3.1 BACKGROUND OF PROGRAM ELEMENT

The Demand Responsive (DR) program element covers the full spectrum of end-user markets in California, ranging from small residential and commercial customers to large commercial and industrial (C&I) facilities. This report documents the 2003 performance of small C&I and residential program elements, and presents an integrated summary of results that also covers large C&I related activities. In total, the DR program consists of four sub-elements that have been funded by the following two successive state legislative actions over the last three years:

- *Assembly Bill 970 (AB 970)*: Passed in September of 2000 with a total funding of $11.45 million. AB 970 targeted 50 MW of peak demand savings during the summer of 2001 from contractors that aggregated load reductions at large C&I facilities (Sub-element 1) and from individual C&I or government entities that were direct program grantees (Sub-element 2).
- *Senate Bill 5X (SB5X)*: Passed in April of 2001 adding $27.28 million to increase the targeted peak demand savings of AB 970 by an additional 164 MW through the summer of 2002. SB 5X added two new groups to the DR program—small C&I customers (Sub-element 3) and residential end-users (Sub-element 4) that provided load curtailments through contractors.

Figure 3-1 illustrates the timing and level of funding provided to the DR program sub-elements.

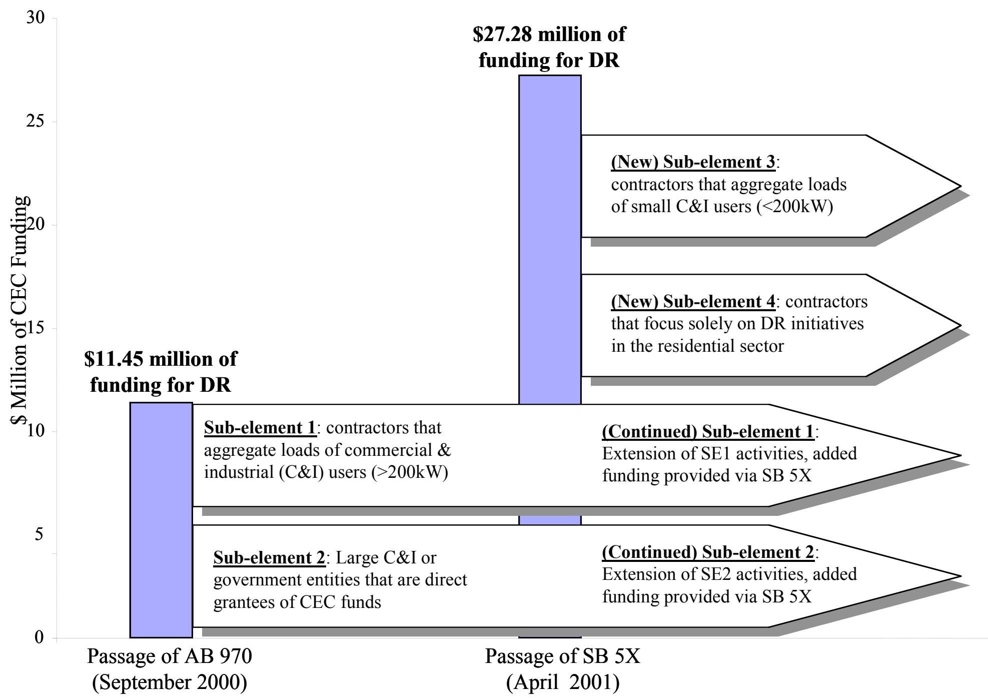

Figure 3-1: DR Funding Sources By Program Sub-element

This report supplements the Demand Responsive Section (3) of the 2002 Year-End Peak Load Reduction Program report. As previously noted, however, the focus of this report is on the 2003 evaluation of DR program Sub-elements 3 and 4 for the summer period. In order to provide cumulative results for all four DR program elements as of the end of 2003, this report also contains results from other sub-elements that were provided in the 2002 Year-end report.

The remainder of this document details the planning, execution, and key results of Nexant's measurement, verification and evaluation (MV&E) methodology for Sub-elements 3 and 4. The main sections of this report are broken out as follows:

- Section 3.1 provides an overview of the four sub-elements and describes the program funding cycles and administrative hierarchy. Descriptions of Sub-elements 3 and 4 are provided along with an overview of the purpose and process of program pilot tests.
- Section 3.2 summarizes the performance of each of the four DR program sub-elements. Key performance indicators such as cumulative program participation and total demand savings are presented. However, additional summary results are provided for Sub-elements 3 and 4, given this report's focus is on the evaluation of small C&I and residential programs.
- Section 3.3 outlines Nexant's MV&E approach that utilizes automated and manual analysis tools and surveys.
- Section 3.4 identifies the key evaluation (research) objectives for Sub-elements 3 and 4, and describes how the actual MV&E process was carried out in order to answer the evaluation objectives. A review of specific data collection and analysis techniques that were applied to help achieve Sub-element 3 and 4 research objectives are explained.
- Section 3.5 presents the summary results of Nexant's evaluation of all DR program sub-elements. Total demand savings achieved during pilot tests and Stage II emergency curtailments are reported for Sub-elements 3 and 4. Program participation levels are also examined along with significant findings pertaining to program evaluation objectives.
- Section 3.6 evaluates the cost-effectiveness of the DR program as a whole and by program sub-element. Analysis is also presented of Sub-element 3 and 4 program administrators.
- Section 3.7 presents the results of surveys and audits that were conducted of Sub-element 3 and 4 program administrators and participants. Administrator survey results chronicle program implementation successes and challenges, while participant surveys offer insight into customer perceptions of the DR program and how it was administered.
- Section 3.8 states the main conclusions of the 2003 program evaluation of Sub-elements 3 and 4. Key findings from previous sections and the fundamental lessons learned from the implementation of DR programs are summarized.

The balance of this section provides further background on the DR program element before moving on to subsequent discussions of the MV&E process and key program results.

3.1.1 Program Goals and Administration

In the summer of 2001, the program targeted a total of 65 MW of peak savings, 50 MW from AB 970 participants and 15 MW from SB 5X. Although additional funds were provided through the passage of SB 5X, the principles of the DR program's design remained the same. However, the composition of the program was expanded to include two new market segments, namely: Sub-element 3 covering small commercial participants with connected loads of 200 kW or less, and Sub-element 4 covering residential customers.

The goals of the state-funded DR program element are accomplished through participant load shedding during power emergencies signaled by the California Independent System Operator (CAISO) Stage II and III alerts.[1] These emergencies were expected during summer, non-holiday weekdays from June 1 to September 30, between the hours of 2:00 to 6:00 pm, when air conditioning loads are high.

To achieve the program's shedding objectives, funding and technical assistance were provided to participating electricity end-users to assist with the installation of the metering and communication equipment that is necessary to respond to CAISO emergency curtailments and/or to participate in CAISO or utility DR incentive programs. As a prerequisite to participating in this program, participants had to perform pilot tests to demonstrate the load shedding capability of their DR equipment. Program participants included commercial, institutional, industrial, and residential facilities. Program funds were allocated to these entities in the form of contracts and grants. Administration of the program was carried out through either program contractors or direct grantees that consisted of the following entities:

- Program Contractors: Responsible for recruiting and managing projects for customers with one or more participating facilities. Contractors served as aggregators of curtailable load across program participants. Program contractors represented a diverse group of organizational entities, including municipal utilities, investor-owned utilities (IOUs), power retailers, and non-profit and for profit private enterprises. Contractors' customers included college campuses; federal, state and local public agencies; corporate retail and restaurant chains; and office complexes.
- Program Grantees: Participants that were directly responsible for administering the implementation and performance of DR systems in one or more of their own facilities. Program grantees included college campuses; federal, state and local public agencies; corporate retail chains; and office complexes.

3.1.2 Program Sub-elements

As noted earlier, following the adoption of SB 5X, there were four DR program sub-elements covering several key end-user segments. Listed below is a description of the main participants for each DR program sub-element.

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[1] Stage II events occur when generation reserves are less than 5% of system requirements. Stage III events occur when reserves are below 3%.

- **Sub-element 1**: Contractors were responsible for aggregating loads at medium and large commercial and industrial (C&I) facilities with peak demands of 200 kW or greater. Contractors recruited customers that can host projects at facilities under their management. Typical Sub-element 1 customers include offices campuses, colleges, hotels, and retail chains. Participating facilities or customers with one or more building sites under the management of the customer organization negotiated a sub-contract with contractors.
- **Sub-element 2**: Grantees that are comprised of medium and large commercial and governmental entities with building sites directly under their management. Grantees were typically office campuses of technology firms, or retail, hotel and restaurant chains with facilities distributed across California. For grantees, the Energy Commission holds grant agreements directly with the public or private entity responsible for the managed facilities. One aspect of Sub-element 2 is that there is a direct institutional relationship between the grantee and the facilities from which demand responsive loads are aggregated.
- **Sub-element 3**: Contractors were responsible for aggregating loads at small commercial facilities with connected loads of less than 200 kW. Sub-element 3 contractors, ICF and Webgen, recruited commercial customers that could manage energy projects in a large number of similar or identical facilities, such as commercial restaurant and retail chains. The homogeneity of customer facilities in this sub-element allows for economies of scale in the replication of installed DR projects. A high degree of automation during curtailments and the selection of DR projects with a relatively easy level of implementation were essential to successfully aggregating loads for Sub-element 3 customers.
- **Sub-element 4**: Contractors were responsible for implementing projects for residential customers. Sub-element 4 involved two contractors, Energyn and Sacramento Municipal Utility District (SMUD). Energyn operated a single pilot program within the PG&E service territory, while SMUD operated two individual programs within their own service territory. Unlike Sub-elements 1 and 3, there are no customer-level entities in Sub-element 4 that act as intermediaries between contractor and residential program participants. However, program implementation did require active program marketing, recruiting, and signing participant agreements for projects to proceed. Given differences in the energy use patterns in the residential sector and the unique implementation structure of this sub-element, the evaluation methodology for Sub-element 4 is different from the other sub-elements.

All of the contractors and grantees of Sub-elements 1, 2 and 3 were obligated to implement and test their systems to demonstrate a capability to respond to CAISO Stage II and III emergency curtailment signals. In these pilot tests, each grantee and contractor had to demonstrate a simultaneous activation of curtailments across all participating buildings within 30 minutes of receiving the test signal. Although most participants were not obligated to participate in any actual CAISO emergency curtailments during summer months, all were required to test and maintain the installed systems throughout the four summer months of June through September.

Sub-element 4 contractors were not required to conduct pilot tests, but they did need to demonstrate and record the results of demand responsive load shedding through operation of their respective programs. Figure 3-2, shown below, illustrates the administrative hierarchy of the DR program, and displays how responsibility for program implementation is assigned across the four sub-elements.

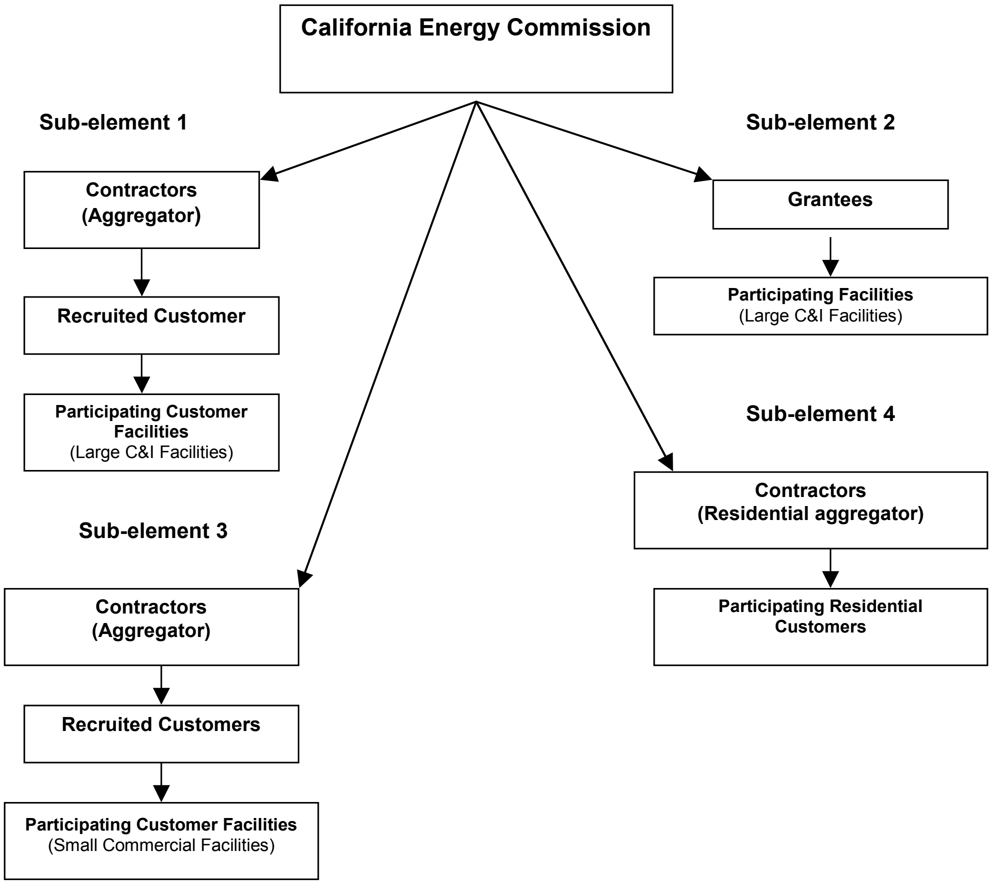

Figure 3-2: Administrative Hierarchy and Program Sub-Elements

Listed below is a brief description of the Sub-element 3 and 4 pilot programs that are evaluated in this 2003 report.

3.1.3 Sub-element 3

The focus of Sub-element 3 is on achieving peak demand reduction at small commercial facilities with connected loads of less than 200 kW. The ICF and Webgen programs that were carried out for Sub-element 3 participants are described below:

ICF Program

This program funds the installation of control and communications technologies that can help end-users monitor their electricity use and respond to program events that call for reductions in demand. Customers installed energy management and control systems to help reduce their loads (most often lighting and HVAC) from a central location. By curtailing peak energy use, program participants lowered their energy bills and helped improve system reliability.

Webgen Program
This program aims to achieve load reductions at participating facilities through the installation of Intelligent use of Energy Systems (IUE). IUEs are an energy-management system that can help end-users monitor and control their use of electricity. IUEs utilize advanced metering, internet interface (Ethernet, SCADA), and other energy monitoring / controls services.

3.1.4 Sub-element 4

Two contractors, SMUD and Energyn, were selected by the Energy Commission to operate three separate residential pilot programs. The objective of these programs was to install DR systems in a pilot group of new and existing homes in order to test homeowners' responses to one or more of the following types of signals to reduce peak loads:

- Dynamic curtailment signals triggered by SMUD according to internal criteria including wholesale price hikes, high temperatures, and capacity constraints (SMUD PowerStat and PowerChoice Programs);
- Static time-of-use price signals in a 3-tiered rate block (PowerChoice Program); and
- CAISO signals issued during Stage II and III emergencies.

PowerStat
A direct load control program run by SMUD that relies on the use of electronic signals that are sent out to cycle residential air-conditioning systems and spa and pool pumps at participants' homes during curtailment periods. Of the Sub-element 4 residential pilot programs only PowerStat was implemented by the end of summer 2002.

Energyn Program
A program offered in PG&E's service territory with Energyn serving as a program administrator/aggregator. Program participants respond to automated signals by pre-programming higher thermostat set-points for curtailment periods.

PowerChoice
A program offered by SMUD that includes three-tiered TOU rate blocks that provide fixed price signals to encourage participants to shift residential loads to off-peak periods. In addition, a fourth, highest-priced tier, designated as a "critical period", serves as a dynamic price signal. This critical period may occur at any time during the peak afternoon hours of summer weekdays.

The remainder of this report details the methodology that was utilized to evaluate Sub-element 3 and 4 programs, and presents key performance related results for each program during the 2003 summer peak period.

3.2 STATUS OF PROGRAM ELEMENT

This section provides a summary of final demand savings for projects completed under the Energy Commission's DR program. Key findings for the 2003 summer peak demand period are presented for Sub-elements 3 and 4. Results are also listed for Sub-elements 1 and 2. Contractors and grantees of AB 970 and SB 5X for Sub-elements 1 and 2 have completed all phases of their programs prior to 2003.[2] Verified demand savings of Sub-elements 3 and 4 have been updated in this supplemental report to reflect program results obtained up to September 30, 2003. Other key results discussed below include a summary of program participants and a description of program activity for Sub-elements 3 and 4 (i.e., test dates, number of tests conducted, and recruitment of participants by contractors).

3.2.1 Program Overview

Program Participation

At the end of the 2003 summer peak demand period, 2,128 participants had been enrolled in programs under the four DR sub-elements. Table 3-1, shown below, breaks out total participant recruitment levels by sub-element as of September 30, 2003.

Table 3-1: Summary of Program Participation by Sub-element as of September 30, 2003

Sub-element	Sub-element description	Current number of participants
1	Contractors, med–large C&I	820
2	Grantees, med–large C&I	512
3	Contractors, small C&I	473
4	Contractors, residential	323
Total		**2,128**

Between September 30 and December 31, 2003, there was little or no change in the total number of participants for all of the sub-elements, with the sole exception of Sub-element 3. For Sub-element 3, ICF recruited an additional 645 participants during the fourth quarter of 2003—representing a 136% increase over the Sub-element 3 total as of September 30. If these additional participants were to be added to the figures listed above in Table 3-1, the total participants for Sub-element 3 would rise to 1,118, and the total participants for all DR program sub-elements would increase to 2,773 as of December 31, 2003.

Demand Savings by Program Sub-elements

Table 3-2, shown below, summarizes the demand savings that were achieved as of September 30, 2003 for all of the AB 970 and SB 5X funded programs combined. Reported and verified demand savings are given for all sites completing pilot tests as of the end of the 2003 summer peak demand season. As discussed in more detail in subsequent sections of this report, reported

[2] Verified demand savings from these sub-elements are the same as those reported in Nexant's 2002 report.

demand savings for the Webgen and Energyn programs are not presented as part of the results for Sub-elements 3 and 4.

Table 3-2: Demand Savings by Program Sub-element as of September 30, 2003

Sub-element		Contracted demand savings (MW)	Reported demand savings (MW)	Verified demand savings (MW)	Realization rate
1	Contractors (Large Commercial & Industrial)	184.4	190.8	175.1	91.8%
2	Grantees (Large Commercial & Industrial)	33.6	33.7	26.9	79.8%
3	Contractors (Small Commercial)	40.0	NA[1]	13.8	99.0%[3]
4	Residential Pilot	3.0	NA[2]	0.39	87.4%[4]
Totals		**261.0**	**NA**	**216.2**	**91.5%**[5]

[1] ICF had reported savings of 11.5 MW. Webgen did not have reported savings (only verified savings were submitted).

[2] PowerChoice and PowerStat had combined reported demand savings of 0.273 MW, while Energyn did not have reported demand savings. Since no reported figures were received for the Energyn program, only verified savings are reported.

[3] Sub-element 3 realization rate calculated based on ICF reported and verified savings.

[4] Sub-element 4 realization rate calculated based on SMUD PowerChoice and PowerStat reported and verified savings.

[5] Total realization rate is calculated based on reported and verified demand savings for all Sub-element 1 and 2 programs, for ICF only in Sub-element 3, and for SMUD PowerChoice and PowerStat only in Sub-element 4.

Further discussion regarding demand savings results, and the methodology used to calculate these savings, is presented in greater detail in Section 3.3, 3.4, and 3.5 of this report.

Cumulative Demand Savings for Summers 2001, 2002, and 2003

Table 3-3, shown below, lists the cumulative verified demand savings for contractors that completed pilot tests as of the end of the summer peak periods ending on September 30 in 2001, 2002, and 2003. At the end of summer 2001, verified demand savings across Sub-elements 1 and 2 were almost exactly as contracted, at just over 155 MW. At the end of summer 2002, verified demand savings of 203.8 MW were 24% below the contracted amounts, largely because Sub-element 3 and 4 contractors had only tested a small proportion of their program participants.

Table 3-3: Cumulative Demand Savings for Summer 2001, 2002, and 2003

	Total facilities contracted	Cumulative contracted demand savings (MW)	Cumulative verified demand savings (MW)	% Difference between contracted and verified savings
Summer 2001	734	155.6	155.1	-0.3%
Summer 2002	1,644	253.0	203.8	-24.0%
Summer 2003 (as of 9/30/03)*	2,128	261.1	216.2	-20.9%

* Does not include expected additional projects by ICF.

At the end of the 2003 summer peak demand period, total verified demand savings were approximately 20% below the cumulative contracted demand level. Similar to the 2002 results, the shortfall in 2003 is driven in part by the lower than expected annual savings from the residential programs in Sub-element 4. Further elaboration on the findings listed above in Table 3-3 is contained in Section 3.5.

3.2.2 Program Activity Summary of SB 5X

Although Sub-elements 1 and 2 were completed at the end of 2002, the final outcome of Sub-elements 3 and 4 were not realized until the end of the 2003 summer peak period. Table 3-4, shown below, displays the results for all four sub-elements of the SB 5X program.

Table 3-4: Summary of SB 5X Program Activity as of September 30, 2003

Sub-element		Program sub-element status	Contracted curtailable load	Reported curtailable load from pilot tests	Verified demand savings as of September 30, 2003	Number of facilities as of September 30, 2003
1	Contractors, med–large C&I	Completed, 2002	90.5 MW	87.8 MW	85.2 MW	309
2	Grantees, med–large C&I	Completed, 2002	19.6 MW	19.7 MW	16.0 MW	334
3	Contractors, small com.	Implementation expected to be completed by 6/1/03	40.0 MW	11.5[1]	13.8 MW	473
4	Contractors, residential	Implementation expected to be completed by 6/1/03	3.0 MW	0.27[2]	0.391 MW	323
Totals			**153.1 MW**	**NA**	**115.4 MW**	**1,439**

[1] Reported savings are for ICF only. Webgen did not have reported demand savings.

[2] Reported demand savings include results for only the PowerChoice and PowerStat programs (not Energyn).

As Table 3-4 illustrates, the total Sub-element 1 contracted demand savings of 90.5 MW represents 60 percent of the total SB 5X contracted demand savings, while Sub-element 2 represents 13 percent (19.7 MW). Sub-element 1 and 2 participants have finalized program implementation and have performed at least one pilot test. Sub-element 1 contractors reported achieving 97 percent of their contracted goal. Nexant was able to verify a 94 percent accomplishment. Sub-element 2 grantees reported achieving 100 percent of their contracted demand savings, while Nexant's verification was 82 percent. The combined reported demand savings of 107.5 MW for Sub-elements 1 and 2 is 96 percent of the combined contracted demand savings of 110.1 MW. Nexant has verified 101.2 MW in demand savings for Sub-elements 1 and 2, or 92 percent of contracted demand savings for these two sub-elements.

Total Sub-element 3 contracted demand savings of 40 MW represents approximately 26% of total SB 5X contracted demand savings, while Sub-element 4 represents only 2 percent (3 MW).

For Sub-element 3, 13.8 MW of verified demand savings were achieved. This represents only 35% of the contracted 40 MW that was initially set at the outset of these programs. The primary reason for this shortfall is that Sub-element 3 enrollment was below initial expectations. For Sub-element 4, the 0.391 MW of verified savings from residential pilot programs represent only 3% of the total contracted demand. The large disconnect between the verified and the contracted demand savings reflects in large part the experimental nature of the residential DR pilots.

3.2.3 Summary of Program Status of Sub-elements 3 and 4

Sub-element 3 Contractors

Webgen and ICF Consulting, the two contractors for Sub-element 3, conducted recruitment of small commercial participants throughout 2002 and 2003. By working primarily with large chains of restaurants, retail outlets, and banks, they recruited 473 participants as of September 30, 2003. As noted above, ICF continued the aggressive recruitment and testing of participants, adding 645 additional sites between the end of the summer peak season and the end of the 2003 calendar year. Table 3-5, shown below, summarizes the activity of Sub-element 3 as of September 30, 2003.

Table 3-5: Program Activity for Sub-element 3 as of September 30, 2003

Contractor	Total of customer sites recruited	Total facilities conducting pilot tests	Contracted curtailable load (MW)	Reported curtailable load (MW) [1]	Verified curtailable load (MW)	Realization rate
ICF Consulting	392	392	30.0	11.53	11.41	99.0%
Webgen	81	81	10.0	NA	2.39	NA
Totals	**473**	**473**	**40.0**	**NA[1]**	**13.80**	**99.0%**

[1] In Sub-element 3, Webgen used the DR tool and therefore had no reported demand savings-- preventing a realization rate calculation. The reported demand savings of 11.53 MW is for ICF only.

All 473 of the participating sites conducted pilot tests in 2003. ICF Consulting conducted pilot tests for all of their 392 sites and reported a total demand savings of 11.53 MW.

Sub-element 4 Contractors

SMUD and Energyn were selected by the Energy Commission to operate pilot programs that aggregate curtailable loads for residential participants under Sub-element 4. Energyn operated one residential pilot program, whereas SMUD originally intended to operate three programs—two Time-of-Use (TOU) programs called PowerChoice and one direct load control program called PowerStat. The two intended TOU programs were to cover existing and new residential customers, although the program for new residential customers was dropped. Table 3-6, presented below, summarizes program activity as of September 30, 2003.

Table 3-6: Program Activity of Sub-element 4 as of September 30, 2003

Contractor	Number of customers recruited	Number of customers tested	Expected demand savings (MW)	Reported demand savings (MW)	Verified demand savings (MW)	Realization rate
SMUD—PowerStat	178	178	0.15 –0.30	0.241	0.19	82.7%
SMUD-- PowerChoice (TOU)	73	73	0.15 –0.30	0.032	0.039	123%
SMUD —Total	251	251	0.39–0.79	0.273	0.239	87.4%
Energyn	72	69	0.15–0.29	NA	0.153	NA
Totals	**323**	**320**	**0.15–0.79**	**NA**	**0.391**	**87.4%**

Pilot tests were conducted for 320 of the 323 customers recruited for Sub-element 4 programs as of the end of the 2003 summer peak demand season. During 2002, SMUD conducted pilot tests at all 178 PowerStat customers, achieving 0.19 MW of verified demand savings. During the 2003 peak demand season, SMUD conducted pilot tests at all of its 73 PowerChoice customers, achieving a total verified demand savings of 0.039 MW. For Energyn, pilot tests were conducted at 69 of their 72 customers, generating a verified demand savings of 0.15 MW.

The realization rate for the Sub-element 4 is 87.4%. As noted earlier, this realization rate was calculated using the total reported and verified demand savings for the PowerStat and PowerChoice programs only. Given that these two SMUD programs account for over 60% of the total verified savings for the entire sub-element, it was assumed the combined PowerStat and PowerChoice results were representative of the Sub-element 4 population.

3.3 DISCUSSION OF MV&E APPROACH

The MV&E methodology that has been utilized by Nexant for the DR program has evolved over time to reflect both expanding levels of participation and the addition of new market segments. Nexant's original evaluation objectives under the AB 970 program focused on: 1) documenting the program's potential demand savings, 2) measuring the program's cost effectiveness, and 3) analyzing key attributes of the program participant population and their DR systems.

With the passage of SB 5X, however, it was necessary to develop two separate MV&E plans in order to address the growing population of the state's DR program. Given that the population of Sub-elements 1, 2, and 3 include small and large C&I end-users, it was decided that these sub-elements would utilize a common MV&E plan.[3] For Sub-element 4, a separate methodology was required to address its residential population.[4] The MV&E plan used for the SB 5X-funded program Sub-elements 1, 2, and 3 expanded upon the methodology used to evaluate the AB 970

[3] The MV&E plan for Sub-element 3 mirrors the plan utilized for Sub-elements 1 and 2. A copy of the MV&E plan for Sub-elements 1 and 2 was submitted as part of the 2002 Demand Responsive Program Element report.
[4] A copy of the MV&E plan for Sub-element 4 is presented in Appendix A.

Sub-elements 1 and 2 in previous reports. The MV&E plan used for Sub-element 4 required new approaches to evaluating demand savings and addressing a modified list of research objectives, described in Section 3.4 of this report.

3.3.1 Approach to Data Collection and Analysis

Nexant adopted a three-pronged approach to obtain raw data from program participants and to verify demand savings claims. To evaluate the large and diverse group of customers that make-up the DR program population, Nexant designed the DR Tool, which is a web-based automated process for data gathering and analysis. The DR Tool was developed to make program evaluation analysis more robust and to help minimize the costs associated with sampling, data acquisition, project tracking, and program analysis. However, given the complexities of evaluating DR programs, alternate approaches for data collection and analysis were also identified. Listed below is a summary of the three main evaluation approaches that were utilized by Nexant to assess the performance of the various DR program sub-elements:

- Automated analysis—uses Nexant's DR Tool and is the preferred method
- Manual analysis—relies on statistical, manual analysis and is the backup approach
- Administrator and participant surveys—a supplemental data collection approach for SB 5X programs only.

Figure 3-3, shown below, illustrates how these three approaches were utilized to meet the different sets of research objectives, discussed in Section 3.4, that were outlined for the DR program sub-elements. Each of the three MV&E approaches is discussed in Section 3.4.

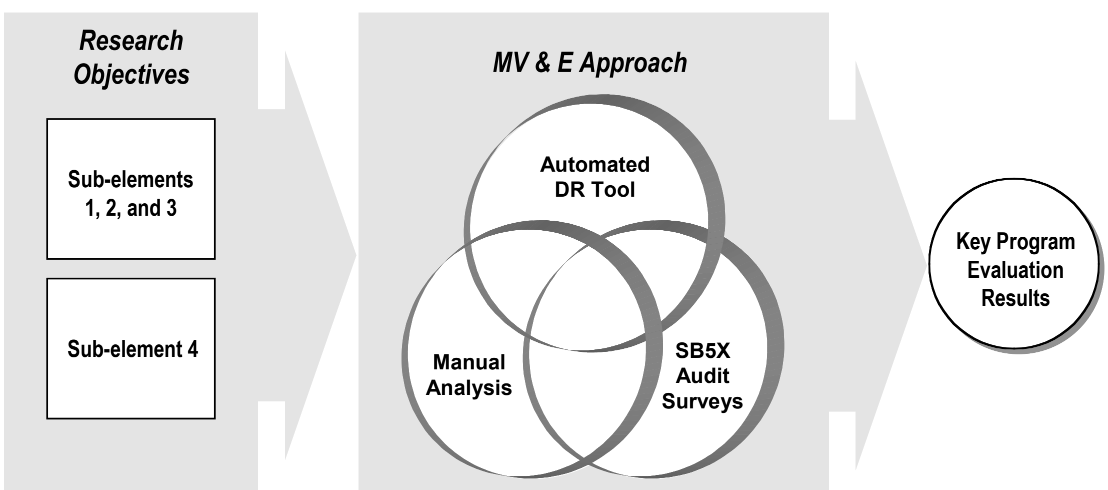

Figure 3-3: Three-Pronged Analytical Approach

3.3.2 Sampling Plan and Statistical Analysis

The M&VE sampling process and statistical analysis approach relies heavily on participant data collected through the DR Tool during pilot tests. This data is then sorted into strata based on administrator, load usage, geographic location, building type, etc. Although Nexant requested data for all curtailments from each program administrator, administrators were not contractually required to provide this data.[5] If an administrator provided a complete set of (pilot test) meter data for all program participants, no sampling was required. However, in cases where administrators supplied meter data for only a subset of program participants (and when manual analysis was required for analysis of these participants) sampling techniques were utilized in a manner that seeks to achieve an 80/20 reliability level.

3.3.3 Methods for Peak Demand Savings Analysis

Peak demand savings are calculated by comparing the difference between the actual load demand and the baseline (average) demand. Demand savings for a particular curtailment event (e.g., a pilot test or a Stage II and III emergency curtailment), can be calculated using Equation (1), shown below.

(1) Peak Demand Savings = Baseline Demand – Actual Event Demand

An example of how this equation can be used to measure peak demand savings is presented below in Figure 3-4.

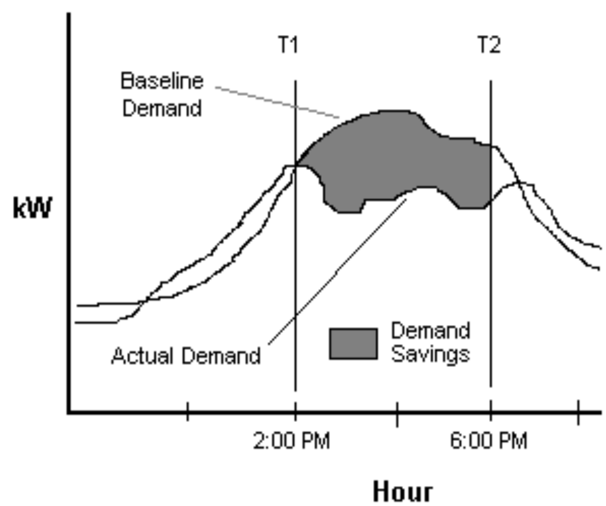

Figure 3-4: Graphical Illustration of Measured Demand Savings

Equation (2), shown below, is used to calculate average demand savings over a curtailment period. The demand savings calculation is based on the actual start time and duration of the event, with the peak demand period defined as the hours of 2:00 pm to 6:00 pm on non-holiday weekdays from June 1 through September 30.

[5] Including the date, time, type of curtailment, and performance.

$$(2) \qquad kW_{saved} = \frac{\sum_{StartTime.}^{EndTime.} kW_{Meter} - \sum_{StartTime.}^{EndTime.} kW_{Baseline}}{CurtailmentPeriod}$$

Where:

StartTime	=	The start time of the curtailment
EndTime	=	The end time of the curtailment
CurtailmentPeriod	=	Difference between End Time and Start Time of the curtailment.
kW_{saved}	=	Average kW demand savings over the curtailment period.

Since there is no difference between a pilot test day and a curtailment in terms of the methodology that should be used to calculate demand savings, the same MV&E procedure was used for both types of events.

3.3.4 Baseline Calculation Methods

Baseline demand savings is a critical element of Equations (1) and (2). Nexant's MV&E plan calculates demand savings using three different baseline methods, all of which require the availability of 15-minute interval meter data at the facility level. The three baseline methods include: (1) the CAISO baseline method, (2) Nexant's modified CAISO-baseline method, and (3) Nexant's temperature-load adjusted (TLA) baseline method.

CAISO Baseline Method

The CAISO baseline is a compilation of average daily (24-hour period) load profiles for each facility approximating the seasonal patterns of building energy use. Each 15-minute baseline demand value is calculated by averaging daily energy (kW) demand (within the same 15-minute time intervals) occurring over the previous ten consecutive, non-holiday, non-curtailed, business days, prior to the curtailment day.

Modified CAISO Baseline Method

Since it is not always possible to receive 10 consecutive days of meter data from participants, a number of parameters in the CAISO baseline method must be relaxed to create a proxy approach. For the purposes of evaluating the DR program, Nexant developed a modified CAISO-baseline that was used when strict adherence to the CAISO method was not possible. The minimum data needed for this method is only five days of usable interval data from the time period prior to the event. Nexant uses as many days as possible, up to the CAISO maximum of ten. The days used in this calculation need not be consecutive business days, but they must fall within the 30-day period immediately preceding or surrounding the curtailment day. Nexant assigned priority to consecutive days preceding the event.

Temperature-load Adjusted (TLA) Baseline Method

Neither the CAISO nor the Nexant-modified CAISO baseline method takes into account the connection between ambient air temperatures and increases in electrical demand due to higher HVAC loads. Therefore, Nexant developed a pre-curtailment, temperature load-adjusted (TLA), baseline that could be used as a proxy for either of the previously discussed baseline methods.

The TLA baseline method more accurately calculates the demand savings during curtailment events by adjusting the CAISO baseline to reflect actual load conditions present on an event day.

3.3.5 Realization Rates

To assess the ability of program administrators and participants to realize potential demand savings, a realization rate was calculated (when possible) for each program sub-element. Equation 3, shown below, lists the key components that were utilized to derive realization rates.

$$(3) \qquad Realization\ Rate = \frac{VerifiedDemand\ Savings,\ kW}{Reported\ Demand\ Savings,\ kW} X100\%$$

The realization rate provides an idea of how accurate participants' claims of reported savings are in comparison with Nexant's verified savings. A value of 100% indicates that the participant-reported savings match the Nexant verified savings.[6] Realization rates may be used to draw inferences about the general population, subject to statistical inaccuracies, based upon analyses performed using a sample of the population. Nexant utilizes realization rates in statistical analyses because it provides an accurate assessment of curtailment performance.

3.3.6 Additional MV&E Elements Included in Sub-element 4 Analyses

The SB 5X evaluation of Sub-element 4 residential pilot programs required modification to the methodology that was used for Sub-elements 1, 2 and 3. A key MV&E methodology distinction included differentiating between critical and non-critical curtailment signals. Critical curtailment signals may be triggered at any time, activating single events based on emergency price or system capacity conditions as established by the CAISO or SMUD. Non-critical signals associated with TOU-rate blocks are static price signals designed to encourage routine peak period demand savings. This distinction is important because the Sub-element 4 MV&E plan uses different analytical techniques for static price (critical) and dynamic price (non-critical) curtailment signals. Table 3-7, given below, summarizes the MV&E approach for each Sub-element 4 program, and identifies baseline calculation methods and key data requirements.

[6] The realization rates used in this report are equivalent to the reliability rates reported in the 2001 year-end report.

Table 3-7: MV&E Approaches for Sub-element 4

Program Administrator and program	Baseline	Data required for demand savings calculation
SMUD—PowerChoice	*For critical signals:* CAISO baseline, Nexant's TLA Baseline Method *For non-critical signals:* Nexant's method for pre- and post-implementation baselines, or alternative method using representative price elasticity	*For critical signals:* Aggregate 15-minute interval kW usage data for previous 10 consecutive, non-holiday, and non-event day weekdays. Aggregate 15-minute interval kW usage data for event days associated with "critical period" TOU signals. *For non-critical signals:* Aggregate 15-minute interval kW usage data for 10 consecutive, non-holiday, non-event, and pre- and post-implementation days. Price elasticity data literature search.
SMUD—PowerStat	*For critical signals:* CAISO baseline, Nexant's TLA Baseline Method	*For critical signals:* Aggregate 15-minute interval kW usage data for previous 10 consecutive, non-holiday weekdays. Aggregate 15-minute interval kW usage data for event days.
Energyn	*For critical signals:* CAISO baseline, Nexant's TLA Baseline Method	*For critical signals:* Same as SMUD—PowerStat

Pilot tests are not required for Sub-element 4 programs. However, participants are required to demonstrate their demand savings capability in response to critical curtailment signals. If pilot tests were conducted, calculations were performed to verify potential peak demand savings for a sample set of participating facilities. The results for the sample facilities were then applied to the entire population. Pilot tests were not used for evaluating non-critical curtailment signals.

Measurement of demand savings from critical signals occurring on curtailment days followed the same procedure as for pilot tests. As noted earlier, from an MV&E perspective, there is no difference between a pilot test and a curtailment in terms of calculating demand savings for individual participants.

3.4 PROGRAM ELEMENT MONITORING AND VERIFICATION

This section summarizes how program element monitoring, verification, and evaluation (MV&E) tasks were executed in relation to the tasks set forth in the two MV&E plans covering Sub-elements 3 and 4. The actual process of data collection, sampling, and analysis of program participants is described, along with a review of how each of the evaluation (research) objectives was addressed. Specifically, this section contains a review of the following elements:

- Summary of research objectives for Sub-elements 1 through 4;
- Overview of key MV&E assumptions
- Description of general MV&E approaches;
- Review of MV&E elements at the individual program level; and

- Description of statistical uncertainty analyses.

The presentation of MV&E results for the 2003 summer peak demand period (for Sub-elements 3 and 4) is subsequently presented in Sections 3.5, 3.6, and 3.7 of this document.

3.4.1 Summary of Research Objectives for Sub-elements 1, 2, and 3

Over and above the core objectives of measuring potential demand savings and DR program cost-effectiveness, Nexant and Energy Commission representatives developed a set of research objectives for SB 5X activities that called for: (a) an analysis of program population characteristics; (b) assessment of the influence of ambient temperature on demand savings; (c) evaluation of building occupants' comfort responses to curtailments; and (d) the persistence of demand savings during the peak period one year after implementation. To achieve these goals, the following research objectives (questions) were established for sub-elements 1, 2, and 3:

1. What were the Nexant verified (total) peak demand savings from all customers from their DR systems during the pilot tests?
2. Are there differences between program administrators' reported potential peak demand savings and Nexant's verified potential peak demand savings from pilot tests? What is the source of any difference?
3. What are the factors, if any, contributing to the differences between the verified potential peak demand savings achieved during the pilot test and the program or contract goals?
4. What was the peak demand savings verified by Nexant achieved by operating demand responsive systems during Stage II and III curtailments in the peak summer months?
5. How do the Stage II and III curtailment documented peak demand savings numbers taken during the summer peak period compare to the demand savings goals stated in the contract or grant?
6. What percentage of documented potential peak demand savings, demonstrated in verified pilot tests, were achieved during Stage II or III curtailments in the summer peak period?
7. Did the level of peak savings vary any within the 4-hour (peak) pilot test times?
8. What level of demand savings, during a curtailment, was achieved for each major building system (e.g. HVAC, lighting, process, onsite generation)?
9. What were the overall realization rates for each major building system that was curtailed?
10. Did curtailment measures used to achieve MW goals have an impact on building occupant comfort? If so, what was the impact?
11. What are building type and location characteristics of the program participants population, and how do these characteristics compare to those found in the general population?
12. What were the differences in peak demand savings resulting from curtailments on "hotter" days relative to demand savings from curtailments occurring on "cooler" days?
13. What proportion of program participants allowed automated responses to curtailment signals?

14. Did the automated signals provide lower or higher levels of demand savings compared to manual systems?
15. What is the level of cost effectiveness expressed as $/kW ($ = Energy Commission payments to program administrators; kW = pilot test demand savings)?
16. What is the persistence of the load reductions?

3.4.2 Summary of Research Objectives for Sub-element 4

Although the objectives contained in the Sub-element 4 MV&E research plan are similar to those utilized for Sub-elements 1, 2 and 3, several research objectives were modified to account for the inherent differences in the structure of residential programs. To help prioritize the analysis of Sub-element 4 objectives, three priority-based tiers were defined by the Energy Commission—Tier 1 represents the highest priority and Tier 3 the lowest.

Tier 1 (Research Objectives 1 and 2)

1. Define and evaluate peak demand savings achieved for each of the four residential programs based on sampling techniques needed to obtain a minimum 80/20 statistical accuracy level.
2. Determine the cost-effectiveness of the program in dollars spent per kW of demand savings and estimate a projected cost per kW for the post-pilot test phase[7].

Tier 2 (Research Objectives 3 to 7)

3. If pilot tests are conducted, provide comparisons between measured peak demand savings documented during the pilot test and peak demand savings from subsequent curtailment events (price, static or dynamic signals) between these events.
4. Determine how levels of demand savings vary across the peak demand period or specified hours of a curtailment period if different than the peak demand period. Identify factors that explain any hourly variation in demand savings.
5. Did the operation of demand responsive systems during curtailment events impact residential occupant comfort?
6. Determine if there are significant differences in peak demand savings on high ambient air temperature days versus cool days for each type of residential pilot program.[8]
7. Characterize relevant household demographics, residential building types, and climatic characteristics of the program participant population.

Tier 3 (Research Objectives 8 and 9)

8. Determine the reasons and the extent to which customers chose to exercise overrides of automated systems during curtailment events.

[7] Research Objective 2 depends on whether pilot tests are conducted as a part of program implementation.
[8] Research Objective 6 can only be met for program participants responding to critical curtailment signals, because no practical method is available that measures the effects of temperature on demand savings from TOU rates.

9. Compare demand savings from curtailment events involving price and/or emergency signals and explain the differences.[9]

3.4.3 Overview of Key MV&E Assumptions

Listed below is a set of key assumptions that were made in an effort to streamline MV&E analyses conducted by the Nexant team:

- It was assumed that the occurrence of peak demand emergency curtailments were strongly correlated to increases in outdoor air temperatures and increases in summer peak loads that are brought on by high levels of air conditioner use. Given the importance of this assumption, the MV&E plan differentiates between heat-sensitive and non heat-sensitive participants. Heat-sensitive participants were defined as those whose facilities include HVAC equipment in their curtailed loads; non-heat sensitive facilities do not. [10]
- It was also assumed that participants would not implement DR systems in facilities that they own, but that are not part of the DR program.
- It was determined that statistical analyses of free-driver and associated conditions are beyond the scope of Nexant's MV&E plan.
- In order to measure potential demand savings, it was necessary to establish suitable and reliable baseline methods against which actual demand savings achieved during pilot tests and emergency curtailments could be measured. Baseline values are difficult to calculate, as they are indicative of energy demand that would have occurred on the day of curtailment in the absence of a curtailment. Therefore, Nexant utilized two principle baseline methods, which are assumed to be the best available methods to be universally applied to a diverse DR program population. The two methods, a modified CAISO-baseline method and a temperature-load adjusted baseline method, were described in Section 3.3.4 of this report.
- Nexant has assumed that all the meter data provided by program administrators for their facilities' pilot tests is accurate. Further, it is assumed that verified demand savings figures from pilot tests are reasonable estimates of the potential demand savings that would occur during Stage II and III emergency curtailments.[11]

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[9] Research Objective 9, which compares responsiveness to curtailments involving price signals and emergency signals, may be difficult to differentiate as the SMUD programs have a set of criteria for sending critical curtailment signals that combine price and capacity constraints.

[10] The MV&E methodology used by Nexant also allows for demand savings verification under other curtailment scenarios (e.g., emergency curtailments triggered by events unrelated to high temperatures); however, further analysis of non-temperature related curtailments is beyond the scope of Nexant's MV&E tasks.

[11] The DR program required all Sub-element 1, 2 and 3 participants to conduct at least one pilot test during the summer non-holiday weekdays between June 1 and September 30 between the hours of 2pm to 6pm. These pilot tests demonstrated the ability of participants to reduce or shed load (i.e., by showing that each tested site has established and maintained the ability to respond to a CAISO Stage II or III curtailment signal).

3.4.4 Description of General M&V Approaches

As previously noted in Section 3.3, Nexant utilized a three-pronged approach to analyze the performance of the various DR program elements. Listed below is a summary of the key elements of each demand savings analysis approach.

Automated DR Tool

The DR Tool, which was the preferred MV&E approach in analyzing program results, assumes that program participants can provide 15-minute interval meter data for both baseline and demand savings calculations. Under this approach, the automated secure DR Tool website is used by program participants to upload data from their customer sites, including interval meter data for pilot tests and similar events. The DR Tool consists of a suite of software components, including a website interface, program participant database (PPD), meter data database (MDD), and an analysis engine. All data, regardless of the M&V approach, is entered into the PPD, which forms the basis for all queries, sampling, audits, and subsequent analysis and reporting.

The DR Tool's different components facilitate the process of obtaining participant information, meter data uploads, data analysis, demand savings calculations, and reporting. Analysis using this software tool allows for the use of different baselines against which Nexant compares curtailment data for any program participant. This provides the basis for the demand savings calculations. The software performs the following specific functions:

- Allows program administrators to add, modify, or delete records in the PPD,
- Enables administrators to upload 15-minute interval data to the MDD,
- Performs error checks and reporting at several stages of data input,
- Allows Nexant to tabulate and analyze the data using several different baseline methods,
- Executes custom queries on research objectives or facility results, and
- Eliminates the need for sampling and the application of statistical inference.

The DR tool was used to analyze demand savings based on data that was provided by contractors or grantees for all participating sites. This automated approach allowed Nexant to analyze data without introducing errors as a result of population sampling or statistical inferences.

Manual Analysis

Nexant's experience with past evaluations of the AB 970 DR program revealed that some administrators could not provide 15-minute interval data for their participants, and/or would not be likely candidates to use the automated DR Tool. In many cases, only 30-minute or 60-minute interval meter data was available and data could only be provided for a subset of participant sites. In either case, the automated approach (DR Tool) could not be effectively utilized.

For the segments of the program population that were not valid DR Tool candidates, a manual statistical approach was used with the DR Tool serving as a guide in listing participants and devising a sampling approach based on standard M&V practices. In cases where data availability was a problem, facilities without interval meter data were grouped together and a representative sample was drawn from the whole. Using the manual analysis method, Nexant then verified demand savings by applying realization rates of similar sites (within a given administrator's portfolio of customers) that supplied usable meter data.

Sampling and verification of savings results under the manual approach were performed in a manner that adhered to the 80/20 criteria (i.e. confidence intervals and accuracy of estimates) as applied to each sub-element. Manual calculations of savings for participants who could provide 30-minute or 60-minute interval meter data were performed using analogous procedures to those used in DR Tool analyses. In cases where no meter data could be provided, demand savings were calculated using evaluation techniques that leverage quantitative and qualitative responses to the M&V objective questions. These techniques involved one or more of the following tasks:

- Taking reported demand savings from participants and extrapolating a correction factor based on realization rates taken from similar sites within an administrator's portfolio,
- Obtaining information through quantitative and qualitative responses to supplemental questions put forth in administrator and participant audits, and
- Performing engineering calculations.

Using techniques of correlation and inference, the results obtained from a limited number of samples from the population without 15-minute meter data was generalized to describe the entire subpopulation of participants with limited data for each administrator. Statistical results estimating the demand savings from this group were then added to the results for the 15-minute interval data group as calculated by the DR Tool. Since most of the program participants have access to 15-minute interval data at their facilities, the use of the manual statistical approach was limited. Since this subpopulation was the primary, if not exclusive, source of statistical error for the whole population, demand savings estimates for the whole population are expected to fall well within the required 80/20 criteria.

Audit Surveys

Although both the DR Tool and the manual analysis method were effective in estimating demand savings for a large number of program participants, a segment of the program population did not have a sufficient level of site and meter data to be evaluated under either of these approaches. In order to evaluate this remaining segment of participants, an audit/survey was utilized to collect required data and to garner additional information on program performance.[12] Responses to additional (supplemental) questions were used to answer, confirm, or correct site data found in the PPD, while providing a method to enhance the statistical accuracy of results.[13] This third approach for supplemental data collection was a key factor in addressing the research objectives stated in the SB 5X MV&E plan for Sub-elements 1, 2, and 3.

[12] A copy of the audit forms (survey guides) that were utilized for Sub-element 3 & 4 programs is presented in Appendix B.

[13] Audit surveys were a new addition to Nexant's MV&E plan for the DR program (i.e., were used only for the SB 5X evaluation), and were conducted for administrators of Sub-elements 1 and 3, and participants of all sub-elements.

Table 3-8 lists the data that Nexant initially requested from program administrators for each of their respective participants. If this data was not provided in the initial request, Nexant made additional requests with program administrators to be able to obtain as much of the requested data as possible. As a final option, Nexant obtained missing data for a sample of sites within each sub-element by asking supplemental questions in the participant audit process.

Table 3-8: Requested Data from Sub-element 3 and 4 Participants and Administrators

Requested Data	Data required	Sub-element 3	Sub-element 4
Participant Facility Data			
Facility name	Yes	☒	☒
Site contacts	No	☒	☒
Building age, size (sq.ft.), address and zip code	No		☒
Building function and type	Yes	☒	
Total summer peak or connected load	No		
Total curtailed load estimated by end use (by end use if available)	Yes	☒	
Curtailment Event Data			
Type of curtailment (pilot test or emergency)	Yes	☒	
Date, start and stop times of curtailment	Yes	☒	☒
Total curtailed load claimed (by end use if available)	Yes	☒	
Type of curtailment signal received	Yes	☒	
Type of load control system used (level of automation)	Yes	☒	
Occupant complaints received during curtailment (lighting and/or HVAC)	No	☒	
Daily high and low temperatures on day of curtailment	No	☒	☒
Interval meter data for baselines, pilot test, and curtailments	Yes	☒	☒

3.4.5 Review of MV&E Elements at the Individual Program Level

This section reviews how the three MV&E approaches were applied to each of the individual programs within Sub-elements 3 and 4. For each sub-element, a brief description of program specific MV&E issues is presented.

Sub-element 3

Table 3-9 illustrates the means by which data was obtained and analyzed by Nexant for each program administrator (contractor). Facilities listed below as *analyzed (sampled)* are those for which the contractor provided usable meter data for pilot tests, either via the DR Tool or by manual submissions. All of these facilities analyzed became part of Nexant's sample.

Table 3-9: Sub-element 3 Data Submissions, Sampling, and Analysis of Participants

Contractor	Total participant facilities	Facilities pilot tested	Facilities analyzed (sampled)	Process for data collection & analysis	Status of pilot test analysis	Completion of audits
ICF Consulting	392	392	15	Manual	Verified	Participant & Administrator
Webgen	81	81	81	Manual	Verified	Administrator only
Totals	**473**	**473**	**96**			

Administrator audits were completed for both the ICF and Webgen programs. However, as is discussed in Section 3.7, participant audits were only completed for the ICF program.

Among all Sub-element 3 contractors, only Webgen conducted pilot tests among all facilities and provided meter data for all of these sites. In most instances, the contractor only reported demand savings for sites where meter data was available, even though additional sites were known to have conducted pilot tests. Listed below is a brief description of the demand savings evaluation methodology that was applied to each of the Sub-element 3 programs.

<u>ICF Consulting</u>

The manual method was applied to the analysis of demand savings for the ICF program. Key steps that were conducted to analyze demand savings include: 1) calculating an average realization rate from the 15 sample participants (4% of the total program participants), 2) verifying that the realization rate used adheres to the 80/20 confidence interval requirement for data relating to the entire sub-element, and 3) multiplying the reported demand savings by the average realization rate to calculate an estimated "verified MW to date" value for each participant and the program as a whole. ICF did not use the TLA method.

<u>Webgen</u>

This program was unique in that verified data was collected for all of the 81 participants using the DR Tool (automated method). The receipt of data via the DR Tool enabled Nexant to collect metered data on a site-by-site basis—the calculation of a realization rate for the program was not needed since each project's calculated demand savings for the Wegben program was in essence "verified." Some manual calculations were performed to ensure the accuracy of the data collected using the DR Tool. Webgen utilized the TLA method in reporting data to Nexant.

Overall, Nexant was able to analyze pilot test data from 96 facilities, representing 20 percent of all tested facilities and the entire Sub-element 3 population.

Sub-element 4

Table 3-10 summarizes the extent to which Sub-element 4 contractors were able to fulfill Nexant's data requests. This table also shows the means by which data was obtained and the manner in which Nexant's pilot test analysis was performed for each administrator.

Approximately 13% (41 households) of total Sub-element 4 participants were sampled as part of this analysis.

Table 3-10: Sub-element 4 Data Submissions, Sampling, and Analysis of Participants

Contractor	Total participant facilities	Facilities pilot tested	Facilities analyzed (sampled)	Process for data collection & analysis	Status of pilot test analysis	Completion of audits
SMUD: PowerStat	178	178	13	Manual	Verified	Participant
SMUD: PowerChoice (TOU)	73	73	18	Manual	Verified	Participant
SMUD —Total	251	251	31	Manual	Verified	
Energyn	72	69	10	Manual	Verified	Participant
Totals	**323**	**320**	**41**			

In accordance with Nexant's contract, participant audits were conducted for the PowerStat, PowerChoice, and Energyn programs.[14] Listed below is a summary of the MV&E methodology that was utilized to estimate the demand savings for each of the Sub-element 4 programs.

Power Stat

Demand savings were evaluated by comparing the aggregate baseline and curtailed loads for a sample of up to 13 PowerStat program participants per cycling event day. Baseline days were selected based on the observation of daily temperatures that were similar to those of the cycling event days. By selecting baseline days based on temperature related conditions, the demand savings analysis applied a *defacto* temperature adjustment in estimating demand savings, albeit in a manner different than the standard TLA baseline method that was outlined earlier.

In order to calculate the demand savings, 15-minute interval meter data was aggregated among sampled customers participating in a given cycling event. This data was then compared to a baseline profile compiled (from temperature-similar days) for the same set of participants. Aggregation of participant metered loads was performed in recognition of the high level of variability in daily load profiles for individual residential customers. Nexant also recognized the strong influence of outdoor temperature on average daily residential loads. Consequently, days similar in average high temperatures (within ±2 degrees) to the given event day were selected for inclusion in aggregate baseline load profiles for program participants.

Treating each cycling event as an aggregate customer profile, Nexant's temperature-load-adjusted baseline method was used to calculate demand savings for each cycling event. Average per customer demand savings results of each cycling event were extrapolated to the entire PowerStat program population to estimate program demand savings. Results of the adapted MV&E methodology applied to SMUD's PowerStat program are reported in the next section.

[14] As noted in Section 7, Nexant was not contracted to perform administrator audits for Sub-element 4.

Reported demand savings for the PowerStat program were not provided in a format similar to what was received by Nexant from other programs. However, an approximated reported demand savings for the program was calculated based on information contained in the PowerStat evaluation report.[15] Operating under the assumption that temperature-dependant curtailments would occur during the hottest temperatures, Nexant averaged the reported pilot test impacts for the highest two temperature groups (outdoor temperatures in Sacramento above 96 degrees). The evaluation report listed average impacts, in kW saved per household, for each cycling strategy in the program (25%, 50%, etc.). The average of these kW per household values at the highest two temperature groups was calculated (1.35 kW/household) and then multiplied by the number of participating households to determine the reported demand savings for the entire program.

PowerChoice

The SMUD PowerChoice Program was implemented during the 2003 summer peak demand season. Total demand savings for the program were calculated by extrapolating an average verified demand savings per household for the sample group to the entire program population. The methodology employed used a sample of 18 households out of the 73 participating households to extrapolate an aggregate demand savings for the total population of participants.

All 18 sample households responded to the three curtailment CAISO events on July 19, 2003, August 18, 2003, and September 12, 2003. A temperature load adjusted (TLA) demand savings for the three curtailments was used to determine an average TLA curtailment in Watts per household. The average TLA curtailment per household was then averaged for the 18 sample households. The sample average TLA curtailment in Watts per household was then extrapolated for all 73 participating households to calculate a total verified MW demand savings to date for the SMUD PowerChoice program.

Similar to the PowerStat program, reported demand savings for the PowerChoice program were not provided in a format similar to what was received from other programs. Nexant was able to approximate the reported demand savings for the program from information contained in the PowerChoice evaluation report.[16] The report provided average kW/household impacts for each SMUD time-of-use (TOU) period. Operating under the assumption that temperature-dependant curtailments would occur during the peak (2 pm to 8 pm weekdays) and critical price TOU periods, Nexant averaged the reported kW/household impacts for these two TOU periods, and then multiplied this value (0.415 kW/household) by the total number of households participating in the program to determine the reported demand savings for the PowerChoice program.

Energyn

The Energyn Program was implemented in the PG&E service territory during the 2003 peak demand season. Due to poor participant survey results, only seven sample households had acceptable responses to curtailment signals. The small sample size required that Energyn program results rely on verified demand savings figures. The absence of reported demand savings meant that realization rates could not be calculated for the Energyn Program. To

[15] "PowerStat Pilot Program Evaluation Report", SMUD and Summit Blue Consulting, October 2003, p. 2.
[16] "PowerChoice Pilot Program Evaluation Report", SMUD and Summit Blue Consulting, May 2004, p. 3.

determine the total demand savings for the program, an average savings per household was calculated for the sample and then extrapolated to the entire program population.

The methodology employed used a sample of seven out of the 72 participating households to extrapolate a total demand savings for the total population of participants. Of the seven households, there were ten successful responses to the two curtailment signals on July 28, 2003 and September 22, 2003. TLA demand savings was used to determine an average curtailment in Watts per household. The average curtailment per household value was extrapolated for all 72 participating households to calculate a total verified MW demand savings to date for the Energyn program

3.4.6 Uncertainty Analysis

A discussion of the statistical uncertainty results of Sub-elements 1 and 2 was presented in the 2002 DR report. In summary, at an 80 percent level of confidence, accuracy of verified demand savings for SB 5X Sub-elements 1 and 2 is 3.4 percent, indicating that the 80/20 statistical goal has been met. Table 3-11 summarizes the sampling and error analysis for Sub-elements 3 and 4.

Table 3-11: Sampling and Error Analysis of Sub-elements 3 and 4

Sub-element	Total participant facilities	Facilities pilot tested	Facilities analyzed (sampled)	Realization rate	Precision at 80% confidence	Verified potential curtailable load
Sub-element 3	473	473	96	98.7%	0.016%	13.8 ± 0.00220 MW
Sub-element 4	323	320	41	87.2%	1.27%	0.391 ± 0.00497 MW
Totals	**796**	**793**	**137**			

The Energy Commission provided Nexant with a goal of verifying program element peak demand savings within a level of 80/20 statistical accuracy. This statistical level implies that the demand savings *at the program element level* should be accurate to within plus or minus 20% at a fixed confidence interval of 80%. Determination of whether or not the 80/20 statistical goal has been reached can only be made *after* the sample results have been analyzed.

Nexant designed its sample populations with the goal of reaching 80/20 statistical accuracy within each sub-element. Reaching this level within each sub-element ensures that the demand savings at the DR program element level exceeds the 80/20 goal. Nexant assumed that sampling rates for the Sub-element 3 and 4 populations exceeded what was needed to meet the 80/20 statistical goal. This assumption was met, as indicated by the "Precision at 80% Confidence" figures in Table 3-11. The precision values for both sub-elements are far less than 20%, easily meeting the 80/20 statistical goal. Combined with the results from Sub-elements 1 and 2, the SB 5X results satisfy the 80/20 statistical goal. Taking into account the calculated errors, the verified potential curtailable loads are given for each sub-element in the last column of Table 3-11.

3.5 PROGRAM ELEMENT EVALUATION

This section presents both historical (dating back to 2001) and current evaluation results for the four sub-elements of the Energy Commission's Demand Responsive Program. Cumulative verified demand savings results for 2001, 2002, and 2003 covering Sub-elements 1 through 4 are presented in this section; however, given that Sub-elements 1 and 2 did not have any activity during 2003, a major emphasis is placed on presenting the performance of Sub-elements 3 and 4.

For the summer 2003 peak demand season, Sub-element 3 programs were contracted to provide 40 MW of demand savings, representing 15 percent of the 261 MW total contracted demand savings for all DR programs. The Sub-element 4 residential pilot programs were contracted to provide 3 MW of demand savings, or one percent of the total contracted demand savings. As is discussed below in more detail, the verified demand savings achieved under both Sub-element 3 and 4 programs fell short of their initial contracted MW targets.

3.5.1 Comparison of Cumulative Demand Savings in 2001, 2002, and 2003

Table 3-12, below, shows the cumulative verified demand savings for all program administrators who have completed pilot tests and provided demand savings estimates as of the end of the summer peak periods in 2001, 2002, and 2003.

Table 3-12: Levels of Cumulative Demand Savings at Summers End 2001, 2002, and 2003

	Total facilities evaluated	Contracted demand savings (MW)	Reported demand savings (MW)	Verified demand savings (MW)
Summer 2001	734	155.6	174.7	155.1
Summer 2002	1,644	253.1	223.1	203.8
Summer 2003 (as of 9/30/03)	2,128	261	236*	216

* For Sub-element 3, Webgen only has verified savings. For Sub-element 4, Energyn only has verified demand savings; Reported demand savings for these two programs are not available. For Sub-element 3, only ICF and for Sub-element 4, only SMUD PowerChoice andPowerStat have both reported and verified demand savings.

As of September 30, 2001, total verified demand savings across Sub-elements 1 and 2 was almost exactly as contracted for 734 evaluated facilities, at just over 155 MW. No Sub-element 3 and 4 facilities were tested by this date. Sub-element 1 and 2 program administrators had reported cumulative demand savings of 174.7 MW, yielding an overall realization rate of 88.8 percent for all tested facilities at the end of summer 2001.

At the end of summer 2002, cumulative verified demand savings had risen to 203.8 MW, although this is below contracted amounts largely due to the fact that one Sub-element 1 contractor and several Sub-element 3 and 4 contractors had not completed pilot tests by September 30, 2002. However, for all facilities tested before September 30, 2002, a realization rate of 91.5 percent is higher than that observed for summer 2001.

Cumulative verified demand savings for 2003 were 216 MW, falling 42 MW short of the 261 MW contracted demand savings goal for all sub-elements. This is due to significant shortfalls in verified demand savings for both Sub-elements 3 and 4.

3.5.2 Summary of Demand Savings and Realization Rates

Table 3-13 provides realization rates and total contracted, reported, and verified demand savings by sub-element and by program funding source. Nexant has analyzed pilot test demand savings for 576, or 43 percent, of the 1,332 total customer sites in Sub-elements 1 and 2 of AB 970 and SB 5X. Nexant analyzed 96 of the 473 total customers, or 20%, for Sub-element 3.

Table 3-13: Demand Savings and Realization Rates by Sub-element

Sub-element	Program funding source	Total customer sites	Facilities analyzed (sampled)	Contracted demand savings (MW)	Reported demand savings (MW)	Verified demand savings (MW)	Realization rate
Total Sub-element 1	AB 970 SB 5X	820	243	184.4	190.8	175.1	91.8 %
Total Sub-element 2	AB 970 SB 5X	512	333	33.6	33.7	26.9	79.8%
Total Sub-element 3	SB 5X	473	96	40	NA	13.8	99.0%[1]
Total Sub-element 4	SB 5X	323	41	3	NA	0.39	87.4% [2]
Totals – DR Program Element		**2,128**	**713**	**261**	**NA**	**216.2**	**91.5%[3]**

1 This estimated realization rate for Sub-element 3 is based on the realization rate that was calculated for the ICF program.

2 This estimate is based on the results of realization rate calculations for the PowerChoice and PowerStat programs only.

3 Total realization rate is calculated based on reported and verified demand savings for all Sub-element 1 and 2 programs, ICF only for Sub-element 3, and for SMUD PowerChoice and PowerStat only for Sub-element 4.

The Demand Responsive Program Sub-elements 1 and 2 have achieved a combined realization rate of 90% percent, where total verified demand savings of 202.0 MW represents 92.6 percent of the total contracted savings and 94.4 percent of the combined legislative goals (214 MW) for AB 970 and SB 5X.

As noted earlier, reported demand savings estimates were not available for the Webgen and Energyn programs. This complicated the calculations of realization rates for both Sub-elements 3 and 4. Therefore, in order to estimate realization rates for Sub-elements 3 and 4 (at the entire sub-element level), the following assumptions were made:

- For Sub-element 3, it was assumed that the realization rate for the ICF program (99%) was representative for the entire sub-element. This reflects that the ICF program accounts for over 80% of total verified demand savings for Sub-element 3. It is assumed that the realization rate calculated for the ICF program is representative for the sub-element as a whole.

- For Sub-element 4, it was assumed that the combined weighted realization rate for the two SMUD programs (87%) was representative for the entire sub-element. This reflects that the PowerStat and PowerChoice programs account for over 60% of total verified savings for Sub-element 4.

Heat-Sensitive versus Non-Heat-Sensitive Facilities

Table 3-14, below, shows 793 program participants drawn from the SB 5X program population categorized into two sub-groupings by load type. Groups labeled "HVAC only" and "HVAC and Lighting" are characterized as heat-sensitive facilities.

Table 3-14: Comparison of SB 5X Facility Load Types

Facility load type	Sites	Average facility demand savings (kW)	Average realization rate (%)
HVAC only	401	6.93	NA*
HVAC and lighting	392	29.11	99.0%
Total	**793**		

*For Sub-element 3, Webgen was HVAC only, while ICF was HVAC and lighting. For Sub-element 4, SMUD PowerStat, SMUD PowerChoice, and Energyn were HVAC only. Webgen had no reported demand savings, preventing calculation of a realization rate.

The "HVAC and lighting" classification represents the ICF portion of Sub-element 3 only, and had 392 sites represented, with an average facility demand savings of 29.1 kW. The "HVAC only" classification represents the Webgen portion of Sub-element 3 and all participants in Sub-element 4, which were residential households. The "HVAC only" classification had 401 sites, with an average facility demand savings of 6.93 kW. Research Objectives 8 and 9 for Sub-element 3 deal with facility load types, but verified curtailment savings cannot be ascertained since there were no curtailments in 2003. Table 3-14 provides a partial answer to these two research objectives, in the form of reported demand savings by facility type.

3.5.3 Sub-element 3 Results and Research Objectives

Table 3-15 shows contracted, reported, and verified demand savings, along with their associated realization rates, for each of the Sub-element 3 contractors for the SB 5X programs. As of September 30, 2003, the total verified program demand savings potential of Sub-element 3 was 13.8 MW. Total verified demand savings account for 34.5 percent of the total contracted savings. The overall realization rate for the Sub-element 3 contractors is 105.6 percent, leading to an overall realization rate of 91.7 percent for the SB 5X demand responsive program as a whole.

Table 3-15: Demand Savings and Realization Rates for Sub-element 3 by Contractor, as of September 30, 2003

Contractor	Customer sites recruited	Customer sites conducting pilot tests	Contracted demand savings (MW)	Reported demand savings (MW)	Verified demand savings (MW)	Realization rate
ICF Consulting	392	392	30	11.5	11.4	99.0%
Webgen	81	81	10	NA*	2.4	NA[1]
Totals	**473**	**473**	**40**	**NA**	**13.8**	**99.0%**[2]

[1] Webgen used the DR tool and therefore had no reported demand savings, preventing a realization rate calculation.

[2] As noted earlier, this estimate is based on the realization rate that was calculated for the ICF program.

The realization rate for ICF is 99%. Nexant's total verified demand savings of 13.8 MW represents 34.5 percent of the total 40 MW contracted demand savings for Sub-element 3.

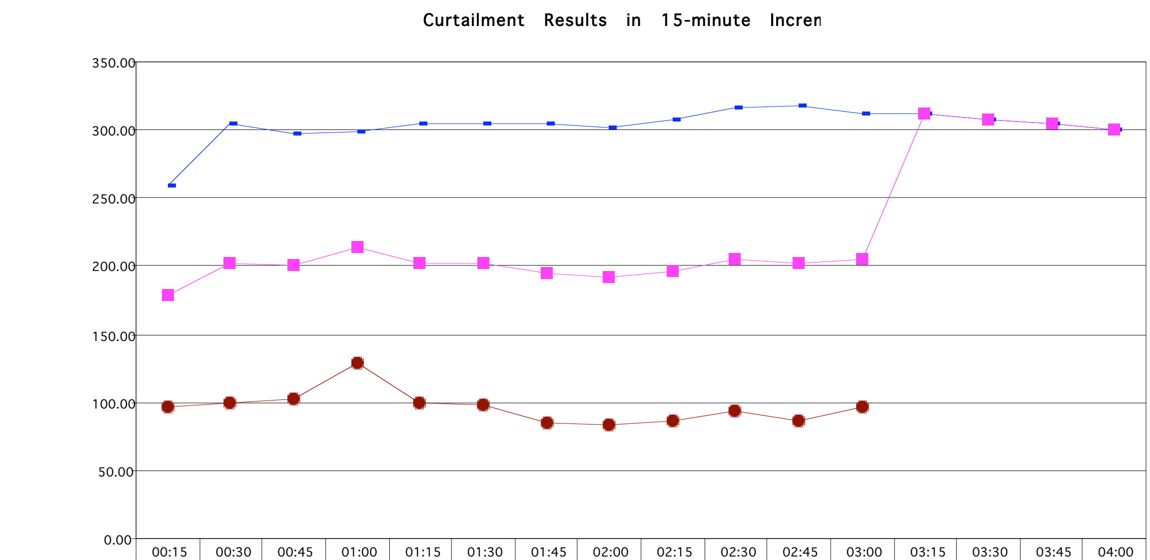
The verified demand savings for ICF Consulting are almost exactly the same as the reported savings. For Webgen, however, reported demand savings were not available due to the method Webgen used to calculate their baseline values. Webgen used temperature-adjusted baseline methods for calculating demand savings for all of their sites, and it is expected that this method varied from Nexant's method. It is also possible that Webgen used different sets of days for their baseline calculations.

Research Objectives 1, 2, and 3 for Sub-element 3 have been answered above. Research Objectives 4, 5, 6, 8, 9, 10, and 12 are dependent on curtailment activities. As there were no curtailments during 2003, these research objectives cannot be addressed. Research Objectives 8 and 9 were discussed briefly in the preceding Section 3.5.2. The remaining research objectives, 7, 11, and 13-16 are answered in the remainder of this section.

Stability of Curtailed Loads Across Pilot Test Period (Research Objective 7)

Research Objective 7 examines the stability and reliability of the aggregate curtailed loads across the four-hour pilot test period relative to capacity margins on the California power grid at large. Data was taken from curtailed loads observed during pilot tests aggregated across 98 sampled program participants from Sub-element 3. Figure 3-5 shows the fluctuations, in 15-minute intervals, of aggregate curtailed loads for this population.

Figure 3-5: Variation in Demand Savings Across Four-Hour Pilot Test Period



	00:15	00:30	00:45	01:00	01:15	01:30	01:45	02:00	02:15	02:30	02:45	03:00	03:15	03:30	03:45	04:00
Webgen	97.26	99.82	102.46	129.08	99.28	98.76	85.32	83.60	85.74	93.68	86.86	96.65				
ICF	259.48	305.06	297.48	298.42	304.77	304.56	304.37	300.94	308.19	316.24	317.53	312.64	311.28	307.84	303.90	300.36
DR Average	178.37	202.44	199.97	213.75	202.03	201.66	194.85	192.27	196.97	204.96	202.20	204.64	311.28	307.84	303.90	300.36

In Figure 3-5, it can be seen that the shape of curtailed loads over the four-hour curtailment period does show some fluctuation. Most of the sampled facilities' curtailed loads include HVAC systems, where the level of curtailment is partially influenced by outdoor temperatures; these are referred to as heat-sensitive or temperature-dependant loads. Nearly all of the sites represented in this analysis performed pilot tests during the summer months, with pilot tests occurring before September 30, 2003.

Distribution and Demand Response of Building Types (Research Objective 11)

The purpose of this analysis is to examine the distribution of program participants by building types, and to evaluate the demand response potential of the most common building types represented in the program populations. Table 3-16 shows the distribution of building types for the Sub-element 3 population.

Table 3-16: Distribution of Major Building Types for Sub-element 3

Building type	Number of buildings	Average realization rate
Office Buildings	79	103%
Retail	367	99%
Hotel & Lodging	1	NA
Grocery	0	NA
Restaurant	22	100%
Industrial & Mining	0	NA
Water / Wastewater	0	NA
Hospital & Healthcare	0	NA
Schools & Colleges	1	100%
Warehouse	1	96%
Other Public Institutional	0	NA
Miscellaneous / Unknown*	2	NA*
Total	**473**	

*Miscellaneous buildings did not have accurate realization rates.

Distribution and Demand Response of Facility Load Control Types (Research Objectives 13 and 14)

The purpose of this analysis is to examine the distribution of program participants by load control systems used to operate emergency load curtailments, and to evaluate the effectiveness of different load types by examining realization rates within each category.

A brief description of load control types is necessary in advance of the discussion of results. Manual load control requires one or more onsite personnel to physically shut down curtailed end uses without automated control systems being operated at a central location within a facility or at a remote location. Direct Load Control technologies are characterized as highly automated systems where offsite personnel remotely signal pre-programmed curtailment sequences of designated end-uses in one or more facilities without the involvement of personnel at the facility. Onsite types of automated load control systems also include automated Energy Management Systems (EMS) and manual EMS systems. Automated EMS systems are typically pre-programmed curtailment sequences initiated by personnel at the facility who do not actively manage curtailed loads after the curtailment is initiated. Manual EMS systems do require the active management of curtailed loads by onsite personnel for the duration of the curtailment. Both automated and manual EMS systems are typically operated from a single control console or location at the participating facility.

Table 3-17, below, shows the distribution and average realization rates of the different load control types.

Table 3-17: Distribution and Realization Rates by Facility Load Control Types

Load control type	Sub-element 3 No. of sites	Sub-element 3 Average realization rate*
Automated	0	NA
Direct Load Control	470	99.7%
Automated EMS	2	97.8%
Manual EMS	0	NA
Manual	1	99.0%

* Average realization rates are calculated from a sample of the total number of sites within category; sample was determined by sites where meter data was available.

Cost Effectiveness and Persistence (Research Objectives 15 and 16)

Results for Research Objective 15, Cost Effectiveness of Sub-element 3, are presented in Section 3.6 of this document. The Sub-element 3 cost effectiveness is $484/kW, which is significantly higher (less cost effective) than the cost effectiveness of Sub-elements 1 and 2. This is discussed in detail in Section 3.6.1.

Research Objective 16 is concerned with the persistence of load reductions. Analyses related to this research objective were not completed in large part due to the following two reasons: 1) Sub-element 3 contractors had not fully completed the testing of their entire population for year 2002 in order to allow a persistence analysis to be conducted; 2) With the exception of PowerStat, Sub-element 4 programs did not start-up until 2003 and were not completed before the end of summer 2003. To conduct a persistence analysis of these programs, MV&E activities would have had to run through the summer 2005 peak demand period, which is beyond the scope of this report.

3.5.4 Sub-element 4 Results and Research Objectives

Table 3-18 provides contracted, reported, and verified demand savings values, along with their associated realization rates, for each of the Sub-element 4 grantees for the SB 5X program.

Table 3-18: Demand Savings and Realization Rates for Sub-element 4 by Contractor, as of September 30, 2003

Contractor	Customer sites recruited	Sites conducting pilot tests	Contracted demand savings (MW)	Reported demand savings (MW)	Verified demand savings (MW)	Realization rate
SMUD PowerStat	178	178	1.0[1]	0.241	0.199	82.7 %
SMUD PowerChoice	73	73	1.0[1]	0.032	0.039	123.0%
Energyn	72	69	1.0	NA[2]	0.153	NA[2]
Totals	**323**	**320**	**3.0**	**NA**[3]	**0.391**	**87.4%**[4]

[1] SMUD total contracted demand savings are 2 MW (individual program contracted demand savings not specified).
[2] Energyn did not have reported demand savings, so no realization rate can be calculated.
[3] Since Energyn did not have reported demand savings, a total reported demand savings value is not meaningful.
[4] The total realization rate is based on SMUD PowerChoice and PowerStat reported and verified demand savings.

As mentioned before, the Sub-element 4 realization rate (87%) is based on reported and verified demand savings that were recorded for the PowerStat and PowerChoice programs. The Energyn program was excluded from realization rate calculations, since no reported demand savings data for the program was received. The decision to utilize solely PowerStat and PowerChoice data for this calculation reflects that these two programs account for over 60% of total Sub-element 4 verified demand savings.

The aggregate verified demand savings of 0.39 MW for Sub-element 4 represents 13 percent of the total contracted demand savings of 3 MW. Lower verified demand savings are explained by technical difficulties with the receipt of curtailment signals that limited the demand response potential in many facilities.

Tier 1 Research Objectives

In this section, results of the Sub-element 4 Tier 1 research objectives are updated from the 2002 Report, based on all data received through September 30, 2003. Research Objective 1 is to define and evaluate peak demand savings achieved for each residential program. Table 3-25, above, summarizes this information. As of September 30, 2003, the verified Sub-element 4 peak-demand savings is 0.39 MW.

Research Objective 2 is to determine the cost effectiveness of the program. Nexant's calculations indicate the Sub-element 4 cost effectiveness is $2958/kW, which is far higher than any other sub-element in DR. The cost is largely due to the fact that a residential DR program is an innovative and mostly untested idea. As experience is gained in implementing residential DR programs, costs should decrease; however, Nexant expects residential DR programs to remain costly compared to non-residential DR programs due to the fact that residential loads—and thus potential curtailment capacities—are small compared to those at commercial and industrial facilities. Additional information about cost effectiveness is given in Section 3.6 of this Chapter.

Tier 2 Research Objectives

The Tier 2 and Tier 3 research objectives presented in this document pertain only to information received in 2003, to remain consistent with the focus of this 2003 Update Report. Additional information on these research objectives can be gleaned from the 2002 report, based on information received during 2002. In particular, several curtailments took place in 2002, and analyses based on these curtailments are presented in the 2002 Report. To summarize the 2002 Report results, average 2002 curtailment demand savings per meter for seven cycling events varied from 0.69 kW to 1.57 kW, with an average demand savings of 1.12 kW per residence.

Research Objective 3 for Sub-element 4 attempts to compare measured peak demand savings documented during pilot tests with peak demand savings from subsequent curtailment events. As there were no curtailment events during 2003, this objective cannot be completed.

Research Objective 4 focuses on any variations in demand savings across the peak demand period of a curtailment period. This objective cannot be answered for 2003, as there were no curtailment events during this period.

Research Objective 5 asks if there were impacts on residential occupant comfort during curtailments. Again, since there were no curtailment events in 2003, this question cannot be answered.

Research Objective 6, which seeks to identify any significant differences in peak demand savings based on ambient air temperatures, cannot be evaluated. This objective can only be met for program participants responding to critical curtailment signals, of which there were none, because no practical method is available that measures the effects of temperature on demand savings from TOU rates.

Research Objective 7 focuses on the analysis of the characteristics of relevant household demographics, residential building types, and climatic characteristics of the program participant population. To address this research objective, interviews were conducted with a sample of representative participants from each of the Sub-element 4 programs as part of the audit process. Based on the audit results, the participant populations of the different Sub-element 4 programs share the following common characteristics:

- Program participants are well-educated, with over 70% of sample respondents having earned a college level degree or higher;
- The majority of participants have a relatively high level of income (i.e., annual income above $75,000); and
- Participants live in relatively large-size gas heated homes.

Table 3-19 provides an overview of selected results from Sub-element 4 participant audits.

Table 3-19: Sub-element 4 Sample Population Characteristics

	PowerStat (n=13)	PowerChoice (n=11)	Energyn (n=9)
House/Dwelling Characteristics			
Avg. Size (sq. ft.)	1,710	2,461	2,371
Age of House (years)	25	47	17
Avg. No. of Stories	1.2	1.5	1.6
Education Level (% of sample)			
Graduate Degree	21%	42%	44%
College Degree	50%	42%	33%
High School or below	29%	16%	0%
Did not respond	0%	0%	23%
Household Income (% of sample)			
>$125 k	No data	25%	23%
>$100 k	collected	17%	11%
>$75 k		25%	33%
$75k or less		17%	0%
Did not respond		16%	33%

Given the importance of climate related issues in evaluating customer responses to program events, a review of the climate characteristics for each of the Sub-element 4 programs was conducted to meet the requirements of Research Objective 7. Specifically, Sub-element 4 programs were segmented into climate zones by utilizing the participating sample project site's zip code and the pre-existing California Energy Commission Demand Forecasting Climate Zones.[17] The majority of the projects are in Climate Zones 4, 5, and 6. The average July temperature for the zones covered as part of Sub-element 4 programs are listed in Table 3-20.

Table 3-20 Average July Temperatures over a 20-year Period

Program	Climate Zone	Average	Max	Min
PowerStat & PowerChoice	6	75.2	93	58
Energyn	1	56.3	60	52
Energyn	4	72	86	57
Energyn	5	58.5	64	53
Energyn	6	75.2	93	58

Source: California Solar Data Manual, CEC. 1987

PowerStat & PowerChoice: As listed in Table 3-20, all sample projects in these SMUD programs are in Climate Zone 6 (i.e., Sacramento weather data). Sacramento is a mild weather climate with an abundance of sunshine. Cloudless skies prevail during the summer and largely in spring and autumn. The summers are remarkably dry, with warm days and pleasant nights.

[17] The number of actual weather stations in a given forecast area limits the climate zones and makes the boundaries approximate. Depending on local features (i.e., trees, fog, lakes, mountains) a microclimate might exist for an individual site that affects its energy consumption compared to another similar site in the same climate zone.

Energyn: The majority of projects for the Energyn program were located in Climate Zones 4 and 5 (San Francisco and Fairfield, respectively). The Pacific Ocean fog being drawn into the warmer Central Valley cools San Francisco in the summertime. This reduces the cooling requirement during peak demand times. For Fairfield, temperatures are warmer and the air is dryer, so more cooling is needed.

Tier 3 Research Objectives

Sub-element 4 Research Objective 8 is to determine the reasons and the extent to which customers chose to exercise overrides of automated systems during curtailment events in 2003. This objective cannot be evaluated since there were no curtailment events in 2003.

Research Objective 9 attempts to explain any differences in demand savings from curtailment events involving price with those involving emergency signals. As there were no curtailment events in 2003, this objective is impossible to evaluate. Even if curtailment events had taken place, this objective would be difficult to differentiate, as the SMUD programs have a set of criteria for sending critical curtailment signals that combine price and capacity constraints.

3.6 PROGRAM ELEMENT COST EFFECTIVENESS

In order to evaluate the cost effectiveness of the DR program element, Nexant calculated the simple cost, in dollars-per-kilowatt of curtailable load ($/kW), for each program administrator. No annualization of project costs and demand savings were applied because the DR program is structured such that program administrators are compensated for securing demand savings potential. They are encouraged, but not obligated, to demonstrate this savings over several years. Pilot tests, conducted in the initial year of program implementation, were the only way the demand savings potential was measured to determine administrators' compensation.

Cost effectiveness is calculated by dividing the total dollar amount invoiced to the Energy Commission per administrator by the Nexant verified demand savings resulting in a $/kW figure. The dollar amounts invoiced and the verified demand savings by administrator are then aggregated to a sub-element level, and the cost effectiveness at the sub-element level is then determined. Cost effectiveness results are presented by program sub-element, and for the program element as a whole.

The four sub-elements had a large variance in the cost effectiveness performance of the programs. Table 3-21 shows the cost effectiveness for Sub-elements 1 through 4 ranges from $80/kW to $2,958/kW.

Table 3-21: Cost Effectiveness by Sub-element

Sub-element	AB 970 ($/kW)	SB 5X ($/kW)	Totals by program funding ($/kW)
Sub-element 1	72	88	80
Sub-element 2	191	246	233
Sub-element 3	NA*	484	484
Sub-element 4	NA*	2,958	2,958

*AB970 did not fund SE3 & SE4.

AB 970 and SB 5X had a combined budget of $44.3 million and a legislated demand savings goal of 214 MW. Nexant used these numbers to establish a program cost effectiveness target of $209/kW[18]. The verified projected cost effectiveness for Sub-element 1 is $80/kW, which is less than half the cost effectiveness target of $209/kW. The Sub-element 2 cost effectiveness of $233/kW falls in between a national benchmarking survey of DR programs[19] where self-reported DR program averages were $487/kW in 2001 and $85/kW for 2002. Sub-element 3 had a cost effectiveness of $484/kW, representing a significant increase between Sub-element 1 and 2. Meanwhile, Sub-element 4 had a cost effectiveness of $2,958/kW, demonstrating the challenges of implementing a demand responsive program at the residential level.

3.6.1 Cost Effectiveness of Sub-element 3

The contracts in Sub-element 3 were awarded based on a cost effectiveness of $250/kW. If the sub-element goal of 40 MW was attained, the cost effectiveness would meet this target, as shown in Table 3-22.

Table 3-22: Cost Effectiveness Results for Sub-element 3 Contractors

Contractor	Contract award (Millions)	Expected cost effectiveness ($/kW)	Total invoiced payments (Millions)	Verifed demand savings (MW)	Verified cost effectiveness ($/kW)
Webgen	$2.5	$250	$0.831	2.39	$348
ICF Consulting	$7.5	$250	$5.849	11.4	$512
Totals	**$10.0**	**$250**	**$6.680**	**13.8**	**$484**

Sub-element 3 had verified demand savings of 13.8 MW, which was 66% lower than the sub-element goal of 40 MW of demand savings. Webgen had a target of 10 MW of demand savings, while ICF had a target of 30 MW of demand savings, resulting in Webgen meeting 24% of its contracted goal and ICF meeting 38% of its contracted goal. When measured by verified cost effectiveness, Webgen had a cost effectiveness of $348/kW, while ICF had a higher cost effectiveness of $512/kW.

3.6.2 Cost Effectiveness of Sub-element 4

The cost effectiveness for Sub-element 4 programs is shown in Table 3-23. The Energyn and SMUD pilot programs had cost effectiveness results of $2,830/kW and $3,040/kW, respectively. Sub-element 4 had a goal of producing 3 MW of demand savings, with SMUD representing 2 MW and Energyn representing 1 MW of demand savings. SMUD achieved 12% of its target, and Energyn achieved 15% of its target.

[18] This figure will be used as a comparison to actual results achieved.

[19] EEI/PLMA Demand Response Benchmarking Survey as reported in a presentation on March 27, 2003 at the CBI DR Conference, Washington, DC.

Table 3-23: Cost Effectiveness Results for Sub-element 4 Contractors

Contractor	Contract award (Millions)	Expected cost effectiveness ($/kW)	Total invoiced payments (Millions)	Verifed demand savings (MW)	Verified cost effectiveness ($/kW)
SMUD	$1.142	$547	$0.726	0.239	$3,040
Energyn	$0.5	$547	$0.432	0.153	$2,830
Totals	**$1.642**	**$547**	**$1.158**	**0.391**	**$2,958**

The expected cost effectiveness, based on a contract award of $1.642 million and a demand savings of 3 MW, is $547/kW. The expected cost effectiveness for the Sub-element 4 programs is expected to be high, since these are pilot programs. If the program succeeds and matures, these costs will go down due to an increase in economies of scale and improvements in levels of efficiency. The total contract awards and demand savings for Sub-element 4 are a small proportion of the DR program element overall, so the lower program savings and cost effectiveness results do not impact the program element significantly.

3.7 ADMINISTRATOR AND PARTICIPANT AUDITS

This section summarizes the results of administrator and participant audits of Sub-element 3 and 4 programs that were conducted by Nexant to assess key qualitative aspects of individual program performance that extend beyond typical analyses of reported demand savings. All audit results focus on the 2003 summer peak demand period with the exception of the PowerStat program that was completed in 2002. Audit results were compiled based on feedback from program administrator and participant responses to a standardized set of survey questions. Although minor adjustments were made to the questionnaires used for each program, a common template was applied in order to facilitate the comparison of audit results across all of the various peak load reduction programs. As outlined below in Table 3-24, Nexant was contracted to perform administrative audits on Sub-element 3 participants only, while program participant audits were carried out for all Sub-element 3 and 4 participants.[20]

[20] Nexant attempted to interview representatives for BofA as part of the assessment of the WebGen program. However, after several attempts to collect this data, no response was received.

Table 3-24 Coverage of Participant and Administrator Audits

	Program participant audits	Program administrator audits
Sub-element 3		
ICF	✓	✓
Webgen*		✓
Sub-element 4		
PowerStat	✓	
PowerChoice	✓	
Energyn	✓	

*No responses were received following several attempts to interview WebGen participants.

Common to all of the audits was use of a five-point evaluation scale for questions that were not open-ended. The five-point scale was used to gauge positive and negative responses surrounding a neutral response. In the case of administrator audits, the five-point scale was also used by Nexant to rate their observations of administrators' competencies. Listed below is an overview of the structure and main components of the administrator and participant audits.

- Administrator audits were conducted with Sub-element 3 contractors. Nine questions were used to address program marketing, recruitment, participation, equipment, and services-related aspects. Other questions addressed processes used for project verification, record keeping, and pre- and post-evaluations of measures. Administrators were also asked to produce project records and invoices for their selected participants.
- Participant audits consisted of 18 open-ended questions covering topics such as program notification, involvement in similar programs, level of satisfaction in different areas of the program administration and project implementation. For 10 of the 18 questions, participants provided numeric five-scale ratings to evaluate their satisfaction with key program elements. For Sub-element 3 participants, supplemental questions were asked to corroborate administrator responses to similar questions.

Performing administrator and participant audits enabled Nexant to compile information necessary to address Sub-element 3 and 4 MV&E research objectives. The remainder of this section presents the key results of administrator and participant audits.

3.7.1 Administrative Audits

Nexant conducted administrative audits for the Sub-element 3 contract administrators, ICF Consulting and Webgen, at the end of July 2003. These audits measured and recorded the effectiveness of each program administrator as evaluated by the following criteria: (1) level of success in participant recruitment and providing participant support services; (2) extent to which project equipment was ordered, delivered, and installed on time; (3) on-time pilot testing, monitoring, and reporting of participant activity; and (4) level of contractual compliance and appropriate spending and allocation of Energy Commission funds.

All administrative audits were conducted through a telephone or in-person questionnaire with the lead administrator. Nexant also requested a sample of each administrator's program files corresponding to their respective program participants selected for program participant audits, as described further in this section. This was done to observe and confirm the viability of paper record-keeping systems which contractors used to justify payments on completed projects.

Appendix B contains a full copy of the questionnaire that was utilized to perform administrative audits for Sub-element 3. In answering many of the questions, administrators deferred to information in their interim or final project reports. In these instances, Nexant conducted report reviews in order to complete answers to the audit questions. Other questions included a standardized five-point scale for rating an administrator's quality of project documentation and standards of program compliance (as set forth by the Energy Commission). To provide these ratings, project documentation of four to seven administrator's customers were requested for review at administrator's offices by Nexant to gauge the effectiveness of the administrator's project documentation.[21] A rating of five on a five-point scale represented full record retention, whereas a one represented a complete lack of documentation. Listed below is a summary of key results from the administrative audits on the following areas:

- Marketing and customer recruitment;
- Customer services and training;
- Project evaluation and verification of pilot test demand savings; and
- Program tracking and reporting.

Marketing and Customer Recruitment

Administrative audits included open-ended questions on marketing and customer recruitment methods. Table 3-25, shown below, lists the different marketing and recruitment techniques that were utilized by ICF and Webgen to promote their respective Sub-element 3 programs.

Table 3-25: Sub-element 3 Administrator Recruiting and Marketing Methods

	ICF	Webgen
Direct mail campaigns (e.g., brochures and emails)	✓	
Website promotions	✓	
Magazine, Newspaper ads		✓
Software-based marketing tools	✓	
Discussions with utility account representatives	✓	
Meetings with equipment vendors	✓	
Discussions with building managers and engineering staff		✓
Word of mouth from existing customers		✓

[21] Administrators were asked to present project invoices, equipment orders, and other documentation for customers that were selected for participant audits. If administrators were able to provide project documentation, Nexant reviewed the documents and rated the administrator on the thoroughness of project documentation.

Although there was no overlap in terms of the specific marketing methods that were utilized by the contractors, both ICF and Webgen did conduct direct meetings with key stakeholder groups, such as equipment vendors, utility representatives, facility owners, and building managers. In addition, ICF relied more heavily on the use of the internet- and software-based marketing tools, while Webgen utilized more traditional methods such as advertisements in trade journals

Customer Services and Training

Each of the Sub-element 3 contractors offered a range of services to support customer participation in their program. This included conducting training courses and help-desk services. Listed below is a summary of key services that were provided to customers:

- Provision of online training (Webgen);
- Set-up of a 1-800 help-desk (Webgen);
- Training to customers/assistance with program applications (ICF and Webgen);
- Web-site description and documents on financial incentives (ICF);
- Direct assistance to customers (ICF and Webgen);
- Due diligence analysis for customers on potential vendors (ICF); and
- Assistance in developing curtailment plans (ICF).

Project Evaluation and Verification of Pilot Test Demand Savings

A series of project evaluation and verification procedures were employed by ICF and Webgen to facilitate the realization of demand savings from Sub-element 3 programs. Listed below is an overview of procedures that were reported by contractor representatives.

Webgen: First, an evaluation was conducted of a customer's bill (kWh and kW analysis). This was completed for both facilities with an individual meter as well as for aggregated sites. Analyses were completed using the capabilities of the IUE systems, including tariff modules, baseline data analysis, weather adjustments, and occupancy adjustments. Second, pilot test analyses were completed. Data for the previous 10 days (weather adjusted) was exported per the Nexant evaluation method (DR tool). Verification of reported results was then conducted. The results were then exported for CEC/Nexant M&V analysis.

ICF: Evaluation procedures focused on two main areas: customer/project applications and project testing. For customer/project applications, the following steps were conducted: 1) targeting of customers, 2) receipt of applications on a first come, first serve basis, and 3) application review and approval (internal ICF review sent to Energy Commission for final approval). For pilot testing, the following steps were followed: 1) collection of data from customers and vendors, and 2) verification of pilot tests by ICF staff, including taking photos of lighting systems, tracking indoor/outdoor temperatures, and assessing occupancy comfort.

Program Tracking and Reporting

ICF and Webgen provided monthly program reports as required to the Energy Commission contract managers. Nexant was able to obtain requested monthly and final program reports when requested from either the Energy Commission contract managers or the program administrators themselves. The following summarizes each administrator's process for conducting ongoing project tracking activities to support their monthly and final reports.

- ICF conducted internal meetings and conference calls with Energy Commission staff, and progress was reported on a monthly basis until all projects were completed and tested. Monthly reports were sent to the Energy Commission, and regular contact was maintained with Nexant.
- Webgen developed monthly reports that were provided up to November 2003 (Phase I). The preparation of reports then resumed in June 2003. Invoices from Bank of America (BofA) were also used to monitor projects.

3.7.2 Participant Audits

Participant audits were performed by Nexant to evaluate the implementation and administrative experience of Sub-element 3 and 4 program participants. The purpose of the participant audits was to: (1) confirm the installation of demand responsive equipment, (2) confirm pilot test results, (3) evaluate program administrative experience, and (4) to obtain missing data through the use of supplemental questions. Participant audits were successfully conducted for all Sub-element 3 and 4 programs with the sole exception of the Webgen program.[22]

End-user facilities that were selected for participant audits were drawn from a random stratified sample. Stratification of the sample was performed by allocating sample sites in proportion to the total number of sites associated with either contractors or grantees. Participant audits were conducted as part of phone interviews with representatives from the sample facilities.

The remainder of this section summarizes key results of Sub-element 3 and 4 participant audits. Sub-element 3 participant questionnaires included a series of 15 questions, while the Sub-element 4 questionnaire included 17 questions. Although a common (standardized) set of questions was utilized, questionnaires for each individual program were slightly customized in order to take into account the needs of different end-user groups and the use of different technologies. A copy of the questionnaire for each program is presented in the Appendix.

Sub-element 3 Results

Participant audits for Sub-element 3 were conducted for the ICF program only. Table 3-26 lists responses to numeric (rating) questions that were asked to four program participants representing seven facilities. Specifically, the minimum, average, and maximum value of responses to selected questions are provided. In general, the results indicate that the sample participants had a high level of satisfaction with the program—with above average ratings being given for program

[22] As noted earlier, after several attempts to contact Webgen participants, no responses were received.

performance, communication procedures, reporting requirements, and invoice and billing process.

Table 3-26 Sub-element 3 Participant Audit Results

Question	Min.	Avg.	Max.
No. 4: Rate the overall quality of the communication process with your administrator (5=complete/thorough; 3=sufficient/adequate; 1=absent/wholly inadequate)	3	4.5	5
No. 6: Rate the reasonableness of the reporting requirements you were required to fulfill (5=Very reasonable/easy; 3=somewhat reasonable/some significant challenges; 1=completely unreasonable)	3	4.1	5
No. 11: Likelihood that you would have performed load-reducing actions without the program (5=without question; 3 =yes, but under different circumstances; 1=under no circumstances)	1	1.3	2
No. 12: From your experience with this program, would you participate in a similar program? (5=without question; 3 =yes, but under different circumstances; 1=under no circumstances)	3	4.5	5
Questions 12 to 16 asked participants to use a five point scale as follows: 5=Outstanding; 3=Average; 1=Unacceptable			
No. 13: How was your experience with the program on the whole?	4	4.25	5
No. 14: How was your administrator?	3	4.5	5
No. 15: How was the program application process?	2	3.6	5
No. 16: How were the invoicing, billing, and payments process?	4	4	4
No. 17:How was the verification process?	3	4	5
No. 18: How was the implementation timeline that you were on?	3	3.8	5

In addition, ICF customer audit results illustrate the importance of the program in generating load reductions. Specifically, the average rating of 1.3 to question No. 11 indicates that few customers would have performed load reduction actions absent their participation in the program. Additional audit results that provide insight to the program's performance include that:

- Respondents first heard about the program through either vendors or consulting firms;
- The primary reason for participating in the program was to save money. However, respondents also noted that they wanted to help the state conserve energy;
- Communications between ICF and program participants was primarily through emails, with some phone calls to follow-up on specific items; and
- All respondents stated that they believed that they achieved their peak demand savings goals.

Sub-element 4 Results

As noted above, participant audits were completed for all of the Sub-element 4 programs. However, it is important to note that participants did not always answer all questions because they either felt the questions were not relevant to their project or they did not recall enough detail to feel confident about a response. Given the use of some customized questions, the numbering of questions is slightly different for each program. Sub-element 4 audits included some questions that asked end-users to respond with a numerical rating, where 1 is "*Unacceptable"* and 5 is "*Outstanding.*" Answers to these numerical rating questions, as well as other selected questions, are detailed below for the Energyn, PowerChoice, and PowerStat programs.

Energyn

Nine Energyn program customers were sampled as part of the Sub-element 4 participant audit process. Overall, respondents had a positive experience participating in the program, as exhibited by the 4.0 average ratings to questions No. 13 and 16. Additional key results from Energyn participant audits are summarized below:

Question 1: How did you find out about the program? How long after you first learned of the program did you decide to become a program participant?

Response: Four participants enrolled after a phone solicitation, 4 participants enrolled at a farmers market, and 1 participant enrolled after an email solicitation.

Question 2: What were your reasons for participating in this program?

Response: Five participants enrolled due to interest in reducing energy costs, and 4 participants enrolled due to interest in energy conservation and energy efficiency.

Question 6: On scale of 1 to 5, evaluate the quality of the communication process with Energyn or other program personnel.

Response: Avg. = 3.94, Max. = 5, Min. = 1

Question 12: On a scale of 1 to 5, what is the likelihood that you would have carried out similar energy saving measures without the Energyn program?

Response: Avg. = 3.22, Max. = 5, Min. = 2

Question 13: On a scale of 1 to 5, rate your experience with the Energyn Program.

Response: Avg. = 4.0, Max. = 5, Min. = 3

Question 14: On a scale of 1 to 5, rate the overall quality of customer service provided by the Energyn or other project personnel that you had contact with.

Response: Avg. = 4.44, Max. = 5, Min. = 3

Question 15: On a scale of 1 to 5, rate the quality of your experience with technical aspects of the Ipower equipment and Energyn website?

Response: Avg. = 3.75, Max. = 5, Min. = 2

Question 16: Based on your experience with the Energyn program, rate your likelihood of repeating this program experience or participating in a similar program (scale of 1-5 scale)?

Response: Avg. = 4.7, Max. = 5, Min. = 4

PowerChoice

A total of 12 PowerChoice program customers were interviewed as part of Sub-element 4 participant audits. The sample customers reported a high level of satisfaction with technical aspects of the program as exhibited by their responses (average ratings > 4) to Questions 4 and 5. Further, PowerChoice participants expressed a strong sentiment that, given the opportunity, they would participate again in a similar program. Listed below is a summary of additional audit results that provide further insight into customer perceptions of the program.

Question 1: How did you find out about the PowerChoice Program?

Response: The majority of sample participants (10 out of 12 customers) enrolled after a SMUD solicitation. Other customers learned about the program through direct contact with a SMUD employee.

Question 2: During the program, did you override the thermostat?

Response: Six participants reported overriding their thermostats during curtailment periods, while 6 participants reported not touching their thermostat during curtailment periods.

Question 3: On scale of 1 to 5, evaluate the quality of the communication process with PowerChoice or other program personnel (with all 12 survey participants responding).

Response: Avg. = 4, Max. = 5, Min. = 2

Question 4: On a scale of 1 to 5, rate the quality of your overall experience with technical aspects of the PowerChoice website (with 5 survey participants responding).

Response: Avg. = 5, Max. = 5, Min. = 5

Question 5: On a scale of 1 to 5, rate the quality of your overall experience with technical aspects of the PowerChoice thermostat (with all 12 survey participants responding).

Response: Avg. = 4.1, Max. = 5, Min. = 2

Question 6: On a scale of 1 to 5, rate your overall experience with the PowerChoice Program on the whole (with all 12 survey participants responding).

Response: Avg. = 4.6, Max. = 5, Min. = 4

Question 7: On a scale of 1 to 5, rate the overall quality of customer service provided by the PowerChoice program (with 10 survey participants responding).

Response: Avg. = 4.4, Max. = 5, Min. = 3

Question 8: On a scale of 1 to 5, rate the quality of your overall experience with technical aspects of the PowerChoice program (with 5 survey participants responding).

Response: Avg. = 4, Max. = 5, Min. = 3

Question 9: Based on your experience with the PowerChoice program, rate your likelihood of repeating this program experience or participating in a similar program on a scale of 1 to 5 (with all 12 survey participants responding).

Response: Avg. = 4.4, Max. = 5, Min. = 4

PowerStat

Listed below is a summary of results from a sample of 14 PowerStat customers. Unlike the results for the Energyn and the PowerChoice program, audit results for PowerStat reflect the program performance during the summer peak demand period of 2002. Audit results highlight that most sample customers encountered initial difficulties with their thermostat. However, participants had an overall positive experience, as indicated by the average rating of 4.4 that was reported for Question 4.

Question 1: During the program, did you override your thermostat?

Response: Nine participants reported overriding their thermostats during curtailment periods, while 5 participants reported not touching their thermostat during curtailment periods.

Question 2: On a scale of 1 to 5, rate the quality of your overall experience with technical aspects of the PowerStat thermostat.

Response: Avg. = 3.8, Max. = 5, Min. = 1

Question 3: Did the PowerStat thermostat technology prove to be an obstacle in participating in the program?

Response: Six participants reported having problems with the PowerStat thermostat, of which 5 reported having SMUD fix the thermostat.

Question 4: On a scale of 1 to 5, rate your experience with the PowerStat Program on the whole.

Response: Avg. = 4.4, Max. = 5, Min. = 1

Question 5: Based on your experience with the PowerStat program, would you continue participation or recommend the program to others?

Response: The majority of respondents (11 of 14) reported yes, while only 3 reported no.

3.8 CONCLUSIONS

The Demand Responsive program element has been successful in achieving potential peak demand savings. The four sub-elements—with over 2,100 participants, including small, medium, and large commercial sites, as well as residential customers—have a combined verified demand savings of 216 MW. The DR program element overall realization rate is 91.5%, attesting to the success of the program design and implementation. However, the results presented in this report highlight some of the challenges associated with capturing demand savings from the type of small C&I and residential end-users that were targeted in Sub-element 3 and 4 programs. Demand responsive programs, such as those in Sub-elements 1 and 2, have traditionally focused on medium and large commercial and industrial facilities, which consume large amounts of energy. The small-sized Sub-element 3 and 4 participants use relatively less amounts of electricity per customer, although in aggregate they account for a substantial portion of demand usage. Listed below is a summary of key conclusions from MV&E analysis results for Sub-elements 3 and 4 during the summer peak demand period of 2003:

- **Participants motivated by dual desires to save money and conserve energy**
  Survey audit results for Sub-elements 3 and 4 reveal that saving money on energy bills was a major motivating factor in end-user decisions to participate in a given DR program. However, participants also stated that a desire to conserve energy and help avoid blackouts was also a key driver (e.g. almost half of the Energyn participants that were surveyed listed conserving energy as the top reason for participating in the program).
- **Marketing efforts for Sub-element 3 gained traction over time**
  The two Sub-element 3 programs were able to recruit 473 small commercial facilities to install demand responsive equipment capable of shedding 13.8 MW of load during an emergency curtailment. ICF was particularly successful at recruiting facilities to join in the program. During the 4th Quarter of 2003 (i.e., post the summer peak demand period evaluated in this report), ICF recruited an additional 645 customers—representing a 136% increase over total Sub-element 3 enrollment as of September 30, 2003.
- **$/kW costs for Sub-element 3 and 4 programs were higher than expected**
  The verified cost effectiveness results of all Sub-element 3 and 4 programs were well above the expected levels. For Sub-element 3, the verified cost effectiveness of $484/kW was almost double the $250/kW projected cost. For Sub-element 4, the $2,958/kW was five-fold greater than the projected $547/kW level. These results underscore the following: 1) Sub-element 3 and 4 programs were highly experimental with little or no track record in California; results indicating higher than projected costs are not entirely surprising; 2) initial cost projections underestimated the significant cost of marketing and implementing DR projects to residential customers and small C&I end-users; 3) early estimates of the demand savings (on a kW per participant basis) were also overly ambitious given the experimental nature of these programs; and 4) the realization of actual demand savings was more challenging than expected, reflecting the more uncertain nature of securing responses from smaller sized end-users.

- **Sub-element 3 and 4 program participants had positive experiences**
  Participant audit results illustrate that the sample customers had a high level of satisfaction with the program—above average ratings were given for program performance, communication procedures, reporting requirements, and the invoice and billing process.

APPENDIX A

DEMAND RESPONSIVE BUILDING PROGRAM ELEMENT MV&E PLAN, SUB-ELEMENT 4

DEMAND RESPONSIVE BUILDING PROGRAM ELEMENT MV&E PLAN, SUB-ELEMENT 4

Introduction

This document provides information about the Measurement, Verification and Evaluation (MV&E) of residential pilot programs within sub-element 4 of the SB 5X Demand Responsive (DR) building program. The MV&E objectives, along with the methodologies to address these objectives, are contained in this document. The objectives are:

- The verification of demand savings
- The characterization of the program population
- The influence of ambient air temperature and curtailment duration on demand savings
- Building occupant comfort issues and responses to automated curtailments

The MV&E methodology is based on a statistical sampling approach where specific methods for calculating demand savings are adapted and applied to the different programs in this sub-element. Implementation details and the mechanics of conducting the verification process are also provided along with reporting requirements.

Program Element Description

The CEC has allocated $2 million for sub-element 4, residential demand responsiveness, of which $1.642 million has been awarded to two program administrators implementing four different and separate residential pilot programs. These programs are expected to capture demand savings of 0.54 to 1.08 MW. A summary description of each program along with program acronyms used throughout the remainder of this report is provided in Table 1.

SMUD's total programs are expected to show demand savings of 0.75 to 1.50 kW per household. Energyn's single program is expecting 0.50 to 1.00 kW per household. In the four programs the expected number of participants multiplied by the expected range of per household demand savings equals the expected range of values for cumulative program demand savings as provided in Table 1.

Table 1. Residential Pilot Sub-element 4 Programs

Program Administrator	Program name	Expected no. of participants	Demand savings goal (MW)	Program description
Sacramento Municipal Utility District (SMUD)	Time-of-use (TOU) energy management system pilot - residential retrofits (TOUR)	200	0.15 - 0.30	▪ Automated control of central air conditioning (CAC), electric domestic hot water heaters and pool pumps by program participant ▪ Based on static and dynamic price and/or emergency signals ▪ Works on a tiered TOU rate structure

Program Administrator	Program name	Expected no. of participants	Demand savings goal (MW)	Program description
	TOU energy management system pilot—residential new construction (TOUN)	125	0.09 - 0.19	▪ Same as above but in new construction
	Radio controlled thermostat pilot (RCTP)	200	0.15 - 0.30	▪ Radio-signaled direct load control CAC program ▪ Customers select from three cycling options activated by SMUD signals.
Energyn	(EGYN)	290	0.15 - 0.29	▪ Customer controlled energy management systems ▪ Responds to CAISO emergency signals through Energyn
TOTAL		**815**	**0.54 - 1.08**	

The program objective is to install DR systems in a pilot or test group of new and existing, homes, testing homeowners' responses to one or more of the following types of curtailment signals to reduce peak loads:

- Signals by the SMUD according to internal criteria including wholesale price hikes, high temperatures and capacity constraints (TOUR, TOUN, RCTP)
- SMUD's TOU 3-tiered static rate block (TOUR, TOUN)
- Signals originating from the California Independent System Operator (CAISO) issued during Stage II and III emergencies

SMUD's Radio Controlled Thermostat Program (RCTP) is a direct load control program where curtailment signals are sent to activate automated curtailments of residential air-conditioning systems as described in number one above.

In addition to the three-tiered TOU rate blocks, SMUD may activate a fourth tier, designated as a "critical period" included in number one above. The critical period has the highest tariff in relation to the three fixed TOU blocks, and it is "dynamic" signal meaning that it may occur at any time. The three fixed tiers within SMUD's TOU programs are based on pre-set, "static"intervals during the day, included in number two, above.

The only established signal that Energyn's program participants will be responding to are those sent by Energyn in their response to the CAISO's Stage II and III emergencies.

For the purposes of this MV&E plan, there is a distinction between the two basic types of curtailment signals, in Table 2, below. Critical curtailment signals may be triggered at any time activating single events and are based on emergency price or system capacity conditions sent by the CAISO or SMUD. These are the only type of signals used in the EGYN and RCTP programs.

Table 2. Types of Program Curtailment Signals

Program	Curtailment Signal	Examples
TOUR, TOUN RCTP EGYN	Critical	SMUD direct load control signals SMUD 4th-tier TOU rate CAISO Stage II and III emergency alerts forwarded from Energyn.
TOUR, TOUN	Non-critical	Static price signals in SMUD's 3-tierTOU rate

Curtailment signals that are associated with daily time intervals are referred to as "non-critical". Within this sub-element, non-critical signals include only those associated with SMUD's two TOU programs. These TOU-rate blocks are static price signals, which cause participants to initiate the programming of home energy management systems to achieve daily demand savings during peak periods.

The identification of critical and non-critical curtailment signals is important because this MV&E plan uses two different analyses of curtailments methodologies according to the signal type. Unlike the other sub-elements, in sub-element 4 program administrators and program participants are not required to conduct pilot tests to demonstrate their ability to reduce peak demand. However, all SMUD TOU program participants are expected to respond to both critical and non-critical curtailment signals. SMUD RCTP and Energyn program participants are expected to respond only to the critical signals of their respective programs.

Program administrators are required to obtain all relevant information from program participants and then supply this data to Nexant. Nexant will coordinate with the program administrators on how to collect and evaluate the demand savings data according to the developed MV&E objectives discussed below.

MEASUREMENT, VERIFICATION AND EVALUATION (MV&E) PLAN

Objectives

The objectives of the MV&E plan are grouped into three CEC defined tiers and described below.

Tier 1

1. Define and evaluate the peak demand savings achieved for each of the four residential DR programs based on sampling techniques necessary to obtain a minimum 80/20 level of statistical accuracy.
2. Determine the cost-effectiveness of the program in dollars spent in this program per/ kW of demand savings and estimate a projected cost per kW for the post pilot test phase.

Tier 2

3. If pilot tests are conducted, provide comparisons between measured peak demand savings documented during pilot test and peak demand savings from subsequent curtailment events (price, static or dynamic signals) between these events.

4. Determine how levels of demand savings vary across the peak demand period or specified hours of a curtailment period if different than the peak demand period. Identify factors that explain any hourly variation in demand savings.
5. Did the operation of demand responsive systems during curtailment events impact residential occupant comfort?
6. Determine if there are significant differences in peak demand savings on high ambient air temperature days versus cooler days for each type of residential pilot program.
7. Characterize relevant household demographics, residential building types and climatic characteristics of the program participant population.

Tier 3

8. Determine the reasons and the extent to which customers chose to exercise overrides of automated systems during curtailment events.
9. Compare demand savings from curtailment events involving price and/or emergency signals and explain the differences.

All the objectives above apply to each of the four residential programs, with the following exceptions:

- Meeting objective 2 depends on whether pilot tests are conducted as a part of program implementation.
- Objective 6 can only be met for program participants responding to the critical curtailment signals because no practical method is available that measures the effects of temperature on demand savings from TOU rates.
- Objective 9 which compares responsiveness to curtailments involving price signals and emergency signals, may be difficult to differentiate as the SMUD programs have a set of criteria for sending critical curtailment signals that combine price and capacity constraints.

Assumptions

Because of the strong correlation between high ambient temperatures and peak summer loads, this study assumes the primary reasons for time-of-use price signals and emergency curtailments are to reduce system capacity demands caused by increased central air conditioner (CAC) use.

It is assumed that curtailment signals will occur on hot days, and program participants will control home AC systems as a primary means for providing demand savings. It is also assumed that participants in this program would not have implemented demand responsive systems in their homes had they not been induced to do so by program offerings.

Statistical analysis of free driver, free rider conditions are beyond the scope of this MV&E plan. Any anecdotal evidence of these phenomena may be discussed in the final year-end reporting. No identified double counting of demand savings by program participants will be included in the reported program results.

Nexant will assume that the demand savings reported are only the result of program participant responses to specific critical and non-critical curtailment signals, as specified in each program.

For the purpose of the baseline calculations, it is also assumed that all program administrators will be able to provide necessary 15-minute interval meter data for any conducted pilot tests and curtailment events.

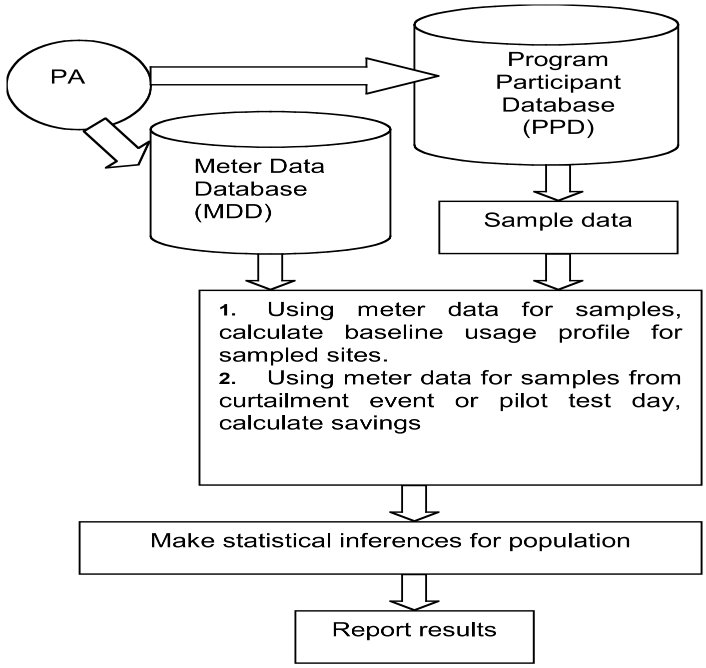
Approach

Nexant will analyze all available data from all the program specific participants. If data is not available, a statistical approach will be used to address the objectives of the plan based on sampling and calculation of demand savings at a sufficient number of sites to satisfy the 80/20 reliability criteria.

Figure 1 is an overview of the sub-element 4 MV&E process. Since each of the programs uses a different set of curtailment signals to achieve peak demand reduction, the definition and the methods for verification of demand savings will differ by program. However, the same basic statistics are common to the entire MV&E process.

As shown in Figure 1, information pertaining to both qualitative and quantitative aspects of the MV&E objectives is stored in the program participant database (PPD) and the meter data database (MDD).

Figure 1. MV&E Plan Flowchart



If selecting samples is necessary, information in the PPD will help and will be used for satisfying qualitative aspects of the MV&E objectives. Information in the MDD will be used to answer quantitative questions about demand savings. Information about all program participants will be in the PPD

Statistical Analysis

Data from both the sampled sub-population and the entire set of program participants will be used to address each of the questions listed in the MV&E objectives. If required a suitable sampling regime will be applied to data in the PPD so that pre-established 80/20 criteria are satisfied.

Demand savings calculations for each of the four contractor programs will be computed by one or more methods depending on the type of program and the available data. Using suitable techniques, the results obtained from a limited number of samples within the population will be generalized to describe the overall program population.

Suitable demand savings calculations will be performed with available aggregated meter data from each of the sampled participants. The demand savings is the difference between actual usage during curtailment or pilot test event and a baseline curve. The baseline curve is calculated in different ways depending on the type of curtailment signal and data availability. This is discussed in more depth in the following sections.

Method for Analysis of Peak Demand Savings

As described in Table 2 above, there are two basic categories of demand responsive curtailment signals each requiring a different methodology for the evaluation of demand savings.
In SMUD's 3-tiered TOU rate schedule, non-critical signals are retail price signals assigned to specific weekdays hours. The demand savings from critical signals will be in added to those resulting from non-critical signals. Verification of demand savings from critical and non-critical curtailment signals within SMUD's TOUR and TOUN programs will be measured separately.

Method for Calculation of Demand Savings from Critical Signals

The analysis of peak demand savings to critical signals consists of the difference between the aggregated curtailed loads and baseline average loads. Depending on the type of critical curtailment event, demand savings for a particular event may be calculated by Equation (1).

How demand savings is measured is illustrated in Figure 2 below, where the shaded area represents demand savings in curtailed energy use (kWh), which can be converted to average demand savings (kW) within the curtailment event period.

(1) Demand Savings = Baseline Demand – Actual Demand

Equation (2) provides the formula for the calculation of the average demand savings over the curtailment period. The demand savings evaluation period is referred to as the event period and it is based on the actual start and end times of discreet curtailment events as triggered by critical curtailment signals.

$$(2) \qquad kW_{saved} = \frac{\sum_{StartTime.}^{EndTime.} kW_{Baseline} - \sum_{StartTime.}^{EndTime.} kW_{Event}}{EventPeriod}$$

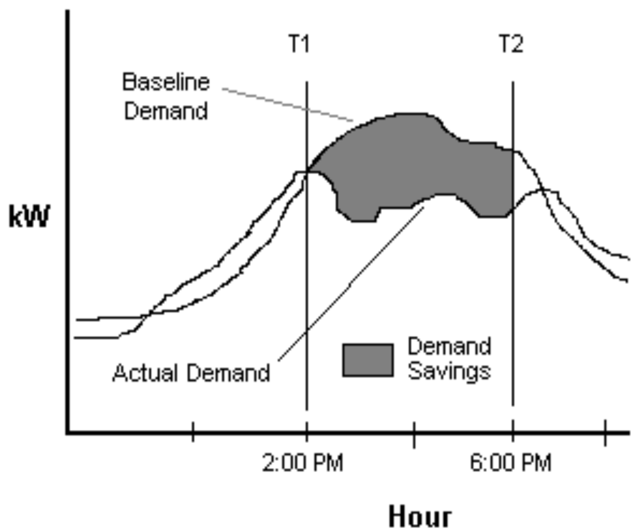
Where:

StartTime	=	Start time of the event period
EndTime	=	End time of the event period
EventPeriod	=	The Demand Savings Evaluation Period; the difference in hours between End Time and Start Time of curtailment signals.
kW_{saved}	=	Average kW demand savings over the event period.

When hours of the event period from a critical curtailment signal are not specified, Nexant will assume that the summer peak demand period is defined as start and stop times are 2:00 PM start to 6:00 PM stop on non-holiday weekdays.

3.4.7 A key component of Equation (2) is the availability of the baseline load demand profile. For critical curtailment signals demand savings will be calculated using two different baseline methods which will be subject to the availability of facility level 15-minute interval meter data.

Figure 2. Illustration of Demand Savings



CAISO Baseline

The CAISO will be used when program administrators have not used any method for adjusting reported demand savings for ambient temperatures

When applied to critical curtailment signals, the CAISO baseline method is used to compile an aggregate or average 24-hour daily load profile for the entire program population or a sampled sub-population in a manner that approximates the current seasonal patterns of building energy use. Each 15-minute baseline demand value is calculated by averaging the daily energy demand values within the same 15-minute time intervals occurring within five to ten previous consecutive, non-holiday, non-curtailed weekdays, prior to the event day.

The CAISO baseline method is vulnerable to daily variability in residential loads caused by temperature changes. Therefore where CAC systems are included in load reductions this method may incorrectly assign demand values for a curtailment event if event day temperatures are significantly different than the average of the other baseline days.

Nexant's Temperature Adjusted Baseline

Nexant's temperature-load adjusted (TLA) baseline method is applied only to analysis of demand savings resulting from critical curtailment signals, and only for facilities which include CAC systems in their curtailments. This TLA method is based on the CAISO baseline technique described above but includes the effects of ambient temperatures on building loads. Because summer peak load at many facilities is the result of increased air-conditioning loads, ambient temperatures can significantly affect the total demand and the demand savings during a critical curtailment. The Nexant TLA method may be summarized as follows:

- Calculate the CAISO baseline.
- Normalize all load values in the baseline curve of Equation (1) by dividing by the maximum average daily load value such that the normalized baseline load profile has a maximum value of 1.0, and all other load values are expressed as a proportion of the maximum demand value.
- Scale the curve in Equation (2) by multiplying each value on the curve by the average load value in the hour prior to initiation of the critical curtailment event. This scaled curve is the temperature load adjusted baseline curve.

This creates a proportional shift in the CAISO baseline curve to reflect actual load conditions on the event day. This adjustment provides a more accurate load value at the starting point of a curtailment from which load reductions are measured. The TLA baseline allows the relationship between outdoor temperatures and CAC loads to be indirectly incorporated thereby providing a more accurate assessment of absolute load reductions triggered by critical curtailment signals.

Calculation Method for Demand Savings from Non-Critical Signals

The method for evaluating demand savings for the SMUD TOUR and TOUN programs requires analysis of load reductions stemming from non–critical curtailment signals in three fixed TOU pricing blocks. TOU prices are intended to promote load shifting by program participants during peak periods using home energy systems that are provided as a part of TOUR and TOUN program. Demand savings will likely become a learned behavior because program participants will probably experiment with their energy control systems for some time before the system is fully programmed, and levels of household demand is stabilized.

Establishing a CAISO baseline in this program is slightly problematic because it would require participants to refrain from experimenting with their energy systems for 10 business days while baseline data is recorded. It is not known how long experimentation may last before participants make their final system modifications. Since this analysis of non-critical signals is not straightforward and taking budgetary and time constraints into consideration, the following method to measure demand savings due to non-critical curtailment signals has been developed.

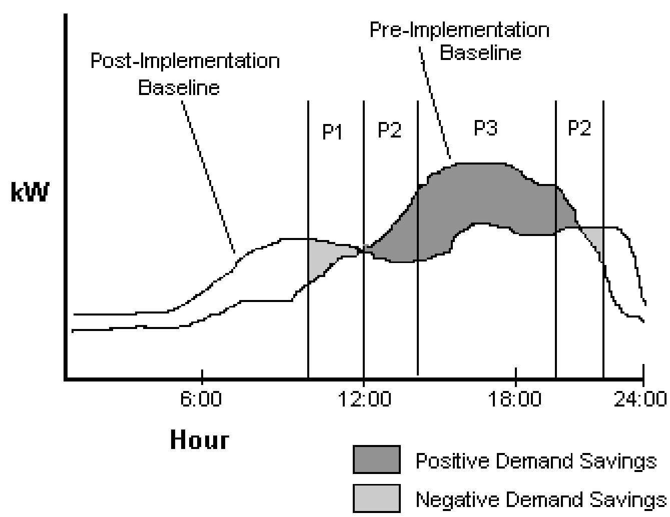
For the analysis of demand savings from non-critical curtailment signals, program administrators will be asked to provide a 5 to 10-day aggregated baseline load profile for the entire population or a sampled sub-population. This load profile is similar to a CAISO baseline used for analysis of curtailments from critical signals because it is aggregated across all participants or a sampled sub-population. This load profile will be used as a *pre-implementation baseline*. It will show daily weekday patterns of residential energy use prior to implementation and participant response to SMUD's non-critical signals.

Nexant will coordinate with SMUD to determine the appropriate duration for program implementation and participant experimentation responses to TOU rates structures. After the implementation period has ended, an aggregate, *post- implementation baseline* will be generated for the same population or sampled subpopulation, as defined by the pre-implementation baseline. If SMUD is unable to provide a post-implementation baseline as described here, an alternative will be used. This is described in the MV&E section "Alternative Method for Evaluation of Demand Savings from Non-Critical Signals".

When comparing the pre-and post-implementation baselines, demand savings will be calculated as in Equation (3). Figure 3 below, provides a illustrated example of the method indicated in Equation (3):

(2) Demand savings = Pre-implementation demand – Post-implementation demand

Figure 3. Illustration of Demand Savings with Non-critical Curtailment Signals



In Equation (4) below, demand savings will be measured within each of SMUD's rate blocks. It is expected that there will be 15-minute intervals within each TOU block that reveals either positive or negative demand savings, as suggested in the example of Figure 3. Nexant will report demand savings within each TOU block and add demand savings across all three, rate blocks. The shaded area in Figure 3 represents demand savings in curtailed energy use (kWh), which can be converted to average demand savings within each of the TOU rate block periods. It is assumed that demand savings in the third rate block (P3) will be the single most important time period for realizing and reporting demand savings because it includes peak demand period hours of 2:00 PM to 6:00 PM.

$$(4) \qquad kW_{saved} = \frac{\sum_{StartTime.}^{EndTime.} kW_{\Pr e-implementation} - \sum_{StartTime.}^{EndTime.} kW_{Post-implementation}}{TOUBlockPeriod}$$

Where:

StartTime	=	Start time of the TOU block period
EndTime	=	End time of the TOU block period
TOUBlockPeriod	=	The Demand Savings Evaluation Period; the difference in hours between End Time and Start Time of the TOU block period.
kW_{saved}	=	Average daily kW demand savings over the TOU block period.

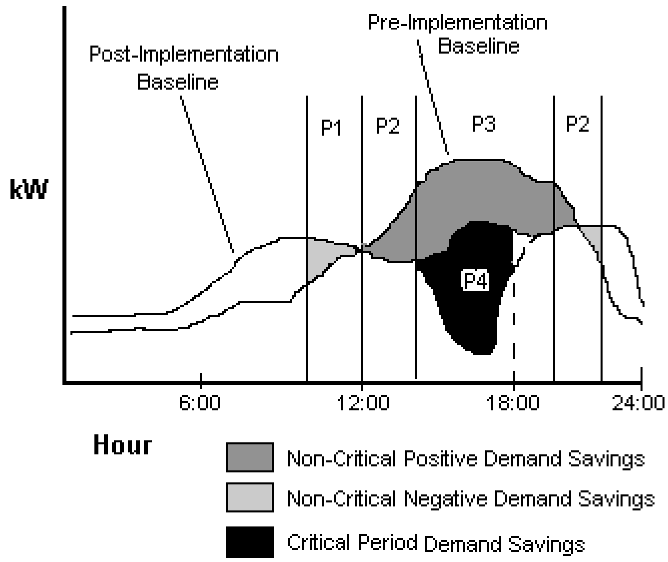
Any curtailments resulting from signals for SMUD's critical period--the fourth TOU rate block-will be measured separately from the non-critical signals associated with the three fixed TOU rate blocks as explained above in "Method for Calculation of Demand Savings in Critical Signals". If the signal for the critical period is issued in the post-implementation period of the three fixed TOU Rate blocks, the post-implementation baseline will be used for measuring demand savings within the critical period (P4) according to equation (5), below, and as illustrated in the example of Figure 4.

$$(5) \qquad kW_{saved} = \frac{\sum_{StartTime.}^{EndTime.} kW_{Post-implementationBaseline} - \sum_{StartTime.}^{EndTime.} kW_{P4Event}}{P4EventPeriod}$$

Where:

StartTime	=	Start time of the "critical period" (P4)
EndTime	=	End time of the "critical period" (P4)
P4EventPeriod	=	The Demand Savings Evaluation Period; the difference in hours between End Time and Start Time of critical period (P4).
kW_{saved}	=	Average kW demand savings over the event period.

Figure 4. Illustration of Demand Savings from Simultaneous Critical and Non-Critical TOU Curtailment Signals



Alternative Method for Evaluation of Demand Savings from Non-critical Signals

In the event that actual load profile data is not available for the pre and post-implementation periods an alternative method will be applied. This method relies upon external price elasticity data obtained from literature on similar programs in the United States. An emphasis will be placed on obtaining price elasticity data from programs operating within similar demographic and climatic service territories as SMUD's. Price elasticity values will only be used for to predict changes in residential demand resulting from non-critical price signals associated with SMUD's TOU rate structure.

The steps of the alternative method are as follows:

1. Obtain a seasonal weekday load profile from SMUD that is representative of the residential program population (Figure 5-A).

2. Scale the seasonal weekday load profile to the approximate levels of demand for the TOUR and TOUN program populations.

3. Group the time periods of the load profile according to the three TOU time blocks to be implemented within the programs. Evaluate kWh usage within each time period of TOU block (Figure 5-B).

4. Research and apply appropriate price elasticity values to changes in prices occurring within each TOU block to obtain predicted change in kWh usage (Figure 6-A).

5. Convert predicted kWh usage values for each TOU block to average demand (kW) values (Figure 6-B).

6. Evaluate demand savings by calculating differences between demand values of the representative seasonal load profile and the predicted average loads in each TOU block (Equation 4 above).

Figure 5. Illustration of Pre-implementation Demand and Energy Use

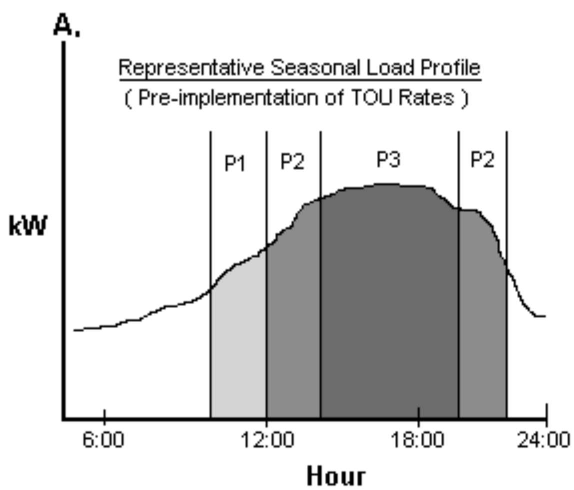
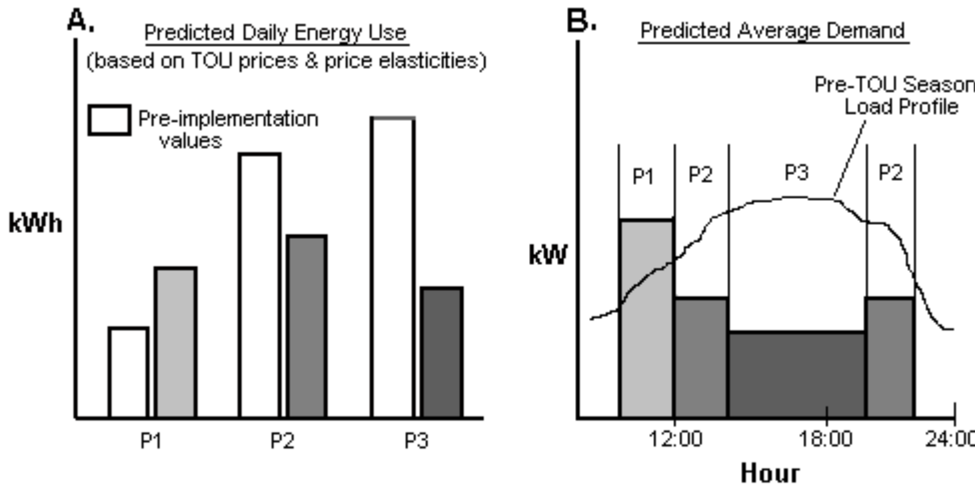


Figure 6. Illustration of Predicted Post-implementation Energy Use and Average Demand



While this alternative method is limited by the absence of actual measured data from program participants an advantage to it is that it can be used to predict expected shifts in residential demand from adjustment made to prices within the TOU blocks.

If actual pre and post-implementation baselines are available from SMUD, price elasticity for the TOUR and TOUN programs could be calculated through adaptations of this method. Actual price elasticity for the TOUR and TOUN programs could be applied for the purpose of more accurately predicting change in demand from changes in TOU Rates.

Table 5 summarizes the MV&E approach to each of the four programs within this sub-element. It also identifies the baseline methods and the data requirements for the successful implementation of each case.

Table 3. MV&E Approaches

Program administrator and program	Baseline	Data required for demand savings calculation
SMUD--TOUR	**For critical signals--** CAISO baseline, Nexant's TLA baseline **For non-critical signals--** Nexant's method for pre- and post-implementation baselines, or alternative method using representative load profiles	**For critical signal--** Aggregate 15-minute interval kW usage data for previous 10 consecutive, non-holiday, non-event day weekdays. Aggregate 15-minute interval kW usage data for event days associated with "critical period" TOU signals. **For non-critical signals--** Aggregate 15-minute interval kW usage data for 10 consecutive, non-holiday, non-event, pre-implementation days. Aggregate 15-minute interval kW usage data for 10 consecutive, non-holiday, non-event, and post-implementation days.
--TOUN	**For critical signals:** same as TOUR **For non-critical signals** :same as TOUR	**For critical signals:** same as TOUR **For non-critical signals:** same as TOUR
--RCTP	CAISO baseline, Nexant's TLA Baseline Method	Aggregate 15-minute interval kW usage data for previous 10 consecutive, non-holiday weekdays. Aggregate 15-minute interval kW usage data for event days.
Energyn--EGYN	CAISO baseline, Nexant's Load Adjusted Baseline Method	Same as SMUD--RCTP

REALIZATION RATES

The realization rate is a percentage that is used to indicate how successful a project or program is. A realization rate of 100% indicates that program administrators provided accurate values for the demand savings achieved. The percentage is calculated by taking the Nexant verified savings number and comparing it with savings reported by the program administrator. In sub-element 4, a single program realization rate will be calculated as an aggregate figure for each implementation program based on data from either the entire program population or a sampled sub-population.

Mathematically, the realization rate is defined as:

(5) $$Realization\ Rate = \frac{VerifiedPeakDemand\ Savings, kW}{\mathrm{Re}\,portedDemand\ Savings, kW} X100\%$$

If baseline and curtailed load data is available for the entire population, greater accuracy will available for the program realization rates. When peak demand savings verification is only possible from sampling the realization rate is calculated for a sub-population sample, which is then used to infer levels of demand savings obtained by the entire population. In this case, the realization rate is used as a normalized measure of project success extrapolated to all projects, subject to the limitations on statistical accuracy imposed by measurement error, sample size and other parameters.

PILOT TEST RESULTS VERIFICATION

Pilot tests are not required as part of this sub-element. However, participants are required to demonstrate their demand savings in response to critical curtailment signals. Pilot tests are not possible for evaluating non-critical curtailment signals. If pilot tests are conducted, Nexant will perform demand savings calculations and make the results available to the CEC.

Evaluation of pilot test may entail calculation of verified potential peak demand savings for a sample set of participating facilities, whereby an extrapolation of these results will be applied to the entire population. All demand savings calculations will be done according to the methods presented in this MV&E plan.

CURTAILMENT ANALYSIS

Measurement of demand savings from critical signals occurring on curtailment days will follow the same procedure as for pilot tests. From a MV&E point of view, there is no difference between a pilot test and a curtailment in terms of the method of calculation for demand savings for individual participants responding to critical curtailment signals.

Demand savings due to critical signals may be calculated by use of the CAISO or TLA baseline methods described above. Curtailment analysis will not include evaluation of demand savings stemming from non-critical curtailment signals because these are not dynamic curtailment signals.

PROGRAM PARTICIPANT AUDITS

The program participant audit will be performed to determine whether participants complied with program requirements. This includes correct, on time installation of DR equipment; confirmation of pilot test actions; comparisons of reported demand saving figures; and how CEC allocated funds were spent. It is expected this audit will provide a vehicle for supplemental questions to help answer some of the research questions identified in the MV&E objectives.

Facilities participating in these audits will be selected at random. Audit questionnaires will preliminarily be conducted by phone. In cases where anomalies are found or data is considered suspect, site visits will be conducted for up to 25% of audits.

PROGRAM ADMINISTRATOR AUDITS

To help the CEC evaluate program administrators, Nexant will conduct an audit. This audit will measure and record the effectiveness of each program administrator. Criteria for examination include the confirmation of:

- The number of participants recruited by a set date for contractors
- Project equipment was ordered and installed on-time
- On-time execution of pilot tests and reporting of net demand savings over all program participants and
- Allocated CEC funds were appropriately spent

All program administrators will participate in this process by telephone. In cases where anomalies are discovered, or data is considered to be suspect, site visits will be conducted for up to a 33% of the program administrators.

Similar to the program participants audits, the program administrator's audits will be used to help answer some of the qualitative questions identified in the MV&E objectives.

MV&E PLAN IMPLEMENTATION

As in Figure 1, above, the MV&E process involves collection of information about participants and their meter data, data analysis and verification of demand savings. Since there are a large number of participants and 15-minute interval data will not be available at all participating sites, a statistical method will be applied to achieve the objectives of this MV&E plan. The implementation of this plan as in Figure 1 and described below. Table 4 presents a summary of the MV&E method used to satisfy each objective.