB 5X Savings in-Progress	Total SB 5X and AB 970 Savings
Curtailment (AB 970 only)	2	37.89	NA	NA	37.89
Total	**78**	**45.12 MW**	**7.09 MW**	**7.79 MW**	**59.99±2.9 MW**

In addition to the 35 projects noted above, four projects dropped out during the fourth quarter 2002, one remains under reevaluation, and two have changed their reported savings. The four projects that have been withdrawn include:

- The Palmdale project, a 250 kW generation project that involved the installation of a catalytic converter on a natural gas generation set, was withdrawn because the participant decided not to proceed with the project.
- The Truckee-Donner project, a 78 kW efficiency project to replace lights and motors, was withdrawn because the project was reduced in size and the new rebate amount was not worth the paperwork required.
- The City of Los Angeles withdrew their 330 kW project, which involved the installation of VFDs on aerators, because the proposed changes would have had a detrimental effect on other plant processes.
- The City of San Bernardino withdrew their 496 kW load shifting project due to an inability to meet the May 31, 2003, deadline.

The project being reevaluated, Brawley, a 275 kW solar aerator installation project is complete. Its inclusion in the program is still being reevaluated, however, because of changes made to the project to achieve the reduction in the biological oxygen demand (BOD) required by local codes. As for those applicants who have revised their savings estimates, San Bernardino increased the estimated savings for their 757 kW load-shifting project (Area 70J) by 274 kW to 1,030 kW, and Palo Alto increased the estimated savings for their 78 kW efficiency project by 231 kW to 309 kW.

Table 8-2 lists all SB 5X projects.

Table 8-2: Active SB 5X Water Agency Projects

Project Name	Reported Size (kW)	Estimated Completion Date	Project Description/Comments
Completed			
Bear Valley Springs CSD	152		New high efficiency motors & pumps; install load controllers
Big Bear Area RWA	600		Replace diesel gen set with larger natural gas unit
City of Corcoran	97		Modify aerobic lagoons, decreasing aerator HP
City of Ferndale	7.88		Replacing mechanical aerators w/ diffused air system
City of Merced	325	Awaiting AQMD approval	Refurbish cogen system to run on digester gas
City of San Diego	1,200	Awaiting AQMD	Modifying diesel gen set to run on blend of diesel and digester

Project Name	Reported Size (kW)	Estimated Completion Date	Project Description/Comments
		approval	gas
City of San Mateo	500		Refurbish cogen system
City of Santa Cruz	1,320		Replacing cogen w/ larger unit and add one cogen unit to replace three diesel gen sets
EBMUD	1,700		Installing natural gas blending to fully load two cogen units
Gridley	32		Installing two Solar Bees
June Lake PUD	78		Installing timers and aerators
North San Mateo County	180		Installing 6-30 kW microturbines on digester gas
Rancho Murieta	144		Replace surface aerators with Solar Bees
S. Bayside System Authority	200		Heat recovery & electrical modifications to fully load cogen
Vallejo S&FCD	2,400		Remove three IC diesels and install two NG gen sets
Active			
Bodega Bay PUD	200	31-May-03	SCADA and Timer controls
City of Benicia WWTP	1,000	31-May-03	Replace diesel gen set with larger natural gas unit
City of Dinuba	164	31-May-03	Replacing 4 mechanical aerators with diffused aeration
City of Torrance	201	31-May-03	SCADA control TOU on well and booster pumps
Contra Costa WD	200	31-May-03	Replacing motors and pumps
Eastern MWD 2	1,200	31-May-03	Retrofitting existing generator w/ emission controls
Eastern MWD 3	60	31-May-03	Install 2-60 kW Micro-turbines w/ heat recovery
EBMUD 2	2,200	31-May-03	Develop food waste receiving facilities to create additional digester gas fuel for 3rd cogen set
EBMUD 3	194		Automation of oxygen production system
Elsinore Valley MWD	25	31-May-03	Converting to Biological Nutrient Removal (BNR), replace blowers and reducing airflow.
Hopland PUD	34	31-May-03	Installing photovoltaics
Marina Coast MWD	369	31-May-03	Installing energy recovery system of RO plant (146 kW) & 4-60 kW micro-turbines w/ heat recovery (~223 kW)
Palo Alto WWTP	309	1-Dec-02; needs documentation	New blowers with Dissolved Oxygen control
Placer County	39	31-May-03	Changing motors on RBCs and shifting sludge pump hours
San Bernardino County	1,733	1-Jun-03	Area 70L Construct storage for off-peak pumping
San Bernardino County	1,030	1-Jun-03	Area 70J Construct storage for off-peak pumping
Santa Clara Valley WD	1,234	30-Jun-03	Installing solar cells and natural gas gen set. . Eligibility of gen set questioned
South Tahoe PUD	1,342	31-Dec-02; needs documentation	SCADA control TOU on effluent pumps
Victor Valley	168	31-May-03	Refurbishing small well to replace large well's on-peak use

Project Name	Reported Size (kW)	Estimated Completion Date	Project Description/Comments
City of Brawley	275	Pending reevaluation	Install solar aerators; inclusion in program being reevaluated
Withdrawn			
Palmdale	250		Generation
Truckee Donner	78		Efficiency
City of Los Angeles	330		Efficiency
San Bernardino	496		Load shifting

8.3 MV&E APPROACH

Verification of the demand savings achieved by the water/wastewater program element was accomplished by monitoring a sample of projects. For each project in the sample, baseline and post-installation electric demands were established either through engineering analysis of a combination of historical data and/or inventory information, or through direct measurements. For both the baseline and post-installation data, the electric demand is defined as the average electric demand between the hours of 2:00 p.m. and 6:00 p.m. on non-holiday weekdays between June 1 and September 30. Electric demand savings were determined by subtracting the post-installation electric demand from the baseline electric demand.

Once the electric demand savings for a project were verified using the process outlined above, a realization rate was determined by dividing the verified savings by the savings estimated for the project in the grant agreement. (Calculation of realization rates is a process that enables a sample of representative projects to be used to estimate the effects of a larger population.) To calculate the realization rate for each subpopulation, Nexant divided a) the sum of the verified savings for the sample projects in the subpopulation by b) the sum of the reported savings for the sample projects in that subpopulation. This realization rate was then multiplied by the total reported demand savings for the appropriate subpopulation to determine the overall verified demand savings for that group. The verified savings for the overall program element is equal to the sum of each subpopulation's verified savings.

It should be acknowledged that the savings estimated in the participant’s applications are computed a variety of ways depending on the applicant’s knowledge of the project when they are completing the application. Some already know the load reduction; others have to determine it as part of their project. A few use an educated estimate knowing that their funding will be limited by project cost. The variety of estimation methodologies is accounted for in the realization rate, which is based on a sample of projects using a variety of methodologies. Two key elements of this program element’s MV&E plan warrant more explanation: first, the sampling strategy and second, the determination of baselines.

8.3.1 Sampling Strategy

Due to the diversity and number of program participants, it was impractical and not cost-effective to directly measure the demand savings achieved by each individual project. Therefore, the entire population of projects was broken down into sub-populations, based on project type. Such a breakdown of projects makes it possible to use a stratified sampling approach, which considers both the amount of variance expected between the various members of a population and the relative demand savings that the sub-population members are expected to have. A sub-population that has a large expected impact compared to the other sub-populations will receive more attention than those with smaller impacts, and a group with more variance among the data collected and analyzed will receive more attention than one with smaller variance. The result of the stratified random sampling is that fewer members of the population need to be monitored to achieve the desired level of confidence and precision of measurement.

In order to implement this approach, projects in the AB 970 program element were segmented into four subpopulations where the involved projects focused on:

1. Curtailment – the reduction of peak demand during critical periods by disconnected loads
2. Generation – repair or upgrade of existing generation facilities, or the installation of new generation facilities
3. Load shifting – moving on-peak loads to off-peak times
4. Efficiency – installation of systems or equipment that reduce energy use

Projects in the SB 5X program element were broken down into the same subcategories, with the exception of curtailment projects as there were none funded under the SB 5X program element. Sample selection was based on the population of completed projects available for inspection. Only a limited number of projects were due for completion by the end of the evaluation year 2002. In order to evaluate a statistically significant number of projects in each of the sub-populations, Nexant had to evaluate nearly all of the projects completed in 2002. Table 8-2 shows the sample population sizes for both program elements.

Table 8-2: Program Element and Sample Population Sizes

	AB 970		SB 5X		Total	
Sub population	**Projects**	**Sampled Sites**	**Projects**	**Sampled Sites**	**Projects**	**Sampled Sites**
Curtailment	2	1	NA	NA	2	1
Generation	6	1*	16	7	22	9
Load shifting	14	2	10	3	24	5
Efficiency	21	2	9	4	30	6
Total	**43**	**6***	**35**	**14**	**78**	**21**

*There were two generation projects evaluated in the AB 970 December 2001 report; the City of Pinole project was subsequently withdrawn from the program.

8.3.2 Baseline Measurements

Baseline measurement was achieved in different ways for each project monitored. In some cases, such as new generation, the baseline was zero and the savings could be determined by simply verifying the power provided by the new equipment. For other projects, the baseline electric demand or augmentation could be determined using historical meter data or through direct measurement of a single point. In some cases, engineering analysis of historical data or of existing systems was performed to estimate baseline conditions.

8.4 PROGRAM ELEMENT MONITORING AND VERIFICATION

As noted in Table 8-2 relative to the AB 970 program element, Nexant monitored and verified savings for a sample population of seven projects, although one subsequently dropped out. These activities, and our results, are reported in full in Nexant's December 2001 report to the Energy Commission. In 2002, Nexant performed persistence verification evaluations for the seven projects that we analyzed under the AB 970 program. The results of these evaluations are presented in the Persistence Verification section of this report.

For the SB 5X program element, Nexant analyzed savings from a sample of 14 projects. As of the writing of this report, two projects in the sample, South Lake Tahoe and Palo Alto, have not completed their final program documentation. Another project for which we had performed a pre-installation site visit (City of Dinuba), has postponed their project’s planned completion to May 31, 2003. In addition, the City of Brawley's project is being re-evaluated as to whether it qualifies for inclusion in the program; the issues at stake are spelled out later in this chapter.

Table 8-3 lists the fourteen projects evaluated for SB 5X in 2002. The table also shows the reported and verified savings for each project, along with a brief description of the project. Detailed discussions on the evaluation of each project follow the table.

Table 8-3: Projects in the SB 5X Sample Population

Project Name	Reported Savings (kW)	Verified Savings (kW)	Project Description/Comments
Efficiency			
City of Dinuba	164*	119*	Replace 4 mechanical aerators with diffused aeration
Bear Valley Springs CSD	152	103	Install SCE load controllers and high efficiency pumps
City of Brawley	275		Install solar aerators; program eligibility being reevaluated
Palo Alto WWTP	309	325	Install new blowers with dissolved oxygen control
Generation			
Big Bear Area RWA	600	469	Replace diesel gen-set with larger natural gas unit
City of Merced	325	250	Refurbish cogen system to run on digester gas
City of San Mateo	500	495	Refurbish cogen system
City of Santa Cruz	1,320	780	Upgrade a 650 kW cogen unit to 820 kW and added a 500 kW cogen unit
EBMUD	1,700	1,117	Install natural gas blending to fully load two cogen units

Project Name	Reported Savings (kW)	Verified Savings (kW)	Project Description/Comments
North San Mateo County	180	172	Install 6-30 kW digester gas microturbines
Vallejo S&FCD	2,400	850	Remove three diesel and install two NG gen-sets
Load Shifting			
Gridley	32	32	Replace surface aerators with Solar Bees
Rancho Murieta	144	58	Replace surface aerators with Solar Bees
South Tahoe PUD	1,342	1,463	SCADA controlled TOU on effluent pumps

*Estimate, based on Nexant's pre-installation inspection; both reported and verified savings may change upon project completion (this is a performance-based project).

For each project listed in Table 8-3, Nexant's savings verification analysis is discussed below. In each case, the baseline value is defined as the average summer peak generation or demand before the implementation of a funded project. The final project demand value is defined as the average summer peak generation or demand after the implementation of the funded project. While individual projects may have generation or demand values higher or lower than the average, these numbers are used to represent the effects of a large number of projects as seen on the grid.

8.4.1 Efficiency

8.4.1.1 The City of Dinuba Water Treatment Plant

Project description: Prior to May 31, 2003, the City of Dinuba plans to replace four 75hp mechanical aerators with an 80hp diffused air system. They estimated that the installation of the diffused air system would allow them to reduce peak demand by 164 kW. The demand savings estimate is based on removing all four grid powered aerators and installing eight 10hp blowers and a diffused air piping system. The Dinuba project is being undertaken through a performance-based contract so the final realization rate will be based on the project's end results.

Findings: During the July 19, 2002 pre-installation inspection, Nexant verified that Dinuba's Wastewater Treatment Plant primary pond had four 75hp grid-connected mechanical aerators. Plant staff informed Nexant that the proposal to convert to a diffused air system had been approved by the city and bids were being reviewed. As of December 2002 (i.e., the end of this reporting period), this project was scheduled to be completed by December 31, 2002.

The project manager for the city informed Nexant that two of the 75hp aerators were in use 24 hrs per day. The other two aerators were shut down daily for only three hours each, one from noon to 3:00 p.m. and the other from 3:00 to 6:00 p.m. Dinuba expected that at the present rate of growth all four aerators will need to run 24 hours a day by the mid-year 2003.

During the pre-installation visit, Nexant took power readings for each of the four existing aerators. Readings ranged from 36 to 53 kW, with a total aggregated baseline peak demand of 179 kW.

Evaluation: The verified baseline for the Dinuba project is 179 kW based on the assumption that all of the aerators will be used fulltime during peak periods. This is 45 kW less than the project proposal's estimated 224 kW that was based on the theoretical 0.746 kW per HP.

Manufacturers' specifications for the proposed diffused air system call for 80hp of blowers with an estimated peak demand of 60 kW. The manufacturers' specifications also indicate that the system could initially operate at less than full capacity.

Based on the measured baseline and the reported final demand, the Dinuba project will, when completed, reflect a peak demand savings of 119 kW, yielding an 83% realization rate when compared to the 164 kW reported by the participant.

8.4.1.2 The City of Palo Alto Waste Water Treatment Plant

Project description: The City of Palo Alto replaced two old supplemental blowers with new high efficiency blowers and installed automated dissolved oxygen (DO) controls on the air valves for each of their four aeration basins. They estimated that the installation of the new blowers and the valve controls would allow them to reduce peak demand by 309 kW. The demand savings are based on the higher efficiency of the new blowers and the reduced flow enabled by the valve controls.

Findings: During the January 10, 2003 site visit, Nexant verified that Palo Alto's wastewater treatment plant has five blowers used for aeration. There is one primary blower with controllable output and four supplemental/backup units with fixed output, two new and two old. During normal operations, the primary blower operates continuously and is augmented by one of the supplemental units that run during peak periods, noon to 8:00 p.m.

The plant has four aeration basins that receive air from the aforementioned blowers. Each basin is served via a valve on the air supply line. Automatic controls have been installed on each of these valves. The valve controls will be connected to the DO sensors in the basin. The DO sensors have been installed, but the installation contractor has requested that the manufacturer perform the final connection. As of the inspection visit, arrangements had been made for this to take place in mid-January.

Previously, during off peak periods, the main blower was manually controlled based on the DO sensors in each of the ponds. If the DO sensor in <u>any</u> pond went below 2.0 mgO2/liter, the main blower's output was increased. Thus, the system was supplying the airflow needed by the worst-case pond to all the ponds. During peak periods, the main blower was augmented by the fixed rate output from one of the supplemental blower units.

Under the new system, the DO sensors control the valves to the individual basins and will reduce the airflow to those basins that continue to have sufficient DO. In other words, the new system can reduce the air supply to basins that meet the minimum DO criteria and thereby reduce overall blower output, thus reducing energy demand as well as consumption. In addition, the two new supplemental blowers have allowed Palo Alto to retire two of the four old blower units.

At the time of the site visit, the control panel on the main blower indicated that it was using 250 kW to produce 10,000cfm. According to the project application (and as confirmed by the City's the project manager), this variable speed blower had, during peak periods, required 414 kW to produce 13,500cfm. Concurrently, the control panel on the new supplemental peak period blower indicated that the unit in use was requiring 263 kW to produce 7,900cfm. Again, per the application and as confirmed by the project manager, the old supplemental blower that had been used during peak periods required 424 kW to produce 10,500cfm. This translates to an improvement from 24 cfm per kWh to 30 cfm per kWh on the supplemental blower output.

Evaluation: The verified baseline for the Palo Alto project is 838 kW from the combined demand of the primary (414 kW) and old supplementary (424 kW) blower units. After the replacement of the supplemental units and oxygen demand control, the verified final demand is 513 kW based on the combined demand of the primary (250 kW) and new supplemental (263 kW) blower units. Thus, the verified peak reduction for this project is 325 kW, yielding a 105% realization when compared to the 309 kW reported by the participant. This realization rate may change pending the connection of the DO sensors to the auto valve controls.

As noted during the inspection visit, all the requisite equipment has been installed but all the connections have not been made. Once that has been accomplished, the applicant will need to inform the program administrator and complete all the program documentation.

8.4.1.3 City of Brawley Water Treatment Plant

Project description: In order to better address the effluent emanating from a local meat processing plant, the City of Brawley's plans were to install three sequential pretreatment aeration ponds along with six solar aerators, two in each pond. The ponds and aerators were to reduce the biological oxygen demand (BOD) treatment required before the effluent reached the main treatment plant. The city estimated that the new ponds and aerators would reduce power demand at the main plant for BOD reduction by 275 kW. The estimated savings were based on average plant energy consumption per unit of BOD processed.

Findings: During the July 26, 2002 site visit, Nexant confirmed that the pre-treatment plant consisted of three ponds. Pond-1 is an anaerobic pond fit with a cover for odor control. At the time of the inspection Solar Bee circulation devices were not installed in this pond. Pond-2 is aerobic with six 40 HP aerators and two Solar Bee circulation devices. The surface aerators were installed on or about April 24, 2002. At the time of the inspection, only four of the six Pond-2 surface aerators were in operation. Pond-3 is for effluent finishing with four Solar Bee circulation devices providing all of the circulation in the pond.

According to Brawley sources, the reason for developing the upgraded pre-treatment facilities discussed in this application was to deal with the effluent coming from Brawley Beef, a nearby meat processing plant that was undergoing renovation. The Solar Bees as well as the addition of the third pond were incorporated into the pre-treatment plant's process during the design phase associated with preparing for the anticipated increased volume of the Brawley Beef effluent. The inclusion of the third pond was built upon the concept of increasing the effluent retention time rather than increasing the number of aerators. The Solar Bees were included in the design in order to mitigate a serious odor issue associated with the meat processing plant, while it was undergoing expansion. Upon completion of the plant's expansion, Brawley staff identified that additional remedial steps were required in order to more effectively address the odor and BOD effluent volume issues. These included: (1) converting Pond-1 to and anaerobic pond by moving the SolarBees from Pond-1 to Pond 3 and placing a cap on Pond-1; (2) installing six grid connected 40HP aerators on Pond-2.

The capacity of the packing plant is 1,600 head of cattle per day. According to plant staff, the current production rate is 1,000 head of cattle per day. The production rate of the facility is variable and directly related to the effluent production, thus is an important consideration when attempting to model the project savings.

In addition the findings noted above in relation to the Brawley Beef pre-treatment facilities, Nexant's noted during its site visit that the City of Brawley's Wastewater Treatment Plant (WWTP) is being renovated and no longer operated as described in the application. The primary clarifier and digesters are not in operation. Treatment capacity has been maintained by expanding the aeration treatment into the three 12,800K gallon stabilization ponds. To increase their plant's aeration capacity, the city purchased and installed twelve 15 HP and six 30 HP surface aerators.

At the WWTP, the city monitors dissolved solids daily; BODs and suspended solids are monitored twice a week. Nexant was provided with these numbers along with a summary of outflow concentrations from the Brawley pre-treatment plant for dissolved oxygen (DO), pH, Biochemical Oxygen Demand (BOD) and ammonia. However, the data provided can be very misleading. Prior to May of 2002, the city sampled 8-hour composites of BOD during plant operating hours when the concentrations are highest. They later switched to 24-hour composites, which lowered the reported average concentration (mg/L). Also, the city temporarily treated the waste with hydrogen peroxide to mitigate the odor problem. Addition of the chemical resulted in significant increases in DO concentrations recorded on March 27, 2002 and April 3, 2002. The chemical treatment was halted after construction of the pre-treatment plant was completed. The city's involvement in the pre-treatment process has been to help the plant meet the Wastewater Pretreatment Ordinance (November 20, 2001) at the lowest installation and operating cost possible. The pre-treatment plant at the nearby meat packing facility is located on a city easement. The Wastewater Pretreatment Ordinance requires that beef plant effluent that is going to the Publicly Owned Treatment Works (POTW) does not contain BOD or Suspended Solids (SS) concentrations in excess of 250 mg/l.

Evaluation: Due to the significant changes from the project proposed in the application, the CEC's program administrator is reevaluating this project. Evaluation of the peak savings for these projects is on hold pending a decision by the program administrator.

8.4.1.4 Bear Valley Springs Community Services District

Project description: The Bear Valley Springs CSD installed timers on five water wells that restricted their use to off-peak hours as well as replaced six inefficient booster pumps with premium efficiency pumps. They estimated that the timer and pump replacement efforts would reduce peak demand by 152.4 kW. Their demand savings estimate is based on all five wells being turned off during peak times along with the cumulative kW savings of all six of the booster pump replacements.

Findings: During the August 29, 2002 site visit to Bear Valley Springs (near Bakersfield), Nexant verified that four of the five well operation timers had been installed by the local utility's contractor. The fifth well timer installation was delayed due to a change as to which additional well would be involved. The new well being considered is larger than the prior candidate and operates a greater number of summer hours; therefore, it will represent a greater savings.

Nexant also verified that all six of the replacement pumps had been installed and were operational. Each involved pump station initially had two pumps, one primary and one backup. With the inclusion of the new efficient pumps fulfilling primary pumping role, the old primary pump was retained for back up, while the redundant back-up pump was retired. With the exception of the newly selected well pump, all of the pumps in this project are operated on an as-needed basis. That is, when the water in the holding tank drops below a certain point, the pump turns on until the tank is filled to the full level. Each pump serves a different tank and therefore they each operate on a different schedule.

During the site visit, Nexant also reviewed the test results gathered by the local utility on the pumps, and verified the demand data for each booster pump. In addition, Nexant reviewed billing data for the wells and confirmed their respective peak demands. Data was also gathered on annual hours of operation for each pump; these results are shown in Table 8-4.

Evaluation: Analysis of the data gathered during the Nexant site visit verified that the demand of each of the well and booster pumps are the same as those in the application. This data also showed, however, that none of the booster pumps and only one of the wells was operational during all of the summer peak hours.

Following standard industry practice, Nexant calculated an effective demand that reflects the impact of intermittent operation of the various pumps during the peak period. In order to do this, Nexant derived a peak period demand modifier that represents the portion of the pump's yearly operational activity that can be expected during summer peak periods. In deriving this modifier, Nexant utilized pumping load data available from the California Department of Water Resources 1996 and 1997 Reports of Operation (published in 2000 and 2001 respectively) to develop an estimate that the operation of these pumps during the four summer months represented half (0.5) of the annual pumping load. In addition, it is estimated that one quarter (0.25) of the daily use occurs during the four-hour peak of this program. These assumptions are used together with calculating 122 summer peak days per year and four peak hours per day to derive the demand modifier factor. Note the following equation:

$$\text{Demand Modifier} = \frac{0.5*0.25}{122*4} = 0.000256 \text{ kWp / kWh / yr}$$

Where:

0.5 = fraction of operation occurring during the June – September timeframe

122 = days in the June – September timeframe

0.25 = fraction of daily operation occurring during the 2:00-6:00 p.m. time frame
4 = hours in 2:00 p.m. to 6:00 p.m. time frame

This demand modifier was used along with data that included the pump demand and hours of operation that Nexant obtained during the site visit to determine the effective peak demand for each pump as follows:

EPD = PD*Hrs*DM

PD = pump demand
Hrs = annual hours of operation
DM = demand modifier (as determined above)

For example, consider well #2 with a demand of 14 kW and 2823 hours of annual operation:

EPD = 14 kW * 2823hrs/yr * 0.000256 kWp / kWh / yr = 10.1 kWp

This process was repeated to determine the baseline for each of the well and booster pumps as well as the final demand for each of the booster pumps. The results of this analysis are presented in the far right columns of Tables 8-4 and 8-5. Note that the well pump CV3 is operated fulltime in the summer only and therefore the pumps' actual demand was used for the average baseline value.

Table 8-4: Bear Valley Springs Well Pump Baseline Data

Well #	Rated HP	Demand (kW)	Hrs/year	Operation	Baseline (kW)
2	20	14	2823	Year round	10.1
11A	40	26	3162	Year round	21.1
31	40	37	953	Year round	9.0
36	15	16	1267	Year round	5.2
CV3	50	38	4000	Summer only	38.0
Total	**165**	**131**			**83.4**

Table 8-5: Bear Valley Springs Booster Pump Baseline Data

Booster #	Rated HP	Demand (kW)	Hrs/year	New hrs/yr	Baseline (kW)	Final (kW)
3C	40	36.2	2628	1644	24.4	15.2
6A1	30	27.5	1030	687	7.3	4.8
6C	50	36.1	1686	992	15.6	9.2
7B	5	3	1228	560	0.9	0.4
9A1	7.5	6.4	1082	572	1.8	0.9
9A2	5	3	1552	641	0.2	0.5
Total	**137.5**	**112.2**			**51.1**	**31.1**

The verified baseline for the Bear Valley Springs project is 134.5 kW, which is the sum of the average baseline kW for the well and booster pumps. After the installation of the well controls and high efficiency booster pumps, the system has an average verified peak demand of 31.1 kilowatts. Thus the verified peak reduction for this project is 103.4 kW, yielding a 68% realization when compared to the 152.4 kW reported by the participant.

8.4.2 Generation

8.4.2.1 City of San Mateo – Digester Gas Engine

Project description: The City of San Mateo project called for modifying an unused digester gas engine to "lean burn" operation, which would allow the use of either natural gas or digester gas. The project also called for upgrading the associated generators' capacity from 335 kW to 500 kW in order to take full advantage of the engine's potential output. The changes were designed to enable San Mateo to obtain air permits for operating the engine/generator plant during peak periods. The city estimated that, based on the potential of the system generation, this project would generate 500 kilowatts during peak periods.

Findings: During the June 12, 2002 site visit, Nexant verified that the generation system was in place, operational, and producing about 485 kW of power. The engine was running on 100% NG and will continue to do so until the completion of the planned digester in 1-2 years. At the time of the visit, plant staff were taking power readings every few hours and recording them by hand. These records showed that the system was consistently producing between 485 kW and 495 kW. The city is working with the utility to obtain a real-time meter for the unit. Plant staff confirmed that the original generation system was used only for emergency generation.

Evaluation: The verified baseline for the San Mateo project is 0 kW based on the understanding that the original generation system was not used during peak periods. After upgrades, the system had an average verified generation of 490 kW. Thus, the verified peak reduction for this project is 490 kW, yielding a 98% realization rate when compared to the 500 kW reported by the participant.

8.4.2.2 Vallejo Sanitation and Flood Control District – Wastewater Treatment Plant

Project description: The Vallejo Wastewater Treatment Plant replaced its three standby diesel generators with two natural gas powered generators. The standby systems were used only for emergency back up generation. The new systems each have a 1.2 MW rating and run on 100% natural gas. In its application, Vallejo estimated that the combined new systems would have a peak generation of 2.4 MW.

Findings: During the June 13, 2002 site visit, Nexant verified that both 1.2 MW generation systems had been installed. Only one system was in operation at the time of the visit. This unit was producing 800 kW. Plant staff informed Nexant that the summer peak demand of the plant was around 1 MW. Details of the interconnection with PG&E' grid were still under negotiation at the time of the visit. Therefore, during peak periods, the treatment plant load was manually disconnected from the grid and served directly by the new generation system. Nexant obtained billing data from plant staff showing a summer peak demand of 1.1 MW. The 2.4 MW capacity is required for winter storm flood control needs. Plant staff confirmed that the original generator system was used only for emergency generation.

Subsequent discussions with Vallejo staff indicated that they eventually signed a contract with PG&E to import 100 kW during peak hours, and are producing the remaining power needed to operate the plant through the new system. Vallejo staff reported that under these conditions the new system has been operating at 850 kW.

Evaluation: The verified baseline for the Vallejo project is 0 kW based on the understanding that the original generation system was not used during peak periods. After upgrades, the system had an average verified peak generation of 850 kW. Thus the verified peak reduction for this project is 850 kW, yielding a 36% realization when compared to the 2.4 W reported by the participant. The district had applied for the installed capacity of the two new generators as opposed to the plant's summer peak demand.

8.4.2.3 City of Santa Cruz – Wastewater Treatment Plant

Project description: The City of Santa Cruz wastewater treatment plant refurbished the engine of one of its generation systems thereby increasing the overall generator potential from 650 kW to 820 kW. They also installed a new 500 kW generation system. Both systems run on mixed natural gas/digester gas. Santa Cruz estimated that the combined refurbished and new systems would increase the average onsite generation by 1320 kW, based on their full generation potential.

Findings: During the July 15, 2002 site visit, Nexant verified that both generation systems had been installed and that they were operational. During the site visit, both systems were in use and producing near their peak power: 820 kW and 500 kW. Plant personnel reported that due to low natural gas and high electricity prices, both systems were running continuously at full output. Each system has its own control with logging capabilities.

Plant personnel reported that, during previous summer seasons, the original generator's peak production had been consistently near its capacity of 650 kW. Staff also indicated that, while there were maintenance issues, those were generally dealt with during off-peak periods. The reliability of the old generator had been decreasing over the years and was expected to get worse due to the unavailability of replacement parts.

Evaluation: The verified baseline for the Santa Cruz project was based on a 20% reduction in availability for the old 650 kW generation systems due to the noted reliability issues. This reduction yielded a verified 520 kW baseline peak generation. After upgrades, the system had an average verified peak generation of 1320 kW. Thus the verified peak reduction for this project is 800 kW, yielding a 61% realization when compared to the 1320 kW reported by the participant.

8.4.2.4 East Bay Municipal Utility District (EBMUD) – Wastewater Treatment Plant

Project description: The EBMUD wastewater treatment plant refurbished its generation system to allow for the supplemental use of natural gas. This change allows the plant to operate, to the full capacity of its air permits, two 2.15 MW generators, 24-hours per day. In its application, EBMUD estimated that the refurbishment would increase the average onsite generation from around 2.6 MW, the average annual peak generation using digester gas only, to the 4.3 MW potential of the two generators, yielding a peak generation increase of 1.7 MW.

Findings: During the August 12, 2002 site visit, Nexant verified that EBMUD had installed the equipment required for mixing natural gas with digester gas, as described in their application. At the time of the visit, the two units were operating, one at nearly 2 MW and one at approximately 1.9 MW. Logger data obtained from EBMUD showed that the generators were generally being operated at less than their combined 4.3 MW capacity, averaging around 3.87 MW during peak periods. Communications with plant staff indicated that this lower operating level was necessary to avoid dangerous power spikes.

The logger data also showed that the historical average summer peak period production was 2.75 MW. This is 150 kW higher than the 2.6 MW presented as the baseline in the application. The 2.6 MW baseline presented in the application was based on the older generation unit's average annual peak.

Evaluation: The verified baseline for the EBMUD project is the average summer peak of 2.75 MW. After upgrades, the system had an average verified peak generation of 3.87 MW. Thus the verified peak reduction for this project is 1.12 MW, representing a 65% realization rate when compared to the 1.7 MW reported by the participant.

8.4.2.5 Big Bear Area Regional Wastewater Agency (RWA)

Project description: The Big Bear RWA's project involved replacing a diesel-fired 550 kW emergency generation system with a 600 kW natural gas generation system. The new system enabled the operators to obtain an Air Quality Certificate that would allow the system to be operated during peak hours, generating 600 kW of electricity. This estimate is based on the new system operating at full capacity during peak periods.

Findings: During the July 26, 2002 site inspection, Nexant verified that the natural gas-fired generation system was installed and operational. Nexant also obtained 30-minute interval data from the appropriate SCADA system. The data indicated that the system was operating between 450 and 500 kW, with an average system output of 469 kW. This output represents the generation required to meet the demand of the Big Bear water treatment plant. Plant staff confirmed that the original generator system was used only for emergency generation.

Evaluation: The verified baseline for the Big Bear Area project is 0 kW, since plant staff confirmed that the original generation system was not used during peak periods. After upgrades, the system has an average verified peak generation of 469 kW. Thus, the verified peak reduction for this project is 469 kW, yielding a 78% realization when compared to the 600 kW reported by the participant.

8.4.2.6 City of Merced – Wastewater Treatment Plant

Project description: The City of Merced wastewater treatment plant application involved refurbishing a non-operational 325 kW generation system to reduce the plant's NOx production.

The reduced NOx production will allow Merced to obtain an air permit for sufficient operating hours to maximize their use of digester gas. Merced estimated that the refurbished plant would be able to generate 325 kW during peak periods. This estimate is based on the new system operating at full capacity during peak periods.

Findings: During the July 18, 2002 site visit, Nexant verified that the system had been refurbished as planned and that the new equipment had been installed. However, there had been some difficulties during testing and the equipment was not yet operational. The installation contractor suspected that the wrong turbo unit had been delivered and one of the circuit breakers associated with the system was found to be faulty. A new turbo unit and a breaker had been ordered. Plant staff also confirmed that the old system had been inoperable prior to this project.

During follow-up communications, plant staff reported that all repairs had been made and that the generator had been operational since early September 2002. The generator was being operated 4 hours per day during peak times, and the output of the system was being limited to 250 kW. This limitation is necessary because output above this amount causes problems with the local grid. Plant staff also reported plans to operate the generator both in the morning and during peak periods. The new schedule would enable the plant to utilize more of the available digester fuel and would bring the total operating time to 6-7 hours per weekday.

Evaluation: The verified baseline for the Merced project is 0 kW, since the original generation system was not operational, let alone used during peak periods. After the upgrades, the system has an average verified peak generation of 250 kW. Thus, the verified peak reduction for this project is 250 kW, yielding a 77 percent realization rate when compared to the 325 kW reported by the participant.

8.4.2.7 North San Mateo County Sanitation District – Wastewater Treatment Plant

Project description: The Sanitation District's wastewater treatment plant application involved replacing a 350 kW back-up generation plant with six 30 kW microturbines. The back-up generation plant was unused due to insufficient levels of fuel (digester gas) and air permit issues. North San Mateo County estimated that the microturbines' installation would allow them to generate 180 kW during peak times. The generation is based on running all six micro turbines at full capacity during the program defined peak period of 2:00 p.m. to 6:00 p.m.

Findings: During the June 12, 2002 site visit to the plant located in Daly City, Nexant noted that the six 30 kW microturbines had been installed. Five out of the six turbines were operational at the time of the visit. The combined output of the five operational units was 136 kW. The sixth unit was inoperable due to having difficulties with blower pressure, and the installer had been scheduled to make repairs. In follow-up communications, the program element administrator informed Nexant that the problems had been rectified and that all six turbines were running consistently with an average output of 172 kW.

Evaluation: The verified baseline for the North San Mateo County project is 0 kW, due to the fact that the original generation system was not used during peak periods. After upgrades, the system has an average verified peak generation of 172 kW. Thus the verified peak reduction for this project is 172 kW, yielding a 96% realization rate when compared to the 180 kW reported by the participant.

8.4.3 Load Shifting

8.4.3.1 City of Gridley – Wastewater Treatment Plant

Project description: The City of Gridley application involved installing two Solar Bee circulation devices at their water treatment plant to replace the peak time usage of six 10 HP grid-connected aerators that have a combined demand of 32 kW. Each of the Solar Bees has a 200 W back-up system for continuous operations when sunlight is insufficient. Gridley staff reported that one Solar Bee circulation device would be installed in the primary pond, the other in the finishing pond. Gridley estimated that the Solar Bee installation would allow them to reduce peak demand by 31.6 kW. The demand savings are based on 32 kW for turning off all six grid-powered aerators during the program-defined peak period of 2:00 p.m. to 6:00 p.m., minus 400W for running the Solar Bees.

Findings: During the June 19, 2002 site visit, Nexant verified that Gridley's wastewater treatment plant consists of one primary pond, one finishing pond, and a series of percolating ponds. The primary pond has two grid-powered aerators and one Solar Bee. The city's project manager reported that two grid-powered aerators from the primary pond had been removed when the Solar Bee was installed. The finishing pond has one grid-powered aerator and one Solar Bee. An additional grid-powered aerator in the finishing pond had been removed when the Solar Bee was installed.

At the time of the visit (about 4:00 p.m.) both of the Solar Bee aerators were in operation along with one grid-powered unit in each pond. The city project manager indicated that the grid-powered units were not supposed to be operating at this time and that he would look into the issue. The system has timers for each unit so it was more than likely due to human error. The project manager later reported that a new staff member had manually turned on the connected aerators. The staff member has been trained as to the new protocol for operating the aerators and signs have been posted on the aerator switchboard to avoid this problem in the future.

The project manager also reports that the solar aerators are working so well that the grid-connected aerators are only needed intermittently. In addition, the project manager provided a detailed report showing the time of use and power consumption demand of the six original grid-connected aerators, indicating a total demand of 32 kW.

Evaluation: The verified baseline for the City of Gridley project is 32 kW, since all six aerators were used fulltime during peak periods. After installation of the Solar Bees, the system has an average verified peak demand of 0 kW. Since there is no shortage of sunlight expected during the summer peak period of 2:00 p.m. to 6:00 p.m., the 400 W capacity back-up system for the Solar Bees is not a factor. Thus, the verified peak reduction for this project is 32 kW, yielding a 101% realization when compared to the 31.6 kW reported by the participant.

8.4.3.2 South Lake Tahoe Public Utility District – Pumping Station

Project description: The South Lake Tahoe PUD's application involved installing a SCADA system to monitor and curtail demand in the Luther Pass a wastewater treatment pumping station. The South Tahoe PUD estimated that the controls installed at the treatment facility would reduce peak demand by 1.34 MW by shutting down the pumps during peak times. The savings are calculated from the minimum utility reported summer monthly peak demand minus the estimated demand from non-pumping equipment.

Findings: During the January 17, 2003 site visit, Nexant verified that all of the controls hardware had been installed at each of the pumping stations, allowing the District to shut down the Luther Pass pumps during peak periods. South Lake Tahoe personnel were in the process of testing and debugging the system. They expected to have the system fully operational by the beginning of the 2003 summer peak demand period. The equipment controlled at the Luther Pass pump station includes two 700 HP and two 1000 HP pumps.

The District's project manager stated that the Luther Pass pumps had previously operated continuously through the summer peak periods. Nexant verified this statement by using data for the average flow rate through the treatment plant and its related pump sizes. The project manager also supplied Nexant with two years of summer billing data (2000 and 2001) and a detailed list of power demand for non-pumping equipment at the Luther Pass pump station. The billing demand varied from month-to-month and averaged 1.47 MW.

The non-pumping equipment included air compressors, heaters, and lighting with a combined reported demand of 34.2 kW. Nexant discounted the amount of the reported demand that was derived from heaters (7.9 kW) since it is unlikely that the heaters would be used during the summer months. Furthermore, the remaining 26.3 kW, which was associated primarily with air compressors, was discounted by 50 percent, since it is unlikely that they would be in use 100 percent of the time. Therefore, the discounted non-pumping equipment demand was set at 13.2 kW.

The Luther Pass pump station is located midway between South Lake Tahoe's water treatment plant and Alpine Meadows. The installation of controls allowed the station pumps to be managed and curtailed remotely from the central control system at the water treatment plant. Communications were facilitated through the use of the District's radio system, which had been recently upgraded. The local control at this pump station also includes wider back-up set points, which in the event of communication loss or malfunction, will trigger the water tanks to return to their normal duty cycle based on the observed reservoir levels.

During the site visit, Nexant confirmed that the necessary remote control equipment, along with its interface at the plant's central control room were installed. The EMS was installed on two existing PC's located in the control center to provide for redundancy. The EMS included four control modes:

1. The Pump Down mode was used for curtailing demand. In this mode, the user simply inputs the start time and duration of the curtailment period. The system will then use a

flow prediction algorithm and modify the pump schedules to minimize pump operation and, if possible, eliminate the need for the Luther Pass pumps to operate during the curtailment period.

2. The Normal mode returns the pump to simple normal duty cycle control, as was used in the baseline system.

3. The Scheduled mode allows for custom scheduling, such as for special events.

4. The Emergency mode maximizes flow through the system to immediately attempt to lower all reservoir levels. This mode is primarily used for storm conditions.

Evaluation: The verified baseline for the South Lake Tahoe PUD project is 1.47 MW due to the fact that the pumps were in operation fulltime during the summer peak. After installation of the EMS control system, the system has an average verified peak demand of 13.2 kW based solely on the demand of non-pumping equipment. Thus the verified peak reduction for this project is 1.46 MW, yielding a 109 percent realization when compared to the 1.34 MW reported by the participant.

8.4.3.3 City of Rancho Murieta – Wastewater Treatment Plant

Project description: The City of Rancho Murieta's application involves installing five Solar Bee circulation devices in their treatment plant's aeration ponds. Rancho Murieta estimated that the Solar Bee installation at the treatment facility would reduce peak demand by 144 kW. The demand savings are based on shutting down 160 HP of grid-connected pumps during peak times. Rancho Murieta staff reported that one Solar Bee circulation device would be installed in each of the five aeration ponds.

Findings: During the August 15, 2002 site visit, Nexant verified that the Rancho Murieta treatment plant has a series of five aeration ponds. The first pond is the primary treatment pond and has four operational grid-powered aerators. The second pond has three operational grid-powered aerators; the third pond has two grid-powered aerators; and ponds 4 and 5 each have one grid-powered aerator. Each of the five ponds has one solar-powered aerator.

At the time of the site visit (10:30 a.m.), each of the solar aerators was operating along with all four of the grid aerators in the primary pond. Plant staff reported that the grid aerators in the primary pond were usually on with the exception of the time period from 1:45 p.m. to 8:15 p.m., coinciding with their local utility's peak period. They also reported that the other grid aerators were only needed intermittently and were not used during peak times.

Also during the visit, Nexant took demand readings on a sample motor of each size at the plant. The plant's project manager provided several digital pictures and a short video of the Solar Bees' installation along with measured current (amp) readings for each of the 12 motors used for aeration. The project manager also provided a description of operations and a plant diagram. Based on the information provided, Nexant created Table 8-6, which shows by pond, which pump is involved, the percent of peak time it was being operated before installation of the Solar

Bees, the pump's rated horsepower and kW demand, and the pump's proportional contribution to peak demand.

Table 8-6: City of Rancho Murieta Aerator Data

Pond #	Motor ID#	Rated HP	KW	On peak %	kW peak
1	2	10	6.9	100%	6.9
1	14	10	7.6	100%	7.6
1	15	15	13.1	100%	13.1
1	16	15	12.6	100%	12.6
2	13	10	8.2	25%	2.0
2	17	20	16.6	25%	4.1
2	18	20	14.8	25%	3.7
3	10	10	10.0	25%	2.5
3	12	10*	9.2	25%	2.3
4	19	10*	5.4	12.5%	0.7
5	3	10	9.7	25%	2.4
Total		**140***	**114.1**		**57.9**

Note: The total horsepower is 140 instead of the 160 listed in the application; the discrepancy is due to changes in the use of the pumps in ponds 3 and 4 that were reduced by 10hp each.

Evaluation: Following industry standard practice, Nexant determined the baseline for the Rancho Murieta project by averaging the peak demand of each motor based on the time in use during the peak period. For example, aerator #10 in pond #3 has a peak demand of 10 kW and operates 25 percent of the peak period, thus has a 2.5 kW average.

Based on this analysis, the verified baseline for the Rancho Murieta project is 58 kW. After installation of the Solar Bees, the system has an average verified peak demand of 0 kilowatts due to the fact that all grid aerators shut down during the summer peak period. Thus, the verified peak reduction for this project is 58 kW yielding a 40 percent realization rate when compared to the 144 kW reported by the participant. The district had applied for the total connected aerator load as opposed to the peak summer load.

8.4.4 Error in Measurement and Verification Analysis

All of the reported project-specific savings values noted above are estimates with an associated level of uncertainty. The "true" value of the demand reduction achieved is reported with an associated precision and confidence level. The precision represents the range of likely values and the confidence level indicates the probability that the true value is within this range. In this program, MV&E efforts were designed for a precision of 20 percent at an 80 percent confidence level; in other words, the documented demand reduction has an 80 percent probability of being within (+/-) 20% of the true value. These levels were chosen in an effort to balance the desirability of reducing the uncertainty with the associated costs (and effort) of doing so.

After Nexant's monitoring and analysis work was performed, the actual "coefficient of variation" was determined to see whether the sample sizes were sufficient to meet the intended precision and confidence levels. In general, additional sampling should be considered if the coefficient of variance (Cv) is greater than 0.5 and the population's contribution is significant enough to affect the overall result.

The C_v is calculated using the following equation:

$$Cv = \frac{SD}{AVG}$$

Where:

Cv = Coefficient of variation
SD = Standard deviation of project realization rates
AVG = Average realization rate

The inspections carried out under the AB 970 and SB 5X program elements indicated that the C_vs calculated for all of the usage groups were less than the assumed C_v of 0.5. These low C_v s indicate that the sample size for all usage groups was sufficiently large to represent the population of that group.

The error for each subpopulation is affected by the portion of the population sampled and the standard deviation of the sampled population. Nexant calculated this sampling error using the following equation:

$$SE_{samp} = \sqrt{(1 - n / N) * SD^2 /(n - 1)}$$

Where:

SE_{samp} = Sampling error

n = Sample size
N = Total population size
SD = Standard deviation of the realization rates

The error for the subpopulation was further affected by errors in verification measurements. For each of the 14 projects evaluated, a device and an operations error were assumed. The device error accounts for errors in the actual device used to measure the power used by the sampled equipment. A two percent measurement error is associated with the one-time power draw measurements taken with a hand held device, while a zero percent measurement error is associated with average measurements taken from extended SCADA system monitoring.

The operations error accounts for uncertainty in hours of use or in level of power production either in the baseline or the verified savings. A 20 percent operations error was assigned to projects with a high uncertainty, such as projects with motors controlled by tank levels or generation systems responding to demand. A 5 percent operations error was assigned to projects with a low uncertainty, such as projects with set schedules of operation or set levels of production. A 10 percent or 15 percent operations error was assigned to projects with a moderate level of uncertainty. All error levels were assigned based on Nexant's experience with MV&E techniques and water/wastewater projects. Table 8-7 lists all the projects, the errors assigned to each, and the overall for each subpopulation. The overall errors were calculated using the root mean square of the component errors.

Table 8-7: Project Device and Operations Error Summation

Project	Measurement Errors		
	Device	Operations	Overall
Generation			
Big Bear Area RWD	0	15	15
City of Merced	2	5	5
City of San Mateo	2	5	5
City of Santa Cruz	2	5	5
EBMUD	0	5	5
North San Mateo County	2	5	5
Vallejo S&FCD	2	15	15
Overall			6
Load Shifting			
South Tahoe PUD	0	10	10
Gridley	2	5	5
Rancho Murieta	2	20	20
Overall			10
Energy Efficiency			
Palo Alto WWTP	2	10	10
City of Dinuba	2	5	5
Bear Valley Springs CSD	0	20	20
Overall			11

The C_Vs for each of the subpopulations are shown in Table 8-8. Also in Table 8-8, note the precision calculated for each administrator at 80 percent confidence. The measurement and operational errors have been added to the calculated sampling error for each subpopulation.

Table 8-8: Program Uncertainty Analysis (Coefficient of Variance)

Project Category	AB 970 Cv	SB 5X Cv	SB 5X Sampling Error	SB 5X Measurement Error	SB 5X Overall Error
Curtailment	N/A	N/A			
Generation	0.2	0.3	6%	6%	9%

Project Category	AB 970 Cv	SB 5X Cv	SB 5X Sampling Error	SB 5X Measurement Error	SB 5X Overall Error
Load Shifting	0.5	0.3	12%	10%	16%
Efficiency	0.5	0.2	10%	11%	15%

The errors presented in Table 8-8 were used to determine the standard error for this element using the following equation:

$$SE_{Water} = \sqrt{\sum (kW_{Vsamp} * ME)^2 + \sum (kW_{Vnonsamp} * OE)^2}$$

Where:

SE_{Water}	=	Standard error for the Water element
kW_{Vsamp}	=	Verified savings from each project in the sampled population
$kW_{Vnonsamp}$	=	Verified savings from non-sampled population for each subpopulation
ME	=	Measurement error
OE	=	Overall error

The results of this calculation were multiplied by 1.28, the z statistic for an 80 percent confidence, to yield a total standard error for the SB 5X water element of plus or minus 938kW. When combined with the AB 970 error the overall water element standard error is plus or minus 2.9MW

8.5 PROGRAM ELEMENT EVALUATION

Nexant used the findings from our analysis of the sample projects to determine the verified savings for the program element as a whole. Nexant determined the realization rate for each sub-population through 1) dividing the sum of the verified savings for the sample projects by 2) the sum of the reported savings for these same projects. The realization rate for each sub-population was then multiplied by the total savings reported for that sub-population to determine the verified savings for the sub-population. The verified savings for each sub-population were then summed to derive the total verified savings for the program.

Table 8-9 shows the realization rates for the AB 970 and the SB 5X program elements. It is necessary to maintain separate realization rates for the two different programs due to the differences in program requirements and application criteria. For a detailed discussion of the measurement and verification of savings for AB 970-funded projects, please see Nexant's December 2001 report to the Energy Commission.

Table 8-9: Realization Rates for SB 5X and AB 970 Sub-Populations

Sub population	Realization Rates AB 970	Realization Rates SB 5X
Curtailment	101%	N/A
Efficiency	42%	88%

Sub population	Realization Rates AB 970	Realization Rates SB 5X
Generation	71%	59%
Load Shifting	36%	102%

The low realization rate for the generation subpopulation is partially a factor of generation project funding policies. The Energy Commission determined at the start of the program to use the continuous rating of the generator as the means for establishing funding. This method was used to help simplify determining funding with the understanding that this method would result in varying payment per actual kW of reduction and that the load reduction reported would both vary from the actual achieved savings change over the duration of the program.

Tables 8-10 and 8-11 show the determination of the verified peak reduction for each sub-population in AB 970 and SB 5X, respectively. These numbers are multiplied together and equal the verified peak reduction that is shown in the far right column of each table.

Table 8-10: Application of AB 970 Realization Rates

Sub population	Reported peak Reduction (MW)	Realization Rates	Verified peak Reduction (MW)
Curtailment	37.5	1.01	37.8
Efficiency	6.38	0.42	2.68
Generation	2.99	0.71	2.12
Load Shifting	5.27	0.36	1.89
Total	**52.14**		**44.49**

Table 8-11: Application of SB 5X Realization Rates

Sub population	Reported Installed (MW)	Realization Rates	Verified Installed (MW)
Curtailment	NA	NA	
Efficiency	1.42	0.88	1.25
Generation	14.5	0.59	8.56
Load Shifting	4.97	1.02	5.01
Total	**20.89**		**14.82**

Table 8-12 shows the savings for each SB 5X sample project and the realization rate for each SB 5X sup-population.

Table 8-12: SB 5X Realization Rates

	Project Name	Participant Reported Savings	Nexant Verified Savings	Realization Rate
Efficiency	City of Dinuba	164	119	0.73
	Palo Alto WWTP	309	325	1.05
	City of Brawley	0	0	TBD

	Project Name	Participant Reported Savings	Nexant Verified Savings	Realization Rate
	Bear Valley Springs CSD	152	103	0.68
	Efficiency Overall	**625**	**547**	**0.88**
Generation	City of San Mateo	500	496	0.99
	Vallejo S&FCD	2,400	850	0.35
	City of Santa Cruz	1,320	780	0.59
	EBMUD	1,700	1,117	0.66
	Big Bear Area RWD	600	469	0.78
	City of Merced	325	250	0.77
	North San Mateo County	180	172	0.96
	Generation Overall	**7,025**	**4,134**	**0.59**
Load Shifting	Gridley	31.8	32.0	1.01
	Rancho Murieta	144	58	0.40
	South Tahoe PUD	1,342	1463	1.09
	Load Shifting Overall	**1,517.8**	**1553**	**1.02**

The relatively low realization rates for efficiency projects (0.88) and generation (0.59) are due in part to the way in which the project implementers calculated their reported savings. Nexant's analysis indicates that reported demand savings for at least 5 of the14 sites visited were not derived from measurements of the change (difference) in production or consumption during summer peak periods. Three-generation projects (EBMUD, Santa Cruz, Vallejo) used their entire new generation potential as their savings estimate instead of calculating the difference between the old and new generation. Similarly, one efficiency project (Rancho Murieta) and one load-shifting project (Bear Valley Springs) used the total potential demand from all equipment affected (even though the equipment did not typically operate concurrently or during peak hours).

8.6 COST-EFFECTIVENESS

The program's cost-effectiveness is portrayed as the levelized cost per unit of demand reduction and is expressed in terms of $/ kW-yr. The general equation for calculating levelized costs of demand reductions is taken from the Energy Commission's *Standard Practice Manual: Economic Analysis of Demand-Side Management Programs,* (1987). The formula for levelized cost at the project level is as follows:

$$LC_{CEC} = LC/DR$$

Where:

LC = total Energy Commission costs used for levelizing

DR = total discounted demand reductions of the project

Since almost all funding was paid up front, no cash flow discounting is required. Demand reductions are expected to persist from 1 to 15 years, depending on the project type. Thus, each project requires discounting the annual expected demand reductions as follows:

$$kW_{total} = \sum_{n=1}^{t} \frac{kW}{(1+d)^{(t-1)}} = kW\left[1 + \frac{(1+d)^{(t-1)} - 1}{d(1+d)^{(t-1)}}\right]$$

Where:

kW_{total} = project discounted kW
kW = expected demand reduction each year
d = discount rate, 4.1%
t = project lifetime in years

This equation does not discount demand reductions in the first year. Non-lighting equipment lifetimes are based on *1999 ASHRAE Application Handbook,* Chapter 35.3, Table 3. Lighting fixtures have been assigned a lifetime of seven years. Demand reductions based on human intervention have been assigned lifetimes of one to three years.

AB 970 Cost-Effectiveness

Using this methodology, Nexant estimated the levelized cost of the AB 970 program element to be $32/ kW-year. This rate represents only the grant monies paid to recruit participants. It does not include the administrative fees charged by program implementers.

Nexant also calculated the levelized cost for the AB 970 program element based on accounting numbers provided by the Energy Commission, which include administrative costs. This analysis is based on program-level aggregated numbers, which indicate that by the end of December 2002, $5,060,688 had been invoiced under AB 970. This figure includes both incentive payments and administration fees invoiced to the Energy Commission by the program administrator and other entities performing tasks for this element. The same Energy Commission report indicates that the program had achieved 51.2 MW of peak savings. Applying the 2002 AB 970 realization rates to this reported savings yields 45.1 MW of verified savings. Assuming an average lifetime of 10 years (except for curtailment projects, for which an average of 3 years was assumed), these numbers yield a simple cost of $112/ kW and a levelized cost of $30/ kW-yr.

Table 8-13: AB 970 2002 Water Agency Program Element Cost effectiveness Results.

	Verified Savings	Incentive	Simple Cost	Levelized Cost
AB 970 2002	45.1 MW	$5,060,688	$112/kW	$30/kW-yr

SB 5X Cost-Effectiveness

Using the same methodology discussed above, Nexant estimates the incentive-only levelized cost of the SB 5X program element to be $44/ kW-year. Generation projects were assumed to have a lifetime of 15 years. The demand reduction contribution from sites purchasing all their fuel was reduced by 50 percent in the fourth year and again in the tenth year. This reduction was based on the assumption that plant operation, after the initial three-year contract, would depend on the cost of producing electricity compared to the cost of purchasing electricity. This reduction was not implemented for projects using primarily digester gas. Efficiency projects were all assumed to have a life of 10 years.

Load shifting projects were assumed to have a life of 6-8 years. The load shifting project lifetime was based on the assumption that the operation of the equipment, after the initial three-year contract, would be based on financial drivers such as time-of-use charges or curtailment incentives and changes in water treatment demands. Load shifting projects with automatic equipment that has the potential to replace some load, such as solar aerators, were given longer lifetimes as it was assumed that they would reduce future demand even as the demand for water treatment grew.

Using the above methodology and assumptions, Nexant determined the incentive-only cost-effectiveness for the SB 5X program element. For each subpopulation and for the program as a whole, Table 8-14 shows the verified savings for projects completed by December 2002, the incentive amount reported by the project administrator, and the simple and levelized costs.

Table 8-14: SB 5X Water Agency Program Element Incentive Only Cost-Effectiveness

Project Category	Verified Savings (kW)	Incentive	Simple Cost	Levelized Cost
Curtailment	NA	NA	NA	NA
Efficiency	496	$121,314	$245	$29/ kW-yr
Generation	4,957	$2,186,250	$441	$45/ kW-yr
Load Shifting	1,633	$305,680	$187	$45/ kW-yr
Overall Total	**7,085**	**$2,613,244**	**$369**	**$43/ kW-yr**

For comparison, a 1 kW project with a 10-year life, receiving a $250/ kW incentive, would have a levelized cost of $30/ kW-yr. The generation projects have a higher cost due to the low realization rate (0.59) for these projects as well as the fact that only half of them were completed in time to receive the $300/ kW incentive ($36/ kW-yr). The levelized cost for load-shifting projects have a higher cost due to their shorter life expectancy.

The SB 5X cost-effectiveness numbers in Table 8-14 represent only incentives paid to recruit participants. They do not include administrative fees charged by program administrators or Energy Commission charges to the program. Nexant also calculated the levelized cost for the SB 5X element based on accounting numbers provided by the Energy Commission, which included administration fees. This analysis is based on program-level aggregated numbers that indicate that by the end of December 2002, $2,181,220 had been invoiced under SB 5X. This figure included incentive payments and administration fees invoiced to the Energy Commission by the program administrator and other entities performing tasks for this element. The same Energy Commission report indicates that the program had achieved 8.7 MW of peak savings. Since this number represents unknown specific projects, the program average realization rate of 0.62 (yielding 5.4 MW of verified savings) and an average lifetime of 10 years were used in the calculation. Nexant calculated a simple cost of $404/ kW and a levelized cost of $48/ kW-yr.

8.7 AB 970 PERSISTENCE VERIFICATION

Nexant conducted persistence verification for the program to verify that projects implemented under AB 970 in 2001 were still achieving their verified savings as of EOY 2002. Nexant verified persistence in two ways: by follow-up site visits and phone surveys. Questions were asked to determine whether or not the measure is still in place and operating, whether or not there have been any major operational changes to the project or the facility that would affect energy savings, and how well the project has been performing. Nexant also solicited comments and feedback on the program as a whole.

Nexant conducted persistence verification efforts for all seven projects in the AB 970 sample population, visiting one of the projects (San Bruno) and surveying the remaining six participants by phone. Each of the participants were asked a series of questions to determine if there had been any significant changes in the project since Nexant's inspection visit in 2001. If there were no significant changes in project *operation* or project *performance*, Nexant assumed that the savings verified in 2001 have persisted. If significant changes in operation or performance were reported, Nexant assumed that the verified savings have not persisted. If a project or portion of a project was withdrawn and the project implementer was no longer claiming the savings associated with that withdrawal, Nexant did not consider the withdrawal a reflection of savings persistence. In those cases, the savings were subtracted from the original verified amount and the realization rates were recalculated accordingly.

Table 8-15 summarizes each AB 970 participant's survey responses. Nexant learned that one entire project and a portion of another had been completely withdrawn from the program before completion or payment. In both cases, the projects were performance based; because Nexant has no way of knowing whether or not the project implementers would have, upon completion, revised their reported savings, Nexant removed the withdrawn project and portion of a project from our persistence verification analysis. The remainder of the findings indicates that the savings verified in 2001 have persisted.

Table 8-15: AB 970 Participant Persistence Verification Survey Results

Participant	Is the project still in place?	Is the project still operating as planned?	Have there been any operating changes?	Has the project been performing as planned?
City of San Bruno	Yes	Yes	No	Yes
LA Bureau of Sanitation	Partially—motor removed, associated savings withdrawn	Yes, for the remaining portions of project	No	Yes, for the remaining portions of project
Moulton Niguel	Yes	Some problems were encountered, but have been corrected	No	Yes

Participant	Is the project still in place?	Is the project still operating as planned?	Have there been any operating changes?	Has the project been performing as planned?
Metro Water District of Southern California	Yes	Yes	No	Yes
San Diego	Yes	Yes	No	Yes
Eastern Municipal Water District (EMWD)	Yes	Yes	No	Yes
Pinole	No, project withdrawn	NA	NA	NA

City of San Bruno Project

Nexant performed one site visit, to the City of San Bruno project. During this visit, the project manager told Nexant that there had been no changes in operation and the system was performing as planned. Nexant verified these reports with a review of documentation, including the final commissioning report, and a first-hand viewing of the system in operation. The project manager also informed Nexant that the project had won the Fall 2002 California-Nevada-American Water Works Association Section Award for Energy Management.

Los Angeles Bureau of Sanitation Project

The LA Bureau of Sanitation reported on the three parts of their project affecting the blowers, lighting, and mixers. The blower and lighting efficiency improvements are still in place and operating as planned. The motor conditioners on digester mixers have been taken offline permanently because the units were not saving as much energy as hoped and were causing problems with the water treatment process.

The removal of the mixer motor from project reduced the reported savings by 146 kW and the verified savings by 15kW. In addition, in their final report, LABS revised their reported savings for the blower and lighting efficiency improvements. The reported savings for the lighting portion of the projects was raised from 21 kW to 42 kW. This increase was based on the 21 kW of lighting load affecting an equivalent savings in cooling load. In 2001, Nexant had verified the 21 kW of lighting load. Based on Nexant's experience with the interaction between lighting reduction and HVAC load reduction in office buildings, a 15% (3kW) credit was added to the verified savings. The reported savings from the blowers was revised from 80 kW to 121 kW, an increase of 41 kW, based on reported improvements in operations associated with the blowers. These newly reported savings from the project’s blower component is treated as incremental reported savings and not incorporated into the calculation of project realization rates or analysis documenting persistence of savings. The new realization rate for the LABS project is based on the reported savings for the lighting portion (42 kW), the reported savings for the blower portion (80 kW), and the verified savings for each portion: 24 kW and 78 kW, respectively. All of these changes yield a new realization rate of 84.4% for the LABS project (102kW divided by 122kW).

Table 8-16: LA Bureau of Sanitation Project – Persistence Results

Sub-project	2001		2002	
	Reported kW	Verified kW	Revised kW	Verified kW
Blowers	80	78	80	78
Lighting	21	21	42	24
Mixer motors	146	15	0	0
Subtotal for realization rate	247	114	122	102
Other	-	-	41	NA
Total	247	NA	163	NA

Moulton Niguel

During the persistence telephone survey, Moulton Niguel reported that the reservoir used for peak time storage had been out of service for inspection for three weeks. During this time, it was necessary to operate the pump during the peak period. The reservoir has since returned to service and the system is operating and performing as planned, with the pump shut down and the water diverted to the reservoir during peak times.

Moulton Niguel noted that at its joint regional treatment plant, one pump had been accidentally run for one hour during the peak period. The staff responsible has been trained regarding the program requirements and the situation has not repeated itself.

During the telephone surveys with each of the following participants, Metropolitan Water District, City of San Diego, and Eastern Municipal Water District, all reported that their projects had seen no changes since 2001 and were operating as planned

Town of Pinole

The town of Pinole had withdrawn from the program. The manufacturer of the microturbine installed by Pinole under the AB 970 program had, after being bought by another company, exercised their right to buy back the unit. The town eventually purchased a new microturbine, partially funded through a PG&E incentive program. Because the Pinole project was withdrawn (and there are no longer any savings reported for this project), the project is no longer used as a factor in calculating the realization rate for the generation subpopulation.

Removal of the Pinole project from the calculation resulted in an adjusted realization rate for that subpopulation of 71.1 percent, up from 70.2 percent. The realization for the efficiency subpopulation has also changed, as a result of the adjusted realization rate for the LABS project. Nexant has calculated the new realization rate for the efficiency sub-population to be 50.4 percent, up from 36 percent. Table 8-17 compares the original realization rates and the adjusted realization rates for all the AB 970 subpopulations.

Table 8-17: Adjusted Realization Rates for Each AB 970 Sub-Population

Sub population	Realization Rate	
	2001	2002
Curtailment	101.0%	101.0%
Efficiency	36.0%	50.4%
Generation	70.2%	71.1%
Load Shifting	35.7%	35.7%

Using the adjusted realization rates, Nexant calculates that the AB 970 program element has achieved verified savings of 44.58 MW.

8.7.1 Participant Feedback

In addition to the four specific questions regarding their projects, participants were asked if they had any comments on the incentive program itself. Most respondents commented that a) the incentives were helpful, b) that the program worked well, and c) recommended that the program be extended, if possible. One respondent noted that the Energy Commission was extremely helpful. Metropolitan Water District, a curtailment project participant, expressed difficulty in scheduling coordination with the California ISO.

8.7.2 Persistence Conclusions/Lessons Learned

Based on the results of the noted persistence verification activities, Nexant concludes that the savings verified for AB 970 projects in 2001 have persisted through the end of 2002.

8.8 ADMINISTRATORS AUDIT AND PARTICIPANTS AUDITS – SB 5X

8.8.1 Administrator Audit Report

Nexant audited the SB 5X program administrator, HDR, Inc.; the AB 970 wastewater program element audit was administered directly by the Energy Commission. The audit's purpose was to determine how the administrator performed the following Energy Commission identified tasks:

1. Participant recruitment
2. Program marketing
3. Goals and accomplishment verification
4. Recordkeeping
5. Communicating to the Energy Commission about program activities

The program administrator was also responsible for ensuring that the proposed projects were installed and completed successfully prior to releasing monies to the participants.

Nexant's audit of HDR's performance took place in December 2002, and involved an on-site visit by a Nexant staff member at the administrator's office. The administrator provided Nexant access to a sample of their program files (10 of 36) to verify that a paper tracking system was in place that justified payments made on projects.

8.8.2 Administrator Audit Results

Below are the responses to each of the 14 questions used as part of the administrative audits. The questions pertain to the procedural tasks involved with running the program. The first eight questions cover areas of the administrator's responsibilities throughout the program process, such as marketing, verification, and reporting. The last six questions look at the administrator's record-keeping practices to discern their level of organization and to check that the procedures and responsibilities required by the Energy Commission have been followed. For questions one, two, and seven the respondent could give more than one answer.

Question 1: How were participants recruited?

HDR used mailing lists to send materials to the California Water Environment Association membership, National Pollutant Discharge Elimination System wastewater discharge permit holders, Department of Health potable water permit holders, and its own clients. It also posted advertisements or articles in "three or four" quarterly trade publications. HDR also sponsored a Distributed generation web site, which promoted the program.

Question 2: What marketing material did you use to attract participants?

HDR utilized an Energy Commission flyer that it sent out along with copies of the ads/articles that it had placed in trade publications.

Question 3: A two-part question: a) How many participants are participating as of December 31, 2002, and b) How many participants dropped out since the program's inception?

HDR reported 16 completed projects, with an additional 18-committed participants. Above and beyond these numbers, 8 projects were undertaken but ultimately dropped out.

Question 5: What equipment and services did you offer to participants?

No equipment or services were offered outside of the program incentive payments, as they were not within HDR's scope of work.

Question 6: Were participants offered training or any other instructional help during any time of their participation?

HDR offered assistance with applications and project definition. Training was not within HDR's scope of work.

Question 7: How did you evaluate your projects?

Applicants were required to fill out applications describing the project and its potential savings. Applications had to be verified and signed by a licensed engineer. HDR personnel reviewed each application for reasonableness.

Question 8: Question 8 had three parts: a) How did you verify installations? b) How many participants or sites were verified, and c) Did you use a sampling plan for this?

Verification of project installation was based on documentation provided in the participants' final report. These reports were turned in to the administrator upon completion of the project and included invoices and receipts for equipment and labor involved with project implementation. On-site verification was an optional task for the administrator, dependent on funding and specific requests from the Energy Commission. No site visits had been requested by the CEC contract manager or made by HDR by the time of the audit.

Question 9: What method was used to track and report project progress to the Energy Commission and/or the M&V contractor?

HDR used a spreadsheet to track projects, and reported weekly or monthly progress depending on the number of changes in the projects.

Questions 10-15 focused on the administrator’s record keeping, and were based on a 5 point scale. The exact scale is described under each question. In general, a rating of "5" equals full record retention and a rating of "1" signifies a complete lack of documentation. Ten participants were selected from those with completed projects. Nexant reviewed the files for these participants, assessed their compliance, and then answered each of the questions. In each case, no discrepancies or deficiencies were found. Thus, the administrator received a score of five for each of the questions.

Question 10: Are documents available for the sampled projects in question?

The scale was 1 to 5 where 5 represented that all requested documents were available; 3=half of requested documents available; 1=no documents available.

Question 11: Were invoices valid—as shown by proper documentation and consistent with the initial agreements between parties involved and the program requirements?

The scale was 1 to 5 where 5 represented that all invoices were consistent; 3=Half of invoices are consistent; 1=Invoices completely inconsistent or not available.

Question 12: Was the verification process noted above followed?

The scale was 1 to 5 where 5 = a thorough verification process with full documentation; 3=Observed two or more significant deviations from verification process with sound explanations; 1=No verification process.

Question 13: Did the installed equipment agree with the invoice?

The scale was 1 to 5 where 5 represented complete consistency between invoices and equipment; 3=Observed two or more discrepancies between invoices and equipment; 1=Invoices completely inconsistent with equipment or not available**.**

Question 14: Were participants paid according to the customer agreement?

The scale was 1 to 5 where 5 represented that all payments were made according to customer agreements; 3=Most payments made according to customer agreements, two or more discrepancies; 1=Payments not made at all, or are not made according to agreements, or all payments made are in dispute.

Question 15: Was the tracking/reporting method noted above maintained?

The scale was 1 to 5 where 5 represented that actual tracking/reported method is consistent with planned method, with data available for all requested participant sites; 3=One or more deviations from planned method or half of records inadequate or missing; 1=No effective tracking method observed or data found to be completely inaccurate**.**

8.8.3 Administrator Audit Conclusions/Lessons Learned

Audit results indicate that HDR, Inc., the program administrator for the SB 5X program element, met the program guidelines for marketing the program, tracking participants, maintaining records, and reporting to the Energy Commission.

8.8.4 Participant Audit Report

The purpose of Nexant's participant audits was to evaluate the participants' compliance with the program's various rules and requirements for eligibility, the application process, reporting, and verification. These audits also provided an indication as to the participants' level of satisfaction with the administrator's program process design. The audits were conducted between December 2002 and January 2003.

Each audit was in the form of a 17-question telephone survey, performed by a Nexant staff member. The first eight questions asked participants about each aspect of the program's process such as marketing, communication, reporting, and verification. Questions 9-11 inquire about how the process went and what effect the program itself had on the participant's willingness to undertake an efficiency upgrade. Questions 12-17 use a 5-point rating system to determine the participant's level of satisfaction with each aspect of the program.

Nexant attempted to conduct participant audits for 12 of the 14 projects in the SB 5X sample population, but were able to perform only six audits (four project managers had either retired or moved on, and two projects were incomplete.) The six audits were performed for the following projects; Vallejo, Santa Cruz, Rancho Murieta, East Bay Municipal Utility District, Gridley, and San Mateo.

8.8.5 Participant Audit Results

Below is a series of explanations and charts that categorizes the participants' responses to each of 17 questions.

Question 1: How did you find out about the Energy Commission Water Agency Program?

All respondents found out about the program through the administrator/contractor, HDR. Two specifically mentioned the HDR website and one noted an HDR mailing.

Question 2: Why did you participate in the program?

Every respondent listed financial incentives as the greatest motivator. San Mateo said that this program's funding was available sooner than another program it was considering. Santa Cruz also said it wanted to generate more power.

Question 3: Did you participate in any other similar peak load reduction programs?

Five said yes, one said no. The yes answers included a PG&E program for motion sensor lights, an unspecified program for motors, and an Energy Commission programs on solar power, lighting, air conditioning, and refrigeration.

Question 4: On a scale of 1 to 5, rate the overall quality of the communication process with your administrator (5=complete/thorough; 3=sufficient/adequate 1=absent/ wholly inadequate)

The average was 4.3, with three 5s, two 4s, and one 3. Three respondents referenced weekly communications with the administrator while one said it was monthly.

Question 5: By what means did you most often communicate?

Phone and e-mail were the only answers.

Question 6: On a scale of 1 to 5, rate the reasonableness of the reporting requirements you were required to fulfill (5=Very reasonable, easy to fulfill; 3=Somewhat reasonable; some significant challenges; 1=Completely unreasonable)

The average was 4.5, with three 5s and three 4s. Three respondents indicated that they supplied monthly reports while three said just an initial and a final report were necessary.

Question 7: How long did it take for you to be notified about your application status after you submitted it?

Three respondents said it took one week to find out about their application status. One said it took more than one month. Two others were unsure.

Question 8: Did your program administrator visit your project to verify project completion?

Three respondents said no and three were unsure.

Question 9: On a scale of 1 to 5, rate the obstacles you encountered as if you were to implement the project again (5=no significant obstacles; 3=Obstacles were significant, but would conduct project again; 1=Obstacles were prohibitive)

The average was 3.4. Santa Cruz gave a 2, explaining that the availability of engineers and coordinating with PG&E were obstacles. EBMUD gave a 2, noting “delays.” San Mateo gave a 3, citing coordinating with PG&E as an issue.

Question 10: What is the likelihood that you would have performed peak load-reducing actions without the Water Agency program? (5=without question; 3 =yes, though under different circumstances; 1=under no circumstances)

The average was 3.8. Santa Cruz gave a 2, saying it may have undertaken a smaller project otherwise. Vallejo gave a 3, saying that it would have had to perform the project eventually. EBMUD gave a 4, and said the grant reduced the payback to 4-5 months. San Mateo and Rancho Murieta both gave 5s, but said the projects would have been delayed without the grants.

Question 11: From your experience with this program would you participate again in a similar program? (5=without question; 3 =yes, though under different circumstances; 1=under no circumstances)

The average was 4.8, with five 5s and one 4. Santa Cruz, who gave the 4, said it was not difficult other than the timeline.

Questions 12-17 ask respondents to rate various aspects of the program on a 5-point scale, with five being the highest.

Question 12: How would you rate your experience with the Demand Responsive program on the whole?
Question 13: Your administrator?
Question 14: The application process?
Question 15: The invoicing, billing and payments process?
Question 16: The verification process?
Question 17: The implementation timeline that you were on?

The overall program and the administrator inquiries had the highest average ratings. The payment process was the only category to receive an average below 3.5. Regarding the timeline, Santa Cruz said it was tight and didn’t allow time for competitive bids; Rancho Murieta said the application deadline was too short; and San Mateo said its rating would be a 3 instead of a 5 if it took into account issues with PG&E. Figure 8-1 shows the average ratings.

Figure 8-1: Program Ratings

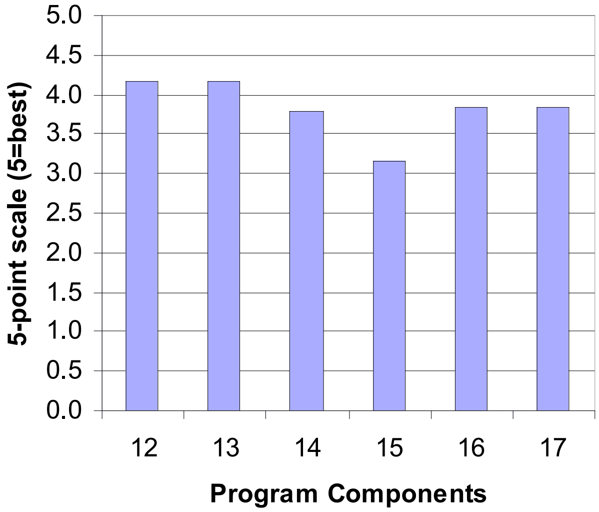


Table 8-17 shows the count of each rating for questions 12-17.

Table 8-17: Program Component Ratings Count

Question No.	Question	Low 1	Ranking Scale 2	3	4	High 5	Average
12	Overall program	0	0	1	3	2	4.2
13	Administrator	0	0	1	3	2	4.2
14	Application process	0	0	1	4	0	3.8
15	Payment process	1	0	3	1	1	3.2
16	Verification process	0	0	1	5	0	3.8
17	Timeline	0	1	1	2	2	3.8

8.8.6 Participant Audit Conclusions/Lessons Learned

Upon completion of the participant audit, Nexant can provide the following conclusions and key lessons learned. While the participants received the program quite favorably, enhancements for any subsequent offerings should take into account the following;

- Working with the utilities to streamline the inspection process could facilitate implementation of future projects. Several of the participants noted delays due to scheduling issues with PG&E inspectors.
- This program was instrumental in getting more savings in place sooner. Some participants stated that, without the incentives, they would have undertaken smaller projects. Others noted that their projects would have been delayed in implementation.

- Future programs, ones not pressed by emergency conditions such as the AB 970 and SB 5X initiatives, should build the project bidding process in their timelines. One participant made the observation that the short time frame limited the time allowed for a competitive bidding process.
- Identifying methods for soliciting participants that have not previously participated in energy efficiency programs may help expand participation. Most of the participants stated that they had participated in other incentive programs. Identifying and marketing to new entities, as well as old, will increase awareness of energy issues and possible alternatives in the water sector. This may, in turn, increase participation.

8.9 WASTEWATER PROGRAM ELEMENT CONCLUSIONS

As of December 31, 2002, the total savings verified from the SB 5X-funded portion of the wastewater program element is 7.1 MW; for the AB 970-funded portion, the total verified savings is 45.1 MW. With the 7.8 MW of savings estimated for the projects due for completion by June 2003, a total savings of 59.9 MW is expected from both the SB 5X and AB 970 program elements combined.

The AB 970 element was successful in restoring to operation several nonfunctional generation systems, installing new generation systems, shifting some peak loads to off peak times, and enabling one municipality to respond to curtailment price signals. Details of these successes are discussed in the AB 970 December 2001 report.

Generation is not the only source of peak reduction at water agencies. Opening the program to load shifting and efficiency projects doubled enrollment and nearly doubled expected savings from the SB 5X program element. Load shifting projects account for one third of the expected savings and had a levelized cost on par with generation. The efficiency projects accounted for a much smaller amount of overall savings than anticipated about 8 percent, but these projects were more cost effective, with levelized costs 33 percent less than either generation or load shifting.

In general, for both programs, simplified savings calculations and evaluation methods were employed to simplify administration of the funds, to the detriment of accuracy. In several cases where equipment was not used full time, project implementers reported connected load as savings. As a result, contracted savings were often overestimated, significantly contributing to low realization rates.

Equipment performance and reliability should be thoroughly researched when considering the installation of energy efficiency equipment at water and wastewater facilities. For example, after considerable testing, the City of Los Angeles learned that its variable frequency drive project would affect the treatment process downstream in a negative way, and therefore withdrew the project. By testing the project first, the city was able to avoid implementing a project that would have failed. Under AB 970, a similar project was shown to increase energy consumption due to the loading characteristics of the motors. While this project had already been implemented, the results kept the participant from expanding the project.

Lower water supply demands can have the equivalent effect of increasing capacity at no or low cost to the water utility. Some effective methods of reducing water demand are proper selection of plant material, optimization of end-use processes, installation of water meters, leak detection, and regular tracking of water consumption to identify potential problems.

During site visits and communications with participants and the project administrators, Nexant noted that the short lead-time in the initial phase of the application process was an issue for several participants. The main issues were the short timeframe for new projects to go through the planning and approval process. Participants also commented that the construction process usually took longer than planned. The effect of these issues on the program is evident in a number of projects requesting extensions or changes.

The short lead-time issues may also lead to a form of free-ridership. Projects that were already planned (and likely would have proceeded independent of the program's incentives) were able to move faster and take advantage of the higher initial rebate. Conversely, new projects that were being considered as a result of the incentive program had a much more time-consuming planning and approval process; thus, they would be more likely to receive the lower rebate.

Policies and contracts facilitating the sale of electricity back to the grid, at least under emergency conditions, would enable several of the generation projects to reach their full potential. In at least two cases, Vallejo and Big Bear, the installed capacity is not fully utilized by the plant itself. Enabling these two projects to sell back to the grid or contract for emergency power production would add nearly 1.4 MW of peak savings for this element.

Nexant has requested from the Energy Commission an extension of the SB 5X element's monitoring and verification period so that we may evaluate additional projects. We recommend the evaluation of up to seven addition projects within the efficiency and load shifting subpopulations to confirm that our verified savings are representative of the diversity of project types within these subpopulations.