# APPENDIX TO: Evaluation Measurement and Verification of the California Public Utilities Commission HVAC High Impact Measures and Specialized Commercial Contract Group Programs

2006-2008 Program Year

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### Res RCA DEER Parameter Data Collection

| DEER Parameter | Data Collection |
|---|---|
| CTZ - California Thermal Zone | Observed |
| Vintage | Surveyed |
| Total Floor Area | Measured |
| Number of Stories | Observed |
| Occupants | Surveyed |
| Roof Type | Observed |
| Floor Type | Observed |
| Cathedral Ceiling Area | Measured |
| Wall Insulation (Total) | Not Collected |
| Glass Area (% floor) | Measured |
| Vertical Fenestration U-Factor | Lookup from observations |
| Vertical Fenestration SHGC | Lookup from observations |
| Cooling Capacity (tons) | Observed/ Lookup from Model# |
| Cooling SEER | Look-up From Model # |
| Heating HSPF | Look-up From Model # |
| Heating AFUE | Look-up From Model # |
| Gas Heating Capacity (kBtu) | Observed |
| Elec Heating Capacity (kBtu) | Observed |
| Ceiling Insulation (Gas) | Measured |
| Ceiling Insulation (Elec) | Measured |
| Cathedral Insulation (Gas) | Lookup from observations |
| Cathedral Insulation (Elec) | Lookup from observations |
| Duct DeltaT | Not Collected |
| Duct Leakage | Not Collected |
| AC performance mapped data set | Measured/Obtain From Manuf. |
| HP performance mapped data set | Measured/Obtain From Manuf. |
| Infiltration Air Changes Per Hour | Not Collected |
| Ground Floor (over crawl spc) Overall R-val | Measured |
| Thermostat Settings | Surveyed |

## C&I RCA DEER Parameter Data Collection

| DEER Parameter | Data Collection |
|---|---|
| Building Type | Observed |
| Total Area | Measured |
| Vintage | Surveyed |
| Area Served | Measured/Plans |
| Floors | Measured/Plans |
| # Bldgs | Measured/Plans |
| Aspect Ratio | Measured/Plans |
| Floor to Floor Height | Measured/Plans |
| Floor to Ceiling Height | Measured/Plans |
| Perim Zone Depth | Measured/Plans |
| WWR | Measured/Plans |
| Glass Properties | Lookup from observations |
| Ext Wall Construction | Observed/Plans |
| Roof Construction | Observed/Plans |
| Int Shading | Observed/Plans |
| Weekly Occupancy | Surveyed |
| Occupied Dates | Surveyed |
| Cooling Setpoint | Surveyed |
| Heating Setpoint | Surveyed |
| System Type | Measured |
| Alternative System Type | Measured |
| Cooling Type | Measured |
| # Chlrs | Measured |
| Heating Type | Measured |
| Alternative Heating Type | Measured |
| Cooling Efficiency | Look-up |
| Heating Efficiency | Look-up |
| Economizer | Observed/Plans |
| Cool Reset | Surveyed |
| Heat Reset | Surveyed |
| CHW Valve | Plans |
| HW Valve | Plans |
| Fan Control | Plans |
| Design Duct DT | Plans |

## Res AC Replacement DEER Parameter Data Collection

| DEER Parameter | Data Collection |
|---|---|
| CTZ - California Thermal Zone | Observed |
| Vintage | Surveyed |
| Total Floor Area | Measured |
| Number of Stories | Observed |
| Occupants | Surveyed |
| Roof Type | Observed |
| Floor Type | Observed |
| Cathedral Ceiling Area | Measured |
| Wall Insulation (Total) | Not Collected |
| Glass Area (% floor) | Measured |
| Vertical Fenestration U-Factor | Lookup from observations |
| Vertical Fenestration SHGC | Lookup from observations |
| Cooling Capacity (tons) | Observed/ Lookup from Model# |
| Cooling SEER | Look-up From Model # |
| Heating HSPF | Look-up From Model # |
| Heating AFUE | Look-up From Model # |
| Gas Heating Capacity (kBtu) | Observed |
| Elec Heating Capacity (kBtu) | Observed |
| Ceiling Insulation (Gas) | Measured |
| Ceiling Insulation (Elec) | Measured |
| Cathedral Insulation (Gas) | Lookup from observations |
| Cathedral Insulation (Elec) | Lookup from observations |
| Duct DeltaT | Not Collected |
| Duct Leakage | Not Collected |
| AC performance mapped data set | Measured/Obtain From Manuf. |
| HP performance mapped data set | Measured/Obtain From Manuf. |
| Infiltration Air Changes Per Hour | Not Collected |
| Ground Floor (over crawl spc) Overall R-val | Measured |
| Thermostat Settings | Surveyed |

## C&I AC Replacement DEER Parameter Data Collection

| DEER Parameter | Data Collection |
|---|---|
| Building Type | Observed |
| Total Area | Measured |
| Vintage | Surveyed |
| Area Served | Measured/Plans |
| Floors | Measured/Plans |
| # Bldgs | Measured/Plans |
| Aspect Ratio | Measured/Plans |
| Floor to Floor Height | Measured/Plans |
| Floor to Ceiling Height | Measured/Plans |
| Perim Zone Depth | Measured/Plans |
| WWR | Measured/Plans |
| Glass Properties | Lookup from observations |
| Ext Wall Construction | Observed/Plans |
| Roof Construction | Observed/Plans |
| Int Shading | Observed/Plans |
| Weekly Occupancy | Surveyed |
| Occupied Dates | Surveyed |
| Cooling Setpoint | Surveyed |
| Heating Setpoint | Surveyed |
| System Type | Measured |
| Alternative System Type | Measured |
| Cooling Type | Measured |
| # Chlrs | Measured |
| Heating Type | Measured |
| Alternative Heating Type | Measured |
| Cooling Efficiency | Look-up |
| Heating Efficiency | Look-up |
| Economizer | Observed/Plans |
| Cool Reset | Surveyed |
| Heat Reset | Surveyed |
| CHW Valve | Plans |
| HW Valve | Plans |
| Fan Control | Plans |
| Design Duct DT | Plans |

## Duct Sealing DEER Parameter Data Collection

| DEER Parameter | Data Collection |
|---|---|
| CTZ - California Thermal Zone | Observed |
| Vintage | Surveyed |
| Total Floor Area | Measured |
| Number of Stories | Observed |
| Occupants | Surveyed |
| Roof Type | Observed |
| Floor Type | Observed |
| Cathedral Ceiling Area | Measured |
| Wall Insulation (Total) | Not Collected |
| Glass Area (% floor) | Measured |
| Vertical Fenestration U-Factor | Lookup from observations |
| Vertical Fenestration SHGC | Lookup from observations |
| Cooling Capacity (tons) | Observed/ Lookup from Model# |
| Cooling SEER | Look-up From Model # |
| Heating HSPF | Look-up From Model # |
| Heating AFUE | Look-up From Model # |
| Gas Heating Capacity (kBtu) | Observed |
| Elec Heating Capacity (kBtu) | Observed |
| Ceiling Insulation (Gas) | Measured |
| Ceiling Insulation (Elec) | Measured |
| Cathedral Insulation (Gas) | Lookup from observations |
| Cathedral Insulation (Elec) | Lookup from observations |
| Duct DeltaT | Not Collected |
| Duct Leakage | Not Collected |
| AC performance mapped data set | Measured/Obtain From Manuf. |
| HP performance mapped data set | Measured/Obtain From Manuf. |
| Infiltration Air Changes Per Hour | Not Collected |
| Ground Floor (over crawl spc) Overall R-val | Measured |
| Thermostat Settings | Surveyed |

# B. Investigated RCA Analysis Methods

## Introduction

Ultimately, the airside estimates provided the most repeatable method for deployment on the planned samples. The evaluators developed a matrix of the implementation plan and how measurements relate to the various analysis options. The emphasis of developing and presenting the matrix to the CPUC Energy Division was on finalizing the evaluation plan while leaving open the discussions of detailed analysis methodologies. To support this effort, the evaluators simulated a range of heat loss assumptions for the simplest approach which showed reasonable uncertainties even with the assumption being the major unknown. Additional work was done with an uncertainty committee to look into techniques for simulating uncertainty with Monte Carlo techniques for uncertain measurement that then fed into a model with its own level of uncertainty. Also the evaluators and working groups investigated the availability and uncertainties of modeling, maps and their adjustment factors. The matrix is presented with the key at the top in Table B-1, with the green highlighted cells absolutely required of all methods and the orange highlights representing the more difficult to measure items. The yellow highlighted cells indicate that we are still exploring those uncertainties.

There was agreement that the Simple COP using the Assumed Heat Loss method was feasible while exploring the other methods using pilot data. The regression option remained feasible while compressor maps and simulations had low feasibility due to unknown adjustment factors and unknown heat exchanger details. We collected enough data from the pilots to attempt all methods, but the full scale effort could only include a subset of the measurements required for less feasible analysis options.

**Table B-1: Bi-Quadratic DOE-2**

| Part of Verification | Measurement | Uncertainty | Simple COP, Assume Heat Loss | Compressor Map | Change in COP regression vs. Ambient dry bulb | Refrigerant Cyle Simulation |
|---|---|---|---|---|---|---|
| | | **Feasibility** | OK | LOW | OK | LOW |
| | | | 2-4% Evaluator, 5-10% Cal_Con, 10-25% Worst | 5% map ?adj fac | 5-15% f(sample) | 3-10% model ?adj HX |
| Y | Electric Power Input | 1% | R | R | R | R |
| | | | | | | |
| Y | Evaporator Flow | 7%-15% | O/P | O/P | O/P | R |
| Y | Supply T | 1% | O/P | O/P | O/P | O/P |
| Y | Return T | 1% | O/P | R | R | R |
| Y | Supply RH | 3.0% | O/P | O/P | O/P | O/P |
| Y | Return RH | 1.5% | O/P | R | R | R |
| | | | | | | |
| Y | High Pressure | 1% | R | R | O/P | R |
| Y | Low Pressure | 1% | R | R | O/P | R |
| Y | Suction T | 1% | R | R | O/P | R |
| Y | Liquid Line T | 1% | R | R | O/P | R |
| O/P | Discharge T | 1%-10% | R | O/P | O/P | O/P |
| | | | | | | |
| O/P | Condenser Flow | 4%-7% | O/P | O/P | O/P | O/P |
| Y | Condenser In T | 1% | R | R | R | R |
| Y | Condenser Exit T | 1% | O/P | O/P | O/P | O/P |
| O/P | Condenser Ext RH | 1.5% | O/P | O/P | O/P | O/P |
| O/P | Condenser In RH | 1.5% | O/P | O/P | O/P | O/P |

**KEY** **R = Required** **O/P = Optional and included at pilots**

The following describes three methods for estimating AC system efficiency considered but not pursued for the final data analysis: simple COP, compressor map, and refrigerant cycle simulation.

# Simple COP (Assumed Compressor Heat Loss)

This approach used a simplified energy balance across the compressor. The overall equation simplifies to the following:

**Equation B-1: Mass Flow Rate Equation**

$$\dot{m} = \frac{W - f}{\Delta h}$$

Where $\dot{m}$ is the mass flow rate, f is the heat loss from the compressors (and can be assumed to be 2-10% of compressor power input, $W$ ), and $\Delta h$ is the enthalpy difference of the refrigerant before and after it goes through the compressor. Enthalpy values can be obtained based on the temperature and pressures at the suction and liquid lines. An overall mass flow rate can be determined from these parameters.

Some commercially available refrigeration system analyzers use this simple energy balance across the compressor to determine efficiency[1]. This is achieved by assuming the heat loss from the compressor as a percentage of the electrical input power. The heat loss assumption is typically in the range of 2-10% and may be chosen as 7% for hermetic and semi-hermitic air cooled systems. By taking temperature and pressure measurements of the refrigerant entering and leaving the compressor along with simultaneous power measurements, one can estimate the system mass flow rate. The approach is most effective for systems with easily accessible compressors which is not typical for residential split systems and may require removing the condenser fan, installing the temporary sensor and re-installing the fan. This raises additional liability and warranty issues and for some older split systems the fan grill may be riveted to the case preventing access altogether. Infrared measurements may be feasible for some configurations but with lower accuracy than other measurements being simultaneously recorded and additional issues of poor view angles even when distance and line of sight are good. Newer larger systems, especially SEER13 and R-410a systems may have access to the compressor more typical of packaged systems. The heat loss assumption will be investigated further for scroll compressors and two stage compressors.

## Compressor Map

A second method to determine the mass flow rate is by using compressor maps as published by their manufacturers. This data is specified by ANSI/ARI standard 540. The maps have data on the compressors that describes the equations for mass flow rate and are of the form:

**Equation B-2: Map Coefficients Equation**

$$M(T_S,T_D) = C_1 + C_2T_S + C_3T_D + C_4T_S^2 + C_5T_DT_S + C_6T_D^2 + C_7T_S^3 + C_8T_DT_S^2 + C_9T_ST_D^2 + C_{10}T_D^3$$

[1] Klas Berglöf. The use of field measurement equipment with integrated analyzing function as a mean to detect leaks and optimize efficiency. Berglöf Refrigeration Technology Ltd, Nysätravägen 24, S-131 33 Nacka, Sweden, Filename: Paper%20Zero%20leakage.pdf.

*Where C1 - C10 are the map coefficients, TS & TD are the compressor suction & discharge saturation temperatures (°F), and M is the mass flow rate as a function of its TS & TD.*

Given the refrigerant operating pressures, we can determine from compressor maps the efficiency, capacity, power draw, and even amps to within five percent of manufacturer specifications which is the specified accuracy of the maps established by ANSI/ARI Standard 540. The maps also gave us refrigerant mass flow rate from the operating pressures, by using the flow rates and the operating temperatures we estimated capacity and compared the map values. By adding a spot power measurement, we calculated an operating COP and also compared to manufacturers rated COP for those operating conditions according to the performance map. The ease of compressor identification and availability of documentation was adequate for units manufactured after 1992 and poor for older units. Units after 1992 also have manufacturer literature on superheat adjustment factors for the maps at different superheat conditions. When pressures, temperatures, and power input were monitored over varying ambient conditions, ARI Standard 540 was also used to generate new performance maps. There are superheat adjustment factors at least for some for some compressors at different levels, although for TXV systems we did not come across any adjustment factors for different subcooling conditions.

## Simulation Modeling

A third analysis option involved inputting the system through a simulation model such as NIST Cycle D or Oak Ridge National Lab Mark V programs. These models have built in compressor maps though user specified mapping is an available option. The user inputs system characteristics as measured or identified in the field collection phase. The program was able to simulate a vapor compression cycle and calculate a mass flow rate based on these user inputted specifications.

The background development for the Mark V model was also included in the collection of reference material. The primary challenge in using these models was the lack of known or observable information on heat exchanger designs. It was feasible to develop prototype models in one of these software packages and calibrate them to field measured data. These models allowed for the use of default or user specified compressor maps. The models also presented errors themselves beyond the compressor maps they were based on. Based on comparisons to field data, the models themselves may have uncertainties on the order of +/- 3-10%.

# C. RCA Diagnostic Calculations

The program, Title 24, and industry standard procedures are consistent and are used by the verification team. Target superheat or subcooling values are obtained from manufacturer's data or calculated from the 2005 Residential ACM Approval Manual and compared to actual values. The procedure for calculating actual subcooling and superheat is as follows:

1. For Non-TXV systems determine the evaporator saturation temperature ($T_{evap,\ sat}$) from ASHRAE saturation tables for the measured suction pressure. For TXV systems use the measured discharge pressure to determine condenser saturation temperature ($T_{cond,\ sat}$).
2. Calculate the Actual Superheat or Subcooling for Non-TXV and TXV systems, respectively. This is calculated as follows:

$$\text{Actual Superheat} = T_{suction} - T_{evap,\ sat}$$

$$\text{Actual Subcooling} = T_{cond,\ sat} - T_{discharge}$$

3. Determine the Target Superheat or Subcooling for Non-TXV and TXV systems, respectively.
4. Calculate the difference between actual and target values as follows:

Actual Superheat – Target Superheat

Actual Subcooling – Target Subcooling

5. Non-TXV systems: If the absolute value of the difference is less than or equal to 5 the system is considered to be adequately charged.
   a. If the difference is greater than 5, the system is likely undercharged.
   b. If the difference is less than -5, the system is likely overcharged.
6. TXV systems: If the absolute value of the difference is less than or equal to 3 the system is considered to be adequately charged.
   a. If the difference is greater than 3, the system is likely overcharged.
   b. If the difference is less than -3, the system is likely undercharged.

Additional post-field analysis includes using the superheat and subcooling calculations along with pressure and airflow data to determine additional outcomes indicating other potential system issues such as insufficient evaporator or condenser flow, improper TXV operation, etc.

The program requires airflow verification similar to Title 24. The actual temperature split between supply and return dry bulb is calculated as shown in the steps below and compared against the target split as outlined in the 2005 Residential ACM Approval Manual. The method essentially verifies that flow is greater than 350cfm/ton for a large percentage of units based on empirical data.

1. Calculate the Actual Temperature Split as follows:

$$\text{Actual Temperature Split} = T_{return,\ db} - T_{supply,\ db}$$

2. Determine the Target Temperature Split using the appropriate tables from the 2005 Title 24 Residential ACM.
3. Calculate the difference between the actual and target values as follows:

Actual Temperature Split – Target Temperature Split

4. If the absolute value of the difference is less than or equal to 3 than the system has adequate airflow.
    a. If the difference is greater than 3, the airflow is too low.
    b. If the difference is less than -3, it is unlikely that the airflow is too high. Most likely the capacity is low on the system.

In addition the verification effort will utilize direct flow measurements using an orifice plate flow grid and digital manometer. The temperature split method verifies that most systems have flow greater than 350cfm/ton, but we require flow measurements for evaluation purposes as well as later comparison to DEER values.

# D. RCA Details of Metered Units

**Table D-1: Service Performed on Units with No Refrigerant Charge Adjustment**

| Unit | Service Performed by Contractor |
|---|---|
| SCEPP-10-01-12 | Condenser coil cleaning. |
| SCEPP-10-01-13C1 | Condenser coil cleaning. |
| SCEPP-10-01-13C2 | Condenser coil cleaning. |
| SCEPP-10-01-14 | Condenser coil cleaning. |
| SCEPP-10-02-01 | Replaced filter, cleaned condenser. |
| SCEPP-10-02-03 | Replaced filter, cleaned condenser. |
| SCEPP-10-02-04 | Replaced filter, cleaned condenser. |
| SCEPP-10-02-06 | Replaced filter, cleaned condenser. |
| SCEPP-15-01-01 | unknown |
| SCEPP-15-01-02 | unknown |
| SCEPP-10-03-3C2 | Condenser coil cleaning. |
| SCEPP-10-03-3C3 | Condenser coil cleaning. |
| SCEPP-10-03-5 | Condenser coil cleaning. |
| SCEPP-10-04-1C1 | unknown (condenser coil clean is standard for this contractor) |
| SCEPP-10-04-1C2 | unknown (condenser coil clean is standard for this contractor) |
| SCEPP-10-04-4C1 | unknown (condenser coil clean is standard for this contractor) |
| SCEPP-10-04-4C2 | unknown (condenser coil clean is standard for this contractor) |
| SCEPP-08-01-1C1 | Condenser coil cleaning. |
| SCEPP-08-01-1C2 | Condenser coil cleaning. |
| SCEPP-08-01-6 | Condenser coil cleaning. |
| SCEPP-08-02-2 | unknown |
| SCEPP-08-03-2 | unknown |
| SCEPP-08-04-2 | unknown |
| SCEPP-10-05-2 | unknown (condenser coil clean is standard for this contractor) |

The team also examined the resulting changes in performance as a result of any service noted in the table above. These only occurred for units in SCE 2507 territory. The remaining units in SDGE 3043 experienced a failure event, as noted in Table D-1 above. The results of additional tune up service actions are shown in Table D-2, and show a range of improved and degraded performance as a result of service.

**Table D-2: HVAC Changes Resulting from Non-Refrigerant Charge Service**

| Site | Climate Zone | Tons | Change in EER | Change in Capacity (Btuh) | Energy Savings (kWh) | Peak Demand Reduction (kW) |
|---|---|---|---|---|---|---|
| SCEPP-10-01-12 | 10 | 7 | 2.4 | 6,357 | | 1.82 |
| SCEPP-10-01-13C1 | 10 | 15 | 3.8 | 55,098 | | 0.85 |
| SCEPP-10-01-14 | 10 | 3 | -0.95 | -1,080 | | 0.03 |
| SCEPP-10-02-03 | 10 | 5 | -0.2 | -2,044 | | 0.42 |
| SCEPP-10-02-04 | 10 | 3 | 1.4 | 4,043 | | -0.02 |
| SCEPP-10-02-06 | 10 | 6 | 0.09 | 3,215 | | -0.1 |
| SCEPP-15-01-01 | 15 | 5 | 1.34 | 11,149 | | 0 |
| SCEPP-10-03-3C1 | 10 | 5 | -2.1 | -19,004 | | -0.96 |
| SCEPP-10-03-5 | 10 | 4 | -0.3 | 60 | | -0.31 |
| SCEPP-10-04-1C1 | 10 | 10 | 0.08 | -5,679 | | 5.09 |
| SCEPP-10-04-4C1 | 10 | 7.5 | 1.1 | 7,782 | | 0.46 |
| SCEPP-08-01-6 | 8 | 7.5 | 0.8 | 3,736 | | 0.18 |
| SCEPP-08-02-2 | 8 | 5 | 3.5 | 5,862 | | 0.04 |
| SCEPP-08-03-2 | 8 | 5 | -5.4 | -11,564 | | 0.09 |
| SCEPP-08-04-2 | 8 | 5 | 5.4 | 9,825 | | 0.14 |
| SCEPP-10-05-2 | 10 | 4 | 0.4 | -1,845 | | 0.04 |

# Detailed RCA Field Findings

## Residential Pre- Post RCA

Previous field studies used for the DEER estimates have shown similar non-intuitive trends in the efficiency gain from charge improvements for individual units compared to laboratory tests. This was especially true of the C&I results as well as those units identified in the comment. The values of absolute EER are lower than rated values due to measured airflows being lower than nominal values for units with low nominal EER compared to newer units. Note that all measured EER across HVAC HIMs showed low field operating EER relative to rated efficiencies even considering the uncertainty bands of field measurements relative to laboratory measurements. A few cases showed high EER values beyond the rated efficiency of the units which were the result of lower than expected compressor power draw and ideal cooling performance.

### Multifamily

Arrangements were made to monitor 89 units serving apartments in moderate and hot climates. Of those units, 30 had sufficient data to meet all the criteria for inclusion in the analysis. The addition and removal of charge was recorded along with calculated pre and post cooling outputs and efficiencies below.

## Table D-3: Multifamily Pre-Post Results

| Site / Unit | Status | Tons | Adj % | CFM | Total Capacity | Sensible Capacity | Cooling-Capacity base fraction | Cool-sh-cap base fraction | Cooling-eir base fraction | EER | Metering Device |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SCE-MF-PT248 | Pre | 2 | -14.86% | 662 | 16 | 10.9 | 0.88 | 0.87 | 1.11 | 4.34 | Non-TXV |
| | Post | | | 662 | 18.4 | 12.8 | | | | 4.85 | |
| SCE-MF-PT243 | Pre | 2 | N/A | 802 | 18.9 | 12.5 | 0.87 | 0.86 | 1.11 | 5.52 | Non-TXV |
| | Post | | | 802 | 22 | 14.6 | | | | 6.2 | |
| SCE-MF-PT242 | Pre | 2 | -4.17% | 689 | 16.7 | 12.3 | 0.88 | 0.94 | 1.06 | 5.47 | Non-TXV |
| | Post | | | 689 | 19.2 | 13.1 | | | | 5.9 | |
| SCE-MF-PT238 | Pre | 2 | -4.05% | 645 | 12.2 | 8.6 | 1.14 | 1.05 | 0.74 | 3.39 | Non-TXV |
| | Post | | | 645 | 10.6 | 8.1 | | | | 2.52 | |
| SCE-MF-PT234 | Pre | 2 | 8.45% | 632.5 | 15.2 | 12.2 | 1.04 | 1.09 | 1.01 | 5.95 | Non-TXV |
| | Post | | | 632.5 | 14.6 | 11.1 | | | | 5.95 | |
| SCE-MF-PT233 | Pre | 2 | 18.92% | 623 | 10.7 | 8.5 | 0.64 | 0.73 | 1.37 | 3.18 | Non-TXV |
| | Post | | | 623 | 17.4 | 12.1 | | | | 4.56 | |
| SCE-MF-PT231 | Pre | 1.5 | 44.00% | 665 | 15.7 | 10.7 | 1.01 | 1.44 | 1.04 | 3.8 | Non-TXV |
| | Post | | | 665 | 15.5 | 7.1 | | | | 3.95 | |
| SCE-MF-PT230 | Pre | | 6.76% | 702 | 17.9 | 14.1 | 0.89 | 1.01 | 0.97 | 3.08 | Non-TXV |
| | Post | | | 702 | 20.2 | 13.9 | | | | 3.03 | |
| SCE-MF-PT160 | Pre | 2 | 13.85% | 726 | 20.1 | 15.4 | 1.2 | 1.27 | 0.75 | 7.92 | Non-TXV |
| | Post | | | 726 | 16.6 | 11.9 | | | | 5.97 | |
| SCE-MF-PT151 | Pre | 2 | -4.17% | 805 | 18.2 | 14.8 | 1 | 1.01 | 0.99 | 4.13 | Non-TXV |
| | Post | | | 805 | 18.1 | 14.6 | | | | 4.1 | |
| SCE-MF-PT148 | Pre | 2 | -33.78% | 721 | 15 | 9.7 | 0.71 | 0.8 | 1.51 | 4.28 | Non-TXV |
| | Post | | | 721 | 21.7 | 12.5 | | | | 6.57 | |
| SCE-MF-PT143 | Pre | 1.5 | 18.00% | 798 | 19.3 | 13.4 | 0.93 | 0.89 | 1.01 | 5.57 | Non-TXV |
| | Post | | | 798 | 20.9 | 15.1 | | | | 5.7 | |
| SCE-MF-PT138 | Pre | 2 | 21.54% | 599 | 14.6 | 9.9 | 1.02 | 1.04 | 0.92 | 5.96 | Non-TXV |
| | Post | | | 599 | 14.2 | 9.5 | | | | 5.52 | |
| SCE-MF-PT133 | Pre | 2 | -7.04% | 727 | 12.8 | 10.6 | 1.01 | 1.01 | 0.97 | 4.23 | Non-TXV |
| | Post | | | 727 | 12.7 | 10.5 | | | | 4.1 | |

**Table D-4: Multifamily Pre-Post Results Continued**

| Site / Unit | Status | Tons | Adj % | CFM | Total Capacity | Sensible Capacity | Cooling-Capacity base fraction | Cool-sh-cap base fraction | Cooling-eir base fraction | EER | Metering Device |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SCE-MF-PT131 | Pre | 2 | 38.89% | 690 | 7.5 | 6.5 | 0.31 | 0.44 | 1.75 | 8.1 | Non-TXV |
| | Post | | | 690 | 26.5 | 16.2 | | | | 18.37 | |
| SCE-MF-PT130 | Pre | 2 | 0.1757 | 669 | 14.2 | 10.4 | 0.9 | 0.94 | 1.09 | 4.97 | Non-TXV |
| | Post | | | 669 | 15.9 | 11.1 | | | | 5.47 | |
| SCE-MF-H301 | Pre | 2 | 0.00% | 460.7 | 12.4 | 9.3 | 0.87 | 0.89 | 1.2 | 5.33 | Non-TXV |
| | Post | | | 460.7 | 14.5 | 10.5 | | | | 6.43 | |
| SCE-MF-H311 | Pre | 2 | 0.00% | 406.9 | 10.2 | 8.1 | 0.88 | 1.03 | 1.36 | 3.95 | Non-TXV |
| | Post | | | 406.9 | 11.7 | 7.8 | | | | 5.33 | |
| SCE-MF-H312 | Pre | 2 | -6.38% | 607.2 | 15.9 | 12.3 | 0.86 | 0.8 | 1.24 | 4.65 | Non-TXV |
| | Post | | | 607.2 | 18.6 | 15.5 | | | | 5.79 | |
| SCE-MF-H315 | Pre | 1.5 | -7.87% | 421.5 | 12.1 | 8.7 | 1.07 | 1.05 | 0.93 | 7.62 | Non-TXV |
| | Post | | | 421.5 | 11.3 | 8.2 | | | | 7.08 | |
| SCE-MF-H403 | Pre | 2 | 0.00% | 623.4 | 17.6 | 12.4 | 1.06 | 1.18 | 0.95 | 7.45 | Non-TXV |
| | Post | | | 623.4 | 16.5 | 10.3 | | | | 7.04 | |
| SCE-MF-H405 | Pre | 2 | 9.57% | 576.4 | 16.9 | 12.3 | 0.9 | 1.02 | 1 | 7.56 | Non-TXV |
| | Post | | | 576.4 | 18.8 | 12 | | | | 7.72 | |
| SCE-MF-H409 | Pre | 1.5 | 0.00% | 480.8 | 12.2 | 9.9 | 0.96 | 0.99 | 1.08 | 7.33 | Non-TXV |
| | Post | | | 480.8 | 12.8 | 10 | | | | 7.89 | |
| SCE-MF-CC154 | Pre | 2.5 | 36.07% | 908 | 14.8 | 8.8 | 0.92 | 0.88 | 0.85 | 6.03 | Non-TXV |
| | Post | | | 908 | 16.2 | 10.3 | | | | 5.34 | |
| SCE-MF-CC142 | Pre | 2.5 | 24.14% | 940 | 11.6 | 6.4 | 0.94 | 0.82 | 0.8 | 4 | Non-TXV |
| | Post | | | 940 | 12.4 | 8.1 | | | | 3.34 | |
| SCE-MF-CC161 | Pre | 2 | 28.07% | 635 | 8.7 | 6.4 | 0.84 | 0.82 | 1.15 | 4.3 | Non-TXV |
| | Post | | | 635 | 10.5 | 8 | | | | 5.05 | |
| SCE-MF-CC239 | Pre | 2.5 | 63.79% | 829 | 9.4 | 7.2 | 0.84 | 0.84 | 0.85 | 2.95 | Non-TXV |
| | Post | | | 829 | 11.4 | 8.8 | | | | 2.64 | |
| SCE-MF-CC166 | Pre | 2.5 | 26.05% | 942 | 16.9 | 10.8 | 1.05 | 0.96 | 1.12 | 5.12 | Non-TXV |
| | Post | | | 942 | 16 | 11.2 | | | | 5.56 | |
| SCE-MF-CC241 | Pre | 2 | 25.86% | 595 | 12.3 | 8.6 | 0.97 | 0.91 | 0.75 | 3.65 | Non-TXV |
| | Post | | | 595 | 12.8 | 9.6 | | | | 2.8 | |
| PGE-MF-WL123 | Pre | 3 | 5.81% | 676 | 18.9 | 8 | 1.03 | 0.77 | 1.23 | 3.56 | Non-TXV |
| | Post | | | 676 | 18.2 | 10 | | | | 4.3 | |

## Single Family

The single family homes that were monitored generally had two air conditioning units and were coordinated through the programs in normal operation.  The change in system performance and degradation factors were calculated and shown in Table D-5.

## Table D-5: Single Family Pre-Post Results

| Site / Unit | Status | Tons | Adj % | CFM | Total Capacity | Sensible Capacity | Cooling-Capacity base fraction | Cool-sh-cap base fraction | Cooling-eir base fraction | EER | Metering Device |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SCE-SF-PP01 | Pre | 4 | 0.00% | 1117 | 30.9 | 21.5 | 1.06 | 1.01 | 1.02 | 4.71 | Non-TXV |
| | Post | | | 1117 | 28.9 | 21.2 | | | | 4.75 | |
| SCE-SF-PP02A | Pre | 2.5 | -25.14% | 1111 | 27.9 | 24.3 | 1.01 | 0.99 | 1.01 | 5.26 | Non-TXV |
| | Post | | | 1111 | 27.6 | 24.6 | | | | 5.32 | |
| SCE-SF-PP02B | Pre | 3 | 7.00% | 1274 | 30.4 | 26.3 | 0.86 | 0.83 | 1.13 | 5.18 | Non-TXV |
| | Post | | | 1274 | 35.8 | 32.2 | | | | 5.96 | |
| SCE-SF-PP03A | Pre | 4 | -5.31% | 1180 | 24 | 20.4 | 1.17 | 1.28 | 0.92 | 3.84 | Non-TXV |
| | Post | | | 1180 | 20.2 | 15.6 | | | | 3.46 | |
| SCE-SF-PP05A | Pre | 3.5 | 12.35% | 1442 | 26.1 | 22.2 | 0.86 | 0.88 | 1.02 | 3.86 | TXV |
| | Post | | | 1442 | 30.7 | 25.5 | | | | 4.05 | |
| SCE-SF-PP05B | Pre | 4 | 10.42% | 1381 | 39.4 | 32.5 | 0.84 | 0.82 | 1.17 | 5.12 | TXV |
| | Post | | | 1381 | 47.4 | 40 | | | | 6.05 | |
| SCE-SF-PP06 | Pre | 3 | 4.35% | 917 | 22.1 | 17.9 | 1.05 | 1.01 | 1.03 | 4.31 | Non-TXV |
| | Post | | | 917 | 21 | 17.8 | | | | 4.39 | |
| PGE-SF-PP01 | Pre | 4 | 25.49% | 1097 | 22.8 | 16.9 | 0.75 | 0.73 | 1.24 | 4.96 | Non-TXV |
| | Post | | | 1097 | 31.1 | 23.9 | | | | 6.3 | |
| PGE-SF-PP06 | Pre | 3.5 | -5.21% | 821.6 | 21.9 | 16.1 | 0.89 | 0.97 | 1.12 | 6.77 | TXV |
| | Post | | | 821.6 | 24.8 | 16.7 | | | | 7.65 | |
| PGE-SF-PP07 | Pre | 4 | 0.00% | 1618 | 56 | 39.5 | 1.07 | 1.07 | 1.21 | 11.46 | TXV |
| | Post | | | 1618 | 52.4 | 36.9 | | | | 13.27 | |

### Manufacture / Mobile Homes

The third-party comprehensive manufactured and mobile homes programs were also sampled for the residential RCA high impact measure pre and post monitoring study, in addition to the mass market programs presented above. The results are shown in Table D-6 below.

## Table D-6: Mobile Homes Pre-Post Results

| Site / Unit | Pre/ Post | Tons | Adj % | CFM | Total Capacity | Sensible Capacity | Cooling-Capacity base fraction | Cool-sh-cap base fraction | Cooling-eir base fraction | EER | Metering Device |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SDGE-MH-03 | Pre | 3 | 20.00% | 836 | 23 | 17.1 | 0.98 | 1.11 | 0.98 | 6.01 | Non-TXV |
| | Post | | | 836 | 23.7 | 15.2 | | | | 5.97 | |
| SCE-MH-04 | Pre | 3.5 | -9.41% | 1036 | 18.7 | 16.9 | 1.26 | 1.16 | 0.89 | 4.41 | Non-TXV |
| | Post | | | 1036 | 14.3 | 14.3 | | | | 3.71 | |
| SCE-MH-05 | Pre | 4 | -30.77% | 894 | 24.9 | 21.9 | 0.75 | 0.93 | 1.4 | 5.22 | Non-TXV |
| | Post | | | 894 | 33.8 | 23.7 | | | | 7.4 | |
| SCE-MH-06 | Pre | 3 | 32.05% | 1036 | 18 | 13.2 | 0.64 | 0.52 | 1.33 | 5.47 | Non-TXV |
| | Post | | | 1036 | 29.3 | 27.6 | | | | 7.84 | |
| SDGE-MH-06 | Pre | 3 | 9.64% | 783 | 9.5 | 6.3 | 0.8 | 0.79 | 1.28 | 2.87 | Non-TXV |
| | Post | | | 783 | 12.4 | 8.5 | | | | 3.82 | |
| SCE-MH-07 | Pre | 3 | -35.21% | 810 | 18.1 | 13.5 | 0.8 | 1.17 | 1.43 | 4.66 | Non-TXV |
| | Post | | | 937 | 23.2 | 11.3 | | | | 6.88 | |

## Commercial Pre- Post

Similar to the residential programs, the pre and post metering sample was evaluated on the basis of improvements in EER, capacity, and sensible capacity, as well as demand reduction. The changes in total and sensible capacity and energy input ratio were developed as fractions to represent the pre condition where the factors for the post maintenance case would all be equal to one. Finally the change in efficiency was expressed as the pre and post energy efficiency rating (EER). The data has been divided into two separate tables, the first for dual compressor units (Table D-7) and then for single compressor units (Table D-8).

**Table D-7: Dual Compressor C&I RCA Pre-Post Results**

| Site / Unit | Pre/ Post | Tons | Adj % | CFM | Total Capacity | Sensible Capacity | Cooling-Capacity base fraction | Cool-sh-cap base fraction | Cooling-eir base fraction | EER |
|---|---|---|---|---|---|---|---|---|---|---|
| SCEPP-10-15-01 | Pre | 15 | -5.13% | 5230 | 120.3 | 93.2 | 1.01 | 0.98 | 1.06 | 7.82 |
| | Post | | | 5457 | 119.4 | 95.3 | | | | 8.2 |
| SCEPP-10-07-01 | Pre | 15 | 12.00% | 5250 | 121.4 | 102.5 | 0.97 | 1.05 | 1.16 | 8.75 |
| | Post | | | 5250 | 124.9 | 97.7 | | | | 9.98 |
| ACP-VP-P02 | Pre | 10 | 38.98% | 1800 | 33.8 | 31.8 | 1.02 | 1.02 | 1.01 | 3.7 |
| | Post | | | 1800 | 33.3 | 31.3 | | | | 3.72 |
| ACP-VTH-14 | Pre | 10 | 27.59% | 4000 | 73.7 | 59.3 | 0.96 | 0.91 | 1.1 | 8.92 |
| | Post | | | 4000 | 76.8 | 66.2 | | | | 9.69 |
| ACP-PP01-02 | Pre | 7 | 17.02% | 2312 | 65.4 | 49 | 0.99 | 0.97 | 1.02 | 6.74 |
| | Post | | | 2312 | 66 | 50.4 | | | | 6.89 |

**Table D-8: Single Compressor C&I RCA Pre-Post Results**

| Site / Unit | Pre/ Post | Tons | Adj % | CFM | Total Capacity | Sensible Capacity | Cooling-Capacity base fraction | Cool-sh-cap base fraction | Cooling-eir base fraction | EER |
|---|---|---|---|---|---|---|---|---|---|---|
| SDGEPP-10-01-0 | Pre | 5 | 10.00% | 1162 | 42.2 | 30.6 | 1 | 1 | 0.97 | 7.44 |
| | Post | | | 1153 | 42.3 | 30.6 | | | | 7.23 |
| SDGEPP-10-01-0 | Pre | 4 | 15.00% | 990 | 23.6 | 18.5 | 0.89 | 0.9 | 1 | 6.78 |
| | Post | | | 1033 | 26.7 | 20.7 | | | | 6.92 |
| SDGEPP-07-01-0 | Pre | 3.5 | 4.90% | 1007 | 18 | 15.8 | 0.95 | 0.93 | 1.01 | 5.08 |
| | Post | | | 1120 | 19.1 | 17.1 | | | | 5.18 |
| SDGEPP-07-01-0 | Pre | 5 | -3.62% | 1634 | 30 | 27.1 | 0.98 | 1 | 1.01 | 5.65 |
| | Post | | | 1630 | 30.5 | 27.1 | | | | 5.71 |
| SDGEPP-07-01-0 | Pre | 3.5 | 3.92% | 1310 | 28 | 22.5 | 0.89 | 0.92 | 1.06 | 7.65 |
| | Post | | | 1340 | 31.7 | 24.6 | | | | 8.26 |
| SCEPP-10-02-02 | Pre | 3 | 9.09% | 760 | 26.7 | 18.6 | 0.9 | 0.79 | 1 | 6.71 |
| | Post | | | 892 | 30 | 24.1 | | | | 6.8 |
| ACP-VC-07 | Pre | 3.5 | 7.06% | 1289 | 24.7 | 21.7 | 0.86 | 0.81 | 1.16 | 5.79 |
| | Post | | | 1289 | 29.2 | 27.4 | | | | 6.84 |
| ACP-VC-08 | Pre | 6 | 6.00% | 3000 | 67.5 | 59.1 | 0.96 | 0.99 | 1.08 | 4.6 |
| | Post | | | 3000 | 70.9 | 59.5 | | | | 4.96 |
| ACP-VP-P1A | Pre | 5 | 26.85% | 1400 | 51.9 | 50.5 | 0.95 | 1.05 | 1.04 | 7.08 |
| | Post | | | 1400 | 54.8 | 47.9 | | | | 7.41 |
| ACP-VTH-01 | Pre | 6 | 25.33% | 1685 | 46.9 | 40.5 | 1 | 1.12 | 0.93 | 6.72 |
| | Post | | | 1685 | 44.8 | 35.8 | | | | 6.59 |
| ACP-VTH-07 | Pre | 1.5 | 53.85% | 666 | 18.9 | 17.5 | 0.99 | 1 | 1.04 | 2.98 |
| | Post | | | 666 | 19.1 | 17.5 | | | | 3.1 |
| ACP-VTH-17 | Pre | 3 | 14.52% | 1226 | 27.2 | 22.6 | 0.98 | 0.99 | 1.03 | 7.27 |
| | Post | | | 1226 | 28 | 22.8 | | | | 7.49 |
| SCEPP-10-02-05 | Pre | 5 | 33.14% | 1734 | 33.6 | 27.2 | 0.88 | 0.8 | 1 | 8.57 |
| | Post | | | 1710 | 38.7 | 34.6 | | | | 8.85 |

## Residential Post Only RCA

41.9% of the units in PGE 2000 RCA passed the subcooling/superheat test while an additional 9.6% passed the EER target screening, for a total pass rate of 51.5% (Table D-9, Table D-10 and Table D-11).

## Table D-9: PGE2000 RCA Verification Screen

| Site | Quantity (Tons) | Superheat / Subcooling Target Screen | EER Target Screen | Final Screen Result |
|---|---|---|---|---|
| CRCA8743 | 5 | PASS | FAIL | PASS |
| CRCA2403 | 3.5 | FAIL | FAIL | FAIL |
| CRCA3051 | 2 | PASS | FAIL | PASS |
| CRCA3094 | 3 | FAIL | PASS | PASS |
| CRCA9336 | 2.5 | FAIL | FAIL | FAIL |
| CRCA878 | 1.5 | PASS | FAIL | PASS |
| CRCA869 | 1.5 | FAIL | FAIL | FAIL |
| CRCA804 | 1.5 | PASS | FAIL | PASS |
| CRCA9064 | 2 | PASS | FAIL | PASS |
| CRCA2228 | 3 | PASS | FAIL | PASS |
| CRCA9245 | 3 | FAIL | FAIL | FAIL |
| CRCA9347 | 4 | FAIL | FAIL | FAIL |
| CRCA1014 | 3.5 | PASS | FAIL | PASS |
| CRCA8821 | 1 | FAIL | FAIL | FAIL |
| CRCA9250 | 4 | FAIL | FAIL | FAIL |
| CRCA9263 | 4 | FAIL | FAIL | FAIL |
| CRCA8878 | 4 | PASS | FAIL | PASS |
| CRCA9325 | 3.5 | FAIL | PASS | PASS |
| CRCA3029 | 3.5 | PASS | FAIL | PASS |
| CRCA60-DN | 4 | PASS | FAIL | PASS |
| CRCA2597 | 3 | FAIL | PASS | PASS |
| CRCA2009 | 3 | FAIL | FAIL | FAIL |
| CRCA2364 | 4 | FAIL | FAIL | FAIL |
| CRCA92 | 2 | PASS | FAIL | PASS |
| CRCA2774 | 3.5 | FAIL | FAIL | FAIL |
| CRCA27 | 4 | PASS | FAIL | PASS |
| CRCA60-UP | 3 | FAIL | FAIL | FAIL |
| CRCA1820 | 3.5 | FAIL | FAIL | FAIL |
| CRCA3081 | 5 | FAIL | FAIL | FAIL |
| CRCA2433 | 4 | FAIL | FAIL | FAIL |
| CRCA2342 | 2 | FAIL | FAIL | FAIL |
| CRCA8813 | 3 | FAIL | FAIL | FAIL |
| CRCA2385 | 2 | FAIL | FAIL | FAIL |
| CRCA2757 | 3 | FAIL | FAIL | FAIL |
| CRCA2174 | 2 | FAIL | FAIL | FAIL |
| CRCA3278 | 3 | FAIL | FAIL | FAIL |
| CRCA9023 | 2 | PASS | FAIL | PASS |
| CRCA2160 | 2.5 | FAIL | FAIL | FAIL |
| CRCA9798 | 2 | PASS | FAIL | PASS |
| CRCA9620 | 0 | PASS | FAIL | PASS |
| CRCA9566 | 4 | PASS | FAIL | PASS |
| CRCA8809 | 2 | PASS | FAIL | PASS |

**Table D-10: PGE2000 RCA Verification Screen (cont)**

| Site | Quantity (Tons) | Superheat / Subcooling Target Screen | EER Target Screen | Final Screen Result |
|---|---|---|---|---|
| CRCA1896 | 1.5 | PASS | FAIL | PASS |
| CRCA803 | 1.5 | FAIL | FAIL | FAIL |
| CRCA189 | 1.5 | FAIL | FAIL | FAIL |
| CRCA8668 | 2.5 | PASS | FAIL | PASS |
| CRCA2742 | 4 | PASS | FAIL | PASS |
| CRCA2125 | 4 | PASS | FAIL | PASS |
| CRCA2462 | 3.5 | PASS | FAIL | PASS |
| CRCA8665 | 2 | FAIL | FAIL | FAIL |
| CRCA3219 | 3 | PASS | FAIL | PASS |
| CRCA8767 | 2 | FAIL | FAIL | FAIL |
| CRCA2314 | 2 | PASS | FAIL | PASS |
| CRCA251 | 2 | FAIL | FAIL | FAIL |
| CRCA8669 | 3.5 | FAIL | FAIL | FAIL |
| CRCA8874 | 3.5 | PASS | FAIL | PASS |
| CRCA923 | 2 | FAIL | FAIL | FAIL |
| CRCA1035 | 1.5 | PASS | FAIL | PASS |
| CRCA25 | 3 | FAIL | FAIL | FAIL |
| CRCA2033 | 4 | FAIL | FAIL | FAIL |
| CRCA1971 | 3 | FAIL | FAIL | FAIL |
| CRCA2112 | 4 | FAIL | FAIL | FAIL |
| CRCA2529 | 3 | FAIL | FAIL | FAIL |
| CRCA2616 | 3 | PASS | FAIL | PASS |
| CRCA2368 | 3 | FAIL | FAIL | FAIL |
| CRCA2501 | 2.5 | FAIL | FAIL | FAIL |
| CRCA1110 | 1 | FAIL | FAIL | FAIL |
| CRCA994 | 2 | FAIL | FAIL | FAIL |
| CRCA8873 | 5 | FAIL | PASS | PASS |
| CRCA1854 | 2 | PASS | FAIL | PASS |
| CRCA9156 | 3.5 | PASS | FAIL | PASS |
| CRCA2290 | 3.5 | PASS | FAIL | PASS |
| CRCA8923 | 2 | FAIL | FAIL | FAIL |
| CRCA8642 | 2.5 | PASS | FAIL | PASS |
| CRCA891 | 2 | FAIL | FAIL | FAIL |
| CRCA634 | 1.5 | PASS | FAIL | PASS |
| CRCA9009 | 3 | FAIL | FAIL | FAIL |
| CRCA785 | 1.5 | FAIL | FAIL | FAIL |
| CRCA8657 | 2 | PASS | FAIL | PASS |
| CRCA2055 | 2 | FAIL | FAIL | FAIL |
| CRCA9081 | 3.5 | PASS | FAIL | PASS |
| CRCA9206 | 2 | FAIL | FAIL | FAIL |
| CRCA702 | 3 | FAIL | FAIL | FAIL |
| CRCA2234 | 1.5 | FAIL | FAIL | FAIL |

## Table D-11: PGE2000 RCA Verification Screen (cont)

| Site | Quantity (Tons) | Superheat / Subcooling Target Screen | EER Target Screen | Final Screen Result |
|---|---|---|---|---|
| CRCA642 | 5 | PASS | FAIL | PASS |
| CRCA1206 | 2 | FAIL | FAIL | FAIL |
| CRCA127 | 2.5 | PASS | FAIL | PASS |
| CRCA177 | 2 | PASS | FAIL | PASS |
| CRCA1868 | 2 | PASS | FAIL | PASS |
| CRCA1881 | 2 | FAIL | FAIL | FAIL |
| CRCA2006 | 2 | PASS | FAIL | PASS |
| CRCA2258 | 2.5 | PASS | FAIL | PASS |
| CRCA2356 | 2 | FAIL | FAIL | FAIL |
| CRCA2426 | 3 | PASS | FAIL | PASS |
| CRCA2482 | 1.5 | FAIL | FAIL | FAIL |
| CRCA2540 | 2 | PASS | FAIL | PASS |
| CRCA2707 | 2 | PASS | FAIL | PASS |
| CRCA2951 | 3.5 | FAIL | FAIL | FAIL |
| CRCA327 | 1.5 | FAIL | PASS | PASS |
| CRCA362 | 2 | PASS | FAIL | PASS |
| CRCA417 | 2 | FAIL | PASS | PASS |
| CRCA679 | 1.5 | FAIL | FAIL | FAIL |
| CRCA72 | 4 | PASS | FAIL | PASS |
| CRCA8665b | 2 | PASS | FAIL | PASS |
| CRCA8690 | 2 | FAIL | FAIL | FAIL |
| CRCA8733 | 3 | FAIL | FAIL | FAIL |
| CRCA8910 | 0 | PASS | FAIL | PASS |
| CRCA8946 | 4 | PASS | FAIL | PASS |
| CRCA9253 | 4 | FAIL | FAIL | FAIL |
| CRCA9584 | 3 | FAIL | FAIL | FAIL |
| CRCA2960 | 2 | PASS | FAIL | PASS |
| CRCA405 | 2 | FAIL | FAIL | FAIL |
| CRCA380 | 2 | FAIL | PASS | PASS |
| CRCA383 | 2 | FAIL | PASS | PASS |
| CRCA460 | 2 | FAIL | PASS | PASS |
| CRCA463 | 2 | FAIL | PASS | PASS |
| CRCA478 | 2 | FAIL | FAIL | FAIL |
| CRCA409 | 2 | PASS | FAIL | PASS |
| CRCA412 | 2 | FAIL | PASS | PASS |
| CRCA400 | 2 | PASS | FAIL | PASS |
| CRCA429 | 2 | FAIL | PASS | PASS |
| CRCA615 | 1.5 | FAIL | PASS | PASS |
| CRCA863 | 1.5 | PASS | FAIL | PASS |
| CRCA9326 | 3 | PASS | FAIL | PASS |
| CRCA9199 | 4 | PASS | FAIL | PASS |
| CRCA8724 | 3.5 | PASS | FAIL | PASS |
| CRCA9490 | 4 | FAIL | FAIL | FAIL |
| CRCA9532 | 3.5 | PASS | FAIL | PASS |
| CRCA9567 | 0 | FAIL | FAIL | FAIL |
| CRCA9765 | 3 | FAIL | FAIL | FAIL |
| CRCA9765 | 3 | FAIL | FAIL | FAIL |
| CRCA9771 | 3 | FAIL | FAIL | FAIL |
| CRCA9774 | 3 | FAIL | FAIL | FAIL |
| CRCA9612 | 2 | PASS | FAIL | PASS |
| CRCA9817 | 3 | FAIL | FAIL | FAIL |

For SCE 2507, 57 units passed the superheat/subcooling diagnostic test and an additional 13 the failing units passed the EER screen for a final field passing rate of 51.5%. A final adjustment of 14.5% was made based on the fact that SCE 2507 provided detailed RCA performance data for a final pass rate of 66.

## Table D-12: SCE2507 RCA Verification Screen Results

| Site | Quantity (Tons) | Superheat / Subcooling Target Screen | EER Target Screen | Final Screen Result |
|---|---|---|---|---|
| CRCA8743 | 5 | PASS | FAIL | PASS |
| RRCA13858 | 2 | FAIL | PASS | PASS |
| RRCA11131 | 2 | FAIL | FAIL | FAIL |
| RRCA41345 | 1.5 | FAIL | FAIL | FAIL |
| RRCA73969 | 2.5 | PASS | PASS | PASS |
| RRCA61156 | 1.5 | FAIL | FAIL | FAIL |
| RRCA43188 | 2 | PASS | PASS | PASS |
| RRCA21657 | 1.5 | FAIL | PASS | PASS |
| RRCA69132 | 2 | FAIL | PASS | PASS |
| RRCA18382 | 3 | FAIL | FAIL | FAIL |
| RRCA18382 | 2.5 | FAIL | PASS | PASS |
| RRCA66011 | 2 | FAIL | FAIL | FAIL |
| RRCA65732 | 2 | PASS | FAIL | PASS |
| RRCA19865 | 2.5 | FAIL | FAIL | FAIL |
| RRCA72031 | 2 | FAIL | PASS | PASS |
| RRCA77289 | 2 | FAIL | FAIL | FAIL |
| RRCA80988 | 2 | FAIL | FAIL | FAIL |
| RRCA18358 | 1.5 | PASS | FAIL | PASS |
| RRCA59312 | 1.5 | PASS | PASS | PASS |
| RRCA46223 | 2 | FAIL | FAIL | FAIL |
| RRCA81848_E210 | 1.5 | FAIL | FAIL | FAIL |
| RRCA81848_E109 | 1.5 | FAIL | FAIL | FAIL |
| RRCA81848_B248 | 1.5 | PASS | FAIL | PASS |
| RRCA81848_B249 | 1.5 | FAIL | PASS | PASS |
| RRCA21981 | 2.5 | PASS | FAIL | PASS |
| RRCA22537 | 2.5 | PASS | FAIL | PASS |
| RRCA18511 | 4 | FAIL | FAIL | FAIL |
| RRCA21805_84 | 2 | FAIL | PASS | PASS |
| RRCA17881 | 4 | PASS | FAIL | PASS |
| RRCA63104_1610 | 2 | FAIL | FAIL | FAIL |
| RRCA63104_1102 | 2 | PASS | FAIL | PASS |
| RRCA63104_1108 | 2 | PASS | FAIL | PASS |
| RRCA63104_1101 | 2 | FAIL | PASS | PASS |
| RRCA21792_85 | 2 | FAIL | FAIL | FAIL |
| RRCA21805_83 | 2 | FAIL | FAIL | FAIL |
| RRCA21792_81 | 2 | FAIL | FAIL | FAIL |
| RRCA53775_112 | 3 | FAIL | FAIL | FAIL |
| RRCA53775_411 | 3 | FAIL | PASS | PASS |
| RRCA53775_417 | 2.5 | FAIL | FAIL | FAIL |
| RRCA53775_515 | 3 | PASS | FAIL | PASS |
| RRCA20865_102 | 2 | PASS | FAIL | PASS |
| RRCA20865_103 | 2.5 | FAIL | FAIL | FAIL |
| RRCA20872_115 | 2 | PASS | FAIL | PASS |
| RRCA20872_208 | 2.5 | FAIL | PASS | PASS |
| RRCA75940 | 2 | FAIL | PASS | PASS |
| RRCA60943 | 1.5 | FAIL | PASS | PASS |
| RRCA15635 | | FAIL | FAIL | FAIL |
| RRCA10971 | 1.5 | FAIL | FAIL | FAIL |
| RRCA75723 | 1.5 | FAIL | FAIL | FAIL |
| RRCA35652 - 1 | 3 | FAIL | PASS | PASS |
| RRCA35652 - 2 | 4 | PASS | FAIL | PASS |

The RCA verification results for the CMMHP programs, PGE2078, SCE2502 and SDG&E3035, were generally better than the mass market programs, as seen in Table D-13. One program design distinction from the other RCA programs was the use of one primary service provider for all maintenance measures in the program.

**Table D-13: CMMHP RCA Verification Screen Results**

| Site | Quantity (Tons) | Superheat / Subcooling Target Screen | EER Target Screen | Final Screen Result |
|---|---|---|---|---|
| SCEVMH-01 | 3.5 | PASS | PASS | PASS |
| SCEVMH-02 | 3 | PASS | PASS | PASS |
| SCEVMH-03 | 3 | PASS | PASS | PASS |
| SCEVMH-04 | 4 | PASS | PASS | PASS |
| SCEVMH-05 | 3 | PASS | FAIL | PASS |
| SCEVMH-06 | 4 | PASS | FAIL | PASS |
| SDGEVMH-01 | 3 | PASS | FAIL | PASS |
| SDGEVMH-02 | 3 | PASS | PASS | PASS |
| SDGEVMH-03 | 3.5 | PASS | PASS | PASS |
| SDGEVMH-04 | 3 | PASS | FAIL | PASS |
| SDGEVMH-05 | 4 | FAIL | FAIL | FAIL |
| SDGEVMH-06 | 3 | PASS | PASS | PASS |
| SDGEVMH-07 | 3 | PASS | FAIL | PASS |
| PGEVMH-01 | 3 | PASS | PASS | PASS |
| PGEVMH-02 | 2.5 | PASS | PASS | PASS |
| PGEVMH-03 | 3 | FAIL | FAIL | FAIL |
| PGEVMH-04 | 4 | PASS | FAIL | PASS |
| PGEVMH-05 | 4 | PASS | FAIL | PASS |

## Commercial Post Only RCA

40% of PGE 2080 units passed the superheat/subcooling screen and an additional 5.5% passed the EER target screening for a total pass rate of 45.5%, as seen in Table D-14.

**Table D-14: PGE 2080 Verification Screening Results**

| Site | Quantity (Tons) | Superheat / Subcooling Target Screen | EER Target Screen | Final Screen Result |
|---|---|---|---|---|
| PCRCA13941 | 4 | PASS | FAIL | PASS |
| PCRCA26984 | 4 | FAIL | FAIL | FAIL |
| PCRCA26984 | 4 | FAIL | FAIL | FAIL |
| PGRCA12415 | DK | FAIL | FAIL | FAIL |
| RCA24078 | DK | FAIL | FAIL | FAIL |
| RCA24078 | 3.5 | FAIL | FAIL | FAIL |
| PCRCA24042 | 4 | PASS | FAIL | PASS |
| PCRCA13941 | 4 | PASS | FAIL | PASS |
| PRCA27103 | 3 | FAIL | PASS | PASS |
| PCRCA27385 | 4 | FAIL | FAIL | FAIL |
| PCRCA5589 | 3.5 | PASS | PASS | PASS |

For PGE 2068, 8 of units passed the superheat/subcooling diagnostic test and an additional 5 the failing units passed the EER screen for a final field passing rate of 68.4% (Table D-15).

**Table D-15: PGE 2068 Verification Screening Results**

| Site | Quantity (Tons) | Superheat / Subcooling Target Screen | EER Target Screen | Final Screen Result |
|---|---|---|---|---|
| ACP643 | 3 | FAIL | FAIL | FAIL |
| ACP1605 | 5 | PASS | FAIL | PASS |
| ACP1605 | 5 | PASS | FAIL | PASS |
| ACP1240 | 10 | FAIL | FAIL | FAIL |
| ACP2283 | 5 | FAIL | PASS | PASS |
| ACP3496 | 3 | FAIL | FAIL | FAIL |
| ACP3731 | 7.5 | PASS | FAIL | PASS |
| ACP3731 | 3 | PASS | FAIL | PASS |
| ACP2550 | 3 | FAIL | PASS | PASS |
| ACP141 | 4 | FAIL | PASS | PASS |
| ACP26981 | 7.5 | FAIL | FAIL | FAIL |
| ACP1240 | DK | FAIL | FAIL | FAIL |
| ACP108 | DK | FAIL | FAIL | FAIL |
| ACP3441 | DK | PASS | FAIL | PASS |
| ACP 643 | 4 | PASS | FAIL | PASS |
| ACP1605 | 4 | PASS | FAIL | PASS |
| ACP1605 | DK | PASS | FAIL | PASS |
| ACP2283 | DK | FAIL | PASS | PASS |
| ACP 3496 | DK | FAIL | PASS | PASS |

For SCE 2507, 25 units passed the superheat/subcooling diagnostic test and an additional 6 of the failing units passed the EER screen for a final field passing rate of 72% (Table D-16).

**Table D-16: SCE 2507 Verification Screening Results**

| Cadmus Unit ID | Quantity (Tons) | EER Target Screen | Superheat / Subcooling Target Screen | Final Screen Result |
|---|---|---|---|---|
| SCEV-06-01-01 | 3 | FAIL | FAIL | FAIL |
| SCEV-06-01-02 | 3 | FAIL | FAIL | FAIL |
| SCEV-06-02-01 | 4 | FAIL | PASS | PASS |
| SCEV-06-03-01 | 3 | PASS | PASS | PASS |
| SCEV-06-04-01 | 7.5 | PASS | PASS | PASS |
| SCEV-06-04-02 | 7.5 | PASS | FAIL | PASS |
| SCEV-08-01-01 | 3.5 | FAIL | FAIL | FAIL |
| SCEV-08-01-01 | 10 | PASS | FAIL | PASS |
| SCEV-08-01-02 | 12 | PASS | PASS | PASS |
| SCEV-08-02-01 | 5 | PASS | PASS | PASS |
| SCEV-08-03-01 | 7.5 | PASS | FAIL | PASS |
| SCEV-08-03-02 | 7.5 | FAIL | PASS | PASS |
| SCEV-08-04-01 | 12 | FAIL | FAIL | FAIL |
| SCEV-08-04-02 | 1.5 | PASS | FAIL | PASS |
| SCEV-09-01-01 | 5 | PASS | FAIL | PASS |
| SCEV-09-01-02 | 4 | PASS | FAIL | PASS |
| SCEV-09-03-01 | 7 | PASS | FAIL | PASS |
| SCEV-09-03-02 | 7 | PASS | PASS | PASS |
| SCEV-09-04-01 | 4 | FAIL | FAIL | FAIL |
| SCEV-09-04-02 | 3.5 | FAIL | FAIL | FAIL |
| SCEV-09-05-01 | 5 | PASS | FAIL | PASS |
| SCEV-10-01-01 | 4 | PASS | PASS | PASS |
| SCEV-10-01-02 | 4 | PASS | PASS | PASS |
| SCEV-10-02-01 | 5 | FAIL | FAIL | FAIL |
| SCEV-10-03-01 | 3 | FAIL | PASS | PASS |
| SCEV-10-03-02 | 3 | PASS | PASS | PASS |
| SCEV-10-04-01 | 20 | FAIL | PASS | PASS |
| SCEV-10-04-02 | 20 | PASS | FAIL | PASS |
| SCEV-10-05-01 | 5 | FAIL | FAIL | FAIL |
| SCEV-10-05-02 | 5 | FAIL | FAIL | FAIL |
| SCEV-10-06-01 | 5 | FAIL | FAIL | FAIL |
| SCEV-10-06-02 | 5 | FAIL | FAIL | FAIL |
| SCEV-10-07-01 | 4 | PASS | PASS | PASS |
| SCEV-10-07-02 | 5 | PASS | PASS | PASS |
| SCEV-10-09-01 | 4 | FAIL | FAIL | FAIL |
| SCEV-10-09-02 | 4 | FAIL | PASS | PASS |
| SCEV-13-01-01 | 5 | FAIL | PASS | PASS |
| SCEV-13-01-02 | 5 | FAIL | FAIL | FAIL |
| SCEV-13-02-01 | 7.5 | FAIL | FAIL | FAIL |
| SCEV-14-01-01 | 5 | PASS | PASS | PASS |
| SCEV-14-01-02 | 5 | PASS | PASS | PASS |
| SCEV-15-01-01 | 4.5 | PASS | PASS | PASS |
| SCEV-15-01-02 | 3 | PASS | FAIL | PASS |

The SDG&E 3043 RCA measures had six units passing the superheat/subcooling screen and an additional four of the nine passing the EER target screen for a total pass rate of 67% as shown below in Table D-17.

**Table D-17: SDGE 3043 Verification Screening Results**

| Site | Quantity (Tons) | Superheat / Subcooling Target Screen | EER Target Screen | Final Screen Result |
|---|---|---|---|---|
| SDGEV-07-01 | 3 | PASS | FAIL | PASS |
| SDGEV-07-02 | 1.5 | FAIL | PASS | PASS |
| SDGEV-07-03 | 3.5 | FAIL | FAIL | FAIL |
| SDGEV-07-04 | 2 | PASS | FAIL | PASS |
| SDGEV-07-05 | 5 | PASS | PASS | PASS |
| SDGEV-07-06 | 5 | PASS | FAIL | PASS |
| SDGEV-07-07 | 4 | FAIL | FAIL | FAIL |
| SDGEV-07-08 | 4 | FAIL | PASS | PASS |
| SDGEV-07-09 | 5 | PASS | PASS | PASS |
| SDGEV-07-10 | 4 | FAIL | PASS | PASS |
| SDGEV-07-11 | 5 | PASS | PASS | PASS |
| SDGEV-10-01 | 3 | FAIL | FAIL | FAIL |
| SDGEV-10-02 | 5 | PASS | PASS | PASS |
| SDGEV-10-03 | 5 | FAIL | FAIL | FAIL |
| SDGEV-10-05 | 2.5 | FAIL | FAIL | FAIL |

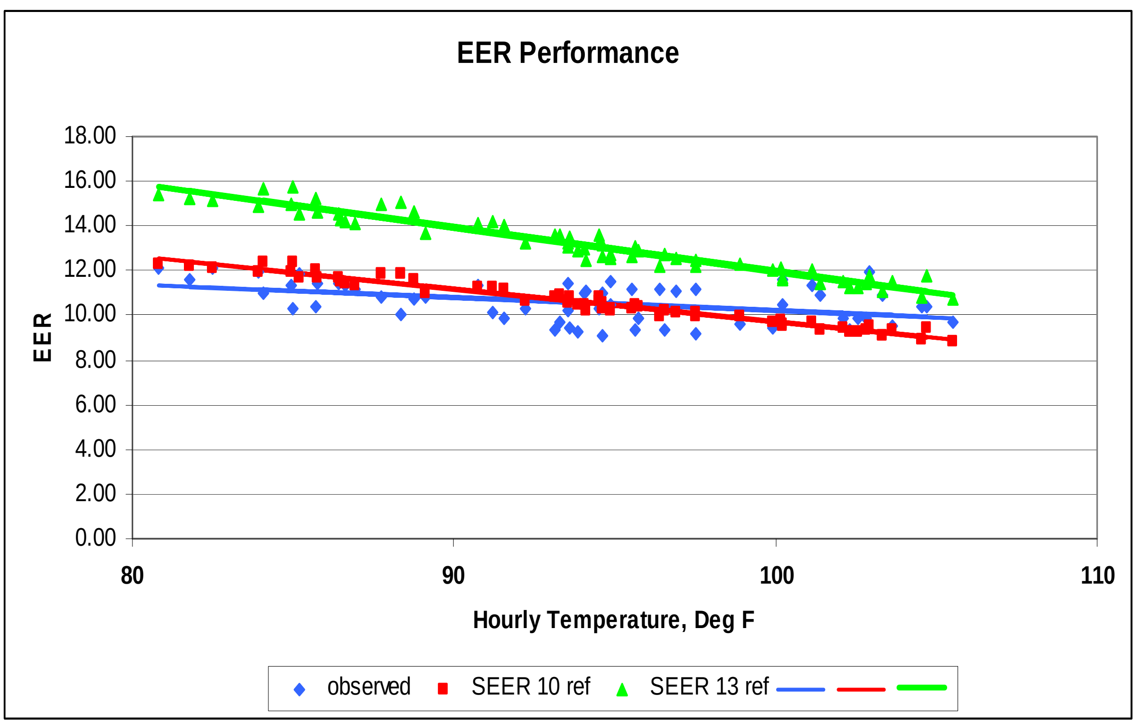
# E. Rooftop or Split System Air Conditioner Replacement Program Methods

This analysis has been structured around three key empirical objectives. Each of these is briefly described here and developed fully below.

## Operating Efficiency Measurement

The first key empirical objective measures the observed efficiency, EER, of the efficient installed unit as a function of hourly temperature. This temperature vs. the efficiency function is then compared to similar temperature vs. efficiency functions calculated for the SEER 10 and SEER 13 base case functions, as derived from DEER values. It is also compared to the base case developed from a sample of actual treated units in the RCA programs. The final output of this empirical effort will appear similar to the operating efficiency description in the RCA methodology. These efficiency functions are then used to estimate the energy use of the hypothetical base case units serving the same observed cooling load. The final output of this empirical effort is shown in Figure E-1.

**Figure E-1: EER vs. Temperature Functions**

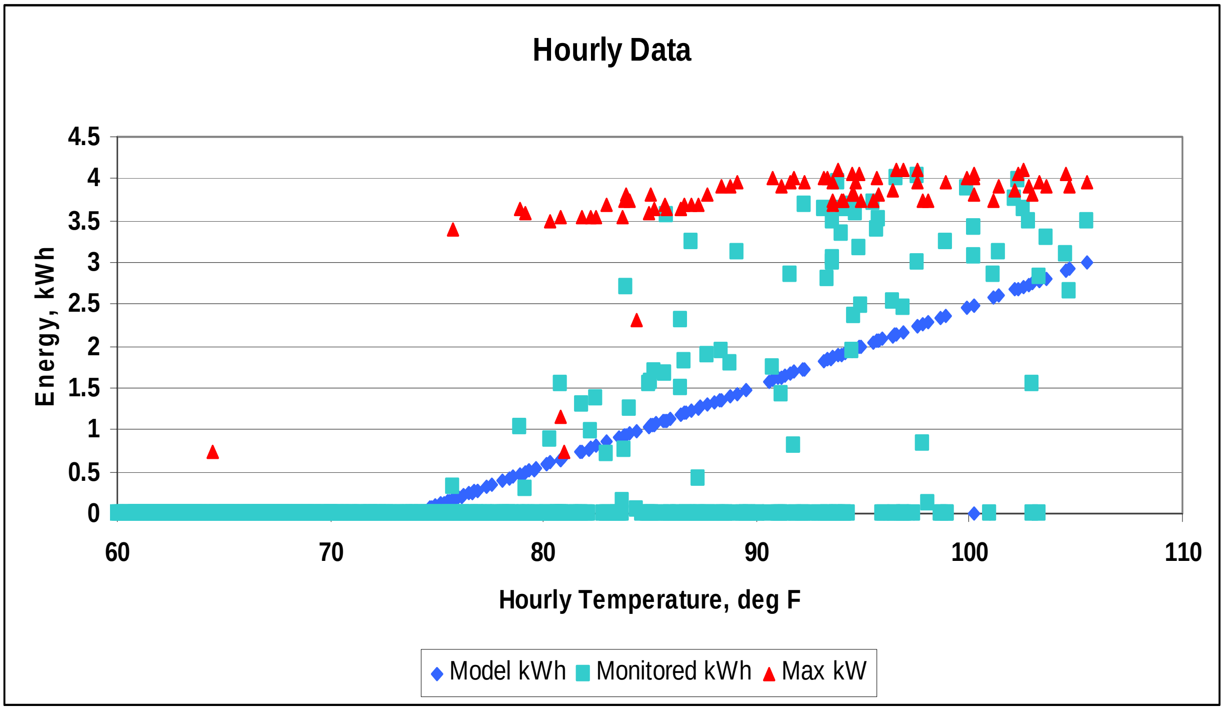


Most of the monitored sites statewide are single-stage units, but there are two stage units in the monitored sample and there are specific subregions where two-stage units are a significant fraction of the total monitored units. The analysis of these units is more complicated and requires the use of some reasonable operating assumptions to develop an operating efficiency measurement. It is important to understand the nature of the monitored EER. The monitored EER is based on measured return and supply air conditions and implicitly includes the effects of conditioning outside ventilation air (most important in commercial units), fan heating (Joule heating), and part load effects. These effects must be applied as corrections to the synthetic base cases EER vs temperature curves before they can be reasonably compared to the monitored EER vs temperature curve.

## The Cooling Energy Model

The second key empirical objective is directed at identifying the unique site compressor-based cooling energy, including the effects of occupancy variation and structural subtleties. In this analysis, the final empirical result is to characterize the site cooling energy for the compressor and condenser fan (not including the supply fan) as a linear function of hourly cooling energy vs. hourly temperature, as shown in Figure E-2. This function will then be used along with hourly temperatures from the California Energy Commission long-term average weather data for the 16 Title 24 climate zones (CZTMY), and a supply fan power measurement, to estimate the refrigeration-based cooling energy for all hours of the year or cooling season.

**Figure E-2: Cooling Energy Functions**




Note in Figure E-2, the number of monitored kWh points that are zero even at high temperatures. In fact, in the early portion of the summer, cooling was not triggered at all, even at high outdoor temperatures. This is because the thermal mass of the building was still in the range of 60-70 deg F, and had not yet responded to the warm days, and was thermally filtering out the brief warm events. After several warm days, the interior of the building had reached the range of 70-80 deg F, and the cooling was then regularly triggered. This type of physical situation calls for the use of a temperature vs. kWh relationship that is conditional on interior or long-term (three-day) running average temperature conditions that exceed a specified limit.

Note also in Figure E-2 that the kWh vs. temperature function does not seem to bisect the cluster of points; it appears low. This low bias has been necessitated by, at many high temperatures, cooling that is unexpectedly not used at all for a variety of unknown occupancy reasons. The model kWh function has been constrained to reproduce the true sum of the cooling energy, including the non-cooling intervals.

Figure E-2 also shows the maximum power, max kW, observed in each cooling hour; this is indicative of site demand, and subsequent analysis uses this information in the estimation of hourly load factors.

In the analysis of the commercial sites the same form of linear temperature based energy model is used, however in these cases the temperature model is constrained to create an hourly energy point representing the average of the hours in ten highest outdoor temperatures observed. This constraint was found necessary to accommodate the commercial sites that were dominated by internal gain instead of outside temperature. The constraint also facilitated a more accurate representation of grid peak.

The empirical cooling efficiency and the cooling energy model are used together as follows. First the hourly cooling energy use for the full cooling season is derived using the kWh vs. temperature model and the appropriate CZTMY. Second, energy use for the base case SEER 10, SEER 13, and RCA sample situations is estimated by starting with the observed cooling energy for a particular hour at the monitored unit and proceeding to an estimate of the energy that would have been used in that hour by the base case unit serving the same load under the same conditions. This is done by finding the EER of the monitored unit and the EER of the base case units at that same temperature, and creating a ratio of the energy use.

## Data Aggregation

The associated *Data Aggregation Spreadsheet* takes the raw site data from three logged data files: an air handler data file, a thermostat data file, and an outdoor unit data file. The Data Aggregation Spreadsheet uses a VBA program to take the varying logging intervals of the three files and produce a single, consolidated table of hourly site monitored data. One of the primary functions of the data aggregation spreadsheet is to preserve key minute-by-minute detail in the monitored data; so hourly data are not just averages but include sub-aggregations on the detail data, such as the number of cooling minutes in the hour (for the high and low cooling modes) or average supply air temperature during a cooling mode and the minimum supply air temperature. This consolidated data are then copied to the *Analysis Spreadsheet*, where it serves as the starting point for the analysis. In theory, a single spreadsheet could serve both these purposes, but, with the expected volume of raw data, such a sheet could become too large. The data aggregation spreadsheet requires manual operations, processing data on a site-by-site basis, but it is immediately functional. It is possible that SAS or STADA could do this aggregation much more quickly, but at this point, the format for the raw input data is variable with regard to the data columns and logging intervals, and this portion of the analysis requires some conscious oversight.

The aggregated hourly data variables that will be the basis for the subsequent site analysis are given in Table E-1, along with the definitions and algebraic symbols for these variables that will be used in the analytical discussion. This table will also serve to define the data aggregation output required from a SAS or STADA approach, should it be needed.

**Table E-1: Aggregated Hourly Variables**

| Variable | Symbol | Units | Notes |
|---|---|---|---|
| Outside Unit kWh First stage | ***kWh out*** | kWh | Total hourly Energy of compressor and condenser fan. In commercial units this hourly energy includes the energy of the evaporator (supply) fan |
| Outside Unit kWh Second stage | | kWh | |
| Outside Air Temperature | ***T OSA*** | Deg F | Average hourly Dry bulb temperature |
| Maximum kW First stage | ***kW out*** | kW | Maximum hourly Power of compressor and condenser fan |
| Maximum kW Second stage | | kW | |
| Cooling Intervals/hr Second stage | ***N cool*** | N | Number of logging intervals with identified cooling, Requires length of logging interval |
| Cooling Intervals/hr First stage | | N | |
| Inside RH @ thermostat | ***RHstat*** | % of full water saturation | This variable is used in lieu of RH return |
| Inside temperature @thermostat | ***T stat*** | Deg F | Average hourly Dry bulb temperature |
| | | | |
| Return air temperature | ***T return*** | Deg F | Average hourly Dry bulb temperature |
| Return air RH | ***RH return*** | % of full water saturation | This variable is subject to variability due to moisture at indoor unit, and is not analytically valid |
| Minimum Return Air temperature | | Deg F | |
| Return Air RH @ minimum | | % of full water saturation | |
| Supply air temperature second stage | ***T supply*** | Deg F | Minimum hourly Dry bulb temperature |
| Supply air temperature first stage | | Deg F | Minimum hourly Dry bulb temperature |
| Return Air Temperature during Fan operation | | Deg F | Average return air temperature during Fan operation |
| Supply temperature Second stage | | Deg F | Average supply temperature second stage |
| Supply temperature First stage | | Deg F | Average supply temperature first stage |
| Supply temperature | | Deg F | Average supply temperature whole hour |
| Heating intervals/hr | ***N heat*** | N | Number of logging intervals with identified heating requires length of logging interval |

Note in Table E-1, most of the variables are not simple averages of the logged values in the hour; they are unique subsets or derivations of the directly monitored variables. For example, the variable *kW out* is the maximum value of the power readings observed in the hourly interval;

the variable *N cool* is a count of all the logging intervals in the hour, with identified cooling separately counted for first or second activity. These variables have proved to be necessary in trial analysis and in subsequent analysis. The variable symbols in the table and the equations in the descriptions below follow an analysis of a single-stage unit. In the interest of keeping this discussion as simple as possible, the analysis of a two-stage unit uses similar equations for each stage, and uses the corresponding variables, which do not have variable symbols.

An initial trial analysis showed some of these variables are subject to unexpected variation, which can adversely affect the analysis. In particular, the variable RH return is subject to variation when the fan is off, probably due to residual moisture on the evaporator coil. Since this variable is central to the return and supply enthalpy estimates, only the RH during period when the fan is on is used in the calculations.

## Deriving the Efficiency Functions for the Monitored Unit and the Base Case Units, Psychrometric Variables and One-Time Site Measurements

The key to deriving the efficiency of the HVAC unit is the airside measurement of the thermal output of the unit. These airside calculations require reference to four psychrometric properties of the circulated airflow, which are shown in Table E-2, along with the algebraic symbol notation.

**Table E-2: Psychrometric Variables**

| Variable | Algebraic Symbol | Units | Input Variables |
|---|---|---|---|
| Specific Volume, air density | *CF return* | Ft3/lb dry air | T return RH return |
| Entering Enthalpy | *H return* | BTU/lb dry air | T return RH return |
| Supply Enthalpy | *H supply* | BTU/lb dry air | T return RH return T supply |
| Entering Wet Bulb Temperature | *T ewb* | Deg F | T return RH return |

These psychrometric variables are all calculated from the monitored hourly variables noted in the table, using enhanced Excel tool pack options or using specialized regression functions derived for this purpose. The Analysis Spreadsheet currently uses the specialized regression functions.

In addition to the psychrometric variables, two one-time site measurements are used in the calculations:

Air flow through the indoor unit, measured as cfm, with the algebraic symbol CFM return

Indoor unit fan power, measured as kW, with the algebraic symbol, kW indoor

***Reliability of Relative Humidity Measurements***

The tables for the monitoring points include a combination RH /Temperature sensor in the supply plenum. The analysis did use the dry bulb temperature recorded by this sensor but the analysis did not use the recorded supply RH. The analysis anticipated the problems associated with measuring the RH of the supply airstream, where common RH sensors perform poorly (and often fail) at RH above 90%, a very common condition for the supply air. Yet the supply RH, or equivalent, is absolutely necessary in order to calculate the supply air enthalpy, and ultimately the thermal output of the unit. Therefore, this analysis uses a two stage process to estimate the supply air enthalpy from sensors considered more reliable, specifically, the return air dry bulb temperature and RH and the supply air dry bulb temperature as follows.

a) Return air dry bulb temperature and RH are used in a psychrometric function to calculate the return air absolute humidity, and the saturation temperature associated with that absolute humidity is calculated.

b) The supply dry bulb temperature is tested; if it is below the saturation temperature, then supply enthalpy is estimated as a function of dry bulb temperature only. If the supply dry bulb temperature is greater than the saturation temperature, then the supply enthalpy is calculated via a psychrometric function from the supply air dry bulb temperature and the return air absolute humidity.

This calculation idealizes the situation for the supply air near the saturation temperature by assuming that it is either condensing or not when in fact the full transition to the condensing state may take place more smoothly in the few degrees above the saturation temperature. This ideal construct also assumes that the supply air below the saturation temperature is at 100% humidity when in fact it may be at only about 98%. However, trial simulations of these differences between the ideal and the actual supply air humidity did not lead to a significant error in the enthalpy or the final savings estimate.

Two other sources of error in the estimate of the thermal output of the unit were considered.

a) The return air RH is itself a difficult measurement. Early test runs of the data logging showed many instances when the return air RH increased to well above all other RH measurements. These anomalously high RH measurements were only recorded when the fan was off and were due to residual water on the coil or in its drain pan, which are reasonably close to the return air Temperature/RH sensor. Diffusion of moisture was strong enough for the water vapor to influence the return air RH sensor when there was no air movement. When the fan was on the air movement overcame the moisture diffusion and the high RH readings were restored to normal values. Accordingly the analysis tests all return RH readings and uses only readings during fan-on conditions.

b) The assumption that the return air absolute humidity can be used as the supply air absolute humidity only applies when there is no moisture added to or removed from the mixed air stream. This is a reasonable assumption if no outside air is added to the airstream as is approximately the case in residential split system applications. But commercial applications involving RTUs, (roof top units), will usually mix a minimum of 10% or more of outside air for ventilation. And much higher fractions of outside air will either be deliberately chosen or accidently used when dampers or economizer are operating incorrectly. In principle this is potentially a complex problem, because the mix fraction of outside air is not known, and the mixed air temperature is not monitored. In a very humid climate this would definitely cause measurement errors. But in the dryer climates associated with this analysis, a review of site monitored data showed that usually the absolute humidity of a range of hypothetical outside air mixes is very close to the absolute humidity of the return air. Trial simulations of the final savings estimates were used to test that the use of the return air absolute humidity in lieu of the unknown mixed air absolute humidity does not lead to significant or disproportionate errors in the final savings result.

***Calculation of Thermal Output and EER of the Monitored Unit***

The following calculation of the thermal output is intended to quantify the steady-state efficiency of the unit and should be applied only to hours that have at least 75% cooling activity. In fact, most hours have no cooling activity, and there will be many cases where the unit was on only very briefly. These brief cooling intervals are not considered in the calculation of steady-state efficiency. It is probable that in the entire monitoring period there may be only on the order of 150 hours with good steady-state cooling data. For each of these steady-state hours, the outdoor temperature and the calculated EER were used in a linear regression fit to establish an efficiency model of EER vs. hourly outdoor temperature. In the case of two-stage units, the EER vs. T OSA function expressed the hourly performance of both the high and low stages for hours with a combined duty cycle for both stages of at least 75%.

EER calculation sequence for a steady-state cooling hour associated with an average hourly outdoor temperature, T OSA:

**Equation 3: EER calculation Sequence for a steady state cooling hour associated with an average hourly outdoor temperature, T OSA:**

*Hourly Lbs cooling air = N cool*1.5 minutes/logging interval*CFM return/CF return/(60min/hour),*
*CF return is the specific volume of the return air, ft3/lb dry air*

*Thermal Output BTU/hr* = Hourly lbs cooling air*(*H return-H supply*),

*EER* = Thermal Output BTU/hr/((*kWh out*)*1000)

This calculation is carried out for all identified steady-state cooling hours in the data set, and, for each such hour, the EER and the associated T OSA are used in a linear regression to find the observed efficiency function, EER=f(T OSA).

In the case of two-stage units, the CFM return can be difficult to measure correctly because the fan is usually controlled by a variable frequency drive, and may have a soft-start cycle, with a duration of 5-10 minutes, and also it is usually difficult to force the operation of the low stage for measurement purposes. For this reason, the field measurements of air flow for two-stage units do not include the first-stage flow, and flow measurements of the second stage are often very low or erratic because of the measurement may include the unrecognized activity of the soft start. It is also notable that a fan controlled by a variable frequency drive can have a very accurately controlled RPM and flow for most duct configurations. Therefore, in the case of two stage units, the high second stage fan flow was assumed to be 350 cfm/kW (when it could not be measured, where kW was the power drawn by the compressor at 90 degree outside air temperature) for the second stage, and the first stage fan flow was assumed to be 0.8 times the second stage flow. Most two stage residential units have different fan flows for the first and second stages, and many two stage commercial units do not have two stage fan flow. The data analysis spreadsheet checks for a flow change between first and second stage by examining the supply air temperatures: If the supply air temperature does not change by more than 3 deg F between first and second stage then the fan operates with two flow stages. If the supply air temperature changes by more than 3 deg F between first and second stage then the fan is considered to have only one flow stage.

***SEER 10 and SEER 13 EER vs. Temperature Functions***

The synthetic SEER 10 and SEER 13 base case calculations use generalized performance functions (bi quadratics) for HVAC units from the DEER data base (DX performance maps DEER 08) that are used in Equest models. These base case calculations were driven by the real observed hourly temperatures, T OSA and T EWB. The DEER generalized performance function was based on a five-variable linear function-augmented by two specifiers that gave the nominal unit performance as is shown in Table E-3 and Table E-4.

**Table E-3: Generalized HVAC Performance Function for SEER 13**

| | c1 | c2 | c3 | c4 | c5 | c6 |
|---|---|---|---|---|---|---|
| **CoolCap** | 1.191 | -0.01965 | 0.000316 | 0.00359 | -9.33E-06 | -7.83E-05 |
| **SesCap** | 2.921 | -0.001 | -0.00033 | -0.00682 | 1.64E-05 | 1.81E-05 |
| **EIR** | -0.06819 | 0.02228 | -0.00012 | 0.001059 | 0.000148 | -0.00021 |
| **Factor 13** | | 0.2567 | | | | |

**Table E-4: Generalized HVAC Performance Function for SEER 10**

| | c1 | c2 | c3 | c4 | c5 | c6 |
|---|---|---|---|---|---|---|
| **CoolCap** | 0.03889 | 0.0091 | 0.000134 | 0.006698 | -1.20E-05 | -0.0001306 |
| **SesCap** | 2.423 | 0.006488 | -0.000365 | -0.001629 | -1.156E-06 | -8.437E-06 |
| **EIR** | 1.115 | -0.002838 | -1.66E-05 | -0.008166 | 0.0001327 | -4.28E-05 |
| **Factor 10** | | 0.3208 | | | | |

These generalized performance functions are capable of calculating the capacity of a specified HVAC unit, as well as the EER and kW. In this analysis, the EER was the objective, and the following calculation sequence pursued only the EER. In calculating the EER, the EIRs (called Factor 13 and Factor 10) in Table E-3 and Table E-4 are the property of interest. The general form of the regression is:

**Equation E-4: Regression Equation for EIR**

$$EIR = c1*T\ ewb + c2*(T\ ewb)^2 + c3*T\ OSA + c4*(T\ OSA)^2 + c5*T\ ewb*T\ OSA$$

For the SEER 13 calculations, the coefficients c1 to c6 from Table E-3 are used, and for SEER 10, the coefficients c1 to c6 from Table E-4 are used.

The energy input ratio, eir = EIR*factor, where the factor is factor 13 or factor 10 from Table E-3 or Table E-4, as appropriate.

**Equation E-5: EER**

*EER = 3.412/energy input ratio, eir*

A SEER 10 and a SEER 13 EER were calculated using the actual *T EWB* and *T OSA* for all of the identified, steady-state cooling hours used to calculate the observed unit EER. Then a linear function was fitted to the SEER 10 and SEER 13 EER and associated *T OSA.* The functional end result for this analytical effort was three linear functions of EER vs. hourly temperature (one for the monitored unit and one for the hypothetical SEER 10 and 13 units), as shown in Figure E-1. This figure also shows the points from which the functions were derived as a check on reasonableness of fit. These linear EER functions were ultimately used in ratio fashion to modify the actual observed energy use to represent the hypothetical energy use that would have been used by the SEER 10 or SEER 13 base case. Note that the linear functions for the SEER 10 EER and SEER 13 EER base cases have been expressed only in terms of *T OSA,* when the EER is also a function of *T EWB.* In fact, it is possible to express the EER as a coherent function of *T OSA* only because *T OSA* and T ewb bear a fairly consistent relationship to each other at a particular site.

At the commercial monitored sites, the SEER 10 and SEER 13 synthetic base cases were derived from different DEER bi quadratics and other factors, depending on the size of the unit, 0-5 tons, 6-10 tons or > 10 tons. In fact, for commercial units, the synthetic base cases were not literally SEER 10 and SEER 13 cases but were for comparable EER designations, however, for this discussion they will continue to be referred to as the SEER 10 and SEER 13 base cases. In the case of commercial sites the derivation of a synthetic EER vs temperature curve requires further corrections for condenser fan power and for an assumed mix of outside ventilation air with the re-circulated return air. In this analysis an assumed outside air mix of 15% is assumed.

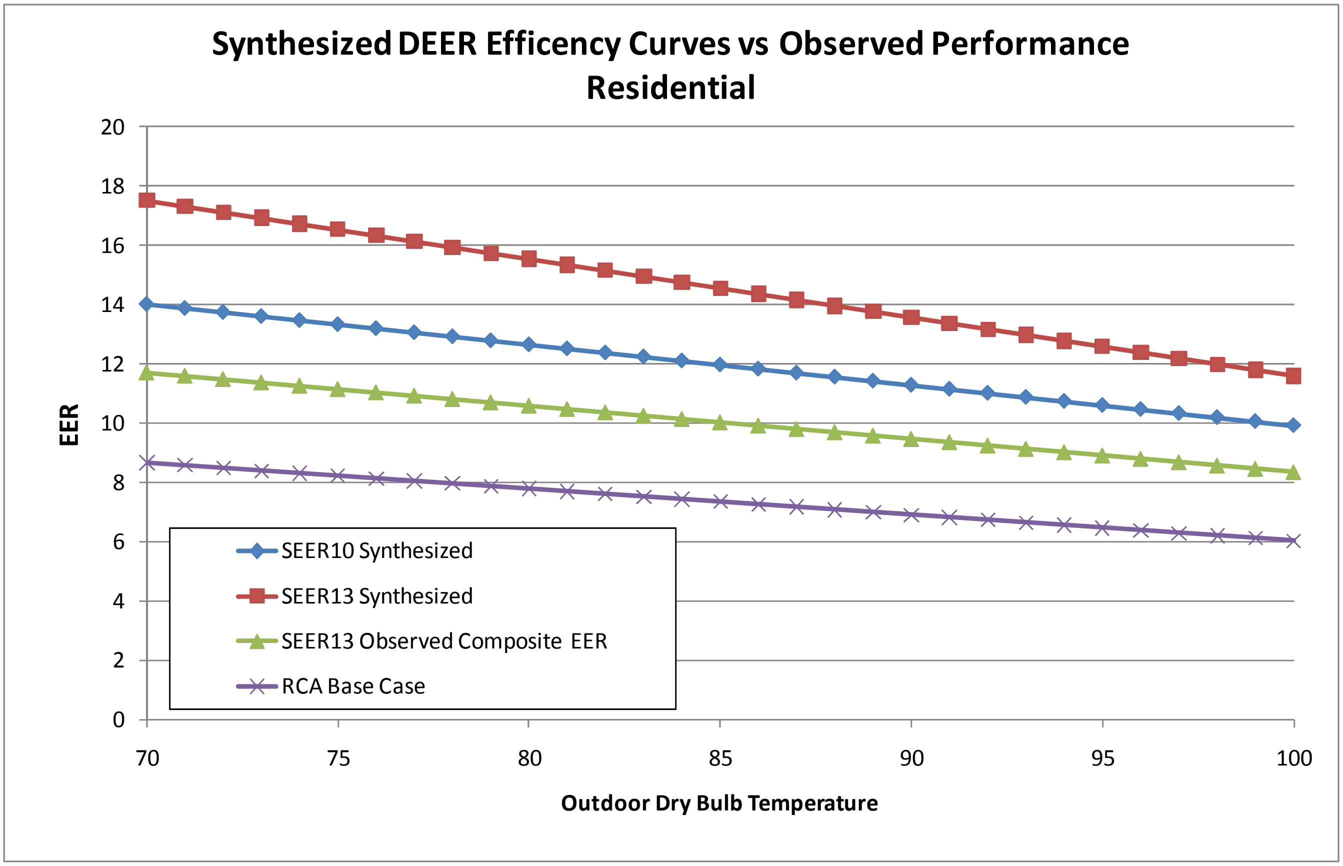
***Empirical Base Cases*** As an initial check on the accuracy of the synthetic (engineered) base cases, three empirically derived base cases were developed.

The first of the empirically derived bases cases is referred to here as the RCA base case. This base case is drawn from the monitored performance of post retrofit RCA sites (participants in the IOU's RCA programs). Eligible sites for this base case required sufficient monitoring data to establish the EER of the unit and the associated outdoor temperature. These sites are an appropriate base case for this evaluation of the effect of an efficiency upgrade because they have recently had an RCA treatment. Thus the savings evident between the program unit and the RCA base case express the benefits of the high efficiency upgrade only, not the benefits of the efficiency upgrade and an RCA treatment. This base case was prepared from a sample of 20 units by deriving the EER vs temperature curve for each unit and aggregating the separate curves in output weighted fashion into a single aggregate curve representing the analyzed sites. This aggregate curve is incorporated into analysis spreadsheet and it is used as the base case for residential early retirement participants.

A second empirical residential base case was developed from residential participants of the evaluated programs with a clearly identified SEER 13 unit. This is referred to here as the SEER 13 base case. There were 19 such participants with adequate data to develop an adequate EER vs temperature curve for each site, and an aggregate EER vs temperature curve for the whole group. Ideally the aggregate curve would be incorporated into the analysis template, but this curve was developed after the residential analysis was complete. Therefore an after-the-fact calibration was done by comparing the annual energy estimates for the empirical SEER 13 base case with the synthetic SEER 13 estimates for the same units under the same conditions. The calibration showed that the synthetic SEER 13 base case predicted too low and needed on average to be multiplied by a factor of 1.33 to match the empirical results. The difference between the empirical and synthetic SEER 13 results suggests that some real world performance effects are not being fully represented in the synthetic base case. For residential participants, the empirical base case is used to estimate the savings associated with "replace on burnout".

A comparison between the empirical and synthesized base cases are shown in.E-3. This shows that the empirical base cases evidence a much lower operating efficiency on average than the synthesized DEER efficiency curves.

**E-3: Comparison of Synthesized and Empirical Base Cases**




A third empirical base case was developed for the analysis of commercial participants. This base case is referred to here as the nonparticipant base case. This base case is drawn from monitoring data of non-participating commercial sites to represent the "as found" performance of sites subject to early replacement. These non-participant sites with adequate data were analyzed to produce an individual site EER vs temperature curve, and then an aggregate curve for all the non-participant sites taken together. The aggregate curve was incorporated into the analysis spreadsheet for commercial units, and is the base case for the early replacement situation.

The original approach for this analysis was to rely entirely on synthetic base cases developed from DEER values as a substitute for the un-monitored base case situation. But as the analysis preceded it became evident that the monitored energy use was generally more than would have been predicted by the synthetic approach, by about 20-30%. This difference prompted the exploration of empirical base cases as a check. The empirical base cases were found to be reasonable and became the primary base cases for the analysis, with the synthetic base case calculations serving as a reasonableness check.

***The Cooling Load***

The cooling load is quite variable and responsive to occupancy activity. At some sites the cooling may be minimized by night ventilation, evaporative cooling, and thermal mass and at other sites the cooling may be quite high because of internal gain or special occupancy needs. In seasons when the outdoor temperature is moderate, the use of cooling may be very irregular or not at all. Notable in a review of these data are cooling lapses either caused by non-occupancy or controls responding to thermal mass or set back events.

In this analysis, the cooling energy and the cooling energy savings are restricted to the refrigeration cooling only and do not include other cooling activity such as night ventilation or evaporative cooling. The savings provided by the efficient HVAC equipment relative to base case equipment with a different efficiency will be principally determined by the magnitude of the cooling load. If the cooling load is almost non-existent the savings will be small, and if the cooling load is large, perhaps even unreasonably so, such as caused by faulty ducts or shell, the savings will also be large. Therefore the crux of the analysis here is to characterize the observed refrigerant cooling load as accurately as possible, even though that cooling load may often be notoriously irregular as is evident in Figure E-4. Ultimately, the irregular cooling energy is made much more orderly by treating it in cumulative fashion.

***Outdoor Unit Cooling Energy Model***

The cooling energy is the monitored variable kWh out. This cooling energy model is only for the compressor and condenser fan energy which was monitored at the outdoor unit. The indoor fan energy is also part of the full cooling energy and this is included by a simple adjustment at a later stage.

The cooling energy model is a simple linear model of cooling energy vs. the hourly outdoor temperature, T OSA

**Equation E-6: Cooling Energy Model**

$$\begin{aligned} kWH\ out &= Mass\ factor * (T\ OSA - T\ set) * slope \quad (for\ T\ OSA > Tset) \\ &= 0 \quad (for\ T\ OSA \le T\ set) \end{aligned}$$

Where Mass Factor = 1 if *T 3day > T saturation*, = 0 if *T 3day <= T saturation*
*T 3day* is the 72 hour running average outdoor temperature

*T set* is the first independent variable in the two variable linear cooling models. It is also loosely related to the physical cooling set point

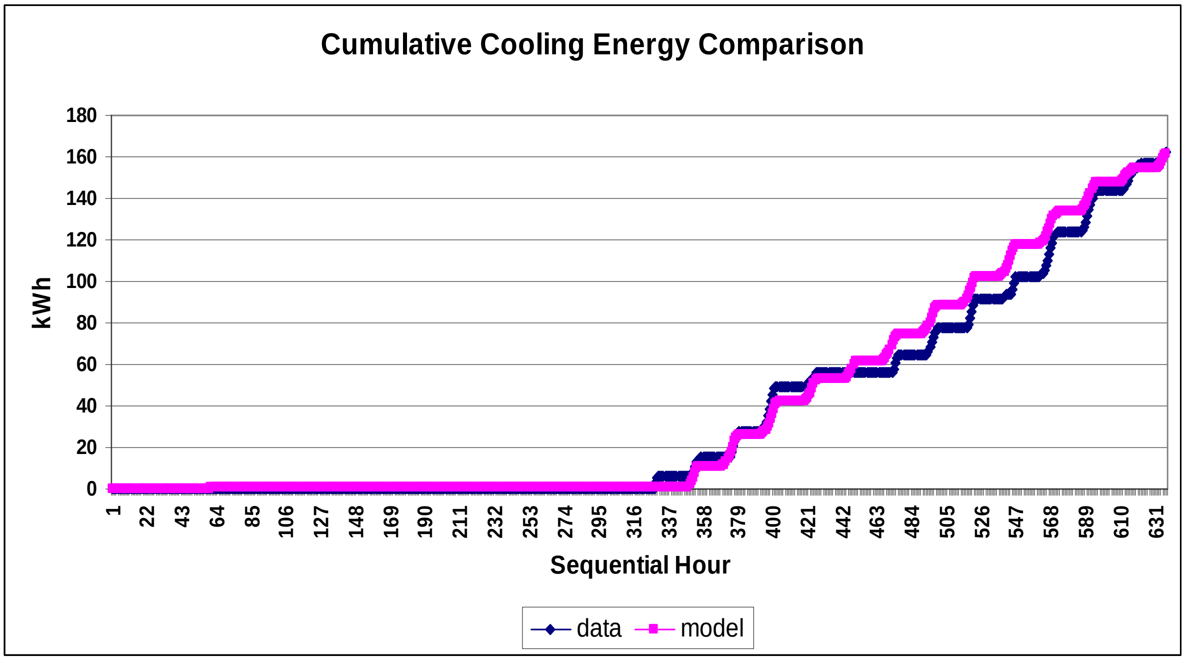
*Slope* is the second independent variable in the two variable linear cooling models

*T saturation is a temperature below which cooling is not triggered*

Currently the variables *T set, Tsaturation,* and *slope* were manually selected based on the constraints that the cumulative total modeled cooling energy be equal to the total monitored cooling energy, and that the curve of the modeled cumulative energy track reasonably closely the curve of the cumulative monitored cooling energy. Figure E-4 is an example of a comparison of the cumulative modeled and monitored cooling energy.

The cumulative energy use is the point of comparison here because the timing of the cooling energy use at the monitored site is quite irregular, but in the longer term the cumulative cooling energy use is reasonably regular and can serve as a point of comparison. The fact that these cumulative cooling curves are reasonably congruent is an indication that the simple linear cooling model is applicable to this type of situation.

**Figure E-4: Cumulative Cooling Energy**




Another view of the monitored vs. modeled cooling energy is given in Figure E-5 which shows four weeks of cooling energy and associated temperatures.

**Figure E-5: Example Test Site Data**

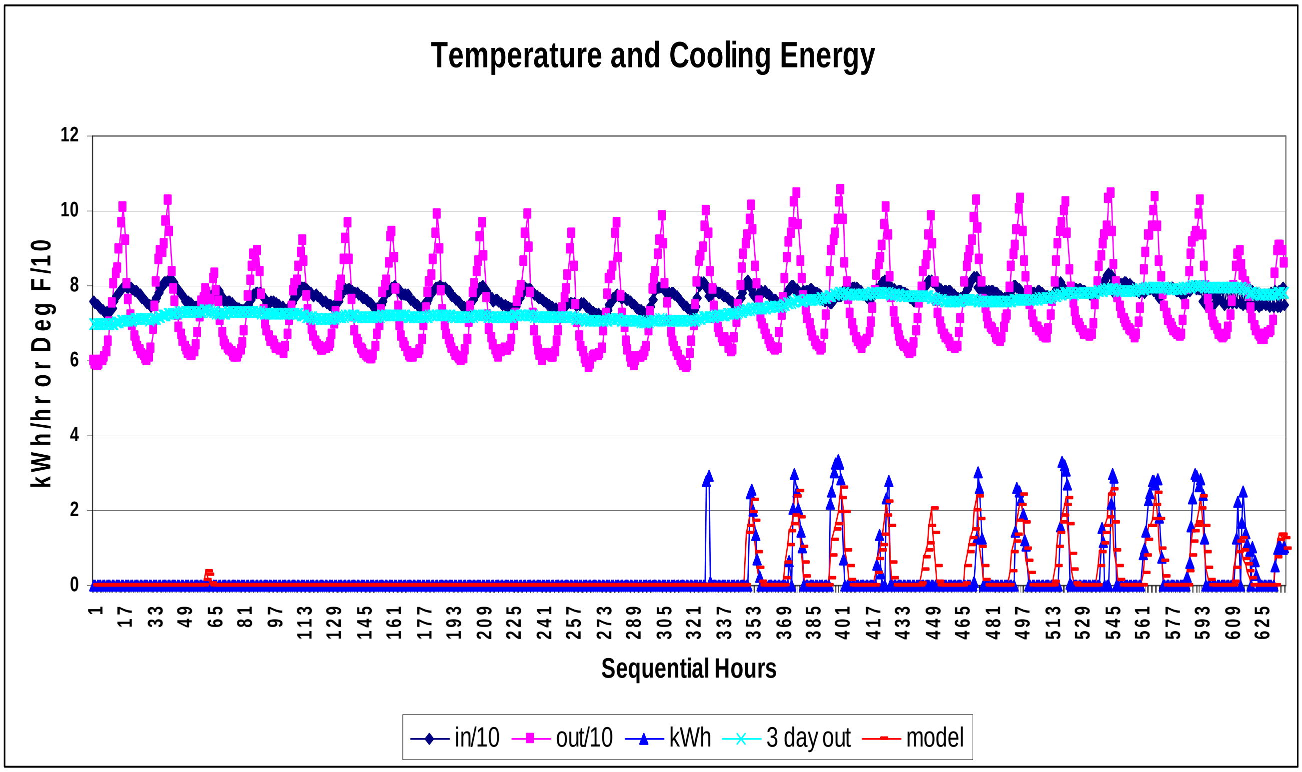



Figure E-5 illustrates the need for the mass factor in the cooling energy model. Note that there is no cooling in the first half of this period, as the building itself comes up to temperature. The cooling does not begin until the three day average outdoor temperature (3 day out) is equal to or above the average indoor temperature. Notably this figure shows an energy model approximately tracks the monitored cooling energy.

## Annualized and 8760 Energy Use

### *Annualized and 8760 Energy Estimates and Peak Demand Estimates*

This cooling model uses a time sequence of average hourly outdoor temperatures as the driver and input. The variable *T 3day,* which is a running average temperature, constrains the model to use time sequence data as opposed to other models which use a temperature histogram as input. When the input temperature sequence is a full year of outdoor air temperatures, as from a CZTMY, then the sum of the hourly cooling energy will be the normalized annual cooling energy for the particular building at the designated CZTMY location.

A CZTMY used with this model will produce an hourly estimate of the cooling energy for the full 8760 hours of the TMY year for that temperature location. The hourly energy can then be distributed into seasonal and hourly costing bins as necessary to support a cost-effectiveness analysis. This monitoring also includes the variable, *kW out*, which is the maximum hourly cooling power. This variable can be accurately derived and it is closely related to the site demand. Site demand, however, is not the same as the utility diversified demand which is the real quantity of interest in the utility system cost-effectiveness perspective. Since the utility diversified demand is essentially average hourly energy use, it is assumed the hourly energy alone will be sufficient to support the cost-effectiveness analysis.

The use of such hourly estimates requires some clarification. In essence the cooling model posits a very regular HVAC, which responds to a particular temperature the same way every time. The monitored HVAC is not so regular and responds to a particular temperature somewhat differently each time. Over time both the model HVAC and the monitored HVAC are constrained to deliver the same cooling day to day and in total.

Briefly, cooling energy used by the synthetic base case units for each of the 8760 annual hours is calculated in four distinct steps:

Estimate the compressor and condenser fan energy for the monitored unit, using the outdoor unit cooling energy model described above.

1. Estimate the corresponding hourly energy for the synthetic base case references using the EER vs. temperature models, derived as above or use the EER vs temperature curves developed for the empirical base cases.

2. Adjust the hourly energy use estimates for the synthetic reference units for the hourly part load conditions. In general, the part-load characteristics of the units will be different for the SEER 10 and SEER 13 units.

3. Add the hourly indoor fan energy. For the monitored unit, this fan energy is based on a one-time measurement of the fan energy and the hourly cooling duty cycle. For the SEER 10 and SEER 13 units, the fan energy is based on the hourly duty cycle and an estimated fan power based on the measured flow rate using fan energy coefficients from DEER. In commercial units the fan power is often evident in the monitored data for fan only operation, and the fan power and any timed fan operation can be detected.

***Annualized Base Case SEER 10 and SEER 13Outdoor Unit Cooling Energy Estimates***

The starting point for estimating SEER 10 or SEER 13 base case energy use was the modeled hourly normalized cooling energy for the monitored site. This normalized cooling energy for each hour was modified by multiplying it by the ratio, *R 10 t out* or *R13 t out* to give the normalized hourly cooling energy for the hypothetical SEER 10 and SEER 13 cases respectively. Note that these ratios were unique to each site.

The hypothetical SEER 10 and SEER 13 base case unit responds to the same load as the monitored unit and in general it uses a different amount of cooling energy such that for each cooling hour:

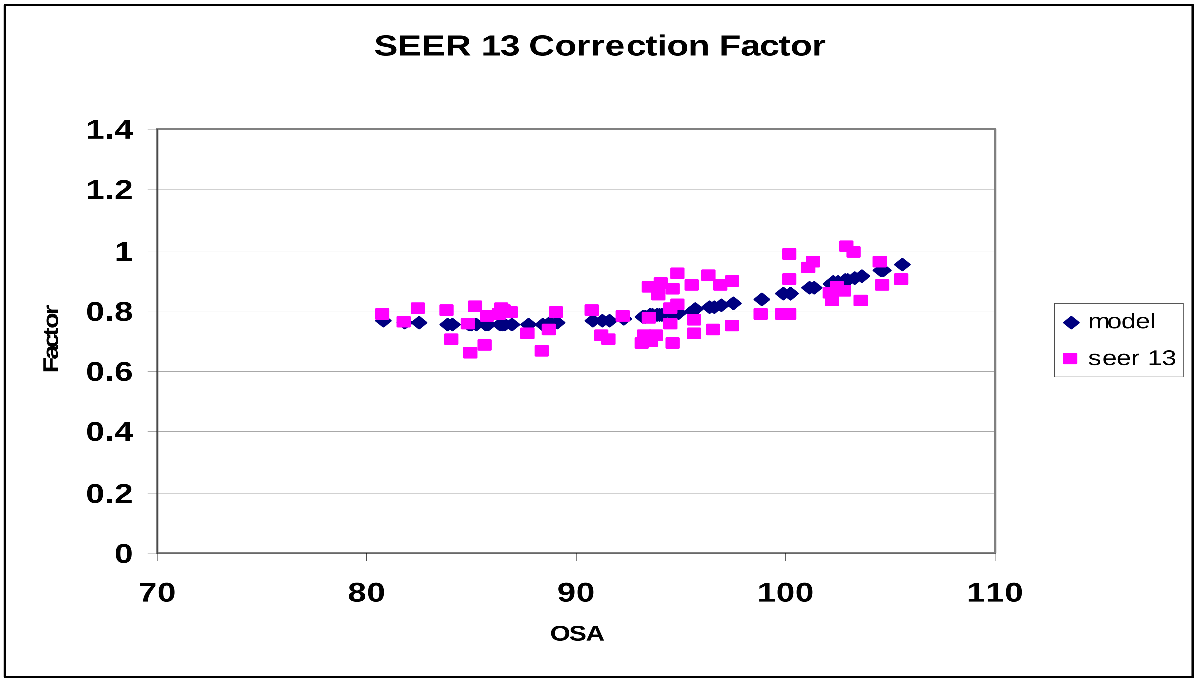
**Equation 7: Cooling Energy Estimate**

*kWh seer10 = kWh total*EERmonitored/EER seer 10 = kWh total*R10 t out,* and
*kWh seer13 = kWh total**EERmonitored/EER seer 13 = *kWh total*R13 t out,*

where the EER monitored and EER seer 10 or EER seer 13 are all functions of temperature.

Note the EER used here were for the compressor and condenser fan only (supply fan energy has not yet been included) and were based on the total cooling output. Figure E-6 shows the temperature dependence of the correction factor, *R13 tout.*

**Figure E-6: Correction Factor for SEER 13**




Ratios of the EERs designated *R10 t out* and *R13 t out.,* were clearly not strictly a linear function of *T out,* as might be expected, but were quadratic functions of *T out* with the form:

**Equation 8: Quadratic functions of EER ratios**

*R10 t out* or *R13 t out* = A+B**T out*+C**Tout*^2

The ratio functions *R10 t out* and *R13 t out* were both functions of the outdoor temperature and potentially unique from hour to hour; so these ratios were calculated and applied to each of the 8760 hours in the normal cooling year.

### *Hourly Part Load Correction*

The hourly part load correction is based on the hourly part load characteristics in the DEER data base (DX performance maps DEER 08) for the specified SEER 10 and SEER 13 units. These part-load characteristics were used with part-load conditions from the model to derive the part-load correction. In the DX performance maps there are two functions developed for part load correction, the EIR_PLR curve fit coefficients and the "Closs" curve fit coefficients. Generally the "Closs" correction is used for residential applications and the EIR_PLR is used for commercial;

only one correction or the other is used. Notably, both corrections express the same physical event in different forms.

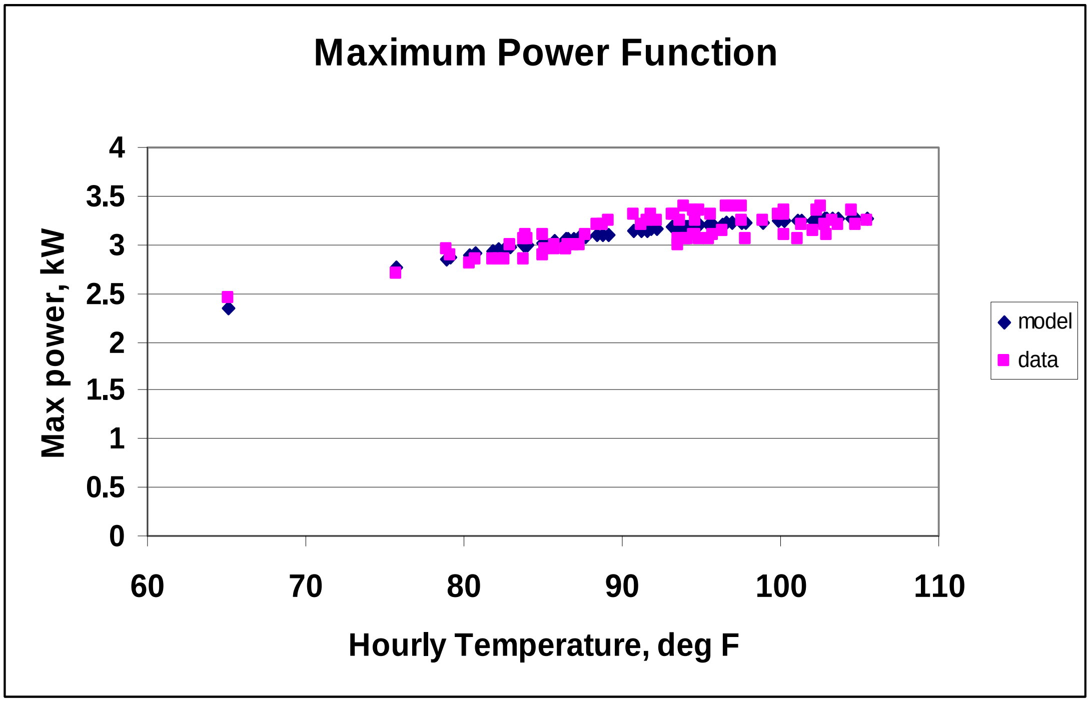
The part-load characteristics for the monitored unit are already implicit in the energy model, which has been calibrated to the total observed cooling energy, including all part-load effects. The part-load correction proceeds in several steps.

First, for each hour, the part-load ratio, PLR, is calculated. The part-load ratio is generally defined as the *hourly load/ hourly capacity*. In terms of this analysis:

*PLR = kWh out/ kW out*

where *kWh out* is from the Outdoor Cooling Energy Model described above, and *kW out* is calculated from a temperature function of *kW out* vs. *T out* derived from the monitored data. An example of this function is shown in Figure E-7.

**Figure E-7: Maximum Power Function**




This figure shows maximum power as a function of outside temperature in the form:

*Max power = kW out = X1 + X2* T out + X3 * (T out)^2*

These hourly part-load ratios are then used as the independent variable inputs to part-load functions stipulated in the DEER database for use in eQuest modeling. These part-load functions are cubic functions of the part-load ratio, PLR, in the form:

*Part Load EIR10 = X1 + X2*PLR + X3* (PLR)^2 + X4* (PLR )^3* the same form of function applies for *Part Load EIR13*.

The coefficients for these functions are given in Table E-5.

**Table E-5: DEER Part Load Coefficients**

| Unit | X1 | X2 | X3 | X4 |
|---|---|---|---|---|
| SEER 10 | .00017 | 1.26645 | -.3629 | .096274 |
| SEER 13 | 1.2E-5 | 1.115296 | .13713 | .021822 |

These functions evaluate to a number slightly larger than the independent variable PLR over the range of 0 to 1. This expresses that it takes more energy to serve a part load situation because some of the cooling output has been stranded in the machinery when the unit shuts off.

For this analysis, this information is cast into the variables used to make the correction for part-load conditions. These variables are *PL E ratio10* and *PL Eratio13* where:

*PL Eratio10 = Part Load EIR/PLR*, and *PL Eratio13 = Part Load EIR13/PLR*

In practice the variable *PL E ratio10* assumes a value of 1 at full load and a value of 1.23 at a *PLR* of .1. The *PL Eratio13* assumes a value of 1 at full load and a value of 1.1 a *PLR* of .1. This expresses the SEER 13 unit has better part-load performance than the SEER 10 unit.

These variables are used to correct the estimates of outside energy use for the SEER 10 and SEER 13 base case units as follows:

*kWh seer 10 part load corrected = kWh seer 10 * PL Eratio10*

and

*kWh seer 13 part load corrected = kWh seer 13* PL Eratio13*

***Indoor Fan Energy***

The monitored cooling energy is only for the compressor and condenser fan. The full refrigerant-based cooling energy should include the indoor fan as well. The energy use by the indoor (supply) fan was not monitored. But, for each hour, it is estimated from a measurement of the indoor fan power, assumed constant, and the hourly duration of the cooling. Note that the fan energy included here is only that associated with refrigerant-based cooling; it does not include fan energy for ventilation. For each hour, the hourly duration of cooling is the *PLR* for that hour. Thus, fan energy for each of the 8760 annual hours is

*Monitored unit hourly fan energy = PLR* site measured fan power*
*SEER 10 base case hourly fan energy = PLR * DEER SEER 10 fan power, and*
*SEER 13 base case hourly fan energy = PLR * DEER SEER 13 fan power*

Where,

*DEER SEER 10 fan power* = .365 fan W/cfm * site measured cfm
*DEER SEER 13 fan power* = .365 fan W/cfm * site measured cfm

The energy from the indoor unit fan, (motor thermal losses, joule heating, and kinetic energy), is released into the cooling airstream, and lessens the delivered cooling rate by the BTU/hr equivalent of the fan energy. This adds to the cooling load and requires increased cooling energy in the amount of EIR* fan energy. This correction for “fan heating” is added to the fan energy estimates for the synthetic base cases (the DEER derivatives); the correction is not added to the empirical base cases because this effect was included in the monitoring upon which the empirical base case was derived

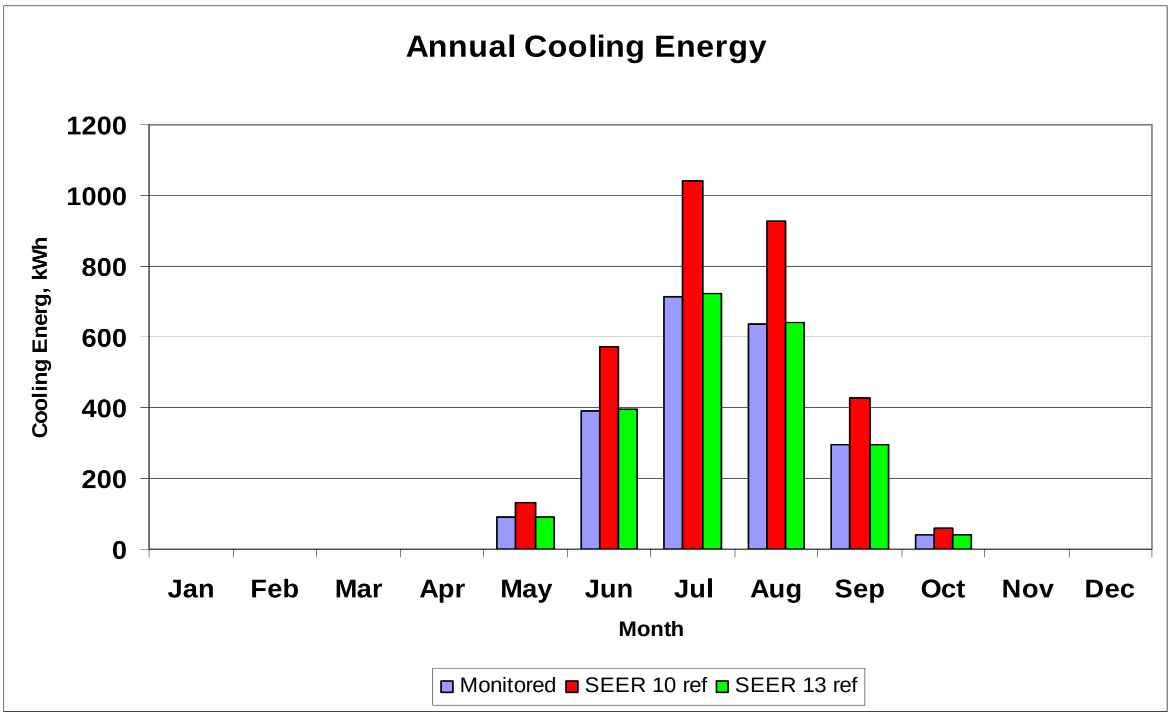
In the case of a monitored two-stage unit, the hourly fan energy is assumed to be composed of the fan energy of the first and second stages, which are mixed in the ratio of the first stage to second stage observed for the whole monitoring period, and the first-stage fan flow is assumed to be 80% of the second-stage fan flow. The fan power is assumed to vary with the square of the flow, thus an 80% fan flow for first stage would have 64% fan power for the first stage.

In the commercial analysis it is common for a fan to operate on a timed schedule, of even a 24 hour/day fan schedule. For the commercial analysis if a timed fan is observed in the data, the energy for the full timed fan cycle is included as operating energy. In the residential analysis a timed fan was rare, and only fan energy associated with active cooling cycles is included as operating energy.

### *Total Cooling Energy*

Total cooling energy is the sum of the outdoor unit energy, as corrected for part load and the supply fan energy. The sum of the total cooling energy for the 8760 hour normalized year is the total annual cooling energy. The final output of the site analysis is an estimate of the annual cooling energy for the monitored unit and for the hypothetical SEER 10 and SEER 13 units, operating under the same conditions that drive the monitored unit. Figure E-8 shows a comparison of the annual energy use by month for a site in Fresno, CA.

**Figure E-8: Comparison of Annual Cooling Energy**




This model for the monitored building and the SEER 10 and SEER 13 alternates may be used with the outdoor temperatures for a particular designated site, as provided by CZTMY hourly outdoor temperatures for that location. In this way, the performance of a building operating under the same conditions that prevailed inside the monitored building may be rendered for a variety of different locations. In the case of Figure E-8, the monitored building was near San Diego CA, but the annual performance was rendered for a much warmer location, Fresno CA.

In principle, the model derived for each building could be used to describe the performance of the monitored building in any climate zone for which hourly temperature data is available. Thus the average performance expected for any particular climate zone can be derived from a sample of all monitored buildings, which improves the precision of an average estimate for climate zones with no monitored data or with very little or erratic monitored data. In practice, it has been observed that the thermostat set points of the hotter zones are higher than for the cool zones. This effect is probably related as much to behavior as it is to physics, and as a precaution, the whole set of monitored sites has been broken into two behavior sets: one for the mild zones, (6, 7, 8, 9), and one for the hotter zones (10, 12, 13, 14, 15). When estimating the average performance in any particular climate zone only the sites in the appropriate behavior zone are used in the aggregation.

One observed limitation to this approach of generating multiple savings estimates from a single unit model was the incompatibility of zone 15 unit models with 8760 TMY temperatures from any other zone. The climate in zone 15 is so severe that, in the residential monitoring, occupant behavior patterns were simply too disparate to include zone 15 in any aggregate behavior zone. Specifically zone 15 residents are less sensitive to extreme heat and tend to have much higher thermostat set points. Generating zone 10 savings estimates with zone 15 unit models significantly biased the annual usage estimates, and savings estimates downward; the converse was true in that using zone 10 unit models for zone 15 estimates significantly biased annual usage estimates, and thus savings estimates upward. After careful consideration, zone 15 residential was considered on its own. This resulted in a loss in precision of the zone 15 savings estimates, although that contributed minimally to the overall precision as zone 15 was a less populous zone. It should be noted that, in the commercial analysis, the lessened effect of occupant psychology on building energy use proved enough to include zone 15 in the hotter behavioral zone.

In Figure E-8, the monthly cooling energy use has been aggregated from an 8760 estimate of hourly cooling energy use, which is the normal output of the *analysis spreadsheet*. If necessary, there is an 8760 hour stream of estimated cooling energy use for the monitored building and for the same building, assuming cooling via the base case SEER 10 and SEER 13 units.

Note in Figure E-8 the monitored unit appears to have the same energy use as the SEER 13 reference, as would be expected from the installation of a code compliant unit. Note also that the SEER 10 reference shows greater cooling energy use due to the generally lower efficiency of the unit.

The final output of all these calculations for a particular site is a single row consisting of about 25 output variables which summarizes the site ID information, site measurements, and calculated results. As each site analysis is completed, this row summary is added row by row to a database of all sites.

***Grid Demand Estimate***

The grid demand used here was defined as the average energy for nine specified peak hours. These peak hours are the hours of 2PM to 5PM on three sequential weekday peak temperature days. The peak temperature days have been specified for each California temperature zone. The grid demand for the monitored unit is therefore the average of the total refrigeration based cooling energy for the nine specified hours of the annual demand event. The energy use for these nine specified peak hours is drawn from the 8760 stream of total cooling energy estimated for the site.

It is notable that this grid demand can be lower than the highest observed cooling demand at the site because the unit may not be operating for an entire peak hour or the unit may be off during a peak hour, and this off time will be averaged into the grid peak estimate making it lower than the highest observed peak power. It is intended that the grid demand estimate include the effects of non-operation during a system peak.

The grid demand for a base case unit will be *Grid Demand Monitored*EER monitored/EER base case*, where the EER for the monitored and base case units is evaluated at the average peak hour temperature.

***Description of Non-Standard Statistical Methods Used***

The unit level uncertainty presented in evaluation report Section 6.4.1 considered the uncertainty relating to the energy model and EER model with a technique referred to as a higher dimensional “bootstrapping” method. “Bootstrapping” involves repeated sampling with replacement from the distribution of observed points for a large and arbitrary number of iterations, then computing the desired summary statistic for each sample generated in this way. In this way the distribution of the desired summary statistic can be considered numerically. Typically bootstrapping is useful when the population distribution, the summary statistic’s distribution, or both, are unknown. In this case the summary statistic is the unit level savings estimate, which is the result of interactions between the energy model, efficiency model, and vector of 8760 hourly temperatures.

To apply this method to the energy model, the observed distribution is a set of points where each point has three individual values: (1) an average outdoor temperature, (2) a three-day running average outdoor temperature, and (3) a monitored energy usage. The distribution of these points is considered as a random sample from a three dimensional random variable. The sample is regenerated by sampling with replacement from the observed, empirical sample. Then the energy model is recalibrated and the unit savings estimate resulting from that energy model is tabulated. The entire process was repeated with 1,000 iterations in the analysis to generate the distribution of unit savings with respect to uncertainty in the energy model.

Applying this method to the EER model was almost identical, except each point consisted of only an outdoor temperature and an EER. The observed distribution of coincident outdoor temperature and EER points was considered as a random sample from a two dimensional random variable. The sample was regenerated as described above to numerically describe the distribution of unit savings with respect to uncertainty in the efficiency model.

The other incidence in the methodology of statistical methods requiring additional explanation and justification involved calculating overall precision levels for utility level program savings estimates. The use of unit models to generate multiple savings estimates across behaviorally similar strata introduced a correlation between those savings estimates. For example, if the evaluation metered a unit that randomly happened to perform better than average in zone 7, then that particular unit model would have been used for zones 6, 7, 8, and 9 and would tend to bias the sample mean of each of those zones upward.

Since the program level savings are calculated as a linear combination of stratum specific unit savings, the variance of the program level savings are the variance of that linear combination. This is somewhat complicated by the fact that each stratum specific unit savings is the sample mean of the individual savings observed in that stratum. By using basic identities of variances and covariances of sums and scalar multiples, the exact analytics were derived. The results from these calculations were checked against the results calculated from an assumption of independence, i.e., inclusion of the positive correlation tended to add around 4% to the magnitude of the error bounds, as to be expected.

***Check Points***

The topic of variability has been discussed at length, and another useful topic to consider while discussing reliability of findings pertains to the accuracy of the evaluated results in an absolute sense. For this work, a limited check on reasonableness of the metered results is provided by a comparison of these results with similar work.

The metering and analysis results for the early replacement HIM provide several points of comparison with other independently derived analyses. The check points will be restricted to other work that may be applicable to this region, and should particularly exclude work done in very different humidity regimes. The evaluation found three applicable check points, (1) an EER check with other field work, (2) an EER check with laboratory measurements, and (3) estimates of annual cooling energy from other field work and from billing analysis. Taken together these comparison checks with other work suggests that the KEMA/CADMUS metering and analysis is in general agreement with other similar metering and analysis.

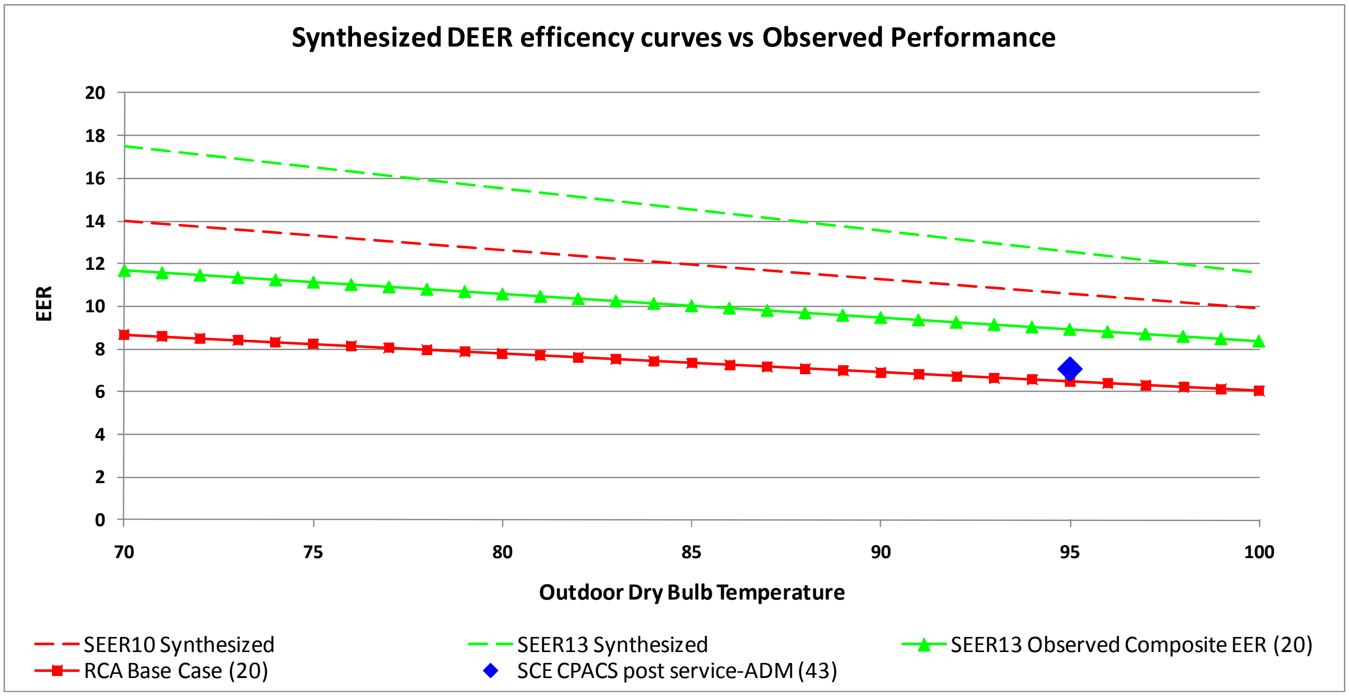
***Check Point 1***

To start with a comparison of EER measurements, a study was commissioned by SCE.[2] This study comprehensively monitored 109 units. EER was determined from on site protocol and yielded a single measurement per site (often for pre and post conditions) which was then normalized to standard conditions, 95 degree outdoor dry bulb and 67 degree air handler entering wet bulb.

A subset of this study consists of 43 EER measurements of units that have completed the RCA treatment. The KEMA/CADMUS work in this current study uses an empirical baseline denoted as the RCA base case that is derived from 20 units that have completed the RCA treatment. It is important to note that the KEMA/CADMUS analysis draws 100 or more steady state EER measurements from monitored data and reduces them to a function of EER vs. temperature, while the ADM approach focuses on developing a single accurate measurement at standard conditions. Figure E-9 compares these two approaches.

[2] ADM Associates, Market Assessment and Field M&V Study for Comprehensive Packaged AC Systems Program, prepared for Southern California Edison, Final Report, Draft 2, May 2009.

**Figure E-9: Comparison of EER Measurements**

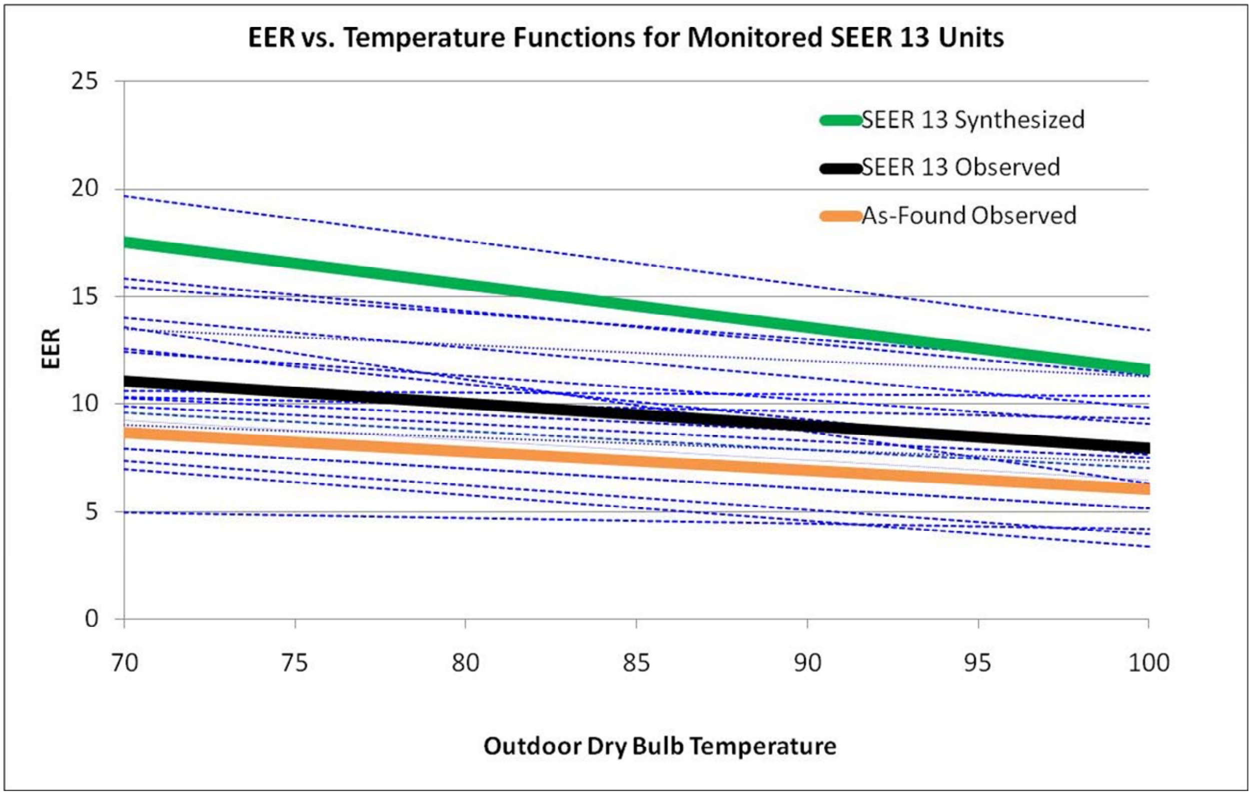



This figure shows a close comparison between the efficiency measurements in the ADM study and the KEMA/CADMUS study at the common temperature, 95 deg F. There was no information in the ADM study that would allow comparison at another temperature point. A two point comparison would give the further information necessary to determine the slope of the EER curve. In the case of the ADM work, that slope will revert to the slope of the laboratory measurements of unit performance because that information was used to normalize the field performance to the 95 degree outdoor dry bulb and 67 degree entering wet bulb normal conditions.

***Check Point 2***

The evaluation team also compared this study's field observed EER vs. temperature functions indirectly to laboratory performance estimates. The DEER, eQuest, DOE constellation of modeling relies on the steady state laboratory measurements of many specific equipment types and formulates these measurements into general performance functions (bi-quadratics, cubics, etc). These performance functions can accurately render a steady state EER estimate for given field conditions. This EER estimate can be put into the form of an EER vs. temperature function that would represent the reasonable highest performance to be expected, i.e. performance at steady state laboratory conditions. Two of the KEMA/CADMUS base cases, (the SEER 13 residential, and the commercial nonparticipant base case) both consist of new SEER 13 units. In Figure E-10 and Figure E-11 the individual site EER functions are compared to the DEER SEER 13 EER function.

**Figure E-10: Residential SEER 13 Units**




Note in this figure that the DEER SEER 13 line approximately forms the upper bound for the performance functions for the individual sites.

Figure E-11 shows approximately the same pattern as Figure E-10 where the DEER SEER 13 function forms the upper limit of the individual site EER functions.

**Figure E-11: Commercial Non-Participant Base Case**

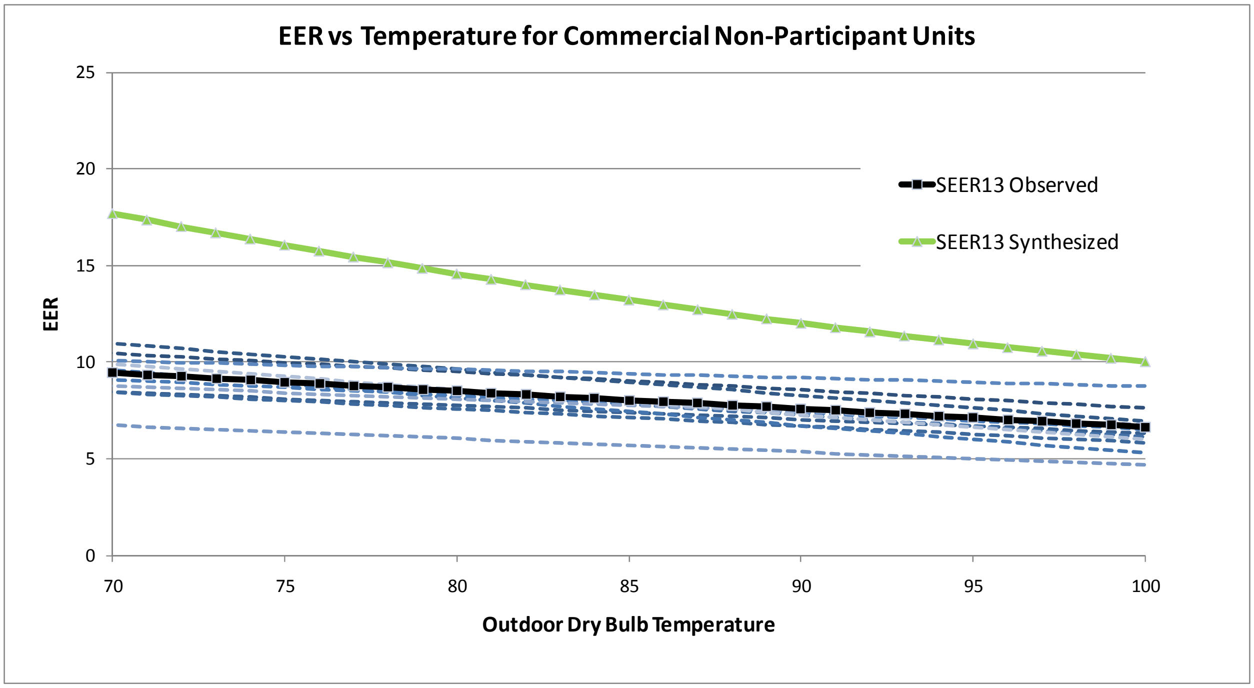



Figure E-11 is from a much smaller data set than Figure E-10 and does not show the full range of results as is shown for Figure E-10, but the composite results of Figure E-11 are very similar to those in Figure E-10. Note that the largest difference in efficiency between the observed units and the synthesized case is at outdoor temperatures in the 70s or low 80s, which contributes minimally to annual cooling energy.

These two figures show that the field results do not exceed the ideal results, which would suggest a significant measurement bias. The figures also show that, most probably, the ideal laboratory test results form an upper bound for the actual field performance.

If this is the case then it is hard to escape the question of why the field units perform so poorly on average. In the residential case, Figure E-10, some perform fully at expectations, about 15%, but on average the composite performance is much lower than the ideal. It may be possible to ascribe the spread in these field measurements to measurement errors, but if so, there still remains a significant difference between the ideal and the mean. This observation lends credence to the current need to investigate and to optimize installation conditions.

***Check Point 3***

The three recent studies, including this current study, reviewed for this analysis estimated the annual cooling energy as shown in Table E-6.

**Table E-6: Annual Cooling Energy**

| Study | Average Annual Unit Cooling kWh | Analysis type | Sample Size |
|---|---|---|---|
| KEMA/CADMUS | 1316 | Site monitoring | 170 |
| ADM | 1303 | Site Monitoring | 43 |
| EMI[3] | 2500 | Billing Analysis | >2000 |

The annual cooling energy is important because it relates strongly to the final UES and realization rate. The monitored sites have produced remarkably similar estimates for average annual cooling. A more detailed review of the monitored data shows a wide variation with climate which will dominate any average, so a rigorous comparison would require consideration of a distribution by climate zone which was not available.

Also it should be noted that the EMI estimate is based on a mathematical disaggregation to end-uses, and not on direct measurement. There are several good reasons why these estimates will be higher than the monitored estimates.

1) The EMI estimate is by premise, not by AC unit, and may include more than one AC unit at some premises.

2) The monitored estimates do not include fan energy which may be functionally serving a cooling need such as night venting, evaporative cooling and venting in general.

[3] Energy Market Innovations, Inc., CPACS RCA Billing Analysis Report, prepared for Southern California Edison, April 2009.

# F. Rooftop or Split System Air Conditioner Replacement Site and Meter Issues

Issues related to equipment failure and contractor actions reduced the quantity and quality of metered data achieved. The following tables document the failure events for SCE 2507 and SDGE 3029 commercial and residential data analysis. The tables indicate whether the site was removed from the analysis for metering related issues such as equipment malfunction or for analytic reasons, such as insufficient cooling.

**Table F-1: Residential SDGE 3029 Analysis and Meter Issues**

| Unit ID SDGE 3029 Residential | Analysis Issues | Meter Issues |
|---|---|---|
| 1 | Outdoor Unit only took readings for 10 minutes so this site cannot be used for analysis | Meter was not set up properly |
| 2 | Central AC was not working due to a placement of the furnace fan cover. The safety switch was not released to allow the air handler fan to operate. | None |
| 3 | Insufficient observed cooling | MicroStation battery problem - microstation was jarred and batteries were no longer correctly connected |
| 4 | Outdoor unit malfunctioned - no observed cooling | Meter was not set up properly |
| 5 | Not enough observed cooling data. Unit 2 | None |
| 6 | No observed cooling | None |
| 7 | Insufficient observed cooling | None |
| 8 | No observed cooling | None |
| 9 | The outdoor meter got water inside and will not download. | The outdoor meter got water inside and will not download. |
| 10 | No outdoor meter data | None |
| 11 | Insufficient observed cooling | None |

| | | |
|---|---|---|
| 12 | Indoor unit meter only recorded for 13 minutes so this site cannot be used for analysis | MicroStation battery problem - microstation was jarred and batteries were no longer correctly connected |
| 13 | Not enough observed cooling | None |
| 14 | Supply temp was responding to compressor operation, but was consistently 20-40 degrees too high. Sensor may have been misplaced or may have simply malfunctioned | Bad Temp sensor |
| 15 | Insufficient observed cooling | MicroStation battery problem - microstation was jarred and batteries were no longer correctly connected |
| 16 | Air handler temperature sensors malfunctioned, Unit 2/2 | MicroStation battery problem - microstation was jarred and batteries were no longer correctly connected |
| 17 | Insufficient observed cooling | MicroStation battery problem - microstation was jarred and batteries were no longer correctly connected |

**Table F-2: Residential SCE 2507 Analysis and Meter Issues**

| Unit ID Res SCE 2507 | Analysis Issues | Meter Issues |
|---|---|---|
| 1 | Downstairs Unit. Outdoor Unit malfunctioned | Meter was not set up properly |
| 2 | Upstairs unit. Outdoor unit malfunctioned | Meter was not set up properly |
| 3 | Insufficient observed cooling | MicroStation battery problem - microstation was jarred and batteries were no longer correctly connected |
| 4 | Insufficient observed cooling | Meter was not set up properly |
| 5 | Insufficient observed cooling | MicroStation battery problem - microstation was jarred and batteries were no longer correctly connected |
| 6 | No outdoor temperature data, unit 1 of 2 | Meter was not set up properly |
| 7 | No outdoor temperature data, unit 2 of 2. | Meter was not set up properly |

| | | |
|---|---|---|
| 8 | Insufficient observed cooling | None |
| 9 | Insufficient observed cooling | None |
| 10 | Insufficient observed cooling | None |
| 11 | Insufficient observed cooling | None |
| 12 | Insufficient observed cooling | None |
| 13 | Insufficient observed cooling | None |
| 14 | Unit 1 of 2. Only 2 cooling intervals | None |
| 15 | Unit 2 of 2. Only 11 cooling intervals | None |
| 16 | Outdoor unit malfunctioned; Customer not in "Site Info" database | None |
| 17 | Thermostat stopped working after one reading, condenser meter stopped working after 28.5 minutes. | Meter was not set up properly |
| 18 | Errors throughout condenser data | Bad meter |
| 19 | No thermo, air handler meter stopped after 1.5 hours, cond meter stopped after approx 2 hours. | Meter was not set up properly |
| 20 | Thermostat stopped working after one reading, condenser meter stopped working after 34 minutes, air handler stopped working after 34 minutes. | Meter was not set up properly |
| 21 | Lack of customer data | Meter was not set up properly |
| 22 | Insufficient observed cooling | None |
| 23 | No data from outdoor unit | Meter was not set up properly |
| 24 | Insufficient observed cooling | None |
| 25 | Large gaps in outdoor unit data | Bad meter |
| 26 | Insufficient observed cooling; lack of customer data | None |
| 27 | No condenser data unit 1/2 | Meter was not set up properly |
| 28 | Air handler and condenser both stopped working after 20 minutes. Unit 2/2 | Meter was not set up properly |
| 29 | Insufficient observed cooling | None |
| 30 | Insufficient observed cooling | None |
| 31 | Very few rows with cooling activity | None |
| 32 | Return 2 file is from a different site, or the air handler meter was installed three months before the others. | Meter was not set up properly |
| 33 | Metered participant unit, not non part unit | None |
| 34 | Insufficient observed cooling | AC Unit was not working properly |

**Table F-3: Commercial SDGE 3029 Analysis and Meter Issues**

| Unit ID SDGE 3029 Commercial | Analysis Issues | Meter Issues |
|---|---|---|
| 1 | Supply temp and power do not match. | None |
| 2 | Supply temp and power do not match. | None |
| 3 | Air handler data cuts out | MicroStation battery problem - microstation was jarred and batteries were no longer correctly connected |
| 4 | Air handler malfunctioned | MicroStation battery problem - microstation was jarred and batteries were no longer correctly connected |
| 5 | Unit did not deliver any cooling -- Supply temps are approximately equal to return temps. | None |
| 6 | Unit malfunction | MicroStation battery problem - microstation was jarred and batteries were no longer correctly connected |
| 7 | No observed cooling | None |
| 8 | Insufficient observed cooling | None |
| 9 | Insufficient observed cooling | None |
| 10 | No observed cooling | None |
| 11 | No observed cooling | None |
| 12 | No air handler data | None |
| 13 | Unrealistic EERs | None |
| 14 | Problems with EERs | None |
| 15 | Nonsensical counts vs. temp data | None |
| 16 | Nonsensical counts vs. temp data | None |
| 17 | This site had two units connected in parallel. Analysis based on combined power produces unrealistic EERs. | None |
| 18 | This site had two units connected in parallel, and analysis based on combined power produces unreasonable results. | None |
| 19 | Data from outdoor unit was nonsensical. | Meter was not set up properly |
| 20 | Errors in EER calculations | None |
| 21 | No observed cooling | None |
| 22 | Insufficient observed cooling | None |
| 23 | Insufficient observed cooling | None |

**Table F-4: Commercial SCE 2507 Analysis and Meter Issues**

| Unit ID Commercial SCE 2507 | Analysis Issues | Meter Issues |
|---|---|---|
| 1 | No cooling at high temps, had to change the 10 degree within max assumption to 25 to fit the model. The fit is as a result somewhat unrealistic | No metering error |
| 2 | Insufficient observed cooling | No metering error |
| 3 | Insufficient observed cooling | No metering error |
| 4 | Insufficient observed cooling | No metering error |
| 5 | This unit is not on the participant list | No metering error |
| 6 | No observed cooling | No metering error |
| 7 | Cooling was too sporadic to fit energy model | No metering error |
| 8 | Cooling was too sporadic to fit energy model | No metering error |
| 9 | Cooling was only observed at low temperatures--no cooling when it was 100 deg but lots of cooling when it was 70 deg, couldn't fit the model | No metering error |
| 10 | Cooling was too sporadic to fit energy model | No metering error |
| 11 | No observed cooling | No metering error |
| 12 | Air handler temps did not respond to compressor activity | Bad Temp sensor |
| 13 | No observed cooling | No metering error |
| 14 | Air handler temps did not respond to compressor operation | Bad Temp sensor |
| 15 | Air handler temps did not respond to compressor operation | Bad Temp sensor |
| 16 | Not enough observed cooling. Also, the compressor meter occasionally took unreasonably high readings (~500kW) | Bad Pulse Adapter |
| 17 | Non-Participant | No metering error |
| 18 | Cooling was too sporadic to fit energy model | No metering error |
| 19 | Supply sensor malfunctioned | Bad Temp sensor |
| 20 | Non-Participant | No problem |
| 21 | Not enough observed cooling to create energy model | No metering error |
| 22 | Non Participant | No problem |
| 23 | Air handler temps did not respond to compressor activity | Bad Temp sensor |

**Table F-5: Commercial PGE2080 Analysis and Meter Issues**

| Unit ID Comm. PGE 2080 | Analysis Issues | Meter Issues |
|---|---|---|
| KEMA112057 - Unit 2 | High OSA temp (and small range), and small supply/return temp split produce very low observed EER and skewed EER10/13 | None |
| KEMA2183 - Unit 2 | None | Bad Wattnode sensor or setup |
| KEMA23439 - HP3 | Supply/return temp. split very small. Causes unrealistic EER performance | Possibly bad airside sensors, or incorrect placement of sensors |
| KEMA3113 - Unit 2 | Unrealistic observed EER values - OSA range was small, and temp was high | None |
| KEMA31626 - Room 31 | None | Bad Wattnode sensor or setup |
| KEMA6348 - Unit 1 | 2-Stage power issues | None |
| KEMA71805 - Room 16 | Supply/return temp. split very small. Causes unrealistic EER performance | Possibly bad airside sensors, or incorrect placement of sensors |
| KEMA71805 - Room 9 | Small OSA temp range | OSA temp sensor might have been bad, or placed in an undesirable location |
| KEMA81495 - AC5 | Supply/return temp. split very small. Causes unrealistic EER performance | Possibly bad airside sensors, or incorrect placement of sensors |
| KEMA81495 - AC6 | None | Bad airside sensors, or incorrect placement of sensors |
| KEMA9022 - Break room | None | Bad Wattnode sensor or setup |
| KEMA9022 - Direct Unit | Small OSA temp range, and unrealistic supply/return temps | Possibly bad placement of airside sensors |
| KEMA9022 - Main Unit | Unrealistic supply/return temps | Possibly bad placement of airside sensors |
| KEMA9022 - Unit 3 | None | Bad Wattnode sensor or setup |
| KEMA9117 - Unit 1 | Insufficient cooling periods - Average supply was greater than average return (heater) | None |
| KEMA9117 - Unit 14 | Psychrometric Issue | None |
| KEMA9117 - Unit 15 | Suspected low heat load and longer run times - gives unrealistic EER | None |
| KEMA9302 - Unit 1 | Unrealistic observed EER values | None |

| | | |
|---|---|---|
| KEMA9302 - Unit 3 | Temp Split was very small. It's possible that the sensors were not placed in ideal locations in the air plenums, or a/the sensor(s) were bad | Possible bad air sensor |
| KEMA9308 - Studio 2 | Bad weather (OSA) data | None |
| KEMA9338 - Unit 2 | Insufficient weather data | None |
| SA_ID1720487440 - Unit 1 | Small OSA temp range and short cooling periods give unrealistic observed EER | None |
| SA_ID1720487440 - Unit 4 | Small OSA temp range and short cooling periods give unrealistic observed EER | |
| SA_ID1991367847 - Unit 1 | Small OSA temp range and short cooling periods give unrealistic observed EER | |
| SA_ID4533038105 - Unit 1 | None | Bad Wattnode sensor or setup |
| SA_ID4533038105 - Unit 2 | Small OSA temp range, large temp split, and unusually low OSA for designated CZ gives unrealistic observed EER values | None |
| SA_ID4533038947 - Unit 1 | None | Bad Wattnode sensor or setup |
| SA_ID4533038947 - Unit 2 | None | Bad Wattnode sensor or setup |
| SA_ID4730943020 - Police | Very small OSA temp. range for the small number of cooling periods available give very skewed EER results | None |
| sa_id629609005 - Unit 1 | None | Bad Wattnode sensor or setup |

# G. Rooftop or Split System Vendor Analysis

**Overview**

Vendor analysis was completed for:

- PG&E 2080 C/I Upstream A/C
- SCE 2507 C/I Upstream A/C
- SDG&E 3029 ER - C/I Upstream A/C
- SDG&E 3029 ER - Res Upstream A/C

## PGE 2080 C/I Upstream A/C

The Vendor NTG Survey Instrument for the PGE 2080 C/I program was administered by HVAC Evaluation Team staff to ten vendors for PGE 2080 commercial and industrial customers. All of the vendors surveyed for this program are distributors, but will be referred to as vendors in the remainder of this memo. See Appendix G for complete survey instrument. No customer survey was implemented for this program.

### Summary of Results

Survey results revealed:

- 100% of vendors recommended the installation of the measure to the customer in question.
- Vendor awareness of the PEP increased their recommendation of efficient measures by almost 35%.
- Past participation in a rebate or audit program sponsored by the utility was the most important attribute on vendor recommendations.
- On average, 50% of vendors' sales in PGE's service territory qualify for incentives from the Program, and vendors recommend Program qualifying equipment in 100 percent of their sales in this territory.
- 70% of the vendors sell energy efficient equipment in areas where customers do not have access to incentives. All but one of these vendors promote energy efficient models equally in areas with and without incentives.
- All vendors with the exception of one said that all of their qualifying sales received incentives (and they had no problems with receiving it).
- The program has strong influence on vendor recommendations. The estimated VMAX scores for these vendors ranged from 8 to 10, with an average of 9.4.
- Seven vendors surveyed have changed their stocking practices due to the program.

## Background Information on Sample

The survey was given to ten vendors out of 24 total vendors. For the sample, installation completion dates ranged from May 12, 2006 to December 12, 2008.

## Vendor Involvement with Customer Implementation

All ten vendors said that they recommended the installation of the measure to the customer.

## Influences on Vendor Recommendations

The program appears to influence vendor recommendation of efficient measures:

- 57% of vendors recommended the measure before they learned of the Program, while 92% recommend the measure since working with the Program (one did not know), an increase of almost 35% (see Figure G-1). This is the highest increase in recommendations seen in this overall research effort.
- The Program had an average importance rating of 8.7 in influencing vendors recommendations, on a scale from 0 to 10 where 10 is extremely important. If the Program had not been available, vendors indicated an average likelihood rating of 6.2 that they would have recommended this measure to customers, on a scale from 0 to 10 where 10 is extremely likely (see Figure G-2).

**Figure G-1: Influence of PGE 2080 C/I on Vendor Recommendation of Efficient Measures**

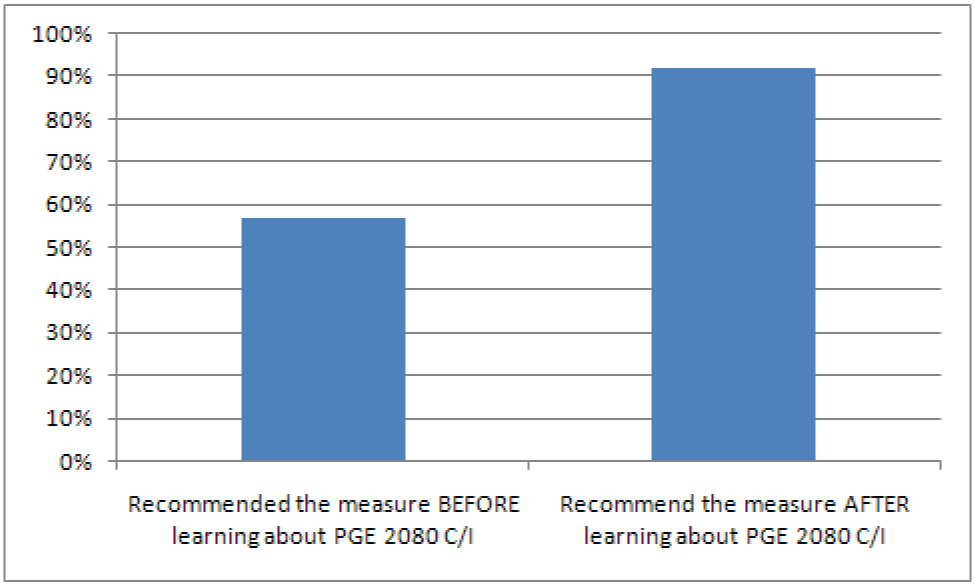
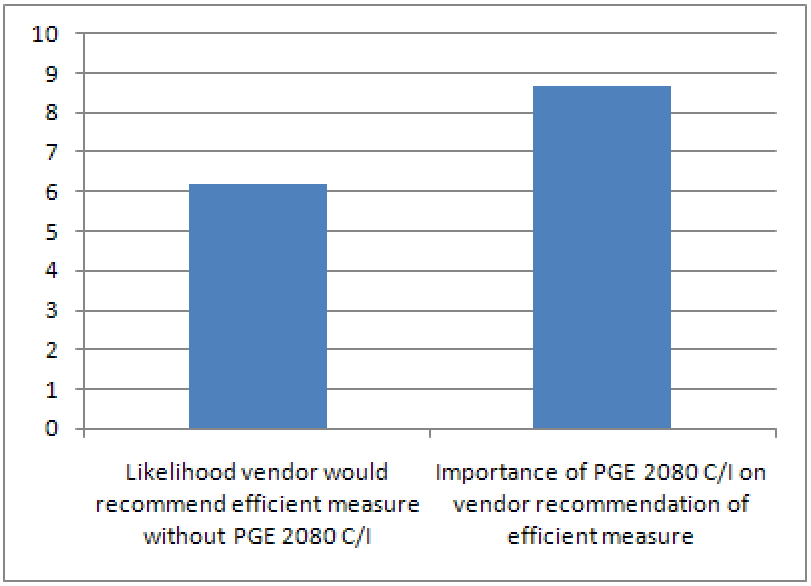


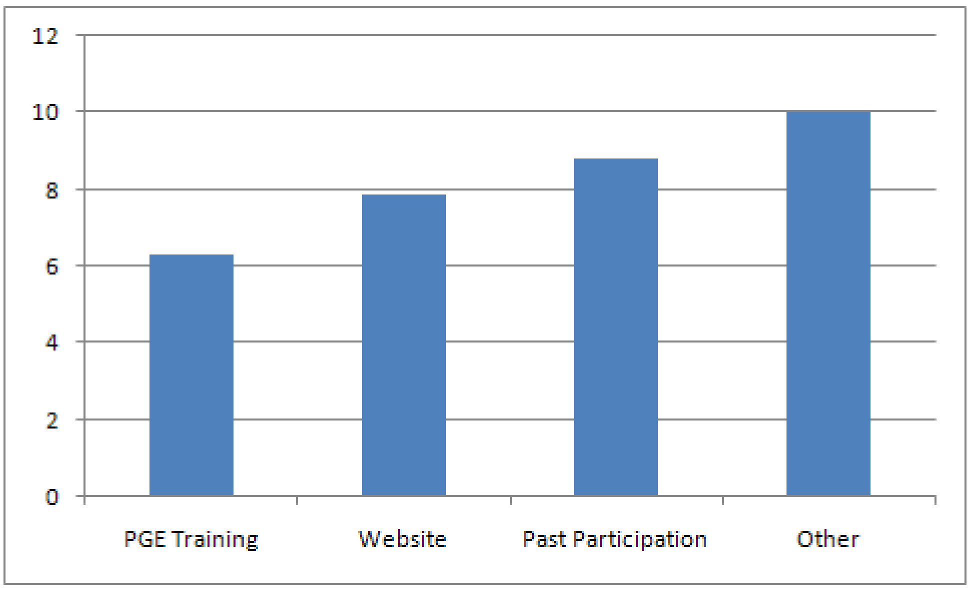

**Figure G-2: Importance Rating of PGE 2080 C/I**




Then, a series of questions, a scale from 0 to 10, were given to reveal influences on vendor recommendations (see Figure G-3):

- ***Past Participation.*** Past participation in a rebate or audit program sponsored by the utility was given an average importance of 8.8 on recommendations.
- ***Website.*** The information provided by the utility website was given an average importance of 7.9.
- ***PGE Training.*** The utility-sponsored training seminar was given an average importance of 6.3.
- ***Other.*** Two "Other" reasons were given an average importance of 10. "Other" reasons include:
    - "Education component: contractors are more confident that it is right thing to do."
    - "Training around this topic is enhanced. Importance of energy efficiency. Enhanced Evaluation Team's knowledge how to discuss impact of units."

**Figure G-3: Influences on Vendor Recommendations**




## Territory Information

On average, 50 percent of vendors' sales in PGE's service territory qualify for incentives from the Program, and vendors recommend Program qualifying equipment in 100 percent of their sales in this territory.

70% of the vendors sell energy efficient equipment in areas where customers do not have access to incentives. All but one of these vendors promote energy efficient models equally in areas with and without incentives. On average, 15 percent of vendor sales occur in these areas where incentives are not offered, and an average of 40 percent of sales are of the energy efficient models that would qualify for incentives in PGE's service territory.

### Incentives

Of the installations in PGE's service territory that qualify for incentives, all vendors but one have always received the incentive. One vendor said that “funds were mismanaged with 3rd party analysis with residential Duct incentive.”

Regarding the rebate from PGE:

- Four vendors keep the rebate.
- Three vendors passed the rebate directly to the customer.
- Two vendors split the rebate with the customer (1 gives the customer 50% of the rebate, while another gives the customer 70%).
- One vendor does not have a consistent rebate process.
- Two vendors quoted the customer a price and then identified the rebate as a deduction from the price, while two vendors quoted the customer a net price minus the rebate, not specifically identifying the rebate.

### Other Issues

Most of the vendors have changed their stocking practices as a result of the incentive program (seven said they changed, two said they did not, and one did not know).

Several vendors said they worked with many other vendors or contractors during implementation and/or installation.

### VMAX Score

A VMAX score was calculated for each survey respondent, using the algorithm provided. The score can range from 0 (program having no influence on vendor sales) to 10 (program having significant influence on sales). The estimated VMAX scores for these vendors ranged from 8 to 10, with an average of 9.4. This indicates that the Program has strong influence on vendor recommendations, and a NTGR of 94%.

## SCE 2507 C/I Upstream A/C

The Vendor NTG Survey Instrument for the SCE 2507 Program was administered by HVAC Evaluation Team staff to ten vendors (of the top 32 saving vendors) for SCE 2507 Early Retirement commercial and industrial customers. The survey examined vendor involvement with customer implementation, program influences on vendor recommendations, territory information, and items related to incentives.

## Summary of Results

Survey results revealed:

- 90% of vendors recommended the installation of the measure to the customer in question.
- Vendor awareness of the Program increased their recommendation of efficient measures by 14%.
- Training sponsored by the utility was the most important attribute on vendor recommendations.
- On average, 43% of vendors' sales in SCE's service territory qualify for incentives from the Program, and vendors recommend Program qualifying equipment in 97% of their sales in this territory.
- 70% of the vendors sell energy efficient equipment in areas where customers do not have access to incentives. All but two of these vendors promote energy efficient models equally in areas with and without incentives.
- Of the installations in SCE's service territory that qualify for incentives, vendors did not receive incentives an average of 7% of the time.
- The Program has strong influence on vendor recommendations. The estimated VMAX scores for these vendors ranged from 8 to 10, with an average of 9.6.
- Three out of 10 vendors surveyed have changed their stocking practices due to the Program.

## Background Information on Sample

The survey was given to ten vendors (of the top 32 saving vendors) out of 142 total vendors. For the sample, installation completion dates ranged from May 14, 2007 to June 11, 2009.

## Vendor Involvement with Customer Implementation

All vendors but one said that they recommended the installation of the measure to the customer. The one who did not stated the following:

- "We were the installation contractor: [the customer] had specific requirements."

## Influences on Vendor Recommendations

The Program appears to influence vendor recommendation of efficient measures:

- 69% of vendors recommended the measure before they learned of the Program, while 83% recommend the measure since working with the Program (one did not know), an increase of 14% (see Figure G-4).
- The Program had an average importance rating of 7.7 in influencing vendors recommendations, on a scale from 0 to 10 where 10 is extremely important. If the Program had not been available, vendors indicated an average likelihood rating of 5.9 that they would have recommended this measure to customers, on a scale from 0 to 10 where 10 is extremely likely (see Figure G-5).

**Figure G-4: Influence of the SCE on Vendor Recommendation of Efficient Measures**

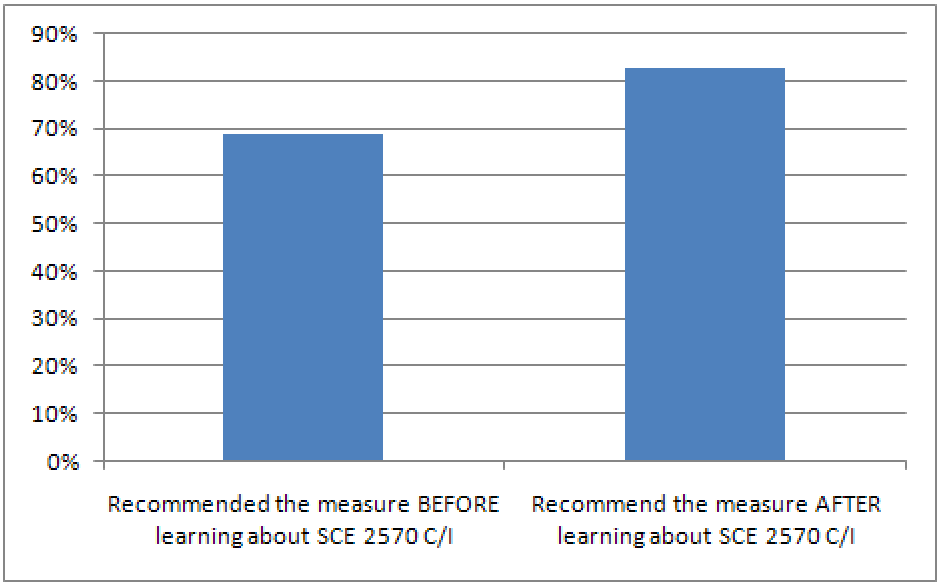
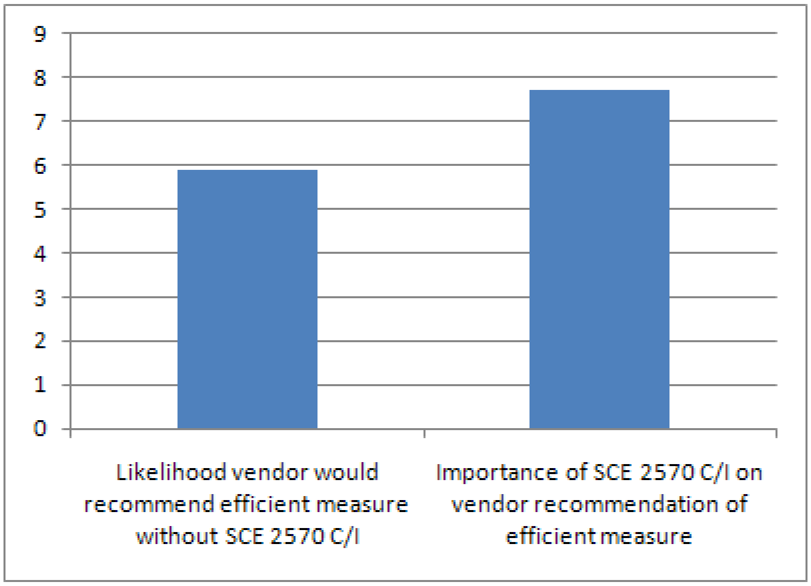


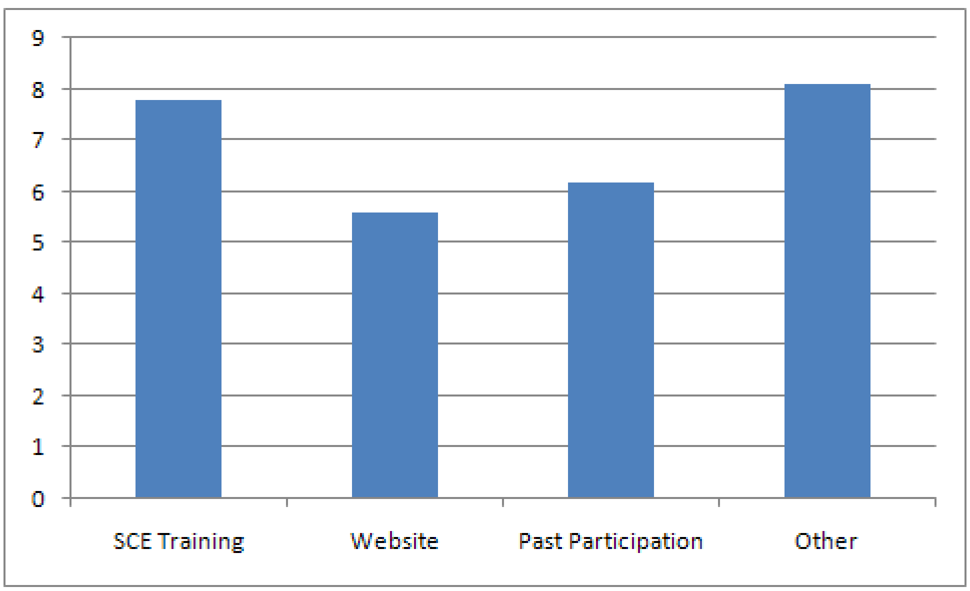

**Figure G-5: Importance Rating of the SCE 2507 C/I Program**




Then, a series of questions, a scale from 0 to 10, were given to reveal influences on vendor recommendations (see Figure G-6):

- ***SCE Training.*** The utility-sponsored training seminar was given an average importance of 7.8.
- ***Past Participation.*** Past participation in a rebate or audit program sponsored by the utility was given an average importance of 6.2 on recommendations.
- ***Website.*** The information provided by the utility website was given an average importance of 5.6.
- ***Other.*** "Other" reasons were given an average importance of 8.1. "Other" reasons include:
    - Incentives/Rebates (8 vendors)
    - "It made them more aware of actual cost savings and what an EE unit actually does. For a long time, no one knew what the difference was between a 15/16 SEER. Helped to quantify what actual numbers are. "
    - "Provided tools to help persuade customers about high efficiency air conditioners."
    - "Knowledge is important; telling people about EE."
    - "Tools that would enable us to send out information regarding the rebate to customers."

**Figure G-6: Influences on Vendor Recommendations**




## Territory Information

On average, 43% of vendors' sales in SCE's service territory qualify for incentives from the Program, and vendors recommend Program qualifying equipment in an average of 97% of their sales in this territory.

70% of the vendors sell energy efficient equipment in areas where customers do not have access to incentives. All but two of these vendors promote energy efficient models equally in areas with and without incentives. On average, 34% of vendor sales occur in these areas where incentives are not offered, and that an average of 64% of sales are of the energy efficient models that would qualify for incentives in SCE's service territory.

### Incentives

Of the installations in SCE's service territory that qualify for incentives, vendors did not receive incentives an average of 7% of the time. Vendor stated the following reasons why they think they did not receive an incentive:

- “Lot of times it’s beyond their control. System is a little more complicated than it needs to be.”
- “Typically they didn’t qualify, because there are some restrictions on phase; single phase models are more for residential applications and do not receive incentives.”
- “Failed to follow through on processing of paperwork and documentation to receive rebate.”

Regarding the rebate from SCE:

- One vendor keeps the rebate.
- Three vendors passed the rebate directly to the customer.
- Four vendors split the rebate with the customer (1 gives the customer 20% of the rebate, another gives 50%, another gives 80% and another gives 90%).
- Two vendors do not have a consistent rebate process.
- Two vendors quoted the customer a price and then identified the rebate as a deduction from the price, while one vendor quoted the customer a net price minus the rebate, not specifically identifying the rebate.

### Other Issues

Three out of the 10 vendors surveyed stated that they have changed their stocking practices as a result of the incentive program.

All vendors stated they did not work with other vendors or contractors during implementation and/or installation.

### VMAX Score

A VMAX score was calculated for each survey respondent, using the algorithm provided. The score can range from 0 (program having no influence on vendor sales) to 10 (program having significant influence on sales). The estimated VMAX scores for these vendors ranged from 8 to 10, with an average of 9.6. This indicates that the Program has strong influence on vendor recommendations, and a NTGR of 96%.

## SDGE 3029 C/I Upstream A/C

The Vendor NTG Survey Instrument for the SDGE 3029 (the Program) was administered by HVAC Evaluation Team staff to ten sales and installation contractors for SDGE 3029 C/I customers. This effort falls under the scope of the HVAC HIM evaluation.

The Evaluation Team surveyed ten of the top (by resulting savings) sales and installation contractors for SDGE 3029 C/I customers (out of 94 total vendors) to examine vendor involvement with customer implementation, program influences on vendor recommendations, territory information, and items related to incentives. See Appendix G for complete vendor survey instrument.

### Summary of Results

Survey results revealed:

- 90% of vendors recommended the installation of the measure to the customer in question.
- Vendor awareness of the program increased their recommendation of efficient measures by almost 20%.
- Past participation in a rebate or audit program sponsored by SDGE was the most important attribute on vendor recommendations.
- Almost half of vendors' sales in SDGE's service territory qualify for incentives from the Program.
- Nine out of 10 vendors promote energy efficient models equally in areas with and without incentives.
- Almost 10 percent of qualifying sales did not receive an incentive in the end.
- The program has strong influence on vendor recommendations. The estimated VMAX scores for these vendors ranged from 6.5 to 10.0, with an average of 9.4.
- However, none of the vendor surveyed have changed their stocking practices due to the Program.

### Background Information on Sample

The survey was given to ten vendors out of 94 total vendors. The ten highest-saving vendors (by kWh) were attempted, but ten out of the 15 highest-saving vendors were surveyed. The vendors listed in the database that were not surveyed, were not surveyed for the following reasons:

- Company listed was not the vendor (2)
- Contact was at the location (e.g., school), not the vendor
- Invalid number
- Unreachable (did not call back).

For the sample, installation completion dates ranged from July 20, 2007 to December 31, 2008.

### Vendor Involvement with Customer Implementation

Nine out of ten (90%) of the vendors said that they recommended the installation of the measure to the customer. One vendor supplied the equipment only.

When asked to explain what the firm's involvement with the customer's implementation of the equipment was, answers include:

- "Made recommendations, selected equipment and installed" (6)
- "Supplied the equipment"
- "Maintain the building"
- "Designed the job (as a design/build HVAC engineering design)"
- "Worked as the engineer, performing energy analysis and savings"

### Influences on Vendor Recommendations

The program appears to influence vendor recommendation of efficient measures:

- 63% of vendors recommended the measure before they learned of the Program, while 82% recommend the measure since learning about the Program (one did not know), an increase of almost 20% (see Figure G-7).
- The Program had an average importance rating of 7.5 in influencing vendors recommendations, on a scale from 0 to 10 where 10 is extremely important. If the Program had not been available, vendors indicated an average likelihood rating of 6.1 that they would have recommended this measure to customers, on a scale from 0 to 10 where 10 is extremely likely (Figure G-8).

**Figure G-7: Influence of SDGE 3029 C/I on Vendor Recommendation of Efficient Measures**

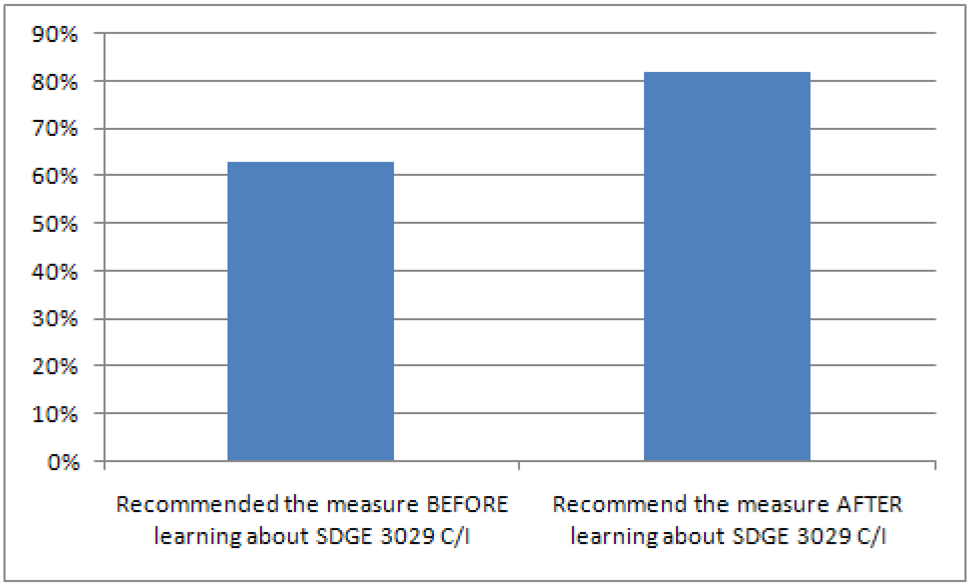
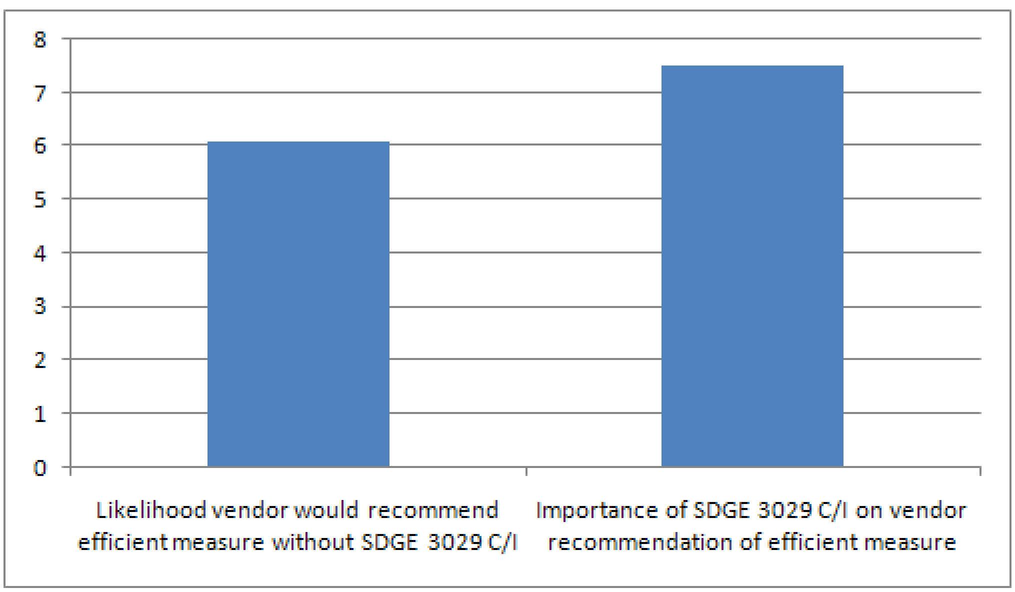


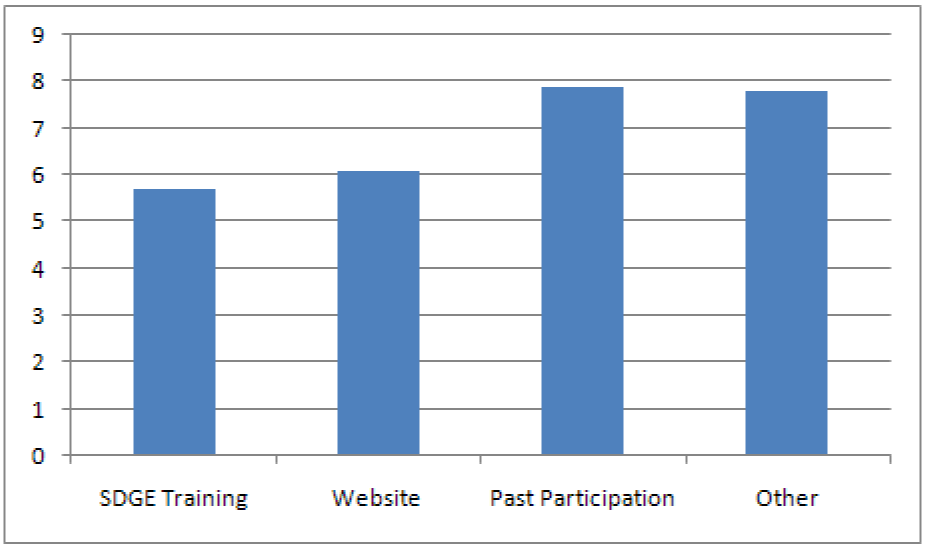

**Figure G-8: Importance Rating of SDGE 3029 C/I**




Then, a series of questions, a scale from 0 to 10, were given to reveal influences on vendor recommendations (see Figure G-9):

- ***Past Participation.*** Past participation in a rebate or audit program sponsored by SDGE was given an importance of 7.9 on recommendations.
- ***Website.*** The information provided by the SDGE website was given an average importance of 6.1.
- ***SDGE Training.*** The SDGE training seminar was given an average importance of 5.7.
- ***Other.*** "Other" reasons were given an average importance of 7.8. "Other" reasons include:
  - "Education."
  - "Making customers aware of reducing costs."
  - "Ease of compliance."

**Figure G-9: Influences on Vendor Recommendations**




## Territory Information

On average, 47 percent of vendors' sales in SDGE's service territory qualify for incentives from the Program, and vendors recommend Program qualifying equipment in 77 percent of their sales in this territory. Vendors stated the following reasons for not always encouraging customers to purchase energy efficient models if they qualify for a rebate:

- "Cost" (4)
- "If the current equipment still has a long functional life"
- "If the customer is moving and not going to be there for more than a few months"
- "If the job is already set and they cannot influence the purchase"

Three vendors sell energy efficient equipment in areas where customers do not have access to incentives (one vendor did not know). Of these 3 vendors, 2 of them stated that 15 percent of their sales occur in these areas where incentives are not offered (and the other did not know), and that an average of 23 percent of sales are of the energy efficient models that would qualify for incentives in SDGE's service territory.

Nine out of 10 vendors said they promote energy efficient models equally in areas with and without incentives: the other did not know.

### Incentives

Of the installations in SDGE's service territory that qualify for incentives, vendors stated that approximately 9 percent of customers do not receive the incentive. The following were stated as reasons why vendors think customers did not receive the incentive:

- "Things could not be confirmed – information was missing"
- "Unaware or chose not to pursue"
- "Maybe the customer went to a smaller unit or not as efficient unit"
- "They have heard that SDGE is out of money, and some did not qualify even though they met the requirement"

Regarding the rebate from SDGE:

- Five vendors passed the rebate directly to the customer.
    - Three quoted the customer a price and then identified the rebate as a deduction from the price
    - Two quoted the customer a net price minus the rebate, not specifically identifying the rebate
- Three vendors keep the rebate.
- One vendor split the rebate with the customer (giving the customer 75% of the rebate).
- One vendor does not have a consistent rebate process. (When this vendor passes the rebate to the customer, they quote the customer a price and then identify the rebate as a deduction from the price.)

### Other Issues

None of the vendors have changed their stocking practices as a result of the SDGE Program.

Four vendors worked with other vendors during implementation and/or installation.

### VMAX Score

A VMAX score was calculated for each survey respondent, using the algorithm provided. The score can range from 0 (program having no influence on vendor sales) to 10 (program having significant influence on sales). The estimated VMAX scores for these vendors ranged from 6.5

to 10.0, with an average of 9.4. This indicates that the Program has strong influence on vendor recommendations.

## SDGE 3029 Residential ER - Res Upstream A/C

The HVAC Evaluation Team surveyed ten of the top (by resulting savings) sales and installation contractors for SDGE 3029 residential customers (out of 94 total vendors) to examine vendor involvement with customer implementation, program influences on vendor recommendations, territory information, and items related to incentives.

### Summary of Results

Survey results reveal:

- 100% of vendors recommended the installation of the measure to the customer in question.
- Vendor awareness of the program increased their recommendation of efficient measures by almost 20%.
- Past participation in a rebate or audit program sponsored by SDGE was the most important attribute on vendor recommendations.
- 65% of vendors' sales in SDGE's service territory qualify for incentives from the Program.
- 100% of vendors promote energy efficient models equally in areas with and without incentives.
- All qualifying sales did receive an incentive (and had no problems with receiving it).
- The SDGE 3029 program has strong influence on vendor recommendations. The estimated VMAX scores for these vendors ranged from 8 to 10, with an average of 9.5.
- However, none of the vendor surveyed have changed their stocking practices due to the Program.

### Background Information on Sample

The survey was given to ten vendors out of 44 total vendors. The ten highest-saving vendors (by kWh) were attempted, but ten out of the 25 highest-saving vendors were surveyed. Three businesses were no longer in operation and the others were unreachable.

### Vendor Involvement with Customer Implementation

All ten vendors said that they recommended the installation of the measure to the customer.

## Influences on Vendor Recommendations

The SDGE 3029 program appears to influence vendor recommendation of efficient measures:

- 79% of vendors recommended the measure before they learned of the Program, while 98% recommend the measure since working with the Program (one did not know), an increase of almost 20% (see Figure G-10).
- The Program had an average importance rating of 8.6 in influencing vendors recommendations, on a scale from 0 to 10 where 10 is extremely important. If the Program had not been available, vendors indicated an average likelihood rating of 7.1 that they would have recommended this measure to customers, on a scale from 0 to 10 where 10 is extremely likely (see Figure G-11). These results indicate some free-ridership may be occurring.

**Figure G-10: Influence of SDGE 3029 Residential on Vendor Recommendation of Efficient Measures**

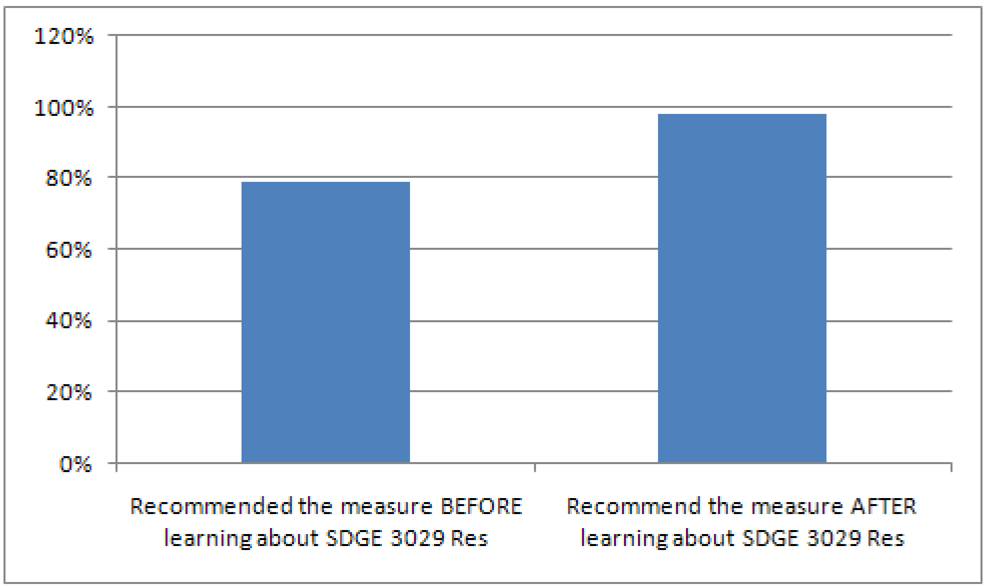
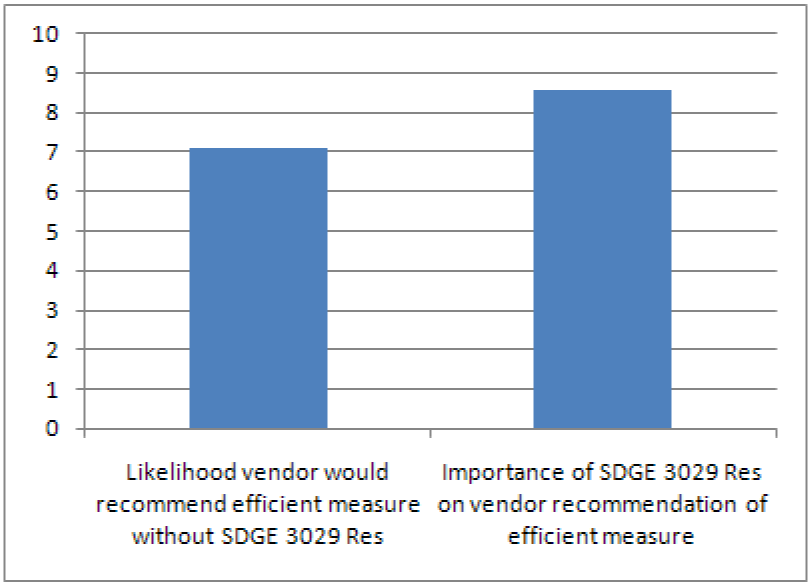


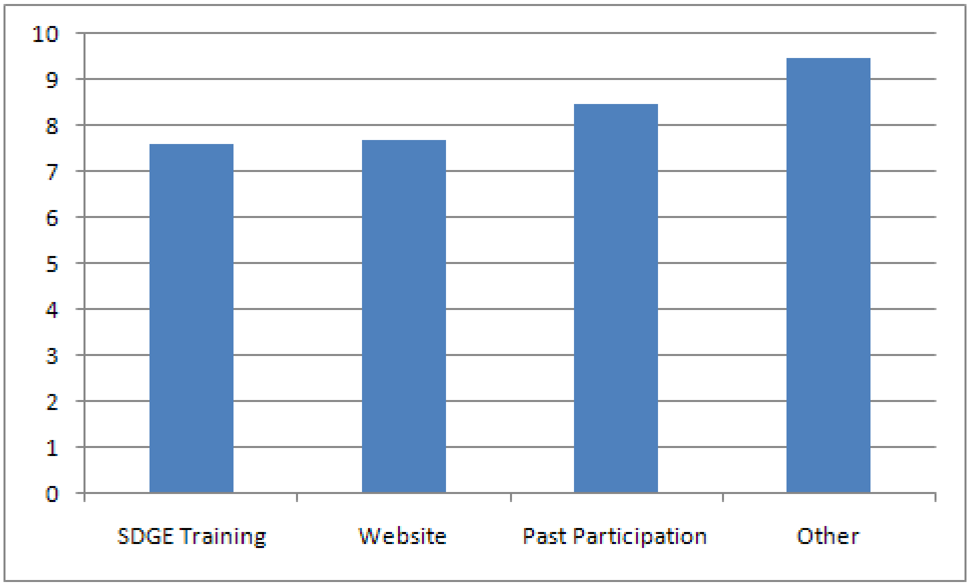
**Figure G-11: Importance Rating of SDGE 3029 Residential**




Then, a series of questions, a scale from 0 to 10, were given to reveal influences on vendor recommendations (see Figure G-12):

- ***Past Participation.*** Past participation in a rebate or audit program sponsored by SDGE was given an average importance of 8.5 on recommendations.
- ***Website.*** The information provided by the SDGE website was given an average importance of 7.7.
- ***SDGE Training.*** The SDGE training seminar was given an average importance of 7.6.
- ***Other.*** "Other" reasons were given an average importance of 9.5. "Other" reasons include:
    - "Cost"
    - "To be more green"
    - "The training gave salespeople better knowledge and confidence to sell efficient units"

**Figure G-12: Influences on Vendor Recommendations**




### Territory Information

On average, 65 percent of vendors' sales in SDGE's service territory qualify for incentives from the Program, and vendors recommend Program qualifying equipment in 91 percent of their sales in this territory. Vendors stated the following reasons for not always encouraging customers to purchase energy efficient models if they qualify for a rebate:

- "If the customer does not need it."
- "If the equipment uses propane."

70% of the vendors sell energy efficient equipment in areas where customers do not have access to incentives. These vendors stated that 48 percent of their sales occur in these areas where incentives are not offered, and that an average of 60 percent of sales are of the energy efficient models that would qualify for incentives in SDGE's service territory.

All 10 vendors said they promote energy efficient models equally in areas with and without incentives.

### Incentives

Of the installations in SDGE's service territory that qualify for incentives, all vendors received the incentive (none stated any problems or non-receipt for any reasons).

Regarding the rebate from SDGE:

- Five vendors keep the rebate.
- Three vendors passed the rebate directly to the customer.
  - Two quoted the customer a price and then identified the rebate as a deduction from the price
  - One quoted the customer a net price minus the rebate, not specifically identifying the rebate
- One vendor split the rebate with the customer (giving the customer 50% of the rebate).
- One vendor does not have a consistent rebate process. (When this vendor splits the rebate with the customer, they split the rebate 50/50. When this vendor passes the rebate to the customer, they quote the customer a price and then identify the rebate as a deduction from the price.)

### Other Issues

None of the vendors have changed their stocking practices as a result of the SDGE Program.

No other vendors or contractors were worked with during implementation and/or installation.

### VMAX Score

A VMAX score was calculated for each survey respondent, using the algorithm provided. The score can range from 0 (program having no influence on vendor sales) to 10 (program having significant influence on sales). The estimated VMAX scores for these vendors ranged from 8 to 10, with an average of 9.5. This indicates that the SDGE 3029 Residential program has strong influence on vendor recommendations.

# H. AC Replacement Vendor Survey Instrument

## SDGE 3029:

- C/I AC replacement
- C/I AC replacement PTAC/PTHP
- Residential AC replacement

**Modified for SDGE 3029**
**Vendor NTG Survey Instrument -- Conduct with Sales & Installation Contractors**

| **Introduction** | | |
|---|---|---|
| AA1 | This is %n calling on behalf of the CPUC [California Public Utilities Commission] from **[XX]**. THIS IS NOT A SALES CALL. I am calling about your firm's recent involvement in ...installation of ...<%MEASURE>… through ...<%PROGRAM>… Would you be the person most knowledgeable about your firm's involvement with customers in connection with your company's involvement in the program? | |
| 1 | Yes | A1 |
| 2 | No | AA2 |
| 88 | Refused | Thank and Terminate |
| 99 | Don't know | Thank and Terminate |
| AA2 | Who would be the person most knowledgeable about your firm's involvement with customers in connection with the program? | |
| 1 | Record name | AA3 |
| 88 | Refused | Thank and Terminate |
| 99 | Don't know | Thank and Terminate |
| AA3 | May I speak with him/her? | |
| 1 | Yes | AA4 |
| 2 | No (not available right now) SCHEDULE APPOINTMENT | Reschedule appt. |

| | | |
|---|---|---|
| AA4 | Hello, my name is ... %n .and I am calling on behalf of the CPUC, [California Public Utilities Commission] from Summit Blue CONSULTING. THIS IS NOT A SALES CALL. I was told that you are the person most knowledgeable about your firm's involvement with....<%PROGRAM>... | |
| 1 | Yes | A2 |
| 2 | No, there is someone else (RECORD NAME) | AA5 |
| 3 | No and I don't know who to refer you to | Thank and Terminate |
| 88 | Refused | Thank and Terminate |
| 99 | Don't know | Thank and Terminate |

| | | |
|---|---|---|
| AA5 | Am I speaking with...<%CONTACT> ...the representative of your company that worked with customers during the planning and installation of their recently completed energy efficiency project? This project involved the installation of...<%MEASURE> .. | |
| 1 | Yes | A1 |
| 2 | Yes, but we need to make an appointment. | Reschedule appt. |
| 3 | No but I will give you to the correct person. | AA4 |
| 88 | Refused | Thank and Terminate |
| 99 | Don't know | Thank and Terminate |

**Before we start, I would like to inform you that for quality control purposes, this call may be monitored by my supervisor. For the sake of expediency, we may record this interview. Also, when I will refer to Program as the Program, and the Measure as the Measure.**

| | | |
|---|---|---|
| A1 | Customers indicated that your firm was involved in the implementation of their installation of ...<%MEASURE> at their facility from 2006 to 2008. ___Is this correct?… | |
| 1 | Yes | A2 |
| 2 | No | Thank and Terminate |
| 88 | Refused | Thank and Terminate |
| 99 | Don't know | Thank and Terminate |

**[DO NOT READ: The following question will determine if we ask about influences on their recommendations. Please be sure to be thorough with this question. If they truly only installed this equipment, then a "No" is fine]**

| | | | |
|---|---|---|---|
| A2 | | As vendor, did you recommend the installation of this measure? | |
| | 1 | Yes | V2 |
| | 2 | No | A3 |
| | 88 | Refused | A3 |
| | 99 | Don't know | A3 |

| | | | |
|---|---|---|---|
| A3 | | Can you please explain what was your firm's involvement with ...<%CUSTOMER>'s ... Implementation of this equipment? [IF NEEDED: were they just an order taker, were they just equipment suppliers, or were they instrumental in what equipment was selected?... | |
| | 77 | RECORD VERBATIM | Thank and Terminate |
| | 88 | Refused | Thank and Terminate |
| | 99 | Don't know | Thank and Terminate |

**[READ] For the sake of expediency, during the balance of the interview, we will be referring to the <%PROGRAM> as the PROGRAM and we will be referring to the installation of ... <%MEASURE> as the MEASURE. I will repeat this from time to time during the interview.**

| | | | |
|---|---|---|---|
| V2 Intro | | I am going to ask you to rate the importance of the PROGRAM in influencing your decision to recommend this MEASURE to customers. Think of the degree of importance as being shown on a scale with equally spaced units from 0 to 10, .. | |
| V2 | | Using this 0 to 10 scale where 0 is NOT AT ALL IMPORTANT and 10 is EXTREMELY IMPORTANT, how important was the PROGRAM, including incentives as well as program services and information, in influencing your decision to recommend that customers install the MEASURE? | |
| | # | Record 0 to 10 score (_______) | V3 |
| | 88 | Refused | V3 |
| | 99 | Don't know | V3 |

| | | |
|---|---|---|
| V3 | And using a 0 to10 likelihood scale where 0 is NOT AT ALL LIKELY and 10 is EXTREMELY LIKELY, if the PROGRAM, including incentives as well as program services and information, had not been available, what is the likelihood | |

that you would have recommended this MEASURE to customers?

| | | |
|---|---|---|
| # | Record 0 to 10 score (_______) | V4 |
| 88 | Refused | V4 |
| 99 | Don't know | V4 |

V4 In what percent of sales situations did you recommend this MEASURE before you learned about the PROGRAM?

| | | |
|---|---|---|
| % | Record PERCENTAGE | V5 |
| 88 | Don't know | V5 |
| 99 | Refused | V5 |

V5 And in what percent of sales situations do you recommend this MEASURE now that you have worked with the PROGRAM?

| | | |
|---|---|---|
| % | Record PERCENTAGE | V6a |
| 88 | Don't know | V6a |
| 99 | Refused | V6a |

V6a In what other ways has the PROGRAM influenced your recommendations regarding this MEASURE?

| | | |
|---|---|---|
| 77 | Record FIRST mention | V6aa |
| 88 | Refused | V6b |
| 99 | Don't know | V6b |

V6aa Using a 0 to 10 scale, how important was this influence on this recommendation?

| | | |
|---|---|---|
| # | Record 0 to 10 score (_______) | V6b |
| 88 | Don't know | V6b |
| 99 | Refused | V6b |

V6b. Was there another way the PROGRAM influenced your recommendations regarding this MEASURE?

| | | |
|---|---|---|
| 1 | No other way | V7a |
| 77 | Record SECOND mention | V6bb |
| 88 | Refused | V7a |
| 99 | Don't know | V7a |

V6bb Using a 0 to 10 scale, how important was this influence on this recommendation?

| | | |
|---|---|---|
| # | Record 0 to 10 score (_______) | V7a |
| 88 | Don't know | V7a |
| 99 | Refused | V7a |

V7a Using the same scale as before, how important was the TRAINING SEMINAR provided by <%UTILITY> in your recommendation?

| | | |
|---|---|---|
| # | Record 0 to 10 score (_______) | V7b |
| 88 | Don't know | V7b |
| 99 | Refused | V7b |

V7b And how important was the information provided by the <%UTILITY> website?

| | | |
|---|---|---|
| # | Record 0 to 10 score (_______) | V7c |
| 88 | Don't know | V7c |
| 99 | Refused | V7c |

V7c And how important was your firm's past participation in a rebate or audit program sponsored by <%UTILITY>?

| | | |
|---|---|---|
| # | Record 0 to 10 score (_______) | V8 |
| 88 | Don't know | V8 |
| 99 | Refused | V8 |

V8 Approximately, what percentage of your sales of this...<%MEASURE_TYPE> installed in <%UTILITY>'s service territory are energy efficient models…that qualify for incentives from the program?

| | | |
|---|---|---|
| % | Record PERCENTAGE | V9 |
| 88 | Don't know | V9 |
| 99 | Refused | V9 |

V9 On a 0 to 100 percent scale, in what percent of sales situations do you encourage your customers in <%UTILITY>'s territory to purchase program qualifying ...<%MEASURE_TYPE>...?

| | | |
|---|---|---|
| % | Record PERCENTAGE | V9a |
| 88 | Don't know | V10 |
| 99 | Refused | V10 |

**IF V9 < 100;**

V9a In what situations do you NOT encourage your customers to purchase energy efficient models if they qualify for a rebate? Why is that?

| | | |
|---|---|---|
| 77 | RECORD VERBATIM | V10 |
| 88 | Refused | V10 |
| 99 | Don't know | V10 |

| | | |
|---|---|---|
| V10 | Of those installations of ...<%MEASURE_TYPE>... in <%UTILITY>'s service territory that qualify for incentives, approximately what percentage do not receive the incentive? | |
| % | Record PERCENTAGE | V11 |
| 88 | Don't know | V12 |
| 99 | Refused | V12 |

| | | |
|---|---|---|
| | **IF V10 > 0;** | |
| V11 | Why do you think they do not receive the incentive? | |
| 77 | RECORD VERBATIM | V12 |
| 88 | Refused | V12 |
| 99 | Don't know | V12 |

| | | |
|---|---|---|
| V12 | Do you also sell ...<%MEASURE_TYPE>.. in areas where customers do not have access to incentives for energy efficient models? | |
| 1 | Yes | V13 |
| 2 | No | V14 |
| 88 | Refused | V14 |
| 99 | Don't know | V14 |

| | | |
|---|---|---|
| V13 | About what percent of your sales of ...<%MEASURE_TYPE> ... are represented by these areas where incentives are not offered? | |
| % | Record PERCENTAGE | V13a |
| 88 | Don't know | V14 |
| 99 | Refused | V14 |

| | | |
|---|---|---|
| | **IF V13 > 10 & V13 < 101;** | |
| V13a | And approximately what percentage of your sales of this ...<%MEASURE_TYPE>..in these areas are the energy efficient models that would qualify for incentives in <%UTILITY>'s service territory? | |
| % | Record PERCENTAGE | V14 |
| 88 | Don't know | V14 |
| 99 | Refused | V14 |

| | | |
|---|---|---|
| V14 | Have you changed your stocking practices as a result of the <%UTILITY> Program? | |
| 1 | Yes | V15 |
| 2 | No | V15 |
| 88 | Refused | V15 |
| 99 | Don't know | V15 |

| | | |
|---|---|---|
| | **IF V12=1** | |
| V15 | Do you promote energy efficient models equally in areas with and without incentives? | |
| 1 | Yes | V16 |
| 2 | No | V16 |
| 88 | Refused | V16 |
| 99 | Don't know | V16 |
| | | |
| V16 | Regarding the rebate you received from <%UTILITY>, did you | |
| | | skip to question |
| 1 | Keep the rebate | V19 |
| 2 | Pass it through to the customer | V18 |
| 3 | Split the rebate with the customer | V17 |
| 88 | Refused | V19 |
| 99 | Don't know | V19 |
| | | |
| V17 | What percentage of the rebate did you pass along to the customer? | |
| % | Record PERCENTAGE | V19 |
| 88 | Refused | V19 |
| 99 | Don't know | V19 |
| | | |
| V18 | Did you... | |
| 1 | Quote the customer a net price minus the rebate, not identifying the rebate? | V19 |
| 2 | Quote the customer a price and then identify the rebate as a deduction from the price? | V19 |
| 88 | Refused | V19 |
| 99 | Don't know | V19 |
| | | |
| V19 | Do you know of any other vendors that worked with ...<%CUSTOMER>... during their implementation and/or installation of ...<%MEASURE> ...? | |
| 1 | Yes | V19a |
| 2 | No | V20 |
| 88 | Refused | V20 |
| 99 | Don't know | V20 |
| | | |
| V19a | Do you have their business name? | |
| 77 | RECORD Business name and contact's name and phone number(s) | V20 |
| 88 | Refused | V20 |
| 99 | Don't know | V20 |

| | | |
|---|---|---|
| V20 | And finally, for verification purposes only, may I please have your first name? | END |
| 77 | RECORD VERBATIM | |
| END | Those are all the questions I have for you today. Thank you very much for your time. | END OF SURVEY |

# I. Reference and Background for Duct Sealing Methods Applied

Savings were claimed only when duct sealing occurred on existing, new or replacement units and measured leakage was 15% of nominal fan flow or less. All tests conducted by the program implementing contractors were using the total leakage test and leakage reductions reported had to be related to actual system leakage reductions.

The effort planned for duct sealing measures did not measure a change in system operating efficiency, but was simplified into the impact on the "effective" change in efficiency and capacity of the system that was compared to modeled results with current heat transfer assumptions. It was apparent from conversations and literature review that it would be difficult to inform modeling assumptions and translate our testing to the actual complexities of real leakage. Better understanding was necessary of the uncertainty of the most repeatable and standard method the leakages to outside at constant house pressure test relative to "reference" testing.

It should be noted that the 2005 Title 24 Energy Standards specify that when any component of the heating or cooling system in a residential application is replaced in certain climate zones duct sealing is required. The standards' requirements for duct leakage depend on the types of changes the ducts undergo when the system is replaced. The meaningful requirements are as follows:

> *If the new ducts are an extension of an existing duct system, the combined new and existing duct system shall meet one of the following requirements:*
>
> > *a. the measured duct leakage shall be less than 15% of fan flow; or*
> >
> > *b. The duct leakage shall be reduced by more than 60% relative to the leakage prior to the equipment having been replaced and a visual inspection shall demonstrate that all accessible leaks have been sealed; or*
> >
> > *c. If it is not possible to meet the duct sealing requirements of Subsections a. or b., all accessible leaks shall be sealed and verified through a visual inspection by a certified HERS rater.* [4]

The DEER contains two duct sealing measures for all residential applications: One quantifies savings of reducing leakage to outside from 40% to 12% and the other from 24% to 12%. The smaller leakage reduction is based on empirical data, while the large reduction is a created scenario. Below is a discussion of the assumptions inherent in the DEER models.

---

[4] 149 (b) (2) (D), 2005 Title 24 Energy Efficiency Standards

*The DEER base case for the first duct leakage measure is "40% total air leakage" (TL). Of this total, half is supply leakage. For single-story houses, 75% of the supply leakage is assumed to go to the unconditioned attic (SupLeakTO), with the remainder leaking to the conditioned spaces (SupLeakH). Duct leakage to the conditioned spaces, while typically part of most duct loss measurements, is not actually "lost" and is treated as supply CFM for the DEER simulation. Since more of the ducts are assumed to be located within the conditioned space for a two-story house, the fraction of total supply leakage that goes to the attic is lowered to 67%.*

*The multifamily apartment building configuration has much less opportunity for leakage to the outside and, on average; DEER savings assume that supply air leakage to an unconditioned space is only half of the fraction assumed for single-family homes[5].*

It was found in the DEER study that contractors were overestimating leakage rates by an average of 70% on the supply side and by 60% on the return side. Initial estimates had leakage rates at 42% at the air handling unit (AHU). This number was adjusted to 24% based on the excess leakage estimates and the 40% category was added to account for leakier systems.

The evaluation of duct leakage for program participants included tests of total leakage for comparison to contractor measurements and tests for leakage to outside to relate those site specific measurements to actual leakage. This study leveraged an earlier M&V effort by Southern California Edison (SCE) which related leakage to outside testing to a reference leakage method known as tracer gas testing. Long term average tracer gas tests are known to be the most reliable measurement method of leakage and short term tests are believed to be more reliable than pressurization methods. The study revealed that leakage to outside testing at test pressures matched to the system operating pressure in cooling mode offered a substantial reduction in the uncertainty of the leakage measurements. None of the described methods isolated return and supply leakage and current split assumptions were not directly evaluable by the Specialized Commercial CG Evaluation Team.

The leakage to outside measurements appeared to over-estimate the actual system leakages in previous studies. However, a linear correction factor was feasible given the strong correlation between the measurements and tracer gas tests. Prior to the SCE study only small case studies had been presented and a correction could not be developed. By making this correction the system leakage should also be a function of the actual measured airflow, which tended to be lower than the nominal value across all residential airflow tests performed by the Specialized Commercial CG Evaluation Team.

The onsite verification procedure included both total leakage and leakage to outside tests. The ultimate passing of a unit was first analyzed as total leakage at 25Pa being less than 15 percent of nominal fan flow, calculated as 400 cfm/nominal ton. In addition for the verification, if the

[5] Chapter 8: Residential Weather Dependent Measures: DEER Final Report, January 2006

leakage to outside at a house pressure of 25Pa was less than 10 percent of nominal system fan flow it was considered passing. Verification efforts also included a prototype test method known as DeltaQ to ideally prove a method with which to measure supply and return leakage at actual system operating pressures to supplement the DEER assumptions. Unfortunately, the method was subject to large variations and errors and was abandoned as requiring additional development.

The large verification sample was completed and the results showed most units had leakages greater than program requirements and that the contractor collected measurements were unreliable for many of these units. For passing units it was reasonable to use the contractor collected leakage reductions with adjustments to verification measurements to estimate the reduction in total system leakage and leakage to outside at test pressures. Adjustments to the reported leakage reductions were first made based on the evaluators measurements for both passing and failing units. Generally the adjustment for failing units of measured leakage to reported leakage reduced the reported corrections to negligible amounts. All units adjusted leakage reduction was then further adjusted based on the site level measurements of leakage to outside as a function of system operating pressure. All leakage to outside measurements were normalized to one half of the system operating pressure to use the correlation data from the SCE study and corrected for the overestimation produced by pressurization tests. The final adjustment to the leakage reduction for the sampled units was determining the percentage of leakage to outside as a function of measured or estimated actual airflow.

The differences in pre- and post-performance were estimated by a limited sample of pre- and post-sealing measurements and comparisons of large samples of test data to program collected leakage measurements. The resulting actual leakage estimates were then run in the DEER building energy models to develop savings representative of state populations based on residential appliance saturation study data which were embedded in the DEER prototypes and analysis approach. The evaluation used the square footage and basic building construction characteristics (windows, wall height, etc.) obtained from the AC Contractors of America (ACCA) Manual J, a building thermal load estimation method, data collection form to feed into an energy modeling program such as DOE-2. Where necessary for internal loads, the Specialized Commercial CG Evaluation Team used typical energy use intensity (EUI) by end use from the 2009 DOE building energy data book and/or from the actual onsite survey. The evaluated unit energy savings (UES) were categorized by the amount of refrigerant added or removed consistent with the DEER estimates.

# J. MAP Closure Discussions

## Lighting Power Regulator

The Specialized Commercial CG Evaluation Team brought the evaluation of the lighting power regulators to a close in November 2008, and did not meter additional sites. The final analysis included data from two site visits, implementer data, and secondary documents. The Evaluation Team  used SCE's documented work-paper findings to calculate savings for all installed projects through the 2006–2008 program cycle.

### Measure Description Summary

Lighting Power Regulators reduce kW at the lighting panel by controlling voltage to improve the power factor and better match illumination requirements for fluorescent or high-intensity discharge (HID) lighting in offices and garages. The general strategy, regardless of manufactures, is to control voltage directly at the lighting panel or remotely. Depending on the manufacturer, the lighting regulator can be pre-set at a specified level of voltage reduction or be designed to allow multiple reduction levels, either manually or through energy management systems.

### Final Measure Status

Ten Lighting Power Regulators (LPRs) were installed through the course of the 2006–2008 program cycle, with the majority of installations occurring in 2006 (nine). A detailed list of installed LRPs is shown in Table J-1, below. Over the program year, LPR total gross impact savings were 614,696 kWh, and total gross demand savings were 140 kW. The assumed NTG was 0.8, where the total net savings were 491,755 kWh and total net demand savings were 112 kW.

**Table J-1: Lighting Power Regulator (LPR) Technology Installations and Ex Ante Savings**

| Site | Building Type | Ex ante Gross kWh savings | Ex ante Gross kW Savings | Ex ante NTG | Ex ante Net kWh Savings | Climate zone | MAP Project Number |
|---|---|---|---|---|---|---|---|
| 1 | Small Office | 71,531 | 25 | 0.8 | 57,224 | 9 | 002-01-2 |
| 2 | Small Office | 10,989 | 3 | 0.8 | 8,791 | 6 | 003-03-1 |
| 3 | Transportation / Communications / Utility | 165,336 | 19 | 0.8 | 132,269 | 6 | 006-01-1 |
| 4 | Small Retail Store | 52,881 | 18 | 0.8 | 42,305 | 14 | 007-01-1 |
| 5 | Small Retail Store | 60,526 | 19 | 0.8 | 48,421 | 14 | 007-01-2 |
| 6 | Small Retail Store | 73,573 | 17 | 0.8 | 58,858 | 14 | 007-01-3 |
| 7 | Transportation / Communications / Utility | 62,118 | 11 | 0.8 | 49,694 | 9 | 008-01-1 |
| 8 | Misc. Commercial | 36,660 | 8 | 0.8 | 29,328 | 9 | 009-01-1 |
| 9 | Small Office | 29,083 | 7 | 0.8 | 23,266 | 9 | 015-01-1 |
| 10 | Transportation / Communications / Utility | 51,999 | 13 | 0.8 | 41,599 | 9 | 015-03-1 |

## Data Collection

Two site visits were conducted for this evaluation during the LPR commissioning process. The initial plan was to retrieve pre- and post-installation monitored data; however, after discussions with the implementer’s engineering subcontractor, it became clear that collecting two weeks of pre-data was not feasible. Power panel wiring typically was reconfigured during the installation process to make dedicated lighting circuits to LPR specifications. Regulator installation occurred simultaneously with wiring the power panel. Therefore, conducting pre-monitoring prior to rewiring would not provide an accurate pre-post comparison. In addition, as part of the installation procedure, relamping and/or cleaning was recommended, thereby impacting the actual pre-post comparison. It was concluded that the commissioning process would be observed and spot measurements of power and light output collected. Table J-1 details site information.

**Table J-2: Lighting Power Regulator Site Visit Characteristics**

| Site ID | Application | Lamp Type | Fixture Wattage | # Lamps | Estimate Lamp Age | Estimated Annual Operating Hours[6] |
|---|---|---|---|---|---|---|
| 1 | Outdoors | HID Sylvania MH 400 watt | 465 | 54 | 2 Years | 4,380 |
| 2 | Outdoors | Various[7] | Various | 127 | 4+ Years | 4,745 |

The Site 1 outdoor lighting system was designed for staff working during night shifts. The Site 2 outdoor lighting system was designed for public parking and security. Table J-3: Lighting Power Regulator Pre-Post Commissioning Power and Lumen Data  shows the summary of power and lumen data.

**Table J-3: Lighting Power Regulator Pre-Post Commissioning Power and Lumen Data[8]**

| Site ID | Pre kW | Post kW | Average Lumens Pre | Average Lumens Post | kW % Savings | % Lumen Reduction |
|---|---|---|---|---|---|---|
| 1 | 25.06 | 17.96 | 2.83 | 1.51 | 28% | 47% |
| 2 | 43.00 | 29.85 | 2.06 | 1.06 | 31% | 49% |

Based on the two sites, there was a 29.5% average kW savings reduction, but with a significant 48% lighting output penalty. Six or more lumen measurements were taken at each site, and foot-candle measurements were taken at grade. A one-to-one relationship was expected between kW and lumens, but the lumen output was reduced 47% to 49%, a more significant loss than anticipated. While these were data from only two sites, the significant lumen reduction raised potential concerns.

Further, several light fixtures at Site 2 did not strike on, partly due to the regulator. It was concluded those light fixtures were close to the end of their useful life and could not strike with the lower supplied voltage.

## Observations about Lighting Power Regulators

SCE commissioned a lighting power regulator workpaper, WPSCNRMI0078. This paper made similar observations as the conclusions drawn from data collected at the two sites monitored for the evaluation:

[6] Operating hours based on implementer data.

[7] (74) 465 watt HID Metal Halide fixtures, (42) 116 watt HID Metal Halide fixtures, and (11) 95 watt HPS fixtures.

[8] The data presented were collected during the final stages of the commissioning process and further updates to the system may have occurred after the site visits.

*Tests have shown a consistent linear relationship between the reduction in power and the reduction in lighting levels in many settings.*[9] *In other words, a 25% reduction in power will result in an approximately 25% lower lighting level. However, the perception of light level changes is not linear, but logarithmic. Thus, a relatively small change in lighting levels would not be very noticeable to the average person, while a 25% reduction in lighting levels may be unacceptable to many and may even reduce productivity.*[10] *In addition, if lighting requirements differ throughout a facility, a uniform change in lighting levels from the power regulator could affect the quality of lighting in some areas. For these reasons, the greatest savings potential is in facilities that are over lit, where a reduction in lighting would maintain "normal" lighting levels.*

Though the technology may be suitable for overlit areas, some applications providing security or in work areas could suffer a negative impact from lower lighting levels. Not all applications may be suitable, and the Specialized Commercial CG Evaluation Team suggests caution regarding implementation of this technology.

Additionally, potential power reducer users should check with lamp and ballast manufacturers to confirm that their equipment is compatible with a particular power reducer or if use will void lamp or ballast warranties.[11] There are also concerns that regulators may introduce harmonics and affect power factor.[12]

## Practical Limitation of Lighting Power Regulators

As stated, this technology did not suit all applications. Typically, relamping, cleaning, and/or replacing ballasts was recommended as part of the LPR installation procedure. Not all customers may consider the added expense of this option and may not achieve greater performance. At this time, this technology had only been designed for HID and fluorescent lighting systems.

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[9] Bisbee, David A, *Customer Advanced Technologies Program Technology Evaluation Report* "Lighting Circuit Power Reducers for fluorescent Lighting Applications", Sacramento Municipal Utility District, October 2002, page 7.

[10] Platts Research & Consulting, "Lighting Circuit Power Reducers: Are They (Cost) Effective?" July 2003, Vol. ER-03-12. page 4.

[11] Ibid. page 8.

[12] National Lighting Product Information Program Specifier Reports "Lighting Circuit Power Reducers", September 1998 (Revised October 1998), pages 3-5.

## Energy Savings Review

Without monitoring data and with only spot measurements of two sites, savings could not be quantified nor could conclusive results be inferred. As a reasonable approach, the SCE workpaper assumed a 10% reduction in lighting levels as the maximum reduction to maintain acceptable lighting levels; the Specialized Commercial CG Evaluation Team used 10% savings from baseline energy usage as the deemed savings value for all market sectors.[13]

The methodology for estimating lighting power regulator energy savings was derived from a review of the SCE workpaper. Annual kWh savings were determined using the following formulas:

**Equation J-1: Annual kWh Savings**

*(1) Annual Energy Savings (kWh/yr) = Lighting Load (kW/yr) x 10% x OpHrs(Hrs/yr)*

*Lighting Load = Baseline lighting load in kW*
*OpHrs = Annual operating hours (runtime) of the connected lighting system*
*10% = Estimated savings from installed Lighting Power Regulator*

SCE utilized the following equation to determine the demand savings:

**Equation J-2: Peak Demand Savings**

$$\text{(2)}\quad \text{Peak Demand Savings (kW/yr)} = \frac{\text{Annual Energy Savings (kWh/yr)} \times \text{PCF}}{\text{OpHrs (Hrs/yr)}}$$

*PCF = Peak Coincidence Factor[14], assumed to be 0.63*

## Recommendations and Significant Findings

Based on data collected at the two monitored sites, results suggested energy savings with significant reductions in lighting levels. However, these data were too inconclusive to suggest a technology viable in all applications. In some lighting applications, areas were excessively overlit and required reductions in lumen output to meet code and/or comfort levels; lighting regulators, delamping, and other strategies suggested more viable options.

[13] SCE work paper: WPSCNRMI0078.

[14] SCE adopted the Express Efficiency program for the miscellaneous market sector for a 2006 outdoor parking garage.

It was feasible to assume Site 1 could benefit from this technology. However, in Site 2 (24 hour parking), it was difficult to conclude the site successfully implemented the technology at the time of commissioning. The resulting low light levels raised concerns that security may have been compromised; further, some fixtures did not strike after the regulator was activated. This situation may have been addressed and the regulator readjusted.

### Proposed M&V Methodology

The recommended M&V approach for this program would be a short-term monitoring plan per IPMVP, Option A, Partially Measured Retrofit Isolation. This technology involves short-term monitoring, hence uncertainty exists in extrapolating annual data from short-term data. A lighting power regulator would be connected to the building's lighting panel, and a true RMS power meter could monitor the power regulator output. With customer consent, metering could be conducted after measure installation. Engineering support from the manufacturer would be needed to follow the correct procedure in deactivating the installed lighting regulator. This would require a monitoring plan that collects data when the lighting power regulator is on for one week, off one week, on again one week, and off the final week; thus adjusting for external influences. Therefore, baseline data and energy-efficiency measure data could be obtained as part of this on/off test procedure. Annual operating hours would be identified through site visit interviews. To determine measure savings, the pre- and post-data would be used in standard engineering algorithms to calculate the lighting power reduction factor applied to the connected lighting load and operating hours for each lighting circuit.

## Cycle Manager

We completed the evaluation of the cycle manager with a closure memo, utilizing implementer data through the end of 2008. We used the implementer's field data findings to determine savings.

### Measure Description Summary

The HVAC Cycle Manager is designed for Heating, Ventilation, Air Conditioning, and Refrigeration (HVACR) systems to manage a thermostat's setpoint temperature and compressor operation. The controller replaces the antiquated on/off actions of many systems to better manage the cycling pattern and reduce run time. An HVAC Cycle Manager works by monitoring and analyzing the load on the heating or cooling system, in real time, then modifying the way the HVAC system would normally be controlled or “cycled.” The control device acts as an anti-short cycling control. According to the manufacturer, the cycle modification results in a more efficient use of the heating or cooling system, with subsequent reductions of energy consumption.

## Final Measure Status

Through the course of the 2006–2008 program year, 20 HVAC Cycle Managers (CMUs) were installed, with the majority of the installations occurring in 2007 (16 CMU). A detailed list of installed CMUs is shown in Table J-4, below. Total gross savings for CMU installed in this program cycle were 765,993 kWh. This technology did not contribute to kW peak reduction; resulting peak demand savings were zero. The assumed NTG was 0.8 where total net savings for CMU were 612,794 kWh.

**Table J-4: Cycle Manager (CMU) Technology Installations and Savings**

| Site ID | Building Type | Gross kWh savings | Gross kW Savings | Net kWh Savings | Climate zone | MAP Project Number |
|---|---|---|---|---|---|---|
| 1 | Small_Retail_Store | 45,543 | 0 | 36,434 | 10 | 005-01-1 |
| 2 | Small_Retail_Store | 13,845 | 0 | 11,076 | 14 | 007-01-4 |
| 3 | Small_Retail_Store | 20,671 | 0 | 16,537 | 14 | 007-01-5 |
| 4 | Small_Retail_Store | 12,057 | 0 | 9,646 | 14 | 007-01-6 |
| 5 | Misc._Commercial | 3,938 | 0 | 3,150 | 6 | 007-02-1 |
| 6 | Misc._Commercial | 187,227 | 0 | 149,782 | 8 | 007-04-1 |
| 7 | Trans_Comm_Util | 372,908 | 0 | 298,326 | 9 | 007-05-1 |
| 8 | College_University | 20,510 | 0 | 16,408 | 9 | 009-02-1 |
| 9 | Misc._Commercial | 982 | 0 | 786 | 6 | 010-01-1 |
| 10 | Misc._Commercial | 7,160 | 0 | 5,728 | 6 | 010-02-1 |
| 11 | Misc._Commercial | 18,304 | 0 | 14,643 | 6 | 010-03-1 |
| 12 | Trans_Comm_Util | 7,051 | 0 | 5,641 | 6 | 010-04-1 |
| 13 | Misc._Commercial | 5,627 | 0 | 4,502 | 6 | 010-05-1 |
| 14 | Misc._Commercial | 6,041 | 0 | 4,832 | 6 | 010-06-1 |
| 15 | Misc._Commercial | 12,182 | 0 | 9,745 | 6 | 010-07-1 |
| 16 | Misc._Commercial | 3,337 | 0 | 2,670 | 6 | 010-08-1 |
| 17 | Trans_Comm_Util | 1,872 | 0 | 1,498 | 8 | 011-04-1 |
| 18 | Small_Office | 15,729 | 0 | 12,583 | 9 | 014-01-1 |
| 19 | Small_Office | 4,985 | 0 | 3,988 | 9 | 014-02-1 |
| 20 | Small_Office | 6,025 | 0 | 4,820 | 9 | 015-04-1 |

## Observations about HVAC Cycle Managers

Intellidyne, LLC, manufactures the cycle manager control system,[15] which incorporates a microprocessor controller to manage and optimize the compressor cycling pattern. The manufacturer's claim estimated cooling savings of 12.5%. In a cooling system, according to the manufacturer, the load (or demand) is analyzed by monitoring how the pre-existing controls (a thermostat or pressure control) cycle the compressor. The on-time to off-time ratios and how these ratios change indicate the load. The economizer intercedes and changes the beginning of the compressor cycle, which results in a more efficient use of the electrical energy needed to provide the same amount of cooling.[16]

## Practical Limitation of HVAC Cycle Managers

The cycle manager controls for HVAC systems are primarily limited to smaller capacity units, with minimal pre-existing control systems, typically less than 20 tons of cooling capacity. With a few exceptions, this technology has been designed for small retrofit applications with less stringent indoor temperature requirements. The main limitation for the technology is that it is not fully proven, and it is unknown whether it is a viable measure to produce significant savings. Conducting measurements is relatively straightforward for this technology. Overall, according to the implementer, the cycle manager is easy to install, but produces relatively small savings compared to other technologies implemented under the SCE 2537 MAP program, and does not provide kW demand savings potential.

## Energy Savings Review

The 12.5% energy savings estimate provided by the MAP program third-party implementer was based primarily on manufacturer's specifications with little support documentation. The main concern of this technology was how savings were actually achieved. Changing the control set-point temperatures to reduce the quick cycling of the compressor did not inherently provide energy savings. The space temperature of the building was impacted by changing the run time of the compressor. IntelliCon's response to this argument follows:[17]

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[15] The patented device, IntelliCon®, was developed and applicable to both commercial and residential air conditioning applications as an energy economizer according to manufacturer's installation instructions.

[16] Information provided by Intellidyne from Q&A materials.

[17] Information provided by Intellidyne from Q&A materials.

*In the case of a cooling system, the rate and quantity of heat that a cooling system can remove during a given period of time, is greater than the amounts of heat that can be gained by the load (space) for the same period of time. This requires the compressor to be cycled in order to maintain the desired temperature or the space would be over-cooled. The media used to extract heat from the space is air. Air has a very low mass and thus short time-constant (change in temperature per unit of time) compared to items with considerably more mass and thus a longer time-constant (i.e. people, objects, walls, furniture, etc.). The items with a higher mass have a much greater thermal inertia. Thermal inertia is a property of an item to resist a change in temperature [for a given period of time]. Since the compressor is held off for only a small percentage of time, relative to the time-constants of the higher mass items, temperature fluctuations are virtually non-existent.*

This response does not completely resolve the issue, which will require more thorough M&V. This technology's evaluation was closed early in the 2006–2008 evaluation cycle, and the Specialized Commercial CG Evaluation Team did not conduct a full M&V analysis. The implementer[18] in corroboration with SCE and the installing contractor conducted a short M&V study of the technology.

The implementer's study commenced January 16, 2008, and included collecting 14 days of data from one CMU installed on a 3.5-ton unit. The study set up two cases when the controls were activated: 5 days on, 3 days off, and 6 days on. System current, and indoor and ambient temperatures were collected. According to the analysis, when compared to the three-day baseline, results concluded average savings of 8.1%, as shown in Table J-5.

**Table J-5: SCE EM&V Study Results**

| Control | KWH/day | Average Ambient Temp | Corrected KWH/day | KWH saved/day | % saving |
|---|---|---|---|---|---|
| CMU OFF | 14.36 | 53.0 | 14.36 | | |
| CMU ON Case 1 | 11.97 | 54.6 | 12.77 | 1.58 | 11.03% |
| CMU ON Case 2 | 14.11 | 52.0 | 13.61 | 0.74 | 5.16% |

The implementer noted the test would be more accurate during summer months with a longer baseline data.

[18] Energy Innovation Group (EIG)

The methodology to estimate cycle manager energy savings was derived from evaluating the implementer's energy savings project worksheets[19]. Annual kWh savings were determined by the following formulas:

**Equation J-3: Annual kWh Savings**

$$(1)\ EER_D = EER_N \times DF$$

$$(2)\ \frac{kW}{ton} = \frac{12}{EER_D}$$

$EER_N$ = Rated nameplate EER value. The unit's efficiency under ideal conditions.
DF = EER Derate Factor. Represents the efficiency loss due to loss of refrigerant, dirt on the heat exchange coils, etc. Estimated by the implementer.
$EER_D$ = Derated EER value. The operating efficiency expected out of the unit.
kW/ton = The power draw required to supply one ton of cooling.

Formulas' (1) and (2) were used as inputs to calculate the annual savings below:

$$(3)\ \text{Annual Savings (kWh)} = \frac{kBTU}{12} \times \frac{kW}{ton} \times EFLH \times RLF \times ESF$$

kBTU = Nameplate cooling capacity.
EFLH = Equivalent full load hours. Annual hours of operation[20].
RLF = Rated load factor. Estimated by the implementer.
ESF = Energy savings factor. Estimated by the manufacturer.
12 = Number of kBTUs in one ton of cooling.

## Recommendations and Significant Findings

The HVAC Cycle Manager (CMU) is a low-cost measure with low potential impact on energy savings. It is recommended future program cycles evaluate the validity of savings estimates for this technology. We also recommend M&V monitoring during summer months.

[19] EIG's subcontractor Intergy Corp. provided the analysis worksheets and estimated savings. When referring to the "implementer," this includes both companies since data were provided from both sources.

[20] Annual operating hours were derived from the building occupancy schedule.

### Proposed M&V Methodology

The recommended M&V approach for this technology is a simplified short-term monitoring plan per IPMVP, Option A, Partially Measured Retrofit Isolation. All measurements can be taken after the cycle manager is installed to monitor operating hours.[21] Current transformers (CT) will monitor one leg of the three-phase current input to the HVAC compressor to monitor operating hours and pre/post-retrofit operation. Indoor and outside air temperatures, including relative humidity, should be recorded to extrapolate weather-normalized annual savings. Annual energy savings will then be determined from short-term monitoring correlating the outside air temperature with HVAC equipment energy consumption as a function of dry bulb temperature by regressing hourly usage (kWh) with average hourly outside temperatures specific to the monitoring period. Monitored data will then be correlated and extrapolated to normal or design weather data (from the appropriate climate zone) to determine weather-normalized annual energy savings. There are no peak demand (kW) savings with this technology.

Ideally, metering should be conducted after the technology is installed. This requires a monitoring plan where data are collected when the cycle manager is on for one week, off one week off, on again one week, and off the final week. This will adjust for external influences, such as weather impacts.

## CO2 Demand Control Ventilation

This technology and application was similar to the SCE 2561 Energy Efficiency Program for Entertainment Centers. SCE 2561 energy savings realization rates determined through that analysis were applied to this MAP technology. Program evaluation results will be inferred from SCE 2561.

### Measure Description Summary

The $CO_2$ Sensor System is tied into the building's EMS to continuously—in "real-time"—adjust outside air brought into the building, based on changing occupancy. The sensor balances fresh air throughout the building and avoids over-ventilation. Demand-controlled ventilation (DCV) using carbon dioxide ($CO_2$) sensing combines two technologies: $CO_2$ sensors monitor $CO_2$

[21] Other data will be gathered, specifically: the rated cooling capacity, ARI certified cooling efficiency rating (SEER), and age of replaced equipment.

levels in the air inside a building, and an air-handling system uses data from the sensors to regulate the amount of ventilation air admitted.[22,23,24,25]

## Final Measure Status

Six sites installed DCV $CO_2$ sensing systems under the MAP program, through the course of the 2006–2008 program year, with the majority of installations occurring in 2007 (five sites). A detailed list of installed DCV is shown in Table J-6, below. Over the course of the program cycle, total ex ante gross savings for DCV were 1,222,182 kWh. This technology contributed to kW peak reduction to only two of the six sites; thereby, the resulting total peak ex-ante demand savings were 262 kW. The assumed NTG was 0.8, where the total net ex-ante savings for DCV were 977,746 kWh.

**Table J-6: Cycle Manager (CMU) Technology Installations and Savings**

| Site ID | Building Type | Ex ante Gross kWh savings | Ex ante Gross kW Savings | Ex ante Net kWh Savings | Climate zone | MAP Project Number |
|---|---|---|---|---|---|---|
| 1 | Cinema Theaters | 47,207 | 0 | 37,766 | 6 | 017-01-1 |
| 2 | Cinema Theaters | 99,729 | 0 | 79,783 | 6 | 017-01-2 |
| 3 | Cinema Theaters | 408,121 | 0 | 326,497 | 15 | 017-02-1 |
| 4 | Cinema Theaters | 220,952 | 0 | 176,762 | 15 | 017-03-1 |
| 5 | Cinema Theaters | 227,140 | 112 | 181,712 | 8 | 017-04-1 |
| 6 | Cinema Theaters | 219,033 | 151 | 175,226 | 14 | 017-05-1 |

Four additional measures were added to the MAP program with Change Order 3: Daylight Harvesting, Delta P Pressure Valve, Fan Wall, and Hotel Key Card. The measures contained various technologies, such as: solar window film, wireless EMS controls, simple lighting retrofits, VFD, and other HVAC measures. We recommended closing evaluations of these technologies with brief summaries in the following sections.

[22] Source: U.S. Department of Energy, DCV technology has been commercially available with significant research and case studies to support the energy efficiency claims, but has not been introduced into the marketplace.

[23] U.S. Department of Energy. Energy Efficiency and Renewable Energy. Demand-Controlled Ventilation Using CO2 Sensors. March 2004. Oct 30th 2007 www.eere.energy.gov/femp/

[24] Schell, Mike B., Turner, Stephen C. P.E., and Shim, R. Omar. "Application of CO2-Based Demand-Controlled Ventilation Using ASHRAE Standard 62: Optimizing Energy Use and Ventilation." *ASHRAE Transactions Symposia* 1989: 1213-1225

[25] Schell, Mike B., and Smith, Doug. "Assessing CO2 Control In Retrofits." *ASHRAE Journal* November 2002: 34-41

## Additional Measure Description Summary

The ***Daylight Harvesting and Dimmable Ballast*** system provided savings in two ways. First, it allowed a user to adjust the maximum light intensity for a fluorescent light fixture at a lower level than would be achieved with a non-dimmable ballasted fixture. The initial dimming level could be set as low as 40% of full light output. Secondly, the daylight harvesting function allowed lights to be dimmed as much as 80% power below the pre-set light levels, based on the available natural lighting.

The ***Hotel Keycard Energy Control*** system provided savings when a guest leaves a hotel room by cutting off power to lighting and setting back the room HVAC system to a lower energy level.

The ***Delta P Pressure Independent Valve*** system provided savings, when installed with a variable speed pump system, by maintaining a constant flow rate throughout a hydronic heating or cooling system, independently of the pressure drop across the valve. This type of hydronic system design (constant flow, variable pressure) offered an alternative to the more common variable flow, constant pressure design. The constant flow rate enabled the hydronic system to achieve its designed water temperature differential, while reducing pump load.

The ***Fan Wall*** system provided savings by replacing a traditional, single, large plenum fan with an array of smaller fans. The Fan Wall system reduced total fan horsepower by employing direct-drive fans redesigned for optimum efficiency. The array also resulted in better aerodynamic conditions by reducing pressure gradients at the fan inlet and outlet. Additional savings could result from a reduction in sound attenuation requirements, thus reducing duct friction losses. Total savings achieved could be somewhat offset by the lower efficiency of smaller fan motors, compared to the efficiency of a larger, single fan motor.

The ***miscellaneous measures*** will be discussed in the final report.

## Final Status of Additional Measures

Of the additional measures, only a limited number were installed, as shown in Table J-7, below. Two Hotel Key Card systems were installed, for total gross ex ante savings of 565,229 kWh. Seven Daylight Harvesting/Dimmable Ballast systems were installed for total gross ex ante savings of 656,779 kWh.

**Table J-7: Additional Measure Installations and Ex Ante Savings**

| Site # | Technology | Ex ante Gross kWh savings | Ex ante Gross kW savings | MAP Project Number |
|---|---|---|---|---|
| 1 | DH | 149,874 | 59.4 | 03-05-1 |
| 2 | DH | 80,348 | 29.94 | 07-14-1 |
| 3 | HK | 314,108 | - | 07-15-1 |
| 4 | DH | 45,045 | 8.27 | 23-03-1 |
| 5 | HK | 251,121 | 57.33 | 07-23-1 |
| 6 | DH | 25,521 | 0.37 | 23-01-1 |
| 7 | DH | 15,368 | 0.22 | 23-02-1 |
| 8 | DH | 308,512 | 92.27 | 03-03-2 |
| 9 | DH | 32,111 | 13.08 | 15-05-1 |
| | Total Savings | 1,222,008 | 260.88 | |

## Observations about Additional Measures

### Daylight Harvesting and Dimmable Ballast

The Daylight Harvesting/Dimmable Ballast system is only appropriate for open floor plans and perimeter offices, due to the availability of daylight. The effectiveness varies depending on space layout, orientation, proximity of adjoining buildings, and occupant cooperation. Properly used, the system has the potential to save large amounts of lighting energy, and the resulting heating interactions can also reduce the building's cooling load. Building users have also expressed satisfaction with the system's customization and adaptability in meeting specific lighting intensity preferences.

The implementer noted the technology had some demand control potential as most daylight harvesting occurs during peak utility energy usage during the noon to 6:00 PM periods. They proposed a number of methods for calculating energy savings, along with several observations.[26] The primary calculation method involved a comparison of baseline and EEM models in eQuest. For a second option, the implementer proposed performing circuit measurements before and after installation at the circuit or fixture level. This could be useful particularly where the technology is applied in the interior of the building, where daylight harvesting is not available due to lack of natural light. It would capture the overlit areas, which can now be permanently dimmed. A final option developed by the implementer involved basic assumptions or rules of thumb established as the program develops and there more buildings

26 "Methodology For Calculating Energy Saving From Axis Dimmable and Adjustable Lighting Retrofit", Intergy, 1/4/08.

become available as references for saving. The implementer anticipated this approach can be used as the technology has been installed in a number of buildings.

### Hotel Keycard Energy Control

The Hotel Keycard Energy Control system provided a strong opportunity to save energy by addressing issues many hotel guests are not concerned with, such as lighting and HVAC use during unoccupied periods. The Specialized Commercial CG Evaluation Team's literature search indicated this measure has been successfully installed in several locations throughout the United States. However, reports indicated approximately 5% of guests "gamed" the system by keeping an additional keycard in the control slot to prevent the lights, plug loads, and HVAC from turning off during unoccupied periods.

The implementer reported difficulties performing an evaluation of this type of system. One issue involved theft of metering equipment from the hotel room. In addition, the implementer found it difficult to remove metering equipment because the hotel management would not allow access when a guest occupied the room.

The implementer again proposed using eQuest as a means to calculate energy savings for this technology.[27] Energy savings for HVAC (with rooms in both the occupied and vacant status) and lighting would be determined separately, then combined to determine total savings.

### Delta P Pressure Independent Valve

The Delta P Pressure Independent Valve represented one part of a solution to "Low Delta-T Syndrome" in chilled water loop systems. These valves, in conjunction with other optimization efforts, could result in increased chiller efficiency and significant savings. However, no Delta P Pressure Independent Valve systems were installed under the SCE 2537 MAP program.

### Fan Wall

The Fan Wall system possessed a number of benefits, as outlined above. An additional benefit was that individual fans could be removed and replaced in the array with low cost and minimal loss of functionality. Normally, if a large plenum fan fails, replacement is expensive and requires the entire system to shut down. No fan wall systems were installed under the MAP Program.

27 "Methodology For Calculating Energy Saving From Entergize " Intergy 1/4/08

The implementer also proposed using eQuest as the means to calculate energy savings for this technology.[28] Energy savings for HVAC (with rooms in both the occupied and vacant status) and lighting would be determined separately and then combined to determine total savings.

## Practical Limitations of Additional Measures

### Daylight Harvesting and Dimmable Ballast

This technology was reportedly difficult to implement in conjunction with task lighting, which is user-controlled. M&V was complicated because each user had different preferences for acceptable light levels. The system was further complicated by the different light levels available at each face and story of a building, and the relationship to surrounding buildings. It was a very site-specific technology, with results sometimes difficult to extrapolate to other locations. Significant annual variance also occurred in lighting availability, which would require a regression analysis based on solar radiation data, coupled with metered light levels over the M&V period. That regression analysis could be complicated and inaccurate due to light level variability on a daily basis.

### Hotel Keycard Energy Control

The implementation of this system presented difficulty in selecting loads to control, particularly related to plug loads. Guests could choose to charge computers, cell phones, or PDAs while out of the room, and would not appreciate having the electricity cut off. It could also be annoying to continually reset the alarm clock, a plug load that should be separated from the control system. Generally, loads should be restricted to the TV, HVAC, and lighting. One limitation was customers could “game” the system by leaving one of the two cards they typically received in the control system slot. This allowed customers to maintain access to the room but leave the loads on while they were away.

In terms of M&V, this was a difficult technology to accurately evaluate. Each guest had individual preferences for TV, lighting, and HVAC use. Also, loads varied significantly due to outside weather and lighting, requiring a regression analysis. As with Daylight Harvesting, the particular face of the building could have a significant effect on lighting and HVAC use. Also, there were issues with occupancy levels of the room, both for monitoring and applying annual energy saving estimates.

28 "Methodology For Calculating Energy Saving From Fan Wall." Intergy. 1/4/08

The implementer performed M&V on one installation not included in the SCE 2537 MAP scope of projects. They experienced problems removing equipment after the M&V period because the room was occupied. Also, some metering equipment was exposed, and a large portion of those meters were stolen.

### Delta P Pressure Independent Valve

Though this measure should be effective at reducing the delta-T in a chilled water loop system, is should be only one measure in a comprehensive package of efficiency improvements. John Dilliott, Energy and Utilities Manager for UC San Diego,[29] advised that installing pressure-independent control valves was not a “silver bullet solution.” He recommended facilities *“look at its distribution loop as a whole system, not just a valve and a coil”* when engineering solutions for low delta-T. He also noted the size of an existing conventional control valve was not always the right size for a pressure-independent valve, and facilities should look to each building’s cooling load demands to size valves correctly.

M&V can be complicated by attempting to isolate savings from the Delta P Pressure Independent Valve from those of other measures as part of a comprehensive retrofit. In addition, delta-T reduction could vary considerably according to environmental conditions, requiring a regression analysis based on chilled water response to ambient temperature conditions.

### Fan Wall

The primary limitation of this technology involved reduction in efficiency by replacing one large fan with many smaller ones. This efficiency reduction should be balanced by other savings opportunities, as outlined above. However, this raises the question of whether energy savings have been actually achieved, which can only be determined through an evaluation.

The M&V and analysis process should be relatively straightforward in measuring the difference in energy use both pre- and post-installations. The primary complication for the Fan Wall M&V would be the large number of meters and current transformers needed to accurately characterize power draw by the new fans.

29 “University of California, San Diego Chilled Water Valve Upgrades” <http://greenbuildings.berkeley.edu/pdfs/bp2008_ucsd_retrofit.pdf>,

## Recommended M&V Approaches for Additional Measures

### Daylight Harvesting/Dimmable Ballast

The Daylight Harvesting and Dimmable Ballast system represented an effective method to reduce energy savings through lighting control. This was the most popular of the additional measures included in the MAP program, with seven installations expected to save a combined 656,779 kWh per year. However, demand savings appeared widely variable, ranging from ex ante estimates of 0.22 kW to 92.27 kW. The Specialized Commercial CG Evaluation Team recommends an additional M&V effort to determine peak demand savings more accurately.

The recommended M&V approach for this program would be a short-term monitoring plan per IPMVP, Option A, Partially Measured Retrofit Isolation. This option involves short-term monitoring, and there is uncertainty in extrapolating annual data from short-term data. To establish a baseline, the installation contractor should inventory the quantities and types of lamps and ballasts to be replaced. Based on the pre-installation inventory, the CPUC Table of Standard Fixture Wattages should be used to calculate the baseline energy load. The annual operating hours should be identified during a pre-installation site visit interview, and confirmed during the post-installation site visit interview.

The number of fixtures to monitor within each building selected should be determined using a sampling plan based on 90% confidence and 20% precision. The specific fixtures to monitor should be selected using the SLAM ("Statistical Lighting Analysis Macro") program. A true RMS power meter should monitor each selected lighting fixture, including ballast loads. A portable HOBO weather station should be installed on the roof to record solar radiation data. An instantaneous measurement of voltage at each fixture should be taken with a standard voltmeter, with the assumption voltage would remain constant. Monitoring should be conducted only during the post-installation period, with data collected at 15-minute intervals for the three-week duration. To determine the measure savings, the pre- and post-data should be used in standard engineering algorithms to calculate the lighting power reduction factor by building exposure applied to the lighting load and operating hours for each lighting fixture. The solar radiation data should be used to achieve a regression to the annual savings based on average weather year data from the California Energy Commission for the specific climate zone associated with the building location. Table J-8 shows data collection methods recommended for this technology.

**Table J-8: Daylight Harvesting/Dimmable Ballast M&V Data Collection**

| | Pre-Installation | | Post-Installation | |
|---|---|---|---|---|
| **Measure/ Data Field** | *Data Collection Method* | *Responsibility* | *Data Collection Method* | *Responsibility* |
| **Current Measurement** | Data logging for three weeks. Pre and post data recorded concurrently | Evaluation contractor | Data logging for three weeks. Pre and post data recorded concurrently | Evaluation contractor |
| **Voltage Measurement** | Single voltage reading. Pre and post data recorded concurrently | Evaluation contractor | Single voltage reading. Pre and post data recorded concurrently | Evaluation contractor |
| **Solar radiation** | Regional solar radiation database | Evaluation contractor | Data logging for three weeks | Evaluation contractor |
| **Hours of operation** | Site Interview | Implementation contractor | Site Interview | Evaluation contractor |

### Delta P Pressure Independent Valve

A chilled water system upgrade should be staggered to isolate savings associated with the Delta P Pressure Independent Valve. A comprehensive package of measures should be implemented to increase delta-T and system efficiency, but this will make it impossible to identify savings solely associated with the valves. However, staggering an installation in this method may be financially and logistically unfeasible.

The recommended M&V approach for this program would be a short-term monitoring plan per IPMVP, Option A, Partially Measured Retrofit Isolation. This option involves short-term monitoring, and there is uncertainty in extrapolating annual data from short-term data, specifically the pumping system annual operating load characteristics. Prior to the measure installation, each pump's electric power requirements should be measured at full load, and the resulting flow rate recorded. Pump characteristics should also be determined by measuring power and flow rate when opening and closing valves as well as examining the individual and combined performance of primary and secondary pumps. Longer-term metering should be conducted after the measure is installed. The true RMS power for each pump should be determined at peak load. The true RMS power and flow rate should be logged. A HOBO weather station should record dry bulb temperature. This requires a monitoring plan where data would be collected continuously over a three-week period. Annual operating hours should be identified through site visit interviews. To determine the measure savings, the pre- and post-data should be used in standard engineering algorithms to calculate the power reduction factor applied to the pump load. The weather station data should be used to achieve a regression to the annual savings based on average weather year data from the California Energy Commission for the specific climate zone associated with the building location. Table J-9 shows the data collection methods recommended for this technology.

**Table J-9: Delta P Pressure Independent Valve M&V Data Collection**

| | **Pre-Installation** | | **Post-Installation** | |
|---|---|---|---|---|
| **Measure / Data Field** | *Data Collection Method* | *Responsibility* | *Data Collection Method* | *Responsibility* |
| **Current Measurement** | Spot meter | Evaluation contractor | Data logging for three weeks. Pre and post data recorded concurrently | Evaluation contractor |
| **Dry bulb temperature** | N/A | Evaluation contractor | Data logging for three weeks | Evaluation contractor |
| **Flow rate** | Data logging for one hour | Evaluation contractor | Data logging for three weeks | Evaluation contractor |
| **Hours of Operation** | Site Interview | Implementation contractor | Site Interview | Evaluation contractor |

### Fan Wall

The Fan Wall system has gained recognition as a potential energy savings opportunity by various utilities throughout the country. The Specialized Commercial CG Evaluation Team has performed verification studies which include fan wall systems in Portland, Oregon, and Phoenix, Arizona. The Specialized Commercial CG Evaluation Team recommends this as a new construction measure due to the difficulty involved in removing a large plenum fan and retrofitting many smaller fans into the space. The efficiency loss involved in the process could jeopardize potential energy savings. The Specialized Commercial CG Evaluation Team recommends a future M&V effort to effectively characterize savings from installations.

The recommended M&V approach for this program would be a short-term monitoring plan per IPMVP, Option A, Partially Measured Retrofit Isolation. This option involves short-term monitoring, and there is uncertainty in extrapolating annual data from short-term data. Prior to measure installation, the existing large plenum fan's electric power requirements should be logged. After the measure is installed, the true RMS power for the Fan Wall installation should be logged. If multiple Fan Wall systems are installed in a building, each system should be individually metered. A HOBO weather station should record dry bulb temperature. This would require a monitoring plan where data would be collected continuously over a three-week period both pre- and post-installation. Annual operating hours should be identified through site visit interviews. To determine the measure savings, the pre- and post-data should be used in standard engineering algorithms to calculate the power reduction factor to be applied to the fan load. The weather station data should be used to achieve a regression to the annual savings based on average weather year data from the California Energy Commission for the specific climate zone associated with the building location. Table J-10 shows the recommended data collection methods for this technology.

**Table J-10: Fan Wall M&V Data Collection**

| | **Pre-Installation** | | **Post-Installation** | |
|---|---|---|---|---|
| **Measure / Data Field** | *Data Collection Method* | *Responsibility* | *Data Collection Method* | *Responsibility* |
| **Current Measurement** | Data logging for three weeks | Evaluation contractor | Data logging for three weeks | Evaluation contractor |
| **Dry bulb temperature** | Data logging for three weeks | Evaluation contractor | Data logging for three weeks | Evaluation contractor |
| **Hours of Operation** | Site Interview | Implementation contractor | Site Interview | Evaluation contractor |

### Hotel Keycard Energy Control System

The Hotel Keycard Energy Control system provides an excellent opportunity to save energy on systems routinely ignored by guests. However, it represents a significant challenge in performing M&V, as outlined above. The Specialized Commercial CG Evaluation Team should ensure all metering equipment is inaccessible to hotel guests, or safely secured, to prevent theft. In addition, the Specialized Commercial CG Evaluation Team needs to coordinate closely with hotel staff to remove M&V equipment. This will most likely need to occur during periods of room changeover, when staff is cleaning the room.

The recommended M&V approach for this program would be a short-term monitoring plan per IPMVP, Option A, Partially Measured Retrofit Isolation. This option involves short-term monitoring, and there is uncertainty in extrapolating annual data from short-term data, specifically energy usage behavior patterns and comfort needs of hotel guests. The annual average occupancy rate needs to be provided by the hotel. The number of rooms to monitor in a given hotel should be determined using a 90/20 sampling plan, based on the number of rooms with Keycard Controls in the selected hotel. The baseline condition should be determined by monitoring similar hotel rooms (concurrently with the post-installation monitoring) that have not had the Hotel Keycard Energy Control System installed. For each of the post-installation sample hotel rooms, an event logger should be installed and connected to the master wall switch to determine hours of occupancy. A true RMS power meter should be used to characterize electric load for the HVAC system in all modes of operation. Temperature and relative humidity data should be collected by a sensor installed at the HVAC return air grille. A portable weather station should be installed on the roof to collect ambient temperature data for correlation with the annual temperature data for the region. Light loggers should record bathroom lighting usage. This requires a monitoring plan where data would be collected continuously over a three-week post-installation period. Annual operating hours should be identified through the logged entry switch power data. To determine the measure savings, the pre- and post-data should be used in standard engineering algorithms to calculate the power reduction factor applied to the lighting and HVAC loads. The weather station data should be used to achieve a regression to the annual savings based on average weather-year data from the California Energy Commission for the specific climate zone associated with the building location. Table J-11 shows the recommended data collection methods for this technology.

**Table J-11: Hotel Keycard Energy Control M&V Data Collection**

| | **Pre-Installation** | | **Post-Installation** | |
|---|---|---|---|---|
| **Measure / Data Field** | *Data Collection Method* | *Responsibility* | *Data Collection Method* | *Responsibility* |
| **HVAC current Measurement** | Data logging for three weeks | Evaluation contractor | Data logging for three weeks | Evaluation contractor |
| **HVAC temperature and relative humidity** | Data logging for three weeks | Evaluation contractor | Data logging for three weeks | Evaluation contractor |
| **Bathroom light** | Data logging for three weeks | Evaluation contractor | Data logging for three weeks | Evaluation contractor |
| **Dry bulb temperature** | Data logging for three weeks | Evaluation contractor | Data logging for three weeks | Evaluation contractor |
| **Hours of Occupation** | Site Interview | Implementation contractor | Data logging for three weeks | Evaluation contractor |

# K. SCE 2537 TURBOCOR Field Data Collection Forms

**SITE INFORMATION** ***Date:*** ______________________

Customer Name: Project ID: ____________________

Contact Name: ____________________ Phone: ____________________

Address: ____________________

City / Town: ____________________ State: __________ Zip: ____________________

Utility Account: ____________________ Utility Account (2): ____________________

Customer Building Type (Office, Retail, or other - specify): ____________________

| Hours of Operation | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Monday to Friday | from __ __ to __ __ | from __ __ to __ __ | from __ __ to __ __ | from __ __ to __ __ | from __ __ to __ __ | from __ __ to __ __ |
| Saturday | from __ __ to __ __ | from __ __ to __ __ | from __ __ to __ __ | from __ __ to __ __ | from __ __ to __ __ | from __ __ to __ __ |
| Sunday | from __ __ to __ __ | from __ __ to __ __ | from __ __ to __ __ | from __ __ to __ __ | from __ __ to __ __ | from __ __ to __ __ |
| Holidays | from __ __ to __ __ | from __ __ to __ __ | from __ __ to __ __ | from __ __ to __ __ | from __ __ to __ __ | from __ __ to __ __ |
| Total Hours: | | | | | | |
| Schedule Notes: | | | | | | |

**Beverly Hills Central Plant -**

Planned Monitoring Baseline:

1. Install (2) kWh power meters (Dent Elite Pro) for both existing chillers
2. Install (3) temperature sensors for inlet and outlet temps (external to the pipe)
3. Install (1) HOBO weather station on the roof
4. Install (1 or 2) ultrasonic flow meter

Planned Monitoring Measure:

1. Install (4) kWh power meters (Dent Elite Pro) for four new TC chillers
2. Install (5 or 6) temperature sensors for inlet and outlet temps (external to the pipe)
3. Install (1) HOBO weather station on the roof
4. Install (1 or 2) ultrasonic flow meter

| **Turbocor Oil-Free Compressor** | |
|---|---|
| ***Baseline data collection*** | |
| Existing number of compressor(s): | |
| Age of existing unit (s): | |
| Existing capacity (tons): | |
| Notes: (Reason for replacement?) | |

| ***Measure data collection and verification*** | |
|---|---|
| Measure mfr and model # | (See Below) |
| Number of Turbocor(s) to be installed | |
| Is the equipment in working condition? | |
| Does the equipment appear to be properly installed? | |
| Has any of the equipment been removed or replaced since installation? | |
| Upgrades other than Turbocor compressor (no/yes - specify)? | |
| Installation Date | |
| Notes: | |

**Beverly Hills Central Plant – Baseline Conditions**

| ***Compressor: Recorded & Metered Measurements*** | *Baseline: Compressor 1* | *Baseline: Compressor 2* |
|---|---|---|
| *Name Plate: Manufacturer* | | |
| *Name Plate: Model #* | | |
| *Name Plate: Serial #* | | |
| *Name Plate: Tons* | | |

| | | |
|---|---|---|
| *Name Plate: Current (Amps)* | | |
| *Name Plate: Misc* | | |
| *Hours of operation (estimated)* | *From above:* | |
| *Metered kWh* | | |
| *Metered Temp Inlet (average)* | | |
| *Metered Temp Outlet (average)* | | |
| *Metered Flow Rate 1 (average)* | | |
| *Metered Flow Rate 2 (average)* | | |
| *Calculated Hours of Operation* | | |
| *Resulting kWh* | | |
| *Notes:* | | |

## Beverly Hills Central Plant – Measure Conditions

| ***Compressor: Recorded & Metered Measurements*** | *Measure: Compressor 1* | *Measure: Compressor 2* | *Measure: Compressor 3* | *Measure: Compressor 4* |
|---|---|---|---|---|
| *Name Plate: Manufacturer* | | | | |
| *Name Plate: Model #* | | | | |
| *Name Plate: Serial #* | | | | |
| *Name Plate: Tons* | | | | |
| *Name Plate: Current (Amps)* | | | | |
| *Name Plate: Misc* | | | | |
| *Hours of operation (estimated)* | *From above:* | | | |
| *Metered kWh* | | | | |
| *Metered Temp Inlet (average)* | | | | |
| *Metered Temp Outlet (average)* | | | | |
| *Metered Flow Rate 1 (average)* | | | | |
| *Metered Flow Rate 2 (average)* | | | | |
| *Calculated Hours of Operation* | | | | |
| *Resulting kWh* | | | | |

| |
|---|
| *Notes:* |

## Flow Rate Questions and Parameters

| | |
|---|---|
| *Pipe Size (diameter):* | *Inlet:* |
| *Pipe Size (diameter):* | *Outlet:* |
| *Pipe Material:* | |
| *Liquid Type:* | |
| *Estimated Temp Range:* | |
| *Are there bubbles:* | |
| *Distance from bend or valve 1 to 2* | *Inlet:* |
| *Distance from bend or valve 2 to 3* | |
| *Distance from bend or valve 3 to 4* | |
| *Distance from bend or valve 5 to 6* | *Outlet:* |
| *Distance from bend or valve 6 to 7* | |
| *Distance from bend or valve 7 to 8* | |
| *Diagram of bends:* | |

# L. Upstream HVAC SDG&E 3029: High Efficiency Motors

## Program Description

The Upstream Motors program was part of the larger Upstream HVAC/Motors program (SDGE 3029) and was designed to stimulate the supply and sales of premium-efficiency motors at the upstream and midstream levels. Participating motor distributors received incentives for premium-efficiency electric motor sales.

The program's initial focus was primarily educating distributors and manufacturers about ways to promote sales of premium-efficiency equipment rather than equipment that merely met code, and incenting them for each sale of a premium-efficiency motor. The program was unique in that the payment of the rebate to the distributor rather than the motor purchaser. The distributor could choose to give all or part of the rebate to the purchaser, but this was entirely up to the distributor. CSG noted that most distributors elected to keep the incentive rather than share it with their customer.

## Key Program Elements

This program provided education and incentives to motors dealers to encourage customers to purchase premium efficiency motors rather than standard efficiency motors. It also provided a Web site and marketing materials for customers wishing to upgrade their motor equipment. The program stressed the very short simple payback from purchasing a premium efficiency motor rather than a standard efficiency motor. In addition, information on the Web site encouraged potential customers to consider the operating cost savings available from retiring older but still functioning motors, or motors needing repairs and replacing them with premium efficiency motors.

## Evaluation Objectives

This program provided incentives to motors dealers for the sale of premium efficiency open drip pan (ODP), totally enclosed fan cooled (TEFC), and totally enclosed explosion proof (TXPL) motors that met the minimum efficiency requirements, defined as per the Consortium for Energy Efficiency and NEMA Premium Motors Standards, as shown in the Table L-1 below.

**Table L-1: Minimum Efficiency Requirements**

| Motor Size | Totally Enclosed Fan Cooled (TEFC) and Explosion Proof (TXPL) Enclosures | | | Open Drip Proof (ODP) Enclosure | | | Incentive Level |
|---|---|---|---|---|---|---|---|
| HP | 3600 rpm | 1800 rpm | 1200 rpm | 3600 rpm | 1800 rpm | 1200 rpm | 2007-2008 |
| 5 | 0.885 | 0.895 | 0.895 | 0.865 | 0.895 | 0.895 | $45.00 |
| 7.5 | 0.895 | 0.917 | 0.910 | 0.885 | 0.910 | 0.902 | $45.00 |
| 10 | 0.902 | 0.917 | 0.910 | 0.895 | 0.917 | 0.917 | $60.00 |
| 15 | 0.910 | 0.924 | 0.917 | 0.902 | 0.930 | 0.917 | $75.00 |
| 20 | 0.910 | 0.930 | 0.917 | 0.910 | 0.930 | 0.924 | $90.00 |
| 25 | 0.917 | 0.936 | 0.930 | 0.917 | 0.936 | 0.930 | $120.00 |
| 30 | 0.917 | 0.936 | 0.930 | 0.917 | 0.941 | 0.936 | $120.00 |
| 40 | 0.924 | 0.941 | 0.941 | 0.924 | 0.941 | 0.941 | $120.00 |
| 50 | 0.930 | 0.945 | 0.941 | 0.930 | 0.945 | 0.941 | $250.00 |
| 60 | 0.936 | 0.950 | 0.945 | 0.936 | 0.950 | 0.945 | $250.00 |
| 75 | 0.936 | 0.954 | 0.945 | 0.936 | 0.950 | 0.945 | $250.00 |
| 100 | 0.941 | 0.954 | 0.950 | 0.936 | 0.954 | 0.950 | $400.00 |

## Verification and Net-to-Gross

The main goal of the Upstream Motors evaluation was to verify installation of the motors and review the savings estimates for reasonableness. Sample sizes described here were prescribed by the Protocols.[30] For the motors measure, sample sizes were developed to achieve 30% precision at the 90% confidence level. There were 219 motors incented under the program for which savings were claimed during the 2006-2008 program period. These 219 program motors were purchased by 146 unique customers. To achieve 30% precision at the 90% confidence level for the sampling frame of 219 motors and 146 customers, the protocols required a sample of seven sites. Cadmus planned to conduct site visits at a sample of eight participant sites to verify the purchase and installation of all motors recorded in the program participant database at each site.

Both SDG&E and CSG conducted their own verification studies while the program was ongoing. The savings for any motors found to be uninstalled were not included in claimed savings for the program.

[30] *California Energy Efficiency Evaluation Protocols: Technical, Methodological, and Reporting Requirements for Evaluation Professionals*. Prepared for the CPUC by the TecMarket Works Team.

## Methodology

### Methods Used in this EM&V Activity

#### Sample Sizes for Motors EM&V

Within this program, 219 premium efficiency motors were installed at 146 sites. The approach used to select a sample of participant sites for the verification sample met the 30% precision at the 90% confidence level.

**Table L-2: Summary of Participants Installing Premium Efficiency Motors**

| NAICS 2-digit categories | NAICS Code | Number of Motors | Number of Sites |
|---|---|---|---|
| Missing NAICS code | | 1 | 1 |
| 22-Utilities | 22 | 11 | 10 |
| 23-Construction | 23 | 10 | 6 |
| 32-Manufacturing | 32 | 14 | 6 |
| 33-Manufacturing | 33 | 12 | 8 |
| 42-Wholesale Trade | 42 | 12 | 5 |
| 44-Retail | 44 | 3 | 3 |
| 45-Retail | 45 | 2 | 2 |
| 51-Information | 51 | 3 | 3 |
| 52-Finance and Insurance | 52 | 2 | 2 |
| 53-Real Estate, Rental and Leasing | 53 | 12 | 12 |
| 54-Professional, Scientific and Tech Services | 54 | 28 | 21 |
| 55-Management of Companies and Enterprises | 55 | 1 | 1 |
| 56-Administrative, Support, Remediation and Waste Management Services | 56 | 2 | 2 |
| 61-Educational Services | 61 | 8 | 7 |
| 62-Health Care and Social Assistance | 62 | 32 | 23 |
| 71-Arts, Entertainment and Recreation | 71 | 18 | 9 |
| 72-Accomodation and Food Services | 72 | 27 | 8 |
| 81-Other Services(not public admin) | 81 | 17 | 13 |
| 92-Public Administration | 92 | 4 | 4 |
| | **Grand Total** | **219** | **146** |

**Table L-3: High-Efficiency Motor Installations Ex Ante Savings**

| A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|
| Number of Motors | Climate zones | Ex ante Gross kWh savings | Ex ante Gross kW Savings | Ex ante NTG | Ex ante Net kWh Savings [Col C * Col E] | Ex ante Net kW Savings [Col D * Col E] |
| 219 | N/A | 132,430 | 50 | 0.8 | 105,944 | 40 |

Of the 219 motors installed, 55% were installed in San Diego and 18% in El Cajon. All but two other locations had four or fewer motors installed. The participant sample was sorted by number of motors installed per account and by city. Some sites have multiple account numbers, so the Specialized Commercial CG Evaluation Team rolled up any accounts at the same service address to determine the total number of motors purchased by site. Eight sites were selected for verification. Because 73% of the motors were installed in either San Diego or El Cajon, motors installations at these cities were targeted. In addition, although verifying motor installations at seven sites would satisfy the requirement to sample at 30% precision at the 90% confidence level, the Specialized Commercial CG Evaluation Team attempted verification site visits at eight sites. Because the Specialized Commercial CG Evaluation Team was concerned that sites purchasing larger quantities of motors would be more likely to have program motors in storage and would bias the verification results, the participant sites in El Cajon and San Diego were further stratified by number of program motors purchased per site. The following strata were used: greater than five motors, 2-5 motors, and 1 motor.

The final sampling targets are shown in Table L-4 below.

**Table L-4: Final Motors Verification Sampling Targets**

| Stratum | Definition | San Diego | El Cajon | Totals |
|---|---|---|---|---|
| 1 | 1 motor | 2 | 2 | 4 |
| 2 | 2 - 5 motors | 1 | 1 | 2 |
| 3 | > 5 motors | 1 | 1 | 2 |
| Totals | | 4 | 4 | 8 |

### Reference and Background for the Methods Applied

Claimed energy savings (gross kWh and gross kW) used in the Standardized Program Tracking database were deemed using DEER estimates, where available. Savings were available in DEER for 5, 10, 25, 50, and 100 HP motors. DEER does not list energy savings for the following motors: 7.5, 30, 40, 60, and 75 HP motors. Energy savings for these motors were calculated using the Standard Performance Contract methodology.[31] Calculations used 4-pole, 1,800 RPM motors, DEER run hours, assumed baseline nominal full-load efficiency at EPACT standards, and 75% load factor. DEER run hours used were 2,076 annual operating hours for motors 15 HP or smaller, and 2,820 annual operating hours for motors over 15 HP. KW was calculated from kWh using constants derived from the next lower HP motor, which scaled the intermediate HP KW savings to the load shape included in the DEER KW estimates.

Cadmus reviewed the claimed savings assumptions published in the Standardized Program Tracking database. Savings are provided by HP. For HP where DEER estimates were available, the Specialized Commercial CG Evaluation Team verified the correct DEER RunID's were used for each HP and enclosure type, and that the correct savings were used to estimate per unit savings.

For HP where DEER estimates were not available, the Specialized Commercial CG Evaluation Team used the estimation form published in the 2004-2005 Database for Energy Efficiency Resources (DEER) Update Report, p. 3-23 to re-estimate kWH and kW savings. For kWh savings, the form is as follows:

*Energy Savings* = ((Motor HP / EPACT motor efficiency) X kW / HP x Hrs of Operation x Motor Loading)

- ((Motor HP / Premium motor efficiency) X kW / HP x Hrs of Operation x Motor Loading)

EPACT motor efficiencies used were nominal full load efficiencies for 4-pole motors published in the Federal Register, Vol. 64, No. 192, p. 54158. Premium motor efficiencies used were those published in the program incentive table, assuming an 1800 rpm motor. For annual operating hours, the team used the same run hour assumptions published in program planning documents: DEER run hours of 2,076 for motors 15 HP and under, and 2,820 for motors greater than 15 HP. Motor loading and kW per HP constants were provided by the DEER Update Report. For reference purposes, the team re-estimated savings for HP with DEER estimates as well.

Table L-5 shows the kWh savings estimates calculated using the DEER methodology and compared to those provided on the stand from which program savings are calculated.

[31] 2001 SPC Procedures Manual. Section 3: Measurement and Verification. March 2001 pp 3-18 through 3-20.

## Table L-5: Evaluated Energy Savings Estimates

| Open Drip Pan | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Motor HP | EPACT Motor Efficiency | kW/HP | Hours of Operation | Load Factor | Premium Motor Efficiency | $kWh_{(calc)}$ | $kWh_{(E3)}$ | kWh Difference | % diff |
| 5 | 0.875 | 0.746 | 2076 | 0.75 | 0.895 | 148.3189 | 148.3189 | 0.00 | 0.00% |
| 7.5 | 0.885 | 0.746 | 2076 | 0.75 | 0.91 | 270.4233 | 276.7999 | -6.38 | -2.36% |
| 10 | 0.895 | 0.746 | 2076 | 0.75 | 0.917 | 311.3564 | 311.3564 | 0.00 | 0.00% |
| 15 | 0.91 | 0.746 | 2076 | 0.75 | 0.93 | 411.7412 | 411.7412 | 0.00 | 0.00% |
| 20 | 0.91 | 0.746 | 2820 | 0.75 | 0.93 | 745.7356 | 745.7356 | 0.00 | 0.00% |
| 25 | 0.917 | 0.746 | 2820 | 0.75 | 0.936 | 873.1676 | 873.1676 | 0.00 | 0.00% |
| 30 | 0.924 | 0.746 | 2820 | 0.75 | 0.941 | 925.4603 | 939.9999 | -14.54 | -1.57% |
| 40 | 0.93 | 0.746 | 2820 | 0.75 | 0.941 | 793.2851 | 846 | -52.71 | -6.65% |
| 50 | 0.93 | 0.746 | 2820 | 0.75 | 0.945 | 1346.467 | 1346.467 | 0.00 | 0.00% |
| 60 | 0.936 | 0.746 | 2820 | 0.75 | 0.95 | 1490.49 | 1504 | -13.51 | -0.91% |
| 100 | 0.941 | 0.746 | 2820 | 0.75 | 0.954 | 2284.833 | 2284.833 | 0.00 | 0.00% |
| **Totally Enclosed Fan Cooled** | | | | | | | | | |
| Motor HP | EPACT Motor Efficiency | kW/HP | Hours of Operation | Load Factor | Premium Motor Efficiency | $kWh_{(calc)}$ | $kWh_{(E3)}$ | kWh Difference | % diff |
| 5 | 0.875 | 0.746 | 2076 | 0.75 | 0.895 | 148.3189 | 148.3189 | 0.00 | 0.00% |
| 7.5 | 0.895 | 0.746 | 2076 | 0.75 | 0.917 | 233.5173 | 207.6 | 25.92 | 11.10% |
| 10 | 0.895 | 0.746 | 2076 | 0.75 | 0.917 | 311.3564 | 311.3564 | 0.00 | 0.00% |
| 15 | 0.91 | 0.746 | 2076 | 0.75 | 0.924 | 290.0904 | 290.0904 | 0.00 | 0.00% |
| 20 | 0.91 | 0.746 | 2820 | 0.75 | 0.93 | 745.7356 | 745.7356 | 0.00 | 0.00% |
| 25 | 0.924 | 0.746 | 2820 | 0.75 | 0.936 | 547.2965 | 547.2965 | 0.00 | 0.00% |
| 30 | 0.924 | 0.746 | 2820 | 0.75 | 0.936 | 656.7557 | 657.9999 | -1.24 | -0.19% |
| 40 | 0.93 | 0.746 | 2820 | 0.75 | 0.941 | 793.2851 | 846 | -52.71 | -6.65% |
| 50 | 0.93 | 0.746 | 2820 | 0.75 | 0.945 | 1346.467 | 1346.467 | 0.00 | 0.00% |
| 60 | 0.936 | 0.746 | 2820 | 0.75 | 0.95 | 1490.49 | 1504 | -13.51 | -0.91% |
| 75 | 0.941 | 0.746 | 2820 | 0.75 | 0.954 | 1713.625 | 1692 | 21.63 | 1.26% |
| 100 | 0.945 | 0.746 | 2820 | 0.75 | 0.954 | 1575.112 | 1575.112 | 0.00 | 0.00% |

Using the DEER estimation method, to the Specialized Commercial CG Evaluation Team replicated the kWh savings estimates for all HP for which there are savings estimates in DEER. For the intermediate HP (7, 30, 40, 60 and 75), however, the team was unable to replicate the values used to claim savings, although all but two re-estimated values are within 2% of the claimed savings values.

The estimation form for demand savings from the 2004-2005 DEER Update Report is:

*Demand Savings* = (Motor HP x kW/HP x Coincidence Factor / EPACT Motor Efficiency) –

(Motor HP x kW/HP x Coincidence Factor / EPACT Motor Efficiency)

The coincidence factor provided in the DEER Update Report was assumed, and the following kW savings were calculated.

**Table L-6: Evaluated Demand Savings Estimates**

| Open Drip Pan | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Motor HP | EPACT Motor Efficiency[1] | kW/HP[3] | Load Factor | Premium Motor Efficiency[3] | Coincidence Factor | $kW_{(calc)}$ | $kW_{(E3)}$ | kW Difference | % diff |
| 5 | 0.875 | 0.746 | 0.75 | 0.895 | 0.74 | 0.070492 | 0.070492 | 0.00 | 0.00% |
| 7.5 | 0.885 | 0.746 | 0.75 | 0.91 | 0.74 | 0.128525 | 0.131556 | 0.00 | -2.36% |
| 10 | 0.895 | 0.746 | 0.75 | 0.917 | 0.74 | 0.147979 | 0.147979 | 0.00 | 0.00% |
| 15 | 0.91 | 0.746 | 0.75 | 0.93 | 0.74 | 0.195689 | 0.195689 | 0.00 | 0.00% |
| 20 | 0.91 | 0.746 | 0.75 | 0.93 | 0.74 | 0.260919 | 0.260919 | 0.00 | 0.00% |
| 25 | 0.917 | 0.746 | 0.75 | 0.936 | 0.74 | 0.305505 | 0.305505 | 0.00 | 0.00% |
| 30 | 0.924 | 0.746 | 0.75 | 0.941 | 0.74 | 0.323802 | 0.328889 | -0.01 | -1.57% |
| 40 | 0.93 | 0.746 | 0.75 | 0.941 | 0.74 | 0.277556 | 0.296000 | -0.02 | -6.65% |
| 50 | 0.93 | 0.746 | 0.75 | 0.945 | 0.74 | 0.471104 | 0.471104 | 0.00 | 0.00% |
| 60 | 0.936 | 0.746 | 0.75 | 0.95 | 0.74 | 0.521495 | 0.526222 | 0.00 | -0.91% |
| 100 | 0.941 | 0.746 | 0.75 | 0.954 | 0.74 | 0.799422 | 0.799422 | 0.00 | 0.00% |
| **Totally Enclosed Fan Cooled** | | | | | | | | | |
| Motor HP | EPACT Motor Efficiency[1] | kW/HP[3] | Load Factor | Premium Motor Efficiency[3] | Coincidence Factor | $kW_{(calc)}$ | $kW_{(E3)}$ | kW Difference | % diff |
| 5 | 0.875 | 0.746 | 0.75 | 0.895 | 0.74 | 0.070492 | 0.070492 | 0.00 | 0.00% |
| 7.5 | 0.895 | 0.746 | 0.75 | 0.917 | 0.74 | 0.110984 | 0.098667 | 0.01 | 11.10% |
| 10 | 0.895 | 0.746 | 0.75 | 0.917 | 0.74 | 0.147979 | 0.147979 | 0.00 | 0.00% |
| 15 | 0.91 | 0.746 | 0.75 | 0.924 | 0.74 | 0.137872 | 0.137872 | 0.00 | 0.00% |
| 20 | 0.91 | 0.746 | 0.75 | 0.93 | 0.74 | 0.260919 | 0.260919 | 0.00 | 0.00% |
| 25 | 0.924 | 0.746 | 0.75 | 0.936 | 0.74 | 0.191489 | 0.191489 | 0.00 | 0.00% |
| 30 | 0.924 | 0.746 | 0.75 | 0.936 | 0.74 | 0.229787 | 0.230222 | 0.00 | -0.19% |
| 40 | 0.93 | 0.746 | 0.75 | 0.941 | 0.74 | 0.277556 | 0.296000 | -0.02 | -6.65% |
| 50 | 0.93 | 0.746 | 0.75 | 0.945 | 0.74 | 0.471104 | 0.471104 | 0.00 | 0.00% |
| 60 | 0.936 | 0.746 | 0.75 | 0.95 | 0.74 | 0.521495 | 0.526099 | 0.00 | -0.88% |
| 75 | 0.941 | 0.746 | 0.75 | 0.954 | 0.74 | 0.599566 | 0.591862 | 0.01 | 1.29% |
| 100 | 0.945 | 0.746 | 0.75 | 0.954 | 0.74 | 0.551103 | 0.551103 | 0.00 | 0.00% |

As with the kWh estimates, the Specialized Commercial CG Evaluation Team used the DEER estimation method and replicated the KW estimates for all HP for which there are savings estimates in DEER. For the intermediate HP (7, 30, 40, 60 and 75), however, we were unable to replicate the values published in SDG&E's E3 calculator, although we note that all but two re-estimated values are within 2% of those in the E3.

While most of the re-estimated energy and demand savings values are within 2% of the values used by the utility, the Specialized Commercial CG Evaluation Team's savings estimation methodology is consistent over all HP and consistent with DEER methodology. Therefore, these re-estimated values were used to estimate final program savings. The adjusted ex ante savings are provided Table L-7. The total percent change in energy savings is 0.5% and 0.4% for demand savings.

**Table L-7: High-Efficiency Motor Installations Evaluated Savings Summary**

| | A | B | C | D | E |
|---|---|---|---|---|---|
| Number of Motors | Ex ante Gross kWh savings adjusted for re-estimated savings per HP | Ex ante Gross kW Savings adjusted for re-estimated savings per HP | Ex ante NTG | Ex ante Net kWh Savings [Col A * Col C] | Ex ante Net kW Savings [Col B * Col C] |
| 219 | 131,756 | 50 | 0.8 | 105,405 | 40 |

## Confidence and Precision of Key Findings

### Planned Confidence and Precision

This impact evaluation for the high-efficiency motors component of SDGE 3029 was a Verification Guided Direct and Indirect Impact Evaluation. The CPUC stipulated a *verify* rigor level for both energy and demand savings estimation, and a *basic* rigor level to assess indirect impacts.

For this program, the installation contractors receiving rebates and purchasers of equipment were identifiable and contact information available. For the NTG estimation, we estimated the ratio through vendor surveys, rather than using the *option* level of rigor stipulated by the CPUC. We used the *basic* level of rigor, and administered surveys to estimate free-ridership using the approved Joint Simple SR NTG Method.

**Table L-8: CPUC-Stipulated and Final Evaluation Rigor Levels for SDGE 3029 Motors**

| Evaluation Component | CPUC Stipulated | Final Rigor Levels |
|---|---|---|
| Energy | Verify | Verify |
| Demand | Verify | Verify |
| Net-to-Gross | Option | Basic |
| Indirect | Basic | Basic |

To meet basic levels of rigor, the CA Protocols called for sample sizes meeting 90% confidence and 30% precision. This 90/30 sampling plan was used for the motors verification.

Survey sample sizes were prescribed by the Protocols, at least 300 per program for NTG analysis. This program was an upstream program, and the incentive was given to the participating motor distributor rather than the purchasing customer. However, according to the program implementer, the motors distributors generally did not pass on the incentive to their customers; therefore, customers were not aware they had "participated" in a program. There were seven participating motor distributors listed on the marketing materials provided on the Premium Efficiency Motors Program Web site: Brithinee Electric, Chick's Electric Motor Service, Electric Motor Specialists, Kaman Industrial Technologies (three locations), and Sloan Electric. Eighty-six percent of the motors sold for which savings were claimed in the 2006-2008 program cycle were sold by Chick's Electric Motor Service and Sloan Electric; and approximately 50% of all program motors were sold by Chick's Electric Motor Service. There were no program motors sold by Electric Motors Specialists.

The Specialized Commercial CG Evaluation Team used the Vendor survey and interviewed all motors distributors to evaluate the effects the program training and education had on the distributor's willingness to recommend premium efficiency motors.

### Achieved Confidence and Precision

The Specialized Commercial CG Evaluation Team met the required 90/30 confidence and precision by conducting verification site visits at seven sites.

In addition, the Specialized Commercial CG Evaluation Team conducted NTG vendor surveys with representatives from all four participating distributors.

## Validity and Reliability

As this evaluation was verify only, no on-site metering of premium efficiency motors was conducted. The site visits verified installation of all motors claimed at each site.

## Detailed Findings

The pool of participant sites by stratum is shown in Table L-9 below.

**Table L-9: Participant Sites per Stratum**

| Stratum | Definition | San Diego | El Cajon | Totals |
|---|---|---|---|---|
| 1 | 1 motor | 67 | 10 | 77 |
| 2 | 2 - 5 motors | 17 | 2 | 19 |
| 3 | > 5 motors | 2 | 2 | 4 |
| Totals | | 86 | 14 | 100 |

The Specialized Commercial CG Evaluation Team conducted verification site visits at seven sites where program motors were purchased. Although the team planned to conduct site visits at eight sites, finding customers willing to participate in a verification site visit proved difficult. Some businesses purchased motors from contractors who purchased motors under the program but did not discuss the program with the business; therefore the business did not know where the program motor was installed. Many of the records in the participant database contained the distributor's name in the customer contact field rather than customer contact information so it was often difficult to determine the name and phone number of the correct person to contact at the business. Some persons listed as customer contacts were no longer employed by the participating business, and remaining employees were uninterested or unable to help locate the motors. Because motors can be used in many different applications, it was difficult for customers who had bought multiple motors to determine where the exact motors listed in the program tracking database were located.

The team was unable to conduct a site visit for the two sites in Stratum 3 in San Diego. At one site, the employee who was responsible for purchasing the motors had left the company on less than amicable terms, and the person contacted did not think anyone else would be able to find the motors. At the other site, the customer contact did not want to spend the time necessary to locate the motors.

Because customers did not receive the rebate themselves and were therefore unaware that the motor they purchased was part of a program, its purchase was unremarkable to them in comparison to any other motor purchased. Rather than standing out in their memory as special or different, these program motors were just like any other motors they purchased. The Specialized Commercial CG Evaluation Team was successful, however, in conducting seven site visits. A summary of the number of site visits conducted by stratum is provided in Table L-10.

**Table L-10: Site Visits Conducted per Stratum**

| Stratum | Definition | San Diego | El Cajon | Totals |
|---|---|---|---|---|
| 1 | 1 motor | 1 | 1 | 2 |
| 2 | 2 - 5 motors | 3 | 1 | 4 |
| 3 | > 5 motors | 0 | 1 | 1 |
| Totals | | 4 | 3 | 7 |

The Specialized Commercial CG Evaluation Team verified the manufacturer and model number of the motor, and noted whether or not the motor was in use or in storage. Table L-11 shows the results of the verification site visits.

**Table L-11: Site Visit Motors Verification Disposition**

| Site no. | City | Stratum | Number of. Motors in Program Database | Number. Verified | Number Installed | Number. In Storage |
|---|---|---|---|---|---|---|
| 1 | El Cajon | 3 | 18 | 15 | 5 | 10 |
| 2 | El Cajon | 2 | 3 | 3 | 3 | 0 |
| 3 | El Cajon | 1 | 1 | 1 | 1 | 0 |
| 4 | San Diego | 2 | 4 | 4 | 3 | 1 |
| 5 | San Diego | 2 | 4 | 3 | 1 | 2 |
| 6 | San Diego | 2 | 2 | 0 | 2 | 0 |
| 7 | San Diego | 1 | 1 | 1 | 1 | 0 |
| | Totals | | 33 | 27 | 16 | 13 |

As suspected, businesses purchasing only one or two motors were able to locate them. Those purchasing greater quantities of motors were more likely to have some in storage and to have more trouble identifying the location of the program motors at their site. At one site, the motors purchased under the program were installed but had already failed. The customer noted that he had not noticed any savings in his electricity consumption, and that the motor burned out faster than a standard efficiency motor and faster than it would have taken him to get simple payback. He noted that he subsequently purchased a motor of lesser HP in the hopes that it would run cooler and not burn out as fast.

The Specialized Commercial CG Evaluation Team averaged the installation rates by stratum and calculated an overall installation rate weighted by the number of motors installed per stratum.

**Table L-12: High Efficiency Motors Installation Rate Adjustment**

| Installation Rate Adjustment | | | | |
|---|---|---|---|---|
| **Stratum** | **Definition** | **Average Installation Rate** | **Number of Motors** | **Weighted Average** |
| 1 | 1 motor | 1.00 | 112 | 112.00 |
| 2 | 2 - 5 motors | 0.75 | 66 | 49.50 |
| 3 | > 5 motors | 0.28 | 41 | 11.39 |
| Totals | | | 219 | 0.79 |

Because the program can only claim savings from motors in use, this rate is used to adjust the adjusted gross savings downward to account for the percentage of motors that are not in use.

**Table L-13: High-Efficiency Motor Installations Verified Installation Summary**

| | A | B | C | D | E |
|---|---|---|---|---|---|
| **Number of Motors Sold** | **Ex ante Gross kWh savings adjusted for verified installations** | **Ex ante Gross kW Savings adjusted for verified installations** | **Ex ante NTG** | **Ex ante Net kWh Savings [Col A * Col C]** | **Ex ante Net kW Savings [Col B * Col C]** |
| 219 | 104,014 | 39 | 0.8 | 83,211 | 31 |

## Detailed Findings

### NTG Surveys

The Specialized Commercial CG Evaluation Team conducted surveys with four distributors in the participant database. While the database had seven distributors listed, as previously mentioned, for the purpose of surveys, all three separate locations of the same distributor were treated as a single entity. and upon inquiry Electric Motor Specialists divulged that they did not actually sell motors under the program. The vendor survey from the Joint Simple Net to Gross battery was modified to collect information on distributor behaviors, assess free-ridership, and to calculate the net to gross ratio. Although this evaluation did not include a process component, information reflecting program processes was shared during the interviews..

Critical questions for assessing free-ridership in this program and a summary of responses are presented in Table L-14, below:

**Table L-14: Free-ridership Response Summary**

| Question Number | Question | Response Range | Average Score |
|---|---|---|---|
| V2 | Using a 0 to 10 scale, where 0 is not at all important and 10 is extremely important, how important was the Program, including incentives as well as program services and information, in influencing your decision to recommend that customers purchase these motors? | 0 - 10 | 4 |
| V3 | Using a 0 to 10 likelihood scale, where 0 is not at all likely and 10 is extremely likely, if the Program, including incentives as well as services and information, had not been available, what is the likelihood that you would have recommended these motors to customers? | 3 - 10 | 7 |
| V4 | In what percent of sales situations did you recommend these measures before you learned about the program? | 50 - 100 | 86.25 |
| V5 | In what percent of sales situations do you recommend these measures now that you have worked with the program? | 5 - 100 | 68.75 |
| V7a | Using a 0 to 10 scale, rate the importance of the training seminar provided by SDGE/CSG? | 0 - 6 | 2.75 |
| V7b | Using a 0 to 10 scale, rate the importance of the information provided by the SDGE website? | 0 - 7 | 3.5 |
| V7c | Using a 0 to 10 scale, rate the importance of your firm's past participation in a rebate or audit program sponsored by SDGE? | 4 - 10 | 8.25 |
| V9 | In what percent of sales situations do you encourage your customers in SDGE's territory to purchase program qualifying premium efficiency motors? | 60 - 100 | 82.5 |
| V14 | Have you changed your stocking practices as a result of SDGE's program? | all | no |

The Specialized Commercial CG Evaluation Team calculated a VMAX score from the vendor survey responses, per the "Proposed Net-to-Gross Ratio Estimation Methods For Nonresidential Customers." The VMAX scores for this Program ranged from 7 to 10, with an average VMAX score of 9, indicating strong Program influence on distributor recommendations of premium efficiency motors. Therefore, the evaluated net-to-gross ratio for this program is 0.9.

The Specialized Commercial CG Evaluation Team has reservations about using a net-to-gross ratio of 0.9. Distributors' ratings of the Program ranged widely on many questions. While conducting the interviews, several distributors made it clear that their firms were strongly committed to selling premium efficiency equipment as standard business practice. One distributor reported that their firm sold only premium efficiency motors, and another claimed that their firm was the largest seller of premium efficiency motors in the State. Distributors' ratings on the Program's influence on their decision to recommend premium efficiency motors to their customers ranged widely from 0 to 10 with an average rating of 4. Two distributors gave the Program's influence on their recommendations a rating of 0. On a 0 to 10 likelihood scale, distributors reported they would have been very likely to recommend these motors to their customers even without the Program, giving an average rating of 7. Two distributors reported that they would have been extremely likely to recommend these motors without the Program, giving a rating of 10.

Distributors reported that they recommended premium efficiency motors in an average of 86.5% of sales situations before they learned about the Program, with three distributors reporting over 90%. They reported recommending premium efficiency motors in an average of 68.75% of sales situations now that they have worked with the Program, however, this lower percentage is skewed by one respondent, who reported that premium efficiency motors are not selling as well in the depressed economy, and therefore their firm is not recommending them. If this respondent is removed from the analysis, the recommendations rise to 90%.

Distributors rated the Program training, website and materials fairly low, rating both approximately 3. What they did value highly was past participation in an audit or rebate program sponsored by SDG&E, and gave this an average rating of 8.25.

When asked to estimate in what percentage of sales situations they encourage their customers in SDG&E's service territory to purchase premium efficiency motors that would qualify for the program rebate, distributors responded with an average of 82.5%. Responses ranged from 60% to 100%. When asked in what situations they would not recommend program-qualifying premium efficiency motors, distributors said "when purchase price is the driving factor in meeting their need, or when customers are very cost-conscious. One distributor remarked that the only time they would not recommend a premium efficiency motor is when there was none available that would serve the customer's purpose.

Most importantly, when distributors were asked if they had changed their stocking practices as a result of SDG&E's program, all responded they had not. Some had not changed their stocking practices at all, and others changed their stocking practices for reasons other than program participation.

One distributor remarked that they were currently selling mostly standard efficiency EPACT motors. He stated that the economy has driven down the purchase price customers are willing to pay.

The other three distributors were selling premium efficiency motors. One distributor remarked that they only stock premium efficiency motors, so the program had not changed their stocking practices. The other two distributors commented that stocking practices had changed to increase the amount of premium efficiency motors, but not because of the program. One cited impending federal regulations that would mandate the sale of premium efficiency motors as well as the desire to be perceived as "green" by their customers. The last distributor said they changed their stocking practices, not because of the current SDG&E program, but because of a study conducted by SDG&E a number of years ago that showed the availability of premium efficiency motors, in stock, is the key to increasing sales of these motors. The respondent stated that it is not enough to provide the energy savings message; if the premium efficiency motor is not available when the customer needs to purchase it, they will buy an available, less efficient motor that is in stock instead.

While the program was appreciated by some of the distributors, it clearly was not instrumental in increasing sales of the motors or changing stocking practices. The economy and impending federal legislation, along with the desire to be a "green" supplier seem to be the real driving factors behind distributor recommendations.

In addition, the Program VMAX score is driven in three of the four distributor interviews by past experience in an SDG&E rebate or audit program, not by any aspects of the current program. If the VMAX score is recalculated, omitting the rating of past experience with an SDG&E rebate or audit program, the VMAX scores range from 4 – 10, with three scores of 7 or below. The new average VMAX score is 6.5, and while still indicating more program influence than the verbatim comments from the distributors would indicate, is probably closer to the true net-to-gross ratio.

### Evaluated Energy and Demand Savings

The final evaluated energy and demand savings are shown in Table L-15 below.

**Table L-15: High-Efficiency Motor Installations Final Savings Summary**

| | | A | B | C | D | E |
|---|---|---|---|---|---|---|
| | Number of Motors Sold | Ex ante Gross savings | Gross Savings Adjusted for Re-estimated kWh | Gross Savings Adjusted for Verified Installation Rate | Evaluated NTG | Evaluated Net Savings [Col C * Col D] |
| Energy | 219 | 132,430 | 131,756 | 104,014 | 0.9 | 93,613 |
| Demand | 219 | 50 | 50 | 40 | 0.9 | 36 |

**Table L-16. High-Efficiency Motor Energy Savings Summary**

| | | A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|
| Measure | Program with Measure | Measure Ex-ante Gross kWh Savings | Measure Ex-post Gross kWh Savings | Measure Install Rate | Measure Installed Ex-post Gross kWh Savings [Col B * Col C] | Measure NTGR | Measure Ex-post Net kWh Savings [Col D * Col E] |
| Premium Efficiency Motors | SDGE3029 | 132,430 | 131,756 | 79% | 104,014 | 0.975 | 101,414 |

**Table L-17. High-Efficiency Motor Demand Savings Summary**

| | | A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|
| Measure | Program with Measure | Measure Ex-ante Gross Peak kW Savings | Measure Ex-post Gross Peak kW Savings | Measure Install Rate | Measure Installed Ex-post Gross Peak kW Savings [Col B * Col C] | Measure NTGR | Measure Ex-post Net Peak kW Savings [Col D * Col E] |
| Premium Efficiency Motors | SDGE3029 | 49.72 | 49.53 | 79% | 39.10 | 0.974 | 38.08 |

## Findings and Recommendations

The Specialized Commercial CG Evaluation Team recommends that the deemed per unit energy and demand savings for this program be adjusted to reflect the evaluated savings re-estimated using the 2004-2005 DEER methodology over all HP. It is recommended that the ex ante energy and demand savings be reduced by an additional 21% to reflect the verified motors installation rate, resulting in a final evaluated gross energy savings of 104,014 kWh and demand savings of 39 KW. The Specialized Commercial CG Evaluation Team further recommends that the program planning assumptions of 0.8 NTG be replaced by the evaluated NTG of 0.97 to calculate the final evaluated net energy savings of 101,414 kWh and net demand savings of 38 kW, as shown above.

During the course of the interviews, distributors shared information that was more process-oriented. One respondent was very enthusiastic about the Program and was very disappointed it had been discontinued. This respondent felt that the presence of the Program as well as the

Program materials helped them explain energy savings during their sales calls. This distributor reported that SDG&E's name on the Program materials helped when selling more expensive premium efficiency motors, and that with the Program behind them, helped to justify the incremental cost.

Two distributors were less enthusiastic about the Program. Both complained that the rebate submission process was arduous. One distributor reported they eventually abandoned working with the Program altogether.

Regarding the rebate received, all distributors reported either keeping the rebate themselves or a mixture of keeping it, passing it to the customer or splitting it with the customer. None of the distributors who split the rebate with or passed the rebate through to customers identified the rebate as coming from the program. Three of the four distributors mentioned that they used the rebates to purchase more premium efficiency motors for their current stock. Several stressed that the rebate should go to the distributors and not the end user. One distributor explained that distributors had to assume the financial risk of having these more expensive motors available in stock, when customers might not be willing to pay extra to buy them. If a distributor invests heavily in premium efficiency stock and customers are not willing or able to pay the price differential for the more efficient motors, they will either buy standard efficiency motors in stock or shop elsewhere, leaving the distributor with either lost business or expensive stock lingering unsold.

While most of the distributors were thankful for the support the program gave them when making the case for the more expensive premium efficiency motors, it did not seem to compel them to change their stocking practices. Program distributors seemed to be either already on message and enthusiastically marketing the premium efficiency equipment, or if not, were preparing to do so in light of upcoming federal regulations. These regulations and the current economic conditions were cited as drivers of stocking changes rather than the Program.

# M. Integrated Schools: SCE 2504

## Evaluation Overview

The EARTH Education and Training Program (formerly the Integrated Schools-Based Program) was targeted to reduce energy costs for schools and educate students about energy efficiency and conservation. The program was composed of three sub-programs: Green Schools, Green Campus, and LivingWise®.

This evaluation of the EARTH Education and Training Program focused on determining the impact of direct-savings measures (CFLs, showerheads, faucet aerators, etc.) distributed through this program. Originally, non-direct impacts were also to be quantified, but, because of the reallocation of resources to HIM programs, the evaluation was limited to only evaluating direct-savings measures.

### Green Schools and Green Campus

For Green Schools and Green Campus, only CFLs were included. As described in the HIM Addendum to the November 24, 2008, Specialized Commercial Evaluation Plan, this report will include:

- A review of Program goals and methods;
- A brief overview of program delivery and a definition of participants; and
- Detailed information on the number of CFLs distributed through program efforts.

For Green Schools, this report also included the number of schools recruited into the program and activities undertaken to reduce energy usage in the schools. For Green Campus, this report included the number of sites, student interns recruited, and program participants engaged at the program's completion.

### LivingWise®

Students received a kit of low-cost energy-efficiency measures to be installed in their homes. The program also promoted participation in other SCE residential energy-efficiency programs.

Evaluation of SCE's LivingWise® Program was scaled down to include the following:

- A review of Program goals and methods;
- A brief overview of program delivery and definition of participants;
- Detailed information on measures distributed through the program efforts; and
- Findings and installation rates from student-returned program surveys.

**Table M-1: Program Specific Evaluations**

| | ***Verification*** | ***Net Savings*** | | | |
|---|---|---|---|---|---|
| *Evaluation Methods →* | *Surveys, on-site Audits* | *Billing Analysis* | *On-site M&V* | *Participant Self Report* | *Discrete Choice* |
| Living Wise | Surveys | None | Simple Engineering Calculation, Secondary data | Ex ante | None |
| Green Schools | Pledge Forms | None | Simple Engineering Calculation, Secondary data | Ex ante | None |
| Green Campus | Pledge Forms | None | Simple Engineering Calculation, Secondary data | Ex ante | None |

## Program Description

The EARTH Education and Training Program (formerly the Integrated Schools-Based Program) was targeted to reduce energy costs for schools and educate students about energy efficiency and conservation. The program was composed of three sub-programs: Green Schools, Green Campus, and LivingWise®.

**Green Schools** specifically targeted school custodians and teachers, who, in turn, educated students about energy efficiency and conservation. As part of this program, CFLs were given away for students to install in their homes. The Green Schools program achieved savings primarily from CFL installations in their students' households, behavioral or operational changes in the households and schools, and product retrofits to decrease energy consumption.

**Green Campus** targeted students at four universities throughout SCE's service territory. The goal was to educate students and campus personnel about energy usage and energy efficiency. The program offered free student audit training for a select number of student interns and CFL giveaways (1,250/year). Indirect savings were expected from behavioral changes and other actions taken by students or the campus.

**LivingWise®** targeted sixth-grade students throughout SCE's service territory. It was offered in some areas jointly with SCG and/or area water utilities. The goal was to educate students about energy usage and energy efficiency. The program offered teachers a specific energy education curriculum. Students received a kit of low-cost energy-efficiency measures to be installed in their homes.

## Key Program Elements

For Green Schools and Green Campus, the only direct impact measures were CFLs. Bulbs were given away to students and townspeople during public events. Each recipient was required to fill out a pledge form indicating they would use the CFL to replace an existing incandescent bulb. The third party implementer collected all the pledge forms and tallied the total number of CFLs distributed.

Through the LivingWise® Program, students received kits containing low-cost energy-efficiency measures to be installed in their homes. These kits included: one CFL, a low-flow showerhead, a faucet aerator, an electro-luminescent night light, and air filter alarm. Installation rates for kits distributed to students were reported from student-returned program surveys.

## Evaluation Objectives

The evaluation objective for the EARTH Schools program was to determine the impact of CFLs distributed through the program (for Green Schools and Green Campus) and the kit contents: one CFL, a low-flow showerhead, a faucet aerator, an electro-luminescent night light, and an air filter alarm (for LivingWise®).

## Methodology

### Methodology and Specific Methods Used

The original evaluation plan for Integrated Schools called for the level of rigor indicated below. The CPUC has stipulated this program evaluation as a Verification Guided Direct and Indirect Impact Evaluation. Rigor levels were stipulated verification for energy and demand, option for NTG, and standard for indirect energy benefits. The Specialized Commercial CG Evaluation

Team, in the original work plan, proposed to increase the level of rigor for net-to-gross and indirect savings. The rigor levels are shown in Table M-2

**Table M-2: CPUC-Stipulated and Final Evaluation Rigor Levels for SCE 2504**

| Evaluation Component | CPUC Stipulated | Final Rigor Levels |
|---|---|---|
| Energy | Verify | Verify |
| Demand | Verify | Verify |
| Net-to-Gross | Option | Basic |
| Indirect | Basic | Standard |

The EARTH Schools program evaluation was limited to only implementer data collected through the end of 2008 (that is, through the 2006–2008 program cycle). As such, only direct savings (those from CFLs for Green Campus and Green Schools) were determined. Savings were based on a simple engineering algorithm:

$$kWh = \#\ bulbs * NTG * Install\ Rate * (W_{inc} - W_{CFL})/1000 * hours$$

The average incandescent wattage, operation hours, and installation rates through these programs were based on the findings from the evaluation of the CFL give-a-ways in the 2006-2007 CPUC Local Government Partnership program. [32] An NTG ratio of .8 was assumed to estimate savings net of free riders.

The LivingWise® Program evaluation focused solely on direct savings from measures installed by program participants. Participant completed surveys were to determine installation rates for measures distributed by the program. Appliance and fuel saturation assumptions and baseline conditions were checked against participant survey data. Measure savings for the measures were assessed either through use of commonly-accepted engineering algorithms, where assumptions were replaced by participant-provided data or through deemed savings provided by secondary data sources.

[32] Verification Report for California Residential CFL Give-A-Way Events, July 29, 2008.

## Discussion of Findings and Recommendations

### Green Schools

In the 2006–2008 program planning period, 73 unique schools participated. Since schools can participate for two or more years, 95 schools participated in the two-year period. In the 2006–2007 school year, 45 schools in eight school districts participated. Twenty-four of those were first-year participants, and 15 were second-year participants. In addition, six "graduated" schools (third-year or more participants) were involved, though they did not receive funding. In the 2007–2008 school year, 50 schools participated: 25 first-year, 18 second-year, and seven graduated schools across seven school districts.

Green Schools program participants include the schools, the students' households, and households of persons receiving CFLs. For this evaluation, which focuses on direct savings, only households of persons receiving CFLs had associated savings. However, activities at the schools, such as turning off computers and lights, or closing blinds and windows, could reduce energy usage in the school.

For the 2006–2008 period, 25,461 CFLs were distributed for this program. Most CFLs were given away at community events, and some were given directly to the students in participating classrooms. Of these bulbs, 948 were 13 W, 398 were 20 W, 653 were 18 W, and the remainder (23,462) were 23 W CFLs. Assumed savings per bulb are shown in the table below.

**Table M-3: Assumed Savings Per Bulb**

| CFL Wattage | Gross kWh per year savings | Gross kW per year savings | Savings Source |
|---|---|---|---|
| 13 W | 34.44 | 0.0030 | WPSCRELG0067.1-015 |
| 18 W | 41.77 | 0.0037 | WPSCRELG0067.1-028 |
| 20 W | 40.30 | 0.0035 | WPSCRELG0067.1-033 |
| 23 W | 49.10 | 0.0043 | WPSCRELG0067.1-040 |

The Local Government Partnership (LGP) program verification report[32] estimates the percentage of CFLs installed at different give-a-way events, such as community events. This report found 80% of bulbs given away to K-12 students and 88% of bulbs distributed at community events were installed. Since it was not possible to know the percentage of the bulbs distributed at each event, the reported overall installation ratio of 85% was assumed. In addition, the LGP report found 90% of the CFLs were used to replace incandescent bulbs.[33] Together, the 85% installation ratio and 90% of incandescent bulbs replaced resulted in a savings factor of 76.5% (85% * 90%).

Using the equation below, total savings from CFLs distributed through the Green Schools were 751 MWh and 66 kW. This puts the program above its target of 586 MWh and 45 kW of savings.

*kWh = # bulbs * NTG * Savings Factor * kWh/bulb*

**Table M-4**: **IOU Claimed kWh Savings and Evaluated Unit Energy Savings Comparison**

| Data | Screw-in CFL 13 Watt | Screw-in CFL 18 Watt | Screw-in CFL 20 Watt | Screw-in CFL 23 Watt |
|---|---|---|---|---|
| Claimed Annual Unit kWh savings | 34 | 42 | 40 | 49 |
| Evaluated Annual Unit kWh savings | 26 | 32 | 31 | 38 |

**Green Campus**

Four universities in SCE's territory participate in Green Campus: UC Irvine, CSU San Bernardino, UC Santa Barbara, and Cal Poly Pomona (added in 2007). At each campus, two to four student interns are hired to increase energy-efficiency awareness at the university. The implementer works with students and stakeholders (e.g., energy managers, residential housing directors, faculty) to educate the campus community on energy efficiency and promote implementation of energy-efficiency practices. Individuals, primarily students, are trained to do energy audits in offices, kitchens, laboratories, or other areas around campus. In addition, CFLs are distributed to students. Finally, the universities held residence hall competitions to educate students about energy efficiency in dorm rooms.

This program distributed 9,824 CFLs. All bulbs were 23 W, each with annual energy savings of 49.10 kWh and 0.0043 kW demand reduction.[34] The LGP program CFL verification report estimated 76% of bulbs distributed at university events were installed. Using the same 90% ratio used to replace incandescent bulbs, the savings factor was 68.4% (90% * 76%).

Using the equation below, total savings from CFLs distributed through the Green Campus were 263 MWh and 23 kW. This put this program above its target of 222 MWh and 20 kW of savings.

[33] The remaining 10% were used to replace other CFLs or "other".

[34] WPSCRELG0067.1-040

$$kWh = \# bulbs * NTG*Savings Factor*kWh/bulb$$

**Table M-5**: **IOU Claimed kWh Savings and Evaluated Unit Energy Savings Comparison**

| Data | Screw-in CFL 23 Watt |
|---|---|
| Claimed Annual Unit kWh savings | 49 |
| Evaluated Annual Unit kWh savings | 38 |

**LivingWise®**

In the 2006-2008 program cycle, 387 schools, representing 136 school districts within SCE's service territory had classrooms delivering the LivingWise® education program to sixth grade students. A total of 73,055 students and teachers participated between 2006 and 2008. Students received teacher-provided education on energy and reducing energy use along with a kit of energy-efficiency measures and other tools designed to help increase energy-saving behaviors in the home. The kit contents were:

- Compact Fluorescent Lamp (14 Watt changed to 23 Watt September, 2007)
- High Efficiency Showerhead (2.0 GPM at 80psi dynamic)
- Kitchen Aerator (1.5 GPM at 80psi dynamic)
- Bathroom Aerator (1.0 GPM at 80psi dynamic)
- Flow Rate Test Bag
- LimeLite® Night Light (Electroluminescent) (removed September, 2007)
- FilterTone® Alarm
- Water Temperature Check Card (removed September, 2007)
- Air Temperature Ruler (removed September, 2007)
- Digital thermometer to measure temperature of water, air, and refrigerator (added September, 2007)
- Energy Cost Calculator (Wheel Chart) (removed September, 2007)
- Natural Resources Fact Chart (added September, 2007)
- Adventures in Green Valley® CD-ROM (removed September, 2007)
- Toilet Leak Detector Tablets
- Rain / Drip Gauge
- Mini Tape Measure (measuring volume of the toilet)
- Cold Water Magnet (added September, 2007)
- Reminder Stickers - Turn off lights, turn off computer, thermostat settings 68 in winter – 78 in summer (added September, 2007)

- Installation Instructions
- Parent Comment Card

Table M-6, below, shows the number of measures that SCE claimed through delivery of the LivingWise® kits. While 73,055 households received a showerhead and two faucet aerators, SCE assumed that less than 2% of the hot water measures would be installed in homes with water heated by electricity. This is much more conservative than the 5% reported in California's 2004 Residential Appliance Saturation Survey (RASS).[35] It was also markedly different than the Specialized Commercial CG Evaluation Team findings that over 32% of participating households have electric water heating. shows the number of measures for which the program claimed savings against the number of measures with savings attributed to them by the Specialized Commercial CG Evaluation Team.

**Table M-6: Number of Measures with Savings Claims**

| Measure Name | Program Claimed Measures | Evaluated Measure Distribution |
|---|---|---|
| Air Filter Alarm | 73,055 | 73,055 |
| Faucet Aerators, Kitchen | 869 | 23,500 |
| Faucet Aerators, Bathroom | 869 | 23,500 |
| LED Night Light | 34,318 | 34,318 |
| Screw-in CFL 14 Watt 800 to 1,099 Lumens | 34,318 | 34,318 |
| Screw-in CFL 23 Watt 1,400 to 1,599 Lumens | 38,737 | 38,737 |
| Showerhead (electric at 2% share) | 869 | 23,500 |

SCE claimed kWh and kW savings for each measure by climate zone; the individual unit measure savings are listed below in Table M-8, and total gross kWh and kW savings by measure and climate zone listed in Table M-9. Table M-11 displays net kWh and kW program savings by measure claimed by SCE.

The Specialized Commercial CG Evaluation Team reviewed all ex ante savings assumptions, including SCE work papers on Air Filter Alarms (WPSCREHC0012), Screw-in CFL giveaways (WPSCRELG0067), and LED or EL nightlights(WPSCRELG0029). The measure saving estimates for faucet aerators and showerheads were DEER estimates, from the 2004-2005 update to the 2001database.

[35] California Statewide Residential Appliance Saturation Study, volume 2, KEMA, June 2004. http://www.energy.ca.gov/reports/400-04-009/2004-08-17_400-04-009VOL2A.PDF

The SCE workpaper on air filter alarms indicated savings averaging at 2.3% between months 3 and 11 of installation. The Specialized Commercial CG Evaluation Team research and engineering analysis showed 2.0% savings of total household annual cooling usage. The SCE workpaper on Screw-in CFL giveaways was accurate and reasonable, however, it assumed a higher installation rate (85.8%) than was achieved in the schools program (67% and 68%). The program claimed savings for an LED nightlight at 0.3 watts, but according to the implementer, a 0.03 watt electroluminescent (EL) nightlight was actually delivered. The SCE workpaper on nightlights detailed installation rates of 85%, with a portion of those, 14%, not replacing a lower-efficiency light source, but adding new load. In the calculations, however, the workpaper used a 100% installation rates. The Specialized Commercial CG Evaluation Team research found that only 72% of students installed the provided EL nightlight, with 58% of those replacing another nightlight.[36] This is likely a conservative estimate, because some households will forego turning on hallway or bathroom lights at night while using the EL nightlight. The difference between installation rates used by SCE in these measure savings calculations and those found by the Specialized Commercial CG Evaluation Team are detailed below in Table M-7.

**Table M-7: Installation Rates in SCE Workpapers versus Evaluated Rates**

| Measure Name | Evaluated Installation Rates | Installation Rate SCE |
|---|---|---|
| Air Filter Alarm | 30% | 47% |
| LED Night Light | 42% | 100% |
| Screw-in CFL 14 Watt 800 to 1,099 Lumens | 67% | 89% |
| Screw-in CFL 23 Watt 1,400 to 1,599 Lumens | 68% | 89% |

Estimates for savings from faucet aerators used by the LivingWise Program are based on DEER savings derived from an evaluation of a low-income program. These showerhead savings estimates were based on an assumed reduction of 0.5 GPM for installation of a high-efficiency showerhead, and a 4% reduction in baseline usage for water heating. The Specialized Commercial CG Evaluation Team savings algorithm utilized in this evaluation to determine savings from hot water measures is defined in the "Savings Algorithms" section below.

[36] Memo:*Assessment of Washington Energy Education in Schools – 2006-2007 Program Year*, Quantec, LLC, December, 2007 recorded 58% of students installing an EL Nightlight replaced an existing nightlight.

### Table M-8:Gross Unit Measure kWh and kW IOU Claimed Savings by Climate Zone

| Climate Zone | Data | Air Filter Alarm | Faucet Aerators | LED Night Light | Screw-in CFL 14 Watt | Screw-in CFL 23 Watt | Showerhead |
|---|---|---|---|---|---|---|---|
| 6 | Annual Unit kWh savings | 1 | 83 | 28 | 34 | 49 | 111 |
| | Annual Unit kW savings | 0.002 | 0.018 | 0.000 | 0.003 | 0.004 | 0.024 |
| 8 | Annual Unit kWh savings | 5 | 83 | 28 | 34 | 49 | 111 |
| | Annual Unit kW savings | 0.002 | 0.018 | 0.000 | 0.003 | 0.004 | 0.024 |
| 9 | Annual Unit kWh savings | 8 | 91 | 28 | 34 | 49 | 121 |
| | Annual Unit kW savings | 0.003 | 0.020 | 0.000 | 0.003 | 0.004 | 0.027 |
| 10 | Annual Unit kWh savings | 8 | 91 | 28 | 34 | 49 | 121 |
| | Annual Unit kW savings | 0.003 | 0.020 | 0.000 | 0.003 | 0.004 | 0.027 |
| 13 | Annual Unit kWh savings | 18 | 91 | 28 | 34 | 49 | 121 |
| | Annual Unit kW savings | 0.004 | 0.020 | 0.000 | 0.003 | 0.004 | 0.027 |
| 14 | Annual Unit kWh savings | 13 | 91 | 28 | 34 | 49 | 121 |
| | Annual Unit kW savings | 0.004 | 0.020 | 0.000 | 0.003 | 0.004 | 0.027 |
| 15 | Annual Unit kWh savings | 24 | 91 | 28 | 34 | 49 | 121 |
| | Annual Unit kW savings | 0.004 | 0.020 | 0.000 | 0.003 | 0.004 | 0.027 |
| 16 | Annual Unit kWh savings | 4 | 100 | 28 | 34 | 49 | 133 |
| | Annual Unit kW savings | 0.002 | 0.022 | 0.000 | 0.003 | 0.004 | 0.029 |

### Table M-9: Program Level Gross Annual Claimed Savings by Measure and Climate Zone

| Climate Zone | Data | Air Filter Alarm | Faucet Aerators | LED Night Light | Screw-in CFL 14 Watt | Screw-in CFL 23 Watt | Shower head | Grand Total |
|---|---|---|---|---|---|---|---|---|
| 10 | Annual Gross kWh Savings | 43,654 | 12,315 | 79,830 | 94,522 | 133,058 | 8,210 | 371,588 |
| | Annual Gross kW Savings | 15 | 3 | - | 8 | 12 | 2 | 39 |
| 13 | Annual Gross kWh Savings | 24,887 | 724 | 6,235 | 7,382 | 57,593 | 483 | 97,304 |
| | Annual Gross kW Savings | 6 | 0 | - | 1 | 5 | 0 | 12 |
| 14 | Annual Gross kWh Savings | 115,109 | 18,835 | 192,286 | 227,675 | 102,469 | 12,557 | 668,931 |
| | Annual Gross kW Savings | 40 | 4 | - | 20 | 9 | 3 | 76 |
| 15 | Annual Gross kWh Savings | 95,406 | 11,772 | 78,236 | 92,634 | 61,766 | 7,848 | 347,661 |
| | Annual Gross kW Savings | 18 | 3 | - | 8 | 5 | 2 | 36 |

| Climate Zone | Data | Air Filter Alarm | Faucet Aerators | LED Night Light | Screw-in CFL 14 Watt | Screw-in CFL 23 Watt | Shower head | Grand Total |
|---|---|---|---|---|---|---|---|---|
| 16 | Annual Gross kWh Savings | 1,466 | 1,399 | 8,883 | 10,517 | 4,910 | 933 | 28,108 |
| | Annual Gross kW Savings | 1 | 0 | - | 1 | 0 | 0 | 3 |
| 6 | Annual Gross kWh Savings | 12,148 | 21,624 | 129,539 | 153,379 | 309,273 | 14,416 | 640,378 |
| | Annual Gross kW Savings | 20 | 5 | - | 13 | 27 | 3 | 68 |
| 8 | Annual Gross kWh Savings | 90,899 | 36,927 | 146,991 | 174,043 | 635,240 | 24,618 | 1,108,717 |
| | Annual Gross kW Savings | 33 | 8 | - | 15 | 56 | 5 | 118 |
| 9 | Annual Gross kWh Savings | 190,477 | 48,717 | 335,035 | 396,695 | 597,631 | 32,478 | 1,601,033 |
| | Annual Gross kW Savings | 64 | 11 | - | 35 | 52 | 7 | 169 |
| **Total Annual Gross kWh Savings** | | **574,045** | **152,313** | **977,033** | **1,156,847** | **1,901,940** | **101,542** | **4,863,720** |
| **Total Annual Gross kW Savings** | | **196** | **34** | **-** | **102** | **167** | **22** | **520** |

**Table M-10: Program Level Net Annual Claimed Savings by Measure**

| Measure Name | Measure Ex-ante Gross kWh Savings | Measure Ex-ante Gross kW Savings | Measure NTGR | Measure Ex-ante Net Savings kWh | Measure Ex-ante Net Savings kW |
|---|---|---|---|---|---|
| Air Filter Alarm | 574,045 | 196 | 0.80 | 459,236 | 157 |
| Faucet Aerators | 152,313 | 34 | 0.80 | 121,851 | 27 |
| LED Night Light | 977,033 | - | 0.80 | 781,627 | - |
| Screw-in CFL 14 Watt | 1,156,847 | 102 | 0.80 | 925,477 | 81 |
| Screw-in CFL 23 Watt | 1,901,940 | 167 | 0.80 | 1,521,552 | 134 |
| Showerhead | 101,542 | 22 | 0.80 | 81,234 | 18 |
| Total | 4,863,720 | | | 3,890,977 | 417 |

**Table M-11: IOU Claimed kWh Savings and Evaluated Unit Energy Savings Comparison**

| Data | Air Filter Alarm | Faucet Aerators | LED Night Light | Screw-in CFL 14 Watt | Screw-in CFL 23 Watt | Showerhead |
|---|---|---|---|---|---|---|
| Range of claimed Annual Unit kWh savings | 1 – 24 | 83 -100 | 28 | 34 | 49 | 111 - 133 |
| Evaluated Annual Unit kWh savings | 9 | 62 - 79 | 13 | 32 | 30 | 269 |

The evaluated annual unit kWh savings shown above include the installation rates as reported below in Figure M-1.

**Student Survey Results**

The LivingWise® program implementer collects surveys from students participating in the program through the classroom teacher. The surveys are intended to be filled out by the student with help from an adult in their household. These surveys provide information on baseline conditions in participant homes, whether provided measures were installed, energy-saving behavioral changes made by the family, and equipment saturations and fuel sources. The results of these surveys provide a larger picture of the program, including broader information about participant households, the measures they installed and pre-installation characteristics. Table M-12, below shows a sample of the questions included on the student survey.

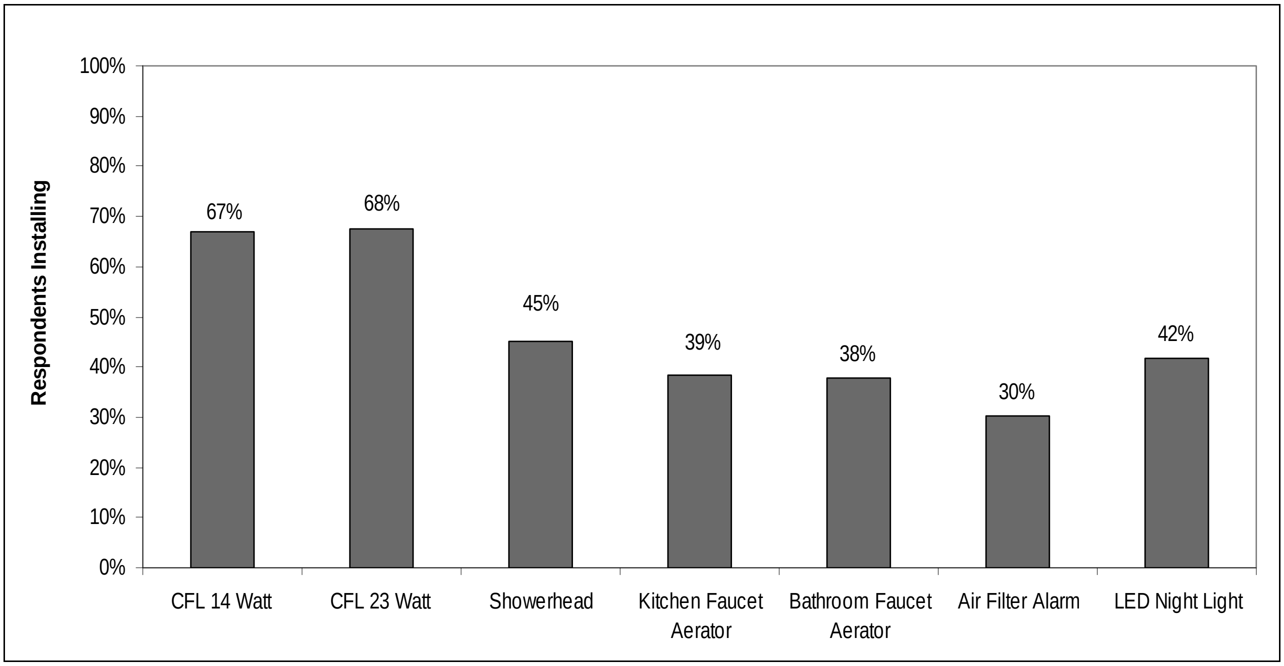
**Table M-12: Questions from Student Surveys**

| |
|---|
| Was your home built before 1992? |
| Is your residence rented or owned? |
| Number of children (age 0-17)? |
| Number of adults (age 18+)? |
| What is your main heating source? |
| Do you have a dishwasher? |
| How many toilets are in your home? |
| What type of energy does your water heater use? |
| What was the flow rate of your old showerhead? |
| What was your bathroom faucet's flow rate before you installed the aerator? |
| What was your kitchen faucet's flow rate before you installed the aerator? |
| Did you install your new energy-efficient (EE) showerhead? |
| What is the flow rate of your new showerhead? |
| Was your toilet leaking? |
| Did you install your new energy-efficient (EE) bathroom sink aerator? |
| What is your bathroom faucet's flow rate after you installed the aerator? |
| Did you install your new energy-efficient (EE) kitchen sink aerator? |
| What is your kitchen faucet's flow rate after you installed the aerator? |
| Did you change the temperature of your hot water heater? |
| Did you change the temperature of your refrigerator? |
| Do you plan to change your thermostat setting for heating? |
| Do you plan to change your air conditioner cooling temp setting? |
| Did you install your new FilterTone® Alarm? |
| If 'yes' to the above question, what was the wattage of the bulb you replaced? |
| Did you install your new 14 Watt Compact Fluorescent Lamp (CFL)? |
| Did you work with your family on this project? |
| Did you change the way you use water? |
| How would you rate the LivingWise program? |

The Specialized Commercial CG Evaluation Team requested and received the data compiled from all student-returned surveys. Students participating in the program completed and returned 37,883, or 52%, of the 73,055 surveys distributed. The vast number of participant surveys collected achieves a precision and confidence level beyond the evaluation target of 90% confidence and ±10%

precision. The primary information recorded through the surveys is the installation of the provided energy-efficiency measures and behavioral changes instituted in the household. Figure M-1, below, details the installation rate respondents reported for the measures included in the kit.

**Figure M-1: Installation Rates for Measures Distributed**




Students also reported energy-saving behavioral actions taken in their household. These included turning up the temperature for air conditioning (48%), turning down the temperature for heating (36%), decreasing the water heater temperature (36%), and increasing their refrigerator/freezer settings (21%). These findings are reported for the benefit of future program impact evaluations. Assessment of indirect energy savings from household behavioral changes is outside the scope of this research.

The 37,883 surveys analyzed also provided information on fuel saturations for heating, cooling, and hot water heating. Of note in this evaluation is the high level of electric water heating reported by participants. The student scantron surveys asked participants if the water heating in their house was electric or gas.[37] While the program expected less than 2% of participants to have electric water heating, over 32% of the participants reported electric water heat.

The surveys also provide data on pre-installation characteristics for the measures installed. Students report the wattage of incandescent bulbs replaced by the installed CFLs. With the provided water flow rate test bag, they determine and record the water flow rate of existing showerheads and the new showerhead as well as the flow rate of faucet aerators before and after replacement. These

[37] The question may have a small bias as participants were not allowed to choose “other” if their primary water heating source was not natural gas or electric. According to California’s RASS, however, only 4% of households statewide have a water heating fuel that is neither gas nor electric.

data are reported below, along with the engineering algorithms the evaluation team used to calculate savings.

**Savings Algorithms**

**Compact Fluorescent Lamps.** Students participating in program prior to September, 2007 were provided with a 14-watt CFL. After that time, students received a 23-watt CFL in their kit. Student surveys recorded the wattage of the bulb replaced by the CFL. The 14-watt CFL replaced a bulb with an average wattage of 70 watts. The 23-watt CFL replaced, on average, a 74 watt incandescent bulb. Savings calculations utilize the hours of operation developed by KEMA in the 2004-2005 DEER Update from the CFL Metering Study, that is, 2.34 hours per day. Figure M-2 below, details the calculation method for determining savings from the CFLs.

**Figure M-2: Unit CFL Savings Calculation**

$$\frac{\left[\textit{Installation rate}\right] * \left[\textit{Average hours/ day} * \textit{365 days}\right] * \left[\textit{Wattage replaced} - \textit{Wattage CFL}\right]}{\textit{1,000}}$$

The average savings per 14-watt CFL are 32 kWh per year, while savings from the 23-watt CFL are 30 kWh per year. These savings factor in the student-reported installation rates of 67% for the 14-watt CFL and 68% for the 23-watt CFL.

**Showerhead.** Program savings from the showerhead were calculated in two steps. First, students were asked to determine the flow rate of their existing showerhead in gallons per minute (GPM), using the flow rate measurement bag included in the LivingWise kit. Annual water savings per participant from the installation of the high-efficiency showerhead were calculated as shown below in Figure M-3.

**Figure M-3: Showerhead Water Savings Calculation**

$$\left[\textit{Average reported pre water flow (GPM)} - \textit{average reported post water flow (GPM)}\right] \left[\textit{No. showers/ week} * \textit{minutes per shower} * \textit{weeks}\right]$$

Survey analysis showed average pre-installation water flow rate was 2.2 GPM; the average post-installation water flow rate was 1.5 GPM. The number of showers per person per day is 0.7 showers, the average length of a shower is 8.2 minutes.[38] The number of people per household was calculated as 5.4 based on student survey data. However, the evaluation team assumed that the equivalent of one person would take baths rather than showers and achieve no savings with the showerhead. The kWh savings from the showerhead measure were calculated as:

**Figure M-4: Showerhead kWh Savings Calculation[39]**

$$\text{Installation rate} * \frac{\text{Annual water savings/}}{\text{participant (gallons)}} * \left( \frac{8.33 \text{ lbs./gallon} * \underline{45°F \Delta T}}{3{,}413 * \text{water heater efficiency (0.90)}} \right)$$

SCE claimed less than 2% of the showerheads distributed (869 of 73,055) were given to households with electric water heating. However, the analysis of student surveys showed electric water heating saturation as more than 32% of participant households (23,500 of 73,055). The Specialized Commercial CG Evaluation Team calculated the average participant savings from the high-efficiency showerhead to be 269 kWh per participant, per year. This average savings number does take into account the installation rate of 45%.

**Kitchen Faucet Aerator.** The Specialized Commercial CG Evaluation Team calculated savings from the kitchen faucet aerator using the methodology from the showerheads shown above. The savings were based on an estimated warm water faucet use of 9.1 minutes per day and a reduction in flow rate, as reported by students, from 1.9 GPM to 1.3 GPM.[40] Further, the team considered the installation rate (39%) reported by respondents for the aerator. Savings from the kitchen faucet aerator were calculated as 32 kWh per participant.

**Bathroom Faucet Aerator.** The Specialized Commercial CG Evaluation Team calculated savings from the bathroom faucet aerator, again, using the showerhead savings methodology. The calculated savings for the bathroom faucet aerators were based on an estimated use of 8.0 minutes per day and a reduction in flow rate from 1.9 GPM to 1.3 GPM. Further, the team considered the installation rate (38%). The evaluation team determined that average annual savings from the bathroom faucet aerator are 28 kWh per participant.

[38] Potential Water and Energy Savings from Showerheads by Peter J. Biermayer, Ernest Orlando Lawrence Berkeley National Laboratory, March 17, 2006. The number of people per household was calculated as 5.4 based on student survey data.

[39] A Btu is the amount of energy it takes to raise the temperature of 1 pound of water 1 degree. The 8.33 is a conversion factor for gallons to pounds, 45 degrees is the assumed temperature differential between ground water and delivered water in the shower, the division by 3,413 converts Btu to. The assumed efficiency of the electric water heater is 90%.

[40] We assumed a 35°F temperature differential from groundwater temperature for sink usage.

**Air Filter Alarm.** Significant dust and dirt build-up on an HVAC system filter requires the system to generate more pressure to move air through the filter, which uses more energy. The air filter alarm creates savings when the alarm alerts a resident to change the filter on their HVAC system sooner than they would have without an alarm. The Specialized Commercial CG Evaluation Team calculated savings resulting from more regular filter replacement to be 2% of the base energy consumption for cooling.[41] With 30% of participants installing the measure, average savings from the filter tone alarm were 9 kWh.[42]

**LED Night Light**. The LivingWise kits included a 0.03W electroluminescent (EL) nightlight to replace an existing 7-Watt light. SCE tracking data indicate it is an LED nightlight operating at 0.03W, however, a sample kit mailed to the Specialized Commercial CG Evaluation Team, and implementer data define it as an EL nightlight. 72% of participants indicated they installed the nightlight. To calculate savings, we assumed 58% of participating students installed the EL nightlight and replaced a pre-existing unit.[43] Resulting savings were calculated as follows:

*(Installation rate * percent replacing exiting lights)* * *(7W * 12 hours/day * 365 days)* - *(0.03W * 12 hours/day * 365 days)*

Average savings per participant from the EL nightlight were 13 kWh.

With the calculated measure savings, and the number of measures distributed through the program, the overall SCE LivingWise® program generated the savings listed below in Table M-14. The net-to-gross ratio applied is the ex ante (default) ratio 0.80.

Evaluated unit energy savings are shown below for each measure in the LivingWise® program.

**Table M-13: Unit Energy Savings**

| Measure Name | Number of participants | Unit Energy Savings (kWh) | Program Gross Savings (kWh) |
|---|---|---|---|
| Screw-in CFL 14 Watt | 34,318 | 32 | 1,098,176 |
| Screw-in CFL 23 Watt | 38,737 | 30 | 1,162,110 |
| Showerhead | 23,500 | 269 | 6,321,500 |
| Kitchen Faucet Aerator | 23,500 | 79 | 1,856,500 |

[41] Engineering Review and Savings Estimates for the "Filtertone" Filter Restriction Alarm, Howard Reichmuth, PE, November, 1999. Average energy use for central cooling in SCE territory is 1494 kWh according to the California Statewide Residential Appliance Saturation Study, volume 2, KEMA, June 2004 http://www.energy.ca.gov/reports/400-04-009/2004-08-17_400-04-009VOL2A.PDF.

[42] Those households without central systems would not be able to install the air filter alarm. Therefore, saturation of central cooling is not included in this calculation.

[43] Memo:*Assessment of Washington Energy Education in Schools – 2006-2007 Program Year*, Quantec, LLC, December, 2007 recorded 58% of students installing an EL Nightlight replaced an existing nightlight.

| | | | |
|---|---|---|---|
| Bath Faucet Aerator | 23,500 | 62 | 1,457,000 |
| Air Filter Alarm | 73,055 | 9 | 657,495 |
| LED Night Light | 34,318 | 13 | 446,134 |

**Table M-14: Evaluated Annual Program Savings by Measure**

| MeasureName | Total Measures | Ex Post Gross kWh Savings | Ex Post Net kWh Savings |
|---|---|---|---|
| Screw-in CFL 14 Watt 800 to 1,099 Lumens | 34,318 | 1,098,176 | 878,541 |
| Screw-in CFL 23 Watt 1,400 to 1,599 Lumens | 38,737 | 1,162,110 | 929,688 |
| Showerhead | 23,500 | 6,321,507 | 5,057,205 |
| KitchenFaucet Aerators | 23,500 | 1,856,502 | 1,485,202 |
| Bathroom Faucet Aerators | 23,500 | 1,457,002 | 1,165,601 |
| Air Filter Alarm | 73,055 | 657,495 | 525,996 |
| LED Night Light | 34,318 | 446,134 | 356,907 |
| Total | | 12,998,925 | 10,399,140 |

## Summary of Findings

Green Schools distributes CFLs to students at participating schools and community members and encourages behavioral changes that reduce energy consumption. The program generated energy savings of 751 MWh and demand savings of 66 kW, surpassing their goal of 586 MWh and 45 kW, respectively. In addition, there are likely indirect savings not quantified through this evaluation.

Green Campus distributes CFLs to students at four participating universities and encourages behavioral changes that reduce energy consumption. The program generated energy savings of 263 MWh and demand savings of 23 kW, surpassing their goal of 222 MWh and 20 kW, respectively. In addition, there are likely indirect savings not quantified through this evaluation.

The LivingWise® program delivered energy efficiency education and measures to 73,055 students, teachers and families throughout SCE territory. The measures installed generated a net 104,399 MWh of savings for SCE, well surpassing the original savings goal of 2,121MWh. The additional savings are mostly a result of participants reporting electric water heat at a much higher rate (greater than 32%) than originally assumed by SCE (less than 2%). The program also appears to have indirect energy savings that could warrant further study.

### Table M-15: Program Level Net Savings and Realization Rate

| | | | A | B | C | D |
|---|---|---|---|---|---|---|
| Sub-Program | Number of Participants | MWh / KW | IOU ex ante | IOU claim Net | Evaluated Net | Realization Rate [Col C / Col B] |
| Green Schools | 51 | MWh | 1,227 | 982 | 751 | 77% |
| | | KW | 107 | 86 | 66 | 77% |
| Green Campus | 4 | MWh | 480 | 384 | 263 | 68% |
| | | KW | 42 | 34 | 23 | 68% |
| LivingWise | 73,055 | MWh | 4,864 | 3,891 | 10,399 | 267% |
| | | KW | 520 | 416 | 687 | 165% |

### Table M-16. Integrated Schools Energy Savings Summary

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| Program Name | Measure Ex-Ante Gross kWh Savings | Measure Ex-Post Gross kWh Savings | Install Rate | Measure Installed Ex-Post Gross kWh Savings [Col B * Col C] | Measure NTG | Measure Ex-Post Net kWh Savings [Col D * Col E] |
| Integrated Schools: Green Campus | 401,580 | 401,580 | 68% | 274,681 | 0.8 | 219,745 |
| Integrated Schools: Green Schools | 1,227,925 | 1,227,925 | 77% | 939,363 | 0.8 | 751,490 |
| Integrated Schools: LivingWise Screw-in CFL 14 Watt | 1,156,847 | 1,639,069 | 67% | 1,098,176 | 0.8 | 878,541 |
| Integrated Schools: LivingWise Screw-in CFL 23 Watt | 1,901,940 | 1,708,985 | 68% | 1,162,110 | 0.8 | 929,688 |
| Integrated Schools: LivingWise Showerhead | 101,542 | 14,047,778 | 45% | 6,321,500 | 0.8 | 5,057,200 |
| Integrated Schools: LivingWise Faucet Aerators, Kitchen | 76,157 | 4,760,256 | 39% | 1,856,500 | 0.8 | 1,485,200 |
| Integrated Schools: LivingWise Faucet Aerators, Bathroom | 76,157 | 3,834,211 | 38% | 1,457,000 | 0.8 | 1,165,600 |
| Integrated Schools: LivingWise Air Filter Alarm | 574,045 | 2,191,650 | 30% | 657,495 | 0.8 | 525,996 |
| Integrated Schools: LivingWise LED Night Light | 977,033 | 1,062,224 | 42% | 446,134 | 0.8 | 356,907 |

## Table M-17. Integrated Schools Demand Savings Summary

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| Program Name | Measure Ex-Ante Gross kW Savings | Measure Ex-Post Gross kW Savings | Install Rate | Measure Installed Ex-Post Gross kW Savings [Col B * Col C] | Measure NTG | Measure Ex-Post Net kW Savings [Col D * Col E] |
| Integrated Schools: Green Campus | 42 | 42 | 68% | 29 | 0.8 | 23.2 |
| Integrated Schools: Green Schools | 108 | 108 | 77% | 82 | 0.8 | 65.6 |
| Integrated Schools: LivingWise Screw-in CFL 14 Watt | 101.58 | 101.58 | 67% | 68.06 | 0.8 | 54.45 |
| Integrated Schools: LivingWise Screw-in CFL 23 Watt | 167.01 | 167.01 | 68% | 113.57 | 0.8 | 90.85 |
| Integrated Schools: LivingWise Showerhead | 22.34 | 604.4 | 45% | 271.98 | 0.8 | 217.59 |
| Integrated Schools: LivingWise Faucet Aerators, Kitchen | 16.75 | 453.3 | 39% | 176.79 | 0.8 | 141.43 |
| Integrated Schools: LivingWise Faucet Aerators, Bathroom | 16.75 | 453.3 | 38% | 172.25 | 0.8 | 137.8 |
| Integrated Schools: LivingWise Air Filter Alarm | 195.89 | 195.89 | 30% | 58.77 | 0.8 | 47.01 |
| Integrated Schools: LivingWise LED Night Light | 0 | 0 | 42% | | 0.8 | |

# N. 80 PLUS Program: SCE 2535

## Program Description

The 80 PLUS Program was an upstream buy-down program that enlisted utilities and computer manufacturers to get more energy-efficient power supplies into desktop computers and servers. 80 PLUS rewarded manufacturers for installing a power supply in any desktop computer or server that met the following specifications: 80% or greater efficiency at 20%, 50%, and 100% of rated load, and true power factor of 0.9 or greater at 100% load. The strategy of the 80 PLUS Program was to overcome the price barrier of premium power supplies while educating customers about the benefits of efficient power supplies to increase market demand. The program offered a $5 manufacturer buy-down for each desktop computer, and $10 for each server containing a qualifying power supply and sold in the SCE service territory.

## Program Status

In February 2008, SCE closed the program for the 2006–2008 program cycle. At that time, third party implementer reported that 45 80 PLUS power supplies were shipped to SCE's service territory. Because of low participation in SCE's service territory and the refusal of the original equipment manufacturers to provide names and contact information for shipments (for competitive market reasons), SCE terminated the program. SCE will claim 2007 savings.

**Table N-1: Program Status**

| Measure | Number of installations** | Net Ex ante kWh* | Ex ante Summer Peak kW* |
|---|---|---|---|
| 80 Plus Power Supply | 45 | 3,374 | 1 |

*Source: SCE Monthly Report filed on EEGA website.

**Source: '80 Plus Measure Flat File Extract for Audit Request 12.19.07.xls' received in response to Specialized Commercial CG Evaluation Team Data request

## Evaluation Status

The 80 PLUS Program evaluation was closed by CPUC directive in November 2008 because: the participation rate was low, the implementer was unable to provide site-level information to verify shipments, and SCE closed the program in February 2008.

The Specialized Commercial CG Evaluation Team reviewed participant data received from SCE. The Specialized Commercial CG Evaluation Team also coordinated with Summit Blue, conducting the Process Evaluation for this program, and added questions to their survey instrument. The Specialized Commercial CG Evaluation Team reviewed data received from surveys of parties involved in the program including the SCE program manager, representatives from original equipment manufacturers and the systems integrators. The Specialized Commercial CG Evaluation Team also compiled data for the final evaluation report (including other 80 PLUS evaluations).

Table N-2 below summarizes responses to four surveys conducted with representatives from the original equipment manufacturers and system integrators.

All respondents ranked the availability of the 80 PLUS incentive and endorsement of the SCE representative as "important to very important." In addition, inclusion of the 80 PLUS power supply in the ENERGY STAR 4.0 Standard clearly had an impact, and was ranked "very important" by the original equipment manufacturers and important by one of the system integrators. Only two respondents replied they would have been likely to install exactly the same power supply in their computers, had the ENERGY STAR 4.0 standard not included the 80 PLUS power supply.

**Table N-2: Responses to Selected Questions: 80 Plus Power Supply Survey**

| Question | OEM 1 | OEM 2 | SI 1 | SI 2 | Average |
|---|---|---|---|---|---|
| How important is _____ in your decision to incorporate 80 Plus power supplies in the systems you build? | | | | | |
| availability of the 80 Plus incentive | 6 | 7 | 6 | 10 | 7 |
| Energy Star 4.0 Standard that became effective July 2007 | 9 | 10 | 4 | 7 | 8 |
| recommendation from a vendor or supplier | 0 | 5 | 6 | 10 | 5 |
| previous experience with this power supply | 5 | dk | 9 | 8 | 7 |
| previous experience with 80 Plus | 8 | 7 | 8 | 8 | 8 |
| a standard practice in your business | 0 | 8 | 6 | 8 | 6 |
| the endorsement or recommendation by 80 Plus staff / ECOS Consulting | 9 | 7 | 6 | 8 | 7 |
| endorsement or recommendation by an SCE representative | 8 | 6 | 7 | 10 | 8 |
| your business or corporate environmental policies or guidelines such as "energy efficient, green or sustainable" policies | 8 | 9 | 7 | 8 | 8 |
| payback on the investment | 9 | 8 | 9 | 10 | 9 |
| payback timeframe | <1 yr | | | 2 yrs | |
| If the SCE program had not been available, what is the likelihood you would have incorporated exactly the same power supply? | 4 | 9 | 3 | 1 | 4 |
| If Energy Star 4.0 standards had not included the 80 Plus power supply, what is the likelihood you would have incorporated exactly the same power supply in your computers? | 8 | 3 | 3 | 8 | 6 |
| Estimated annual number of computers manufactured/assembled with 80 Plus power supplies | 2,500,000 | refused | 300 | 8,000 | |

In evaluating free-ridership, responses to the question, *"If the SCE program had not been available, what is the likelihood that you would have incorporated exactly the same power supply?"* ranged from 1 to 9; however, the respondent answering 9 stated the availability of the 80 PLUS incentive was important (ranked at 7 on a 0–10 scale) to their decision to incorporate 80 PLUS power supplies in the systems they build.

Table N-3 below, shows responses to specific questions and the free-ridership score. The respondent ranking likelihood at 9 was a 90% free rider. This respondent was one of the two largest original equipment manufacturers, producing large numbers of computers with 80 Plus power supplies. The Specialized Commercial CG Evaluation Team estimated the NTG ratio due to free-ridership at 0.775.[44]

[44] 90%/4 respondents = .225 free-rider. 1-.225 = .775 NTG ratio.

**Table N-3: Free-Ridership**

| Free-Ridership Score | Already ordered or installed without program or rebate | Heard of technology before Program | Would have installed w/o Program (likelihood rating) | Incentive instrumental to decision to participate (importance rating) |
|---|---|---|---|---|
| 0% | No | Yes | likelihood = 4 | importance = 6 |
| 90% | Yes | Yes | likelihood = 9 | importance = 7 |
| 0% | No | No | likelihood = 3 | importance = 6 |
| 0% | No | No | likelihood = 1 | importance = 10 |

A common thread connecting the four surveys was the consensus that the rebate was too low for the 80 PLUS power supply. All respondents ranked payback on their investment at 8 or higher, and required a quick payback (responses ranged from less than one year to two years). The rebate did not come close to covering the incremental investment necessary to incorporate the 80 PLUS power supplies. This finding was supported by a market progress and evaluation report prepared for NEEA in July 2008.[45]

The 80 PLUSprogram was important to respondents; should SCE go forward with this program in the future, it should consider increasing the rebate amount to come closer to covering the full incremental cost of the 80 PLUSpower supply. If SCE intends to claim savings, it should ensure that shipping data for power supplies rebated under the program is provided by the Original Equipment Manufacturers and the System Integrators.

**Table N-4: 80 PLUS Energy Savings Summary (kWh)**

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| Program Name | Measure Ex-Ante Gross kWh Savings | Measure Ex-Post Gross kWh Savings | Install Rate | Measure Installed Ex-Post Gross kWh Savings [Col B * Col C] | Measure NTG | Measure Ex-Post Net kWh Savings [Col D * Col E] |
| SCE 2535 80 PLUS | 4,218 | 4,218 | 100% | 4,218 | 0.90 | 3,796 |

[45] Quantec LLC, *Second Market Progress and Evaluation Report: 80 PLUS Personal Computer Power Supplies*, prepared for the Northwest Energy Efficiency Alliance, July 2008.

**Table N-5: 80 PLUS Energy Savings Summary (kW)**

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| **Program Name** | **Measure Ex-Ante Gross kW Savings** | **Measure Ex-Post Gross kW Savings** | **Install Rate** | **Measure Installed Ex-Post Gross kW Savings [Col B * Col C]** | **Measure NTG** | **Measure Ex-Post Net kW Savings [Col D * Col E]** |
| SCE 2535 80 PLUS | .73 | .73 | 100% | .73 | 0.90 | .66 |

# O. Energy Efficiency/Demand Response Flex: SCE 2536

This program evaluation was closed in 2008 because of the shift in emphasis to HIMs and the program's relatively small size.

## Program Status

The 2006–2008 EEDR Program has ongoing enrollment. The program installs T-8 lighting systems that feature demand response dimming technology. The system integrates a paging network and leverages high efficiency dimming electronic ballasts coupled with power line control from the customer's electric panel to the fixtures. The program targets small to medium-size commercial, retail, and light industrial marketplace. Estimated and projected energy and summer peak demand savings are shown below.

**Table O-1: Estimated Peak Demand Savings**

| Program Measures | Gross Ex ante Therm | Gross Ex ante kWh | Gross Ex ante Summer Peak kW |
|---|---|---|---|
| Goals: Lighting, HVAC and Other Controls | 0 | 2,401,919 | 985 |
| Accomplished: HVAC Controls | 0 | 2,005,153 | 1,588 |

## Evaluation Activities Completed

Evaluators reviewed tracking data, developed an on-site data collection plan, developed a NTG survey, developed a revised sampling plan, obtained permission to meter, and installed pre-participation meters at 18 sites.

# P. Lighting Energy Efficiency/Demand Response Flex: SCE 2538

This program evaluation was closed in 2008 because of the shift in emphasis to HIMs and relatively small size and unsuccessful nature of the program.

## Program Status

The 2006-2008 LEEDR Program has not been successful and has been closed to enrollment. Only two customers participated (although 32 buildings), one of which accounts for two-thirds of the savings. One of the customers, with the majority of the buildings, reported uncontrollable dimming patterns and intended to remove the equipment. The program installs T-5 lighting fixtures, and wireless dimmable capability in each facility. The estimated and projected energy and summer peak demand savings are shown below.

**Table P-1: Estimated Peak Demand Savings**

| Program Measures | Gross Ex ante Therm | Gross Ex ante kWh | Gross Ex ante Summer Peak kW |
|---|---|---|---|
| Goals: | 0 | 10,994 | 3,794 |
| Accomplished: | 0 | 291 | 107 |

## Evaluation Status

The evaluators reviewed tracking data, developed on-site data collection plan, developed a NTG survey, developed revised sampling plan, obtained permission to meter, and installed post-participation meters at one site. The one site comprised two-thirds of the savings achieved.

# Q. Escalator PowerGenius Program: SCE 2565

The Escalator PowerGenius program was designed to increase the efficiency of existing escalators. Escalators are currently designed for maximum load conditions while typically operating at underloaded or unloaded conditions. By installing the PowerGenius controller, the escalator can adjust its energy consumption to meet a specific desired load instead of continually operating at the maximum load level. The escalator's speed remains unchanged by the PowerGenius controller.

## Program Description

The primary goal of the Escalator PowerGenius program was to deliver energy savings and peak demand reduction through installation of the PowerGenius controller on commercial escalators. The target audience was large retail stores, hospitals, malls, and large offices, but any building with an escalator could participate.

The program offered an incentive for escalator controls at no cost to the participating customer, provided the customer paid the labor cost associated with installation. The incentive was intended to be an equal share of total installation costs between the customer and the utility.

The implementer's goals were to install 270 PowerGenius controls, with expected gross energy savings of 1,460 MWh, net energy savings of 1,170 MWh, gross demand savings of 260 kW, and net demand savings of 206 kW. The program budget in the implementer's cost proposal was $454,423.

## Program Status

The Escalator PowerGenius program closed on July 1, 2008. No new participants were added after this date, and a handful of projects were completed after July 1. The evaluation closed by the CPUC's directive in November 2008.

### Data Sources

Two conflicting databases were sent to the Specialized Commercial CG Evaluation Team after the July 1 closing deadline. The first dataset was sent August 21, 2008, from the SCE program manager, and the second dataset was sent November 11, 2008, from the program implementer. A comparison of the two data sets is shown in Table Q-1.

**Table Q-1: Differences in Datasets**

| | Number of Installations | |
|---|---|---|
| **Size (HP)** | **Implementer Dataset** | **SCE Dataset** |
| 10 | 23 | 23 |
| 15 | 46 | 51 |
| 20 | 2 | 14 |
| 25 | 1 | 3 |
| **Total** | **72** | **91** |

The implementer database shows 19 fewer installations than the SCE database. The number of participating customers (13) was the same in both datasets. The Specialized Commercial CG Evaluation Team decided to use the implementer database for two reasons:

1. The implementer database included information through November 11, 2009.

2. The SCE database assumed all planned installations were installed. In actuality, one participating customer did not install as many PowerGenius controls as anticipated after a problem with an installation. This problem will be discussed in more detail below.

## Survey Results

The PowerGenius program had 13 participating customers. The Specialized Commercial CG Evaluation Team was able to contact two of the 13. Each participating customer was contacted a minimum of three times, with at least one phone message left. Although survey results could not be used to calculate the NTG ratio for this program, some critical information was gained from these surveys.

The customer referenced above had a minor malfunction of the Escalator PowerGenius control. This was due to improper installation of the control unit. The motor control was improperly sized to work with a motor smaller than the actual motor. This caused the escalator to slightly speed up and gently toss a visitor off the escalator. Although no one was hurt and this program was not expected to continue in the near future, this should be considered a lesson learned if the program is ever reinstated. Some type of training course for the proposed installers could help mitigate future problems with installation of the PowerGenius controls. Due to this error, this customer kept one PowerGenius control installed and stopped all future installations. The total number of installations expected from this customer was 20, accounting for the difference of 19 installations in the SCE database compared to the implementer database.

Due to the small number of completed surveys, the Specialized Commercial CG Evaluation Team passed through the ex-ante NTG ratio of 0.8.

## Data Analysis

For the PowerGenius escalator program, secondary research was used to calculate the demand and energy savings by horsepower (HP) size. Due to a lack of data for these types of controls, only two primary studies were used for this evaluation:

1. The Escalator Power Genius Work Paper, written by Matrix Energy for SCE.
2. Power Efficiency Corporation Performance Controller performed at Caesar's Palace in Las Vegas, written by Paragon Consulting for Nevada Power, April 2006.

One descending escalator and one ascending escalator were metered for 10 days (pre-installation for five days (3/31/06-4/5/06) and post-installation for five days [4/5/06–4/12/06]). These escalators operated for 8,760 hours per year. Table Q-2 shows the results for energy savings using 15 minute interval data collected during the Paragon study.

**Table Q-2: Results from Paragon Study**

| Motor Size (hp) | kWh Savings Up Escalator | kWh Savings Down Escalator | Average kWh Savings | kWh Savings per hp |
|---|---|---|---|---|
| 40 | 18133 | 20148 | 19141 | 479 |

Knowing the operation hours and energy savings per HP, an average demand savings of 0.055 kW/HP was calculated as follows:

*Demand Savings (kW/HP) = Energy Savings (kWh/HP) / Operating Hours (Hours)*
*0.055 kW/HP = 479 kWh/HP / 8760 Hours*

The implementer database had four different sizes of escalator motors: 10, 15, 20 and 25 HP. Demand savings for each motor size was calculated as follows:

*Demand savings (kW) = 0.055 kW/HP * HP of motor*

When calculating demand savings for an installed escalator, the workpaper assumed a 0.8 correction factor to account for decreased savings from high loads. However, as the Paragon metering study was performed on an installed escalator, and Caesar's Palace in Las Vegas should be considered to have a large traffic volume, the Paragon study results should be considered a conservative estimate of demand savings for the PowerGenius controller. Thus, no adjustments were made to demand savings for the escalator program in SCE's territory. Average demand savings for the various motor sizes used in the SCE program are shown in Table Q-3.

These demand savings were larger than depicted in the workpaper due to the correction factor not being used in this study.

**Table Q-3: Average Demand Savings for Various Motor Sizes Used in PowerGenius Program**

| Motor Size (hp) | Average kW Savings |
|---|---|
| 10 | 0.55 |
| 15 | 0.82 |
| 20 | 1.09 |
| 25 | 1.37 |

Once demand savings were known, the only variable needed to calculate energy savings associated with each controller was the hours of operation. This calculation was performed as follows:

$$\text{Energy Savings (kWh)} = \text{Demand Savings (kW)} * \text{Hours of Operation (Hours)}$$

The hours of operation were supplied by the implementer for each participating customer in the database. Also included in the database supplied by the implementer was the number of escalators that had the PowerGenius Controller installed. A summary at the customer level is shown in Table Q-4. Note: Customer G had two motor sizes installed.

**Table Q-4: Summary of Unit and Total Demand and Energy Savings**

| | | A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|
| Customer | Motor Size (HP) | Unit Demand Savings (kW) | Operating Hours | Unit Energy Savings (kWh) | Number of Units | Total Demand Savings (kW) [Col A * Col D] | Total Energy Savings (kWh) [Col C * Col D] |
| Customer A | 10 | 0.55 | 5,278 | 2,883 | 8 | 4.37 | 23,065 |
| Customer B | 15 | 0.82 | 6,080 | 4,982 | 2 | 1.64 | 9,964 |
| Customer C | 15 | 0.82 | 5,788 | 4,743 | 10 | 8.19 | 47,425 |
| Customer D | 10 | 0.55 | 6,570 | 3,589 | 6 | 3.28 | 21,533 |
| Customer E | 15 | 0.82 | 5,110 | 4,187 | 6 | 4.92 | 25,122 |
| Customer F | 10 | 0.55 | 5,110 | 2,791 | 5 | 2.73 | 13,957 |
| Customer G | 15 | 0.82 | 5,110 | 4,187 | 16 | 13.11 | 66,992 |
| Customer G | 20 | 1.09 | 5,110 | 5,583 | 2 | 2.18 | 11,165 |
| Customer H | 25 | 1.37 | 6,575 | 8,979 | 1 | 1.37 | 8,979 |
| Customer I | 15 | 0.82 | 4,745 | 3,888 | 2 | 1.64 | 7,776 |
| Customer J | 15 | 0.82 | 4,234 | 3,469 | 4 | 3.28 | 13,877 |
| Customer K | 15 | 0.82 | 4,186 | 3,430 | 2 | 1.64 | 6,860 |
| Customer L | 10 | 0.55 | 4,380 | 2,393 | 4 | 2.18 | 9,570 |
| Customer M | 15 | 0.82 | 4,160 | 3,409 | 4 | 3.28 | 13,634 |
| Total | | | | | 72 | 53.81 | 279,918 |

As seen above, gross demand and energy savings were estimated at 53.81 kW and 280 MWh, respectively.

Adjusting ex-post gross evaluated savings to account for free-ridership (0.8 NTG ratio), total net demand and energy savings were 43 kW/year and 224 MWh/year. Note, however that the evaluated energy savings were computed using the methods outlined in the white paper; the IOU claimed savings are lower than the evaluated savings.

**Table Q-5. Escalator Power Genius Energy Savings Summary**

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| Program Name | Measure Ex-Ante Gross kWh Savings | Measure Ex-Post Gross kWh Savings | Install Rate | Measure Installed Ex-Post Gross kWh Savings [Col B * Col C] | Measure NTG | Measure Ex-Post Net kWh Savings [Col D * Col E] |
| SCE 2565 Escalator PowerGenius | 199,425 | 279,918 | 100% | 279,918 | 0.80 | 159,540 |

**Table Q-6. Escalator Power Genius Demand Savings Summary**

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| **Program Name** | **Measure Ex-Ante Gross kW Savings** | **Measure Ex-Post Gross kW Savings** | **Install Rate** | **Measure Installed Ex-Post Gross kW Savings [Col B * Col C]** | **Measure NTG** | **Measure Ex-Post Net kW Savings [Col D * Col E]** |
| SCE 2565 Escalator PowerGenius | 45.2 | 53.8 | 100% | 53.8 | 0.80 | 43.04 |

# R. DHW Control Program

This program places controlling devices on domestic hot water boilers in hotels and motels in the San Diego Gas and Electric service territory. The controller reduces the aquastat set-point of the boiler in times of low demand thus reducing overall gas consumption. In addition the controllers provide continuous monitoring which help ensure the proper operation of the DHW system for the duration of the monitoring contract.

## Program Status

As of the March 2008 monthly report, 80,640 therm savings have been filled for this program. It appears there was a true-up in the monthly reported savings that occurred around November of 2007. The savings was reduced from 114,100 therms to the current estimate of 80,640. There are several projects in progress and EDC should have more savings to report soon. The goal of this program is 297,000 therms. This puts the program slightly behind schedule, but as stated, upcoming projects should boost savings.

## Evaluation Objectives

This program was originally slated for verification only. It was proposed and accepted that it be raised to IPMVP Option A. After reviewing the workpapers it was clear that the savings estimates were derived from multi-family installations. Several case studies will be performed early in this evaluation to identify the relevance of the program estimates to hotel/motel settings. Additionally, the accuracy of EDC's online tracking will be verified so that their system may be used in the verification process.

Pre and post controller metered usage data will be used to refine the savings estimates. This data will be combined with occupancy and water usage rates to establish a per-room savings estimate similar to the estimates currently in use by the program.

## Evaluation Status

We have completed the following activities:

- Developed a site data collection plan
- Identified a pilot site for metering
- Reviewed tracking data

The intention of this evaluation is to perform several case studies in 2008 to identify an appropriate savings estimate. Provided the case studies are sufficient the remainder of the evaluation will be verified through on-line verification of operation.

# S. Constant Volume Retrofit

CVRP is focused on converting legacy constant volume systems serving multiple zones to variable air volume operation using wireless technology. The CVRP is a nonresidential program aimed at the large commercial building market sector; the largest sub sector is office buildings. CVRP also targets non-office public buildings such as courthouses and airports, and large hotel buildings.

This program evaluation was closed in 2008 because of the shift in emphasis to HIMs, and the unsuccessful nature and small size of the program.

## Program Status

The 2006-2008 Constant Volume Retrofit Program has ongoing enrollment but only one participant to date. The program converts constant volume systems to variable air volume operation in large commercial buildings. The estimated and projected energy and summer peak demand savings are shown below.

**Table S-1: Estimated Peak Demand Savings**

| Program Measures | Gross Ex ante Therm | Gross Ex ante kWh | Gross Ex ante Summer Peak kW |
|---|---|---|---|
| Goals: | 159,744 | 0 | 0 |
| Accomplished: | 22,235 | 0 | 0 |

## Evaluation Status

The evaluators reviewed tracking data, developed on-site data collection plan, and developed a NTG survey.

The CPUC called for verification guided protocols for energy savings. Given the potential savings for the program and the complexity of the engineering calculations, the Specialized Commercial CG Evaluation Team also propose a pre/post billing analysis of Therms (Basic level of rigor, and IPMVP Option C) and short-term metering for electricity (IPMVP Option B). Demand savings (kW) may be significant if motors are oversized or if measures are installed in buildings closed on summer afternoons (such as schools) and the evaluation should be modified to reflect that significance. NTG rigor was optional but will be measured by self-report surveys of all participants. The evaluation budget calls for 15 site visits, with five calibrated model simulations and metering at five sites.

# T. Enhanced Automation Initiative

The Enhanced Automation Initiative (EAI) was an existing third-party local program serving large (>500 kW or >100,000 sq. ft.), non-residential customers throughout the PG&E service area. The program offers free on-site assessments, technical assistance, and incentives for EMS software and/or hardware enhancements.

## Program Status

As of July 2008, one project was completed for the Enhanced Automation Initiative. Several other projects were in various stages of completion, but no energy savings had been claimed by that time. The program's third party implementer and PG&E planned to complete several projects before the end of 2008.

## Evaluation Objectives

The CPUC designated PG&E's EAI program as a Protocol Guided *Full Impact* evaluation and assigned the rigor levels *Basic*, *Enhanced,* and *Basic,* respectively, to the evaluation's three primary determinations: Energy Impact (gas and electric), Demand Impact, and NTG Ratio.

**Table T-1: CPUC-Stipulated and Revised Evaluation Rigor Levels**

| Evaluation Component | CPUC Stipulated * | Revised |
|---|---|---|
| Energy | Basic | Basic |
| Demand | Enhanced | Enhanced |
| NTG | Basic | Basic |
| Indirect | N/A | N/A |
| *CPUC RFP No. 06 PS 5683 | | |

## Survey Analysis

Though a survey tool was prepared for this project, the survey was not implemented as only one customer had completed measure installation at the time of the evaluation. In July 2008, this evaluation closed at CPUC's directive to refocus efforts on high-impact measures. Therefore, the ex ante 0.8 NTG ratio was used to adjust savings for free-ridership.

## Data Analysis

The analysis tool used to evaluate energy savings for the single completed project was eQuest. This tool is a whole-building analysis tool using an interface along with DOE-2 to model both specific end-use energy consumption and total energy consumption for a building.

### Baseline

The third party implementer supplied the energy model, which was reviewed for accuracy. Since a site visit and a survey were not completed for this project, building characteristics could not be evaluated. However, the model was reviewed for reasonableness. With the data available at this time, no major errors have been found in the baseline model.

### Energy-Efficient Measures

The completed project had several different measures installed to generate energy savings. A list of measures for one project completed at the time of this closure memo, supplied by the third party implementer, is shown in Table T-2. Note that this customer participated in two separate programs. In the PG&E-claimed savings under the EAI program, a flag depicts whether the measure was installed under the EAI or another program. All lighting measures were installed and savings were claimed under a separate PG&E program.

**Table T-2: Measures Installed for Completed Project**

| Measure Name | End Use | Claimed Under EAI Program | Gross Peak Demand Savings (kW) | Gross Energy Savings (kWh) | Gross Energy Savings (therms) |
|---|---|---|---|---|---|
| **All Measures** | **All** | **Yes / No** | **427.4** | **904,531** | **97,300** |
| Install boiler lock out based on outside air temp. | Heating | Yes | 13.3 | 21,949 | 2,317 |
| Install scheduling and supply air temperature reset controls for AC - 1 | Heating/Cooling | Yes | 0 | 179,641 | 22,274 |
| Install scheduling and supply air temperature reset controls for AC - 4 | Heating/Cooling | Yes | 0 | 117,479 | 16,197 |
| Install supply air temperature reset controls for AC - 3 | Heating/Cooling | Yes | 0 | 29,477 | 4,214 |
| Install supply air temperature reset controls for AC - 2 | Heating/Cooling | Yes | 0 | 23,390 | 3,648 |
| Turn off or limit clean room humidification | Heating/Cooling | Yes | 166 | 6,640 | 0 |
| Occupancy sensors - labs and offices | Lighting | No | 16.2 | 62,646 | 0 |
| Delamp lighting fixtures - hallways | Lighting | No | 3.3 | 12,815 | 0 |
| Install latest generation 28W T8 fluorescents | Lighting | No | 18.8 | 71,064 | 0 |
| Reduce lighting levels in labs, offices, conference rooms, and shipping and warehouse areas | Lighting | No | 30.5 | 854 | 0 |
| Total | Total | | 179.3 | 378,576 | 48,650 |

Ex ante energy and demand savings expected for the EAI program are shown in Table T-3. Demand savings were 179.3 kWh and energy savings were 378,576 MWh (electric) and 48,650 therms (gas). Energy savings supplied by the implementer were accepted by evaluators as the best available estimate at the time of the assessment.

## NTG Adjustment

The table below shows total demand and energy savings for one project as of July 2008 for the EAI program. As noted, a 0.8 NTG value was assumed for this project within the program.

**Table T-3: Implementer Provided Total Demand and Energy Savings From Measure Specific Savings**

| | Demand Savings | Energy Savings | |
|---|---|---|---|
| | kW | kWh | therms |
| Savings | 179 | 378,576 | 48,650 |
| NTG Adjusted | 143 | 302,861 | 38,920 |

### Final Claimed Savings

The final three projects completed under this program were completed after this closure analysis. Final claimed savings for the four completed projects are shown in Table T-4. The final claimed savings for the project assessed were adjusted from preliminary data provided by the implementer and do not match.

The Specialized Commercial CG Evaluation Team closed the analysis in July 2008 and has no further project documentation or reason to refute the claimed savings. The final reporting database provides the gross savings and NTG ratio of .8. The database did not list the net savings. Net savings reported in Table T-4 were computed by adjusting gross savings by 0.8.

**Table T-4: IOU Claimed Savings 2006-2008 Program Cycle**

| | A | B | C |
|---|---|---|---|
| **Project** | **Ex Ante Net kWh** | **Ex Ante Net kWh** | **Ex Ante Therms** |
| 1 | 0 | 357,084 | 35484.8 |
| 2 | 0 | 712,952 | 60501.6 |
| 3 | 25.36 | 222,415 | 0 |
| 4 | 23.36 | 863,062 | 84186.4 |

**Table T-5. Enhanced Automation Initiative Energy Savings Summary**

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| **Program Name** | **Measure Ex-Ante Gross kWh Savings** | **Measure Ex-Post Gross kWh Savings** | **Install Rate** | **Measure Installed Ex-Post Gross kWh Savings [Col B * Col C]** | **Measure NTG** | **Measure Ex-Post Net kWh Savings [Col D * Col E]** |
| PG&E 2061 EAI | 2,155,154 | 2,155,154 | 100% | 2,155,154 | 0.80 | 1,724,124 |

**Table T-6. Enhanced Automation Initiative Demand Savings Summary**

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| **Program Name** | **Measure Ex-Ante Gross kW Savings** | **Measure Ex-Post Gross kW Savings** | **Install Rate** | **Measure Installed Ex-Post Gross kW Savings [Col B * Col C]** | **Measure NTG** | **Measure Ex-Post Net kW Savings [Col D * Col E]** |
| PG&E 2061 EAI | 60.90 | 60.90 | 100% | 60.90 | 0.80 | 48.72 |

# U.PGE Air Care Plus

AirCare Plus (ACP) provides incentives to maintenance service contractors for rooftop heating, ventilation, and air-conditioning (HVAC) units for refrigerant charge and airflow modifications, economizer retrofits, and thermostat replacements and adjustments.

## Evaluation Objectives

The baseline for HVAC tune-up measures is the pre-existing condition of the unit prior to maintenance or issue remediation. The baseline for measures implemented by the program are being directly measured and data recorded by the Honeywell Service Assistant. Engineering algorithms will be applied to the system performance database to develop energy savings. The peak demand savings will be derived from simple engineering models by leveraging the engineering algorithms utilized by the energy savings analysis. The Specialized Commercial CG Evaluation Team will also leverage metered data from commercial RCA measures to estimate peak savings. The economizer measures will also have primary data collected to determine if economizers are performing when the temperature conditions warrant.

# V. Guidelines for Estimating Net-To-Gross Ratios Using the Self-Report Approaches

## Introduction

The California Public Utilities Commission (CPUC) recently adopted the *California Energy Efficiency Evaluation Protocols: Technical, Methodological, and Reporting Requirements for Evaluation Professionals* (TecMarket Works, 2006) (referred to by the CPUC as the *Evaluator's Protocols*) for the measurement and evaluation (M&E) of energy efficiency (EE) programs. These guidelines focus on the critical elements of M&E such as impact evaluation, measurement and verification, process evaluation and sampling and uncertainty. These standards are understood to be minimal and are, in many cases, quite general.

A central objective of the California energy efficiency program evaluations is to identify that portion of the gross load impacts associated with a program-supported measure installation or behavior change that would not have been accomplished in the absence of the program. That portion is the net load impacts. In certain situations, the *Evaluator Protocols* allow for the use self-report approach (SRA) to estimate the net-to-gross ratio (NTGR) for the basic and standard levels of impact evaluation rigor (see Table 3 of the *Evaluator's Protocols*). The SRA can also be used in the enhanced level of impact evaluation rigor if used in conjunction with a second approach such as participant and non-participant analysis of utility consumption data that addresses the issue of self-selection or econometric or discrete choice with participant and non-participant comparison that addresses the issue of self-selection. The SRA is a mixed methods approach that uses, to varying degrees, both quantitative and qualitative data and analysis to assess causality[46].

However, while the Protocols allow for the use of the SRA, they are silent regarding basic methodological guidelines that are considered best practice.[47] The primary use of these SRA guidelines, which apply to assessing the influence of the program on both the direct impacts as well any participant spillover impacts, are to make sure that evaluators working under contract for the CPUC's Energy Division are adhering to these best practices.

[46] There is wide agreement on the value of *both* qualitative and quantitative data in the evaluation of many kinds of programs. Moreover, it is inappropriate to cast either approach in an inferior position. The complexity of any decision regarding the purchase of efficient equipment can be daunting, especially in large organizations for which the savings are often among the largest. In such situations, the reliance on only quantitative data can miss some important elements of the decision. The collection and interpretation of qualitative data can be especially useful in broadening our understanding of a program's role in this decision.

[47] These Protocols are also silent regarding methodological guidelines for conducting surveys in general. This is considered appropriate since there is general agreement (contained in numerous textbooks) regarding best methodological practices for designing and implementing surveys but relatively little agreement on what constitutes best methodological practices regarding the estimation of the NTGR using the SRA.

Of course, while one could simply ask analysts to guarantee that they adhered to the methodological guidelines contained in standard textbooks, this may not be sufficiently reassuring either to the CPUC or other stakeholders. Thus, rather than simply trust analysts to follow the guidance contained in the standard methodological textbooks, the CPUC has chosen to develop the *Guidelines for Self-Report Methods for Estimating Net DSM Program Impacts* (GSR) (a summary of which has also been prepared) that requires analysts to address certain key issues rather than to require analysts to address these issues in a specific way. This is the sort of guidance that occupies a position somewhere between the minimal standards represented by the Protocols and the highly detailed guidelines contained in basic methodological texts.

It follows that the GSR must focus on those methodological issues on which there is general agreement regarding their importance within the social science and engineering communities. The GSR will also refer analysts to texts in which more detailed guidance can be found regarding all the issues addressed. Adherence to such guidelines still allows the results to be shaped by the interaction of the situation, the data and the analyst. It is this very interaction and the resulting plethora of legitimate methodological choices that prohibited the creation of a more detailed and prescriptive set of guidelines.

Earlier, the Protocols and Procedures for the Verification of Costs, Benefits, and Shareholder Earnings from Demand-Side Management Programs (1998) (1998 Protocols) provided quality control guidelines in Appendix J (*Quality Assurance Guidelines For Statistical, Engineering, and Self-Report Methods for Estimating DSM Program Impacts*) that addressed, among other methodological issues, the self-report method for estimating NTGRs. More recently, the California Evaluation Framework (TecMarket Works et al., 2004) also addressed many of the same issues associated with the self-report approach. This GSR attempts to draw upon both of these documents. There are two features of these GSR that merit discussion. First, the issues addressed are issues that a variety of basic social science and engineering methodological texts also address. That is, there appears to be a consensus that these issues are important. Second, because some respondents may not be familiar with some of the issues addressed or the terms used, references have been provided that should provide reasonably clear explanations.

## Issues Surrounding the Validity and Reliability of Self-Report Techniques

The SRA deviates from the standard approach to assessing causality, i.e., internal validity. The standard approach to assessing causality is to conduct an experiment or quasi-experiment[48] in which data are collected from both participants and nonparticipants with the data being subjected to a variety of statistical analyses (Shadish, Cook, and Campbell, 2002). In the early 1970s, many began to realize that such evaluation designs were not always desirable or possible (Weiss, 1972; Weiss and Rein, 1972). As a result, many evaluators began to explore alternatives that would allow them to generate causal conclusions (Guba, 1981, 1990; Cronbach, 1986). Such approaches as the

[48] In the literature, evaluations of energy efficiency and conservation programs that involve the use of a true experimental design are very rare.

modus operandi method (Scriven, 1976), intensive case studies (Yin 1994), theory-based evaluations (Chen, 1990; Rogers, et al., 2000), and mixed methods (Tashakkori and Teddlie, 1998) have been explored as alternative ways to generate causal conclusions. The SRA fits well with this tradition.

The SRA is useful in a variety of situations. For example, in some cases, the expected magnitude of the savings for a given program might not warrant the investment in an expensive evaluation design that could involve a billing analysis or a discrete choice analysis of both participants and nonparticipants. Or, key stakeholders might not want to wait for a billing analysis to be completed. Also, if the relationship of the savings to the normal monthly variation in energy use is too small, then a billing analysis should not even be attempted owing to a lack of statistical power. Finally, in some cases, it might not be possible to identify a group of customers to serve as a comparison group since they have been exposed through prior participation or are in some other ways contaminated. So, for budgetary, timing, statistical, and research design issues, the more traditional designs and analyses must sometimes be replaced with the SRA.

More specifically, the SRA is a mixed method approach that involves asking one or more key participant decision-makers a series of structured and open-ended questions about whether they would have installed the same EE equipment in the absence of the program as well as questions that attempt to rule out rival explanations for the installation (Weiss, 1972; Scriven, 1976; Shadish, 1991; Wholey et al., 1994; Yin, 1994; Mohr, 1995). In the simplest case (e.g., residential customers), the SRA is based primarily on quantitative data while in more complex cases the SRA is strengthened by the inclusion of additional quantitative and qualitative data which can include, among others, in-depth, open-ended interviews, direct observation, and review of customer and program records[49]. Many evaluators believe that additional *qualitative* data regarding the economics of the customer's decision and the decision process itself can be very useful in supporting or modifying *quantitatively*-based results (Britan, 1978; Weiss and Rein, 1972; Patton, 1987; Tashakkori and Teddlie, 1998).

Having presented a very brief history of these alternatives approaches, we move on to discuss a number of special challenges associated with the SRA that merit mentioning.

One of the problems inherent in asking program participants if they would have installed the same equipment or adopted the same energy-saving practices without the program, is that we are asking them to recall what has happened in the past. Worse than that is the fact that what we are really asking them to do is report on a hypothetical situation, what they would have done in the absence of

[49] Of course, even in the simplest cases, an evaluator is free to supplement the analysis with additional quantitative and qualitative data such as interviews with architects and engineers involved in residential new construction or HVAC installers and a review of available market share data.

the program. In many cases, the respondent may simply not know and/or cannot know what would have happened in the absence of the program. Even if the customer has some idea of what would have happened, there is, of necessity, uncertainty about it.

The situation just described is a circumstance ripe for invalid answers (low construct validity) and answers with low reliability, where reliability is defined as the likelihood that a respondent will give the same answer to the same question whenever or wherever it is asked. It is well known in the interview literature that the more factual and concrete the information the survey requests, the more accurate responses are likely to be. Where we are asking for motivations and processes in hypothetical situations that occurred one or two years ago, there is room for bias. Bias in responses is commonly thought to stem from three origins. First is the fact that some respondents may believe that claiming no impact for the program is likely to cause the program to cease, thus removing future financial opportunities from the respondent. Closely related to this is the possibility that the respondents may want to give an answer that they think will be pleasing to the interviewer. The direction of the first bias would be to increase the NTG ratio, and the second would have an unclear effect – up or down, depending on what the respondent thinks the interviewer wants to hear.

The second commonly recognized motivation for biased answers is that some people will like to portray themselves in a positive light; *e.g.*, they might like to think that they would have installed energy-efficient equipment without any incentive (the socially desirable response). This type of motivation could result in an artificially low net-to-gross ratio.

The third hypothesized source of bias involves an interaction between the positive perception of taking energy efficiency actions, the often observed difference between stated intentions and actual behaviors, and the fact that the counter-factual outcome cannot be viewed, by the participant or outsiders. Using a series of survey questions to ask a participant about the actions they would have taken if there had been no program to derive a free-ridership estimate is referred to as the self-report approach (SRA). More specifically, this is asking the respondent to state their intentions with respect to purchasing the relevant equipment absent the program. Bias creeps in because people may intend many things that they do not eventually accomplish.

Beyond the fact that the situations of interest have occurred in the past and judgments about them involve hypothetical circumstances, they are often complex. No one set of questions can apply to all decision processes that result in a program-induced course of action. Some installations are simple, one-unit measures, while others involve many units, many different measures, and installations taking place over time. The decision to install may be made by one person or several people in a household, an individual serving as owner/operator of a small business, or, in the case of large commercial, industrial, or agricultural installations by multiple actors at multiple sites. Some measures may have been recommended by the utility for years before the actual installation took place, and others may have been recommended by consultants and/or vendors, making degree of utility influence difficult to establish. Finally, some efficiency projects may involve reconfiguration of systems rather than simple installations of energy-efficient equipment.

Another factor that can complicate the SRA is that, in certain situations, the estimated NTGR combines (more often implicitly than explicitly) the probability of a decision/action occurring and whether the *quantity* of the equipment installed would have been the same. This can complicate the interpretation of the responses and the way in which to combine these types of questions in order to estimate the NTGR.

This type of complexity and variation across sites requires thoughtful design of survey instruments. Following is a listing and discussion of the essential issues that should be considered by evaluators using SRA, together with some recommendations on reporting the strategies used to address each issue.

These should be regarded as recommendations for minimum acceptable standards for the use of the SRA to estimate net-to-gross ratios. Much of this chapter focuses on self-report methodologies for developing NTGRs for energy efficiency improvements in all sectors regardless of the size of the expected savings and the complexity of the decision making processes. However, in a given year, energy efficiency programs targeted for industrial facilities are likely to achieve a relatively small number of installations with the potential for extremely large energy savings at each site. Residential programs often have a large number of participants in a given year, but the energy savings at each home, and often for the entire residential sector, are small in comparison to savings at non-residential sites. Moreover, large industrial customers have more complex decision making processes than residential customers. As a result, evaluators are significantly less likely to conduct interviews with multiple actors at a single residence or to construct detailed case studies for each customer – methods that are discussed in detail in the following sections. *It may not be practical or necessary to employ the more complex techniques (e.g., multiple interviews at the same site, case-specific NTGR development) in all evaluations. Specifically, Sections 2.16 and 2.17 are probably more appropriate for customers with large savings and more complex decision making processes.* Of course, evaluators are free to apply the guidelines in these sections even to customers with smaller savings and relatively simple decision making processes.

### Timing of the Interview

In order to minimize the problem of recall, SRA interviews should be conducted with the decision maker(s) as soon after the installation of equipment as possible (Stone et al., 2000).

## Identifying the Correct Respondent

Recruitment procedures for participation in an interview involving self-reported net-to-gross ratios must address the issue of how the correct respondent(s) will be identified. Complexities to be addressed include situations commonly encountered in large commercial and industrial facilities, such as:

1. Different actors have different and complementary pieces of information about the decision to install, e.g., the CEO, CFO, facilities manager, etc.;
2. Decisions are made in locations such as regional or national headquarters that are away from the installation site;
3. Significant capital decision-making power is lodged in commissions, committees, boards, or councils; and
4. There is a need for both a technical decision-maker and a financial decision-maker to be interviewed (and in these cases, how the responses are combined will be important).

An evaluation using self-report methods should employ and document rules and procedures to handle all of these situations in a way that assures that the person(s) with the authority and the knowledge to make the installation decision are interviewed.

## Set-Up Questions

The decisions that the net-to-gross questions are addressing may have occurred from 1 month to as long as 24 months prior to the interview. Regardless of the magnitude of the savings or the complexity of the decision-making process, questions may be asked about the motivations for making the decisions that were made, as well as the sequence of events surrounding the decision. Sequence and timing are important elements in assessing motivation and program influence on it. Unfortunately, sequence and timing will be difficult for many respondents to recall. This makes it essential that the interviewer guide the respondent through a process of establishing benchmarks against which to remember the events of interest (Stone et al., 2000). Failure to do so could well result in, among other things, the respondent “telescoping” some events of interest to him into the period of interest to the evaluator. Set-up questions that set the mind of the respondent into the train of events that led to the installation, and that establish benchmarks, can minimize these problems. However, one should be careful to avoid wording the set-up questions in such a way so as to bias the response in the desired direction.

Set-up questions should be used at the beginning of the interview, but they can be useful in later stages as well. Respondents to self-report surveys frequently are individuals who participated in program decisions and, therefore, may tend to provide answers ex post that validate their position in those decisions. Such biased responses are more likely to occur when the information sought in questions is abstract, hypothetical, or based on future projections, and are less likely to occur when the information sought is concrete. To the extent that questions prone to bias can incorporate concrete elements, either by set-up questions or by follow-up probes, the results of the interview will be more persuasive.

An evaluation using self-report methods should employ and document a set of questions that adequately establish the set of mind of the respondent to the context and sequence of events that led to decision(s) to adopt a DSM measure or practice, including clearly identified benchmarks in the customer's decision-making process.

### Use of Multiple Questions

Regardless of the magnitude of the savings or the complexity of the decision-making process, one should assume that using multiple questionnaire items (both quantitative and qualitative) to measure a construct such as free-ridership is preferable to using only one item since reliability is increased by the use of multiple items (Blalock, 1970; Crocker & Algina; 1986; Duncan, 1984).

### Validity and Reliability

The validity and reliability of *each question* used in estimating the NTGR must be assessed (Lyberg, et al., 1997). In addition, the internal consistency (reliability) of multiple-item NTGR *scales* should not be assumed and should be tested. Testing the reliability of scales includes such techniques as split-half correlations, Kuder-Richardson, and Cronbach's alpha (Netemeyer, Bearden, and Sharma, 2003; Nunnally, 1978; Crocker & Algina, 1986; Cronbach, 1951; DeVellis, 1991). An evaluation using self-report methods should employ and document some or all of these tests or other suitable tests to evaluate reliability, including a description of why particular tests were used and others were considered inappropriate.

For those sites with relatively large savings and more complex decision-making processes, both quantitative and qualitative data may be collected from a variety of sources (*e.g.*, telephone interviews with the decision maker, telephone interviews with others at the site familiar with the decision to install the efficient equipment, paper and electronic program files, and on-site surveys). These data must eventually be integrated in order to produce a final NTGR.[50] Of course, it is essential that all such sites be evaluated consistently using the same instrument. However, in a situation involving both quantitative and qualitative data, interpretations of the data may vary from one evaluator to another, which means that, in effect, the measurement result may vary. Thus, the central issue here is one of reliability, which can be defined as obtaining consistent results over repeated measurements of the same items.

[50] For a discussion of the use of qualitative data see Section 2.14.

To guard against such a threat at those sites with relatively large savings and more complex decision-making processes, the data for each site should be evaluated by more than one member of the Specialized Commercial CG Evaluation Team. Next, the resulting NTGRs for the projects should be compared, with the extent of agreement being a preliminary measure of the so-called inter-rater reliability. Any disagreements should be examined and resolved and all procedures for identifying and resolving inconsistencies should be thoroughly described and documented (Sax, 1974; Patton, 1987).

## Consistency Checks

When multiple questionnaire items are used to calculate a free-ridership probability there is always the possibility of apparently contradictory answers. Contradictory answers indicate problems of validity and/or reliability (internal consistency). Occasional inconsistencies indicate either that the respondent has misunderstood one or more questions, or is answering according to an unanticipated logic.

Another potential problem with self-report methods is the possibility of answering the questions in a way that conforms to the perceived wishes of the interviewer, or that shows the respondent in a good light (consciously or unconsciously done). One of the ways of mitigating these tendencies is to ask one or more questions specifically to check the consistency and plausibility of the answers given to the core questions. Inconsistencies can highlight efforts to “shade” answers in socially desirable directions. While consistency checking won’t overcome a deliberate and well-thought-out effort to deceive, it will often help where the process is more subtle or where there is just some misunderstanding of a question.

An evaluation using self-report methods should employ a process for setting up checks for inconsistencies when developing the questionnaire items, and describe and document the methods chosen as well as the rationales for using or not using the techniques for mitigating inconsistencies. Before interviewing begins, one should establish rules to handle inconsistent responses. Such rules should be should be consistently applied to all respondents.

Based on past experience one should anticipate which questions are more likely to result in inconsistent responses (e.g., questions of what participants would have done in the absence of the program and reported importance of the program to their taking action could). For such questions, specific checks for inconsistencies along with interviewer instructions could be built into the questionnaire. Any apparent inconsistencies can then be identified and, whenever possible, resolved before the interview is over. If the evaluator waits until the interview is over to consider these problems, there may be no chance to correct misunderstandings on the part of the respondent or to detect situations where the evaluator brought incomplete understanding to the crafting of questions.

In some cases, the savings at stake may be sufficiently large to warrant a follow-up telephone call to resolve the inconsistency.

However, despite the best efforts of the interviewers, some inconsistencies may remain. When this occurs, evaluator could decide which of the two answers, in their judgment has less error, and discard the other. Or, one could weigh the two inconsistent responses in a way that reflects the evaluator’s estimate of the error associated with each, i.e., a larger weight could be assigned to the response that, in their judgment, contains less error.

Regardless of how any inconsistencies are handled, rules for resolving inconsistencies should be established, to the extent feasible, *before* interviewing begins.[51] An evaluation plan using self-report methods should describe the approach to identifying and resolving apparent inconsistencies. The plan should include: 1) the key questions that will be used to check for consistency, 2) whether and how it will be determined that the identified inconsistencies are significant enough to indicate problems of validity and/or reliability (internal consistency), and 3) how the indicated problems will be mitigated. The final report should include: 1) a description of contradictory answers that were identified, 2) whether and how it was determined that the identified inconsistencies were significant enough to indicate problems of validity and/or reliability (internal consistency), and 3) how the indicated problems were mitigated.

However, the rules themselves have sometimes been found to produce biased results, eliminating these respondents (treating them as missing data) has at times been the selected course of action. Thus, whenever any of these methods are used, one must report the proportion of responses affected. One must also report the mean NTGR with and without these responses in order to assess the potential for bias.

## Making the Questions Measure-Specific

It is important for evaluators to tailor the wording of central free-ridership questions to the specific technology or measure that is the subject of the question. It is not necessarily essential to incorporate the specific measure into the question, but some distinctions must be made if they would impact the understanding of the question and its potential answers. For instance, when the customer has installed equipment that is efficiency rated so that increments of efficiency are available to the purchaser, asking that respondent to indicate whether he would have installed the same equipment without the program could yield confusing and imprecise answers. The respondent will not necessarily know whether the evaluator means the exact same efficiency, or some other equipment

[51] One might not always be able to anticipate all possible inconsistencies before interviewing begins. In such cases, rules for resolving such unanticipated inconsistencies should be established before the analysis begins.

at similar efficiency, or just some other equipment of the same general type. Some other possibilities are:

1. Installations that involve removal more than addition or replacement (e.g., delamping or removal of a second refrigerator or freezer in a residence);
2. Installations that involve increases in productivity rather than direct energy load impacts;
3. Situations where the energy-efficiency aspect of the installation could be confused with a larger installation; and
4. Installation of equipment that will result in energy load impacts, but where the equipment itself is not inherently energy-efficient.

An evaluation using self-report methods should include and document an attempt to identify and mitigate problems associated with survey questions that are not measure-specific, and an explanation of whether and how those distinctions are important to the accuracy of the resulting estimate of free-ridership.

In large facilities or with decision-makers across multiple buildings or locations, care must be taken to ensure that the specific pieces of equipment, or group of equipment/facility decisions, are properly identified. The interviewer and respondent need to be referring to the same things.

As part of survey development, an assessment needs to be made of whether there are important subsets within the participant pool that need to be handled differently. For example, any program that contains corporate decision-makers managing building/renovation of dozens of buildings per year requires some type of special treatment. In this case, a standard survey might ask about three randomly selected projects/buildings. Or, a case study type of interview could focus on the factors affecting their decisions in general, for what percentage of their buildings do they take certain actions, what actions do they take in cases where no incentives are available (if a regional or national decision-making), etc. Such an approach might offer better information to apply to all the buildings they have in the program. The point is that without special attention and a customized survey instrument, such customers might find the interview too confusing and onerous.

## Partial Free-ridership

Partial free-ridership can occur when, in the absence of the program, the participant would have installed something more efficient than the program-assumed baseline efficiency but not as efficient as the item actually installed as a result of the program. When there is a likelihood that this is occurring, an evaluation using self-report methods should include and document attempts to identify and quantify the effects of such situations on net savings. Partial free-ridership should be explored for those customers with large savings and complex decision making processes.

In such a situation, it is essential to develop appropriate and credible information to establish precisely the participant's alternative choice. The likelihood that the participant would really have chosen a higher efficiency option is directly related to their ability to clearly describe that option.

An evaluation using self-report methods should include and document attempts to identify and mitigate problems associated with partial free-ridership, when applicable.

## Deferred Free-ridership

Deferred free riders are those customers who would, in the absence of the program, have installed exactly the same equipment that they installed through the utility DSM program, but the utility induced them to install the equipment earlier than they would have otherwise. That is, the utility *accelerated* the timing of the installation of the equipment. Because determining the extent of utility influence on the timing of the installation is a complex process, an evaluator should avoid relying on a single question asked of the key decision-maker. Rather, an evaluator should examine all available data and determine whether the preponderance of evidence supports the conclusion of deferred free-ridership.

The point at which the length of the deferral is interpreted as meaning no free-ridership needs to be explicitly developed in the evaluation plan and should be justified given the length of the measure life (the effective useful life or EUL) and the decision-making process of that type of customer.

Data from such sources as additional closed- and open-ended questions asked of the key decision-maker, information obtained from other people at the site familiar with the decision to install the efficient equipment, and information gathered from the program paper files should also be collected and analyzed. Rules for integrating the responses to closed- and open-ended questions should be established, to the extent feasible, before the analysis begins. Details regarding the establishment and use of such rules are provided in Section 2.14.

Unfortunately, evaluation budgets may only permit such data to be collected and analyzed for those customers with larger savings. For those customers with the smaller savings, the NTGR may be based only on the responses from close-ended questions obtained from the key decision-maker. In such cases, closed-ended questions regarding utility influence on both *what* was installed and *when* it was installed could be asked. These answers could be analyzed mechanically using an algorithm. However, to the extent that closed-ended questions are unable to capture fully the complexity of the decision-making process, any resulting conclusions regarding deferred free-ridership may be biased, with the direction of the bias unknown.

## Scoring Algorithms

A consequence of using multiple questionnaire items to assess the probability of free-ridership (or its complement, the NTGR) is that decisions must be made about how to combine them. Do all items have equal weight or are some more important indicators than others? How are probabilities of free-ridership assigned to each response category? Answers to these questions can have a profound effect on the final NTGR estimate. These decisions are incorporated into the algorithm used to combine all pieces of information to form a final estimate of the NTGR. All such decisions must be described and justified by evaluators.

In some cases, each of the responses in the series of questions is assigned an ad hoc probability for the expected net savings. These estimates are then combined (additively or multiplicatively) into a participant estimate. The participant estimates are subsequently averaged (or weighted averaged given expected savings) to calculate the overall free- ridership estimate. The assignments of the probabilities are critical in the final outcome. At the same time, there is little evidence of what these should be and they are often assigned and justified given a logical argument. With this, however, a multiple number of different probability assignments have been shown to be justified and accepted by various evaluations and regulators. However, we recognize that this can make the comparability and reliability of survey-based estimates problematic.

Finally, evaluators must also conduct sensitivity analyses (e.g., changing weights, changing the questions used in estimating the NTGR, changing the probabilities assigned to different response categories, etc.) to assess the stability and possible bias of the estimated NTGR. A preponderance of evidence approach is always better than relying solely on a weighted algorithm and sophisticated weighting that is not transparent and logically conclusive should be avoided.

## Handling Non-Responses and “Don’t Knows”

In some cases, some customers selected for the evaluation sample refuse to be interviewed (unit nonresponse). In other cases, some customers do not complete an attempted interview, complete the interview but refuse to answer all of the questions, or provide a “don’t know” response to some questions (item nonresponse). Insoluble contradictions fall into the latter category. Evaluators must explain in advance how they will address each type of problem.

Consider those who choose not to respond to the questionnaire or interview (unit nonresponse). Making no attempt to understand and correct for nonresponse in effect assumes that the non-respondents would have answered the questions at the mean. Thus, their net-to-gross ratios would assume the mean NTGR value. Because this might not always be a reasonable assumption, one should always assess the possibility of non-response bias. To assess the possibility of non-response bias, one should, at a minimum, using information available on the population, describe any differences between those who responded and those who didn't and attempt to explain whether any of these differences are likely to affect one's answers to the NTGR battery of questions. If non-response bias is suspected, one should, whenever possible, explore the possibility of correcting for non-response bias. When not possible, one should explain why not (e.g., timing or budget constraints) and provide one's best estimate of the magnitude of the bias.

When some respondents terminate the interview, complete the interview but refuse to answer all the questions, or who provide a "don't know" response to some questions (item nonresponse), decisions must be made as to whether one should treat such cases as missing data or whether one should employ some type of missing data imputation. For example, early methods to handle responses of "Don't Know," missing data, and inconsistent answers involved assuming a 35% or 50% free-ridership rate for these participants (as they might be less likely to have taken actions if they hadn't thought about it or made opposing reactions). These methods, however, were found to create a centrality tendency (the tendency to avoid extremely low scores or extremely high scores) in the overall free-ridership estimate, i.e., driving it towards 35% or 50%.

In all cases, one should always make a special effort to avoid "don't know" responses when conducting interviews. However, some survey methods and procedures have been used that do not allow a "don't know" response where that might be the best response a respondent can provide. Forcing a response can distort the respondent's answer and introduce bias. Such a possibility needs to be recognized and avoided to extent possible.

## Weighting the NTGR

The Protocols require estimates of the NTGR at the program or program component levels (as determined by the CPUC). Of course, such an NTGR must take into account the size of the impacts at the customer or project level. Consider two large industrial sites with the following characteristics. The first involves a customer whose self-reported NTGR is .9 and whose estimated annual savings are 200,000 kWh. The second involves a customer whose self-reported NTGR is .15 and whose estimated savings are 1,000,000 kWh. One could calculate an unweighted NTGR across both customers of .53. Or, one could calculate a weighted NTGR of .28. Clearly, the latter calculation is the appropriate one.

## Ruling Out Rival Hypotheses

An evaluator should attempt to rule out rival hypotheses regarding the reasons for installing the efficient equipment (Scriven, 1976). For example, to reduce the possibility of socially desirable responses, one could ask an *open-ended question* (i.e., a list of possible reasons is **not** read to the respondent) regarding other possible reasons for installing the efficient equipment. A listing by the interviewer of such reasons such as global warming, Flex Your Power, the price of electricity, concern for future generations, and the need for the US to reduce oil dependency might elicit socially desirable responses which would have the effect of artificially reducing the NTGR. The answers to such questions about other possible influences can be factored into the estimation of the NTGR.

In addition to obtaining the respondent's assessment of other possible causes, the evaluator can independently assess the evidence supporting any alternative hypotheses. For example, if there is a corporate policy regarding the purchase of efficient equipment, the evaluator should examine this document to verify its contents and the date on which this policy was established and also attempt to assess compliance with this policy. In addition, they could decide to interview industry experts to determine whether certain equipment has become standard practice in an industry. Or, they could review available market share data to determine whether a particular market for a specific technology has been transformed or is on its way to being transformed.

## Precision of the Estimated NTGR

Most of the discussion thus far has been focused on the accuracy of the NTGR estimate and not the precision of the estimate. The calculation of the achieved relative precision of the NTGRs (for program-related measures and practices and non-program measures and practices) is usually straightforward, relying on the standard error and the level of confidence. For example, when estimating NTGRs in the residential sector, one typically interviews one decision maker in each household with the NTGR estimate based on multiple questions. In such a situation, one could report the mean, standard deviation, the standard error, and the relative precision of the NTGR based on the sample at the 90 percent levels of confidence.

However, in the nonresidential sector, things can get much more complicated since the NTGR at a given site can be based on such information as: 1) multiple interviews (end users as well as those upstream from the end user that might have been involved in the decision), 2) other more qualitative information such as standard purchasing policies that require a specific corporate rate of return or simple payback (*e.g.*, the rate of return for the investment in the energy efficiency measure can be calculated with and without the rebate to obtain another point estimate of the influence of the program), or 3) a vendor, involved in the installation of the efficient equipment, who might have been influenced by a utility training programs. In such a situation, a NTGR will be estimated that uses all of this information. However, one must recognize that the propagation of errors across multiple respondents and other sources of quantitative and qualitative data cannot adequately be reflected in the resulting standard error of the NTGR estimate.

## Pre-Testing Questionnaire

Of course, as with any survey, a pre-test should be conducted to reveal any problems such as ambiguous wording, faulty skip patterns, leading questions, faulty consistency checks, and incorrect sequencing of questions. Modifications should be made prior to the official launch of the survey.

## The Incorporation of Additional Quantitative and Qualitative Data in Estimating the NTGR

When one chooses to complement a mixed methods (quantitative and qualitative) analysis of free-ridership with additional data, there are a few very basic concerns that one must keep in mind.

### Data Collection

#### Use of Multiple Respondents

In situations with relatively large savings and more complex decision-making processes, one should use, to the extent possible, information from more than one person familiar with the decision to install the efficient equipment or adopt energy-conserving practices or procedures (Patten, 1987; Yin, 1994).

It is important to inquire about the decision-making process and the roles of those involved for those cases with relatively large savings and with multiple steps or decision-makers. If the customer has a multi-step process where there are go/no-go decisions made at each step, then this process should be considered when using the responses to estimate the firm's NTGR. There have been program evaluations whose estimates have been called into question when these factors were not considered, tested and found to be important. For example, a municipal program serving cities with financial issues where a department's facility engineer could say without bias that he definitely intended to install the same measure in the absence of the program and that he had requested that the city manager request the necessary funds from the City Council. However, one might discover that in the past the city manager, due to competing needs, only very rarely include the engineer's requests in his budget submitted to the City Council. Similarly, there are cases where a facility engineer continues to recommend efficiency improvements but never manages to get management approval until the efficiency program provides the information in a way that meets the financial decision-makers needs in terms of information or independent verification or leverage by obtaining “free” funds.

These interviews might include interviews with third parties who were involved in the decision to install the energy efficient equipment. Currently, there is no standard method for capturing the influence of third parties on a customer's decision to purchase energy efficient equipment. Third parties who may have influence in this context include market actors such as store clerks, manufacturers (through promotional literature, demonstrations, and in-person marketing by sales staff), equipment distributors, installers, developers, engineers, energy consultants, and architects. Yet, these influences can be important and possibly more so in the continually changing environment with greater attention on global warming and more overlapping interventions. When one chooses to measure the effect of third parties, one should keep the following principles in mind: 1) the method chosen should be balanced. That is, the method should allow for the possibility that the third-party influence can increase or decrease the NTGR that is based on the customer's self report, 2) the rules for deciding which customers will be examined for potential third party influence should be balanced. That is, the pool of customers selected for such examination should not be biased towards ones for whom the evaluator believes the third-party influence will have the effect of influencing the NTGR in only one direction, 3) the plan for capturing third-party influence should be based on a well-conceived causal framework. The onus is on the evaluator to build a compelling case using a variety of quantitative and/or qualitative data for estimating a customer's NTGR

#### Other Site- and Market-Level Data

Information relevant to the purchase and installation decision can include:

1. Program paper files (correspondence between DSM program staff and the customer, evidence of economic feasibility studies conducted by the utility or the customer, correspondence among the customer staff, other competing capital investments planned by the customer)
2. Program electronic files (*e.g.*, program tracking system data, past program participation)
3. Interviews with other people at the site who are familiar with the program and the choice (*e.g.*, operations staff)
4. Open-ended questions on structured interviews with the key decision-maker and other staff who may have been involved with the decision.
5. Incremental costs of the equipment
6. Estimates of the equipment's market share
7. The diffusion (saturation) of the equipment in the market place

Where appropriate, for example, in the case of large-scale commercial and industrial sites, these data should be organized and analyzed in the form of a case study.

### Establishing Rules for Data Integration

In cases where multiple interviews are conducted eliciting both quantitative and qualitative data and a variety of program documentation has been collected, one will need to integrate all of this information into an internally consistent and coherent story that supports a specific NTGR.

Before the analysis begins, one should establish, to the extent feasible, rules for the integration of the quantitative and qualitative data. These rules should be as specific as possible and be strictly adhered to throughout the analysis. Such rules might include instructions regarding when the NTGR based on the quantitative data should be overridden based on qualitative data, how much qualitative data is needed to override the NTGR based on quantitative data, how to handle contradictory information provided by more than one person at a given site, how to handle situations when there is no decision-maker interview, when there is no appropriate decision-maker interview, or when there is critical missing data on the questionnaire, and how to incorporate qualitative information on deferred free-ridership.

One must recognize that it is difficult to anticipate all the situations that one may encounter during the analysis. As a result, one may refine existing rules or even develop new ones during the initial phase of the analysis. One must also recognize that it is difficult to develop algorithms that effectively integrate the quantitative and qualitative data. It is therefore necessary to use judgment in deciding how much weight to give to the quantitative versus qualitative data and how to integrate the two. The methodology and estimates, however, must contain methods to support the validity of the integration methods through preponderance of evidence or other rules/procedures as discussed above.

## Analysis

A case study is one method of assessing both quantitative and qualitative data in estimating a NTGR. A case study is an organized presentation of all these data available about a particular customer site with respect to all relevant aspects of the decision to install the efficient equipment. When a case study approach is used, the first step is to pull together the data relevant to each case and write a discrete, holistic report on it (the case study). In preparing the case study, redundancies are sorted out, and information is organized topically. *This information should be contained in the final report.*

The next step is to conduct a content analysis of the qualitative data. This involves identifying coherent and important examples, themes, and patterns in the data. The analyst looks for quotations or observations that go together and that are relevant to the *customer's decision to install the efficient equipment*. Guba (1978) calls this process of figuring out what goes together "convergence," *i.e.*, the extent to which the data hold together or dovetail in a meaningful way. Of course, the focus here is on evidence related to the degree of program influence in installing the efficient equipment. Identifying and ruling out rival explanations for the installation of the efficient equipment is a critical part of the analysis (Scriven, 1976).

Sometimes, *all* the quantitative and qualitative data will clearly point in the same direction while, in others, the *preponderance* of the data will point in the same direction. Other cases will be more ambiguous. In all cases, in order to maximize reliability, it is essential that more than one person be involved in analyzing the data. Each person must analyze the data separately and then compare and discuss the results. Important insights can emerge from the different ways in which two analysts look at the same set of data. Ultimately, differences must be resolved and a case made for a particular NTGR.

Finally, it must be recognized that there is no single right way to conduct qualitative data analysis:

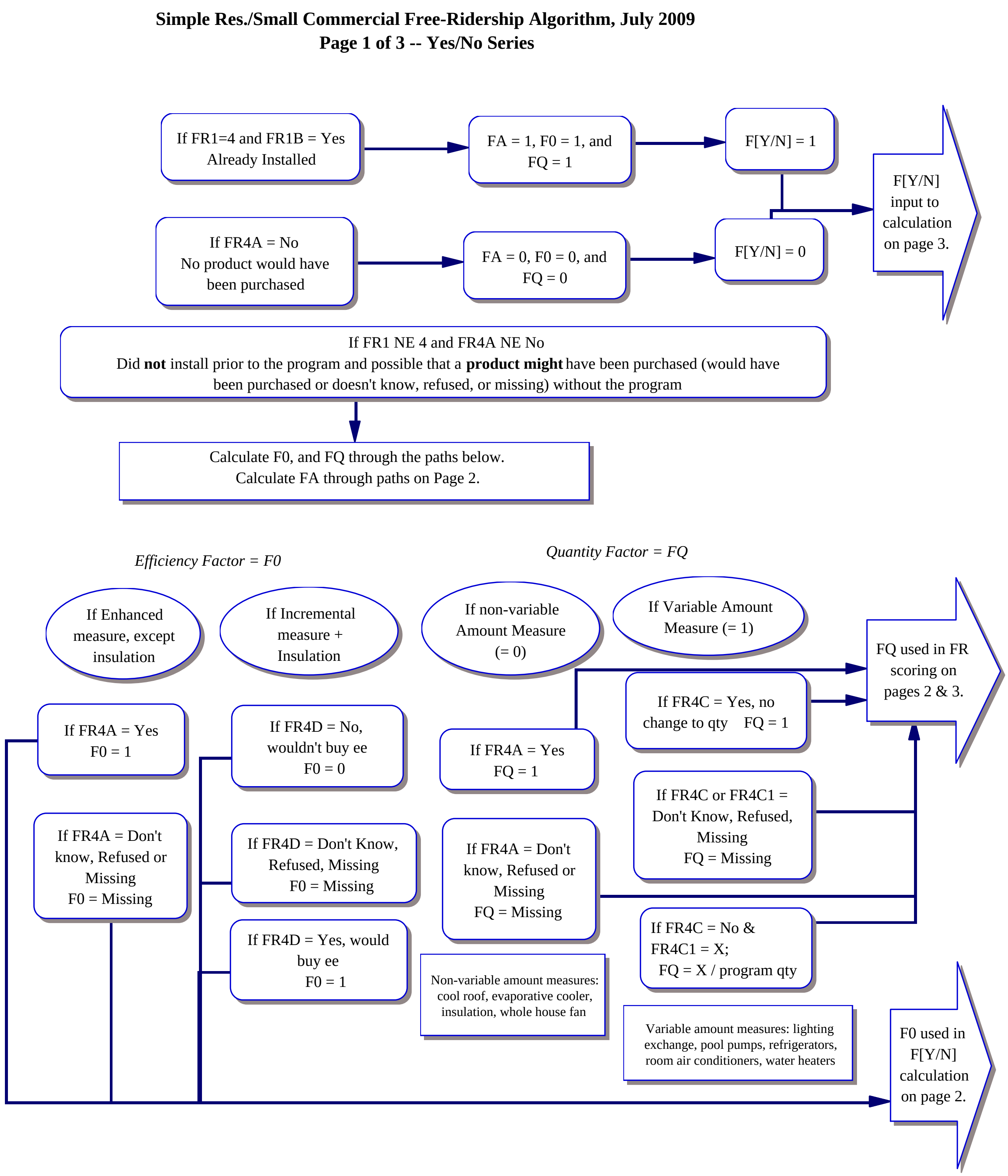
**The analysis of qualitative data is a creative process. There are no formulas, as in statistics. It is a process demanding intellectual rigor and a great deal of hard, thoughtful work. Because different people manage their creativity, intellectual endeavors, and hard work in different ways, there is no one right way to go about organizing, analyzing, and interpreting qualitative data. (p. 146)**

Ultimately, if the data are systematically collected and presented in a well-organized manner, and if the arguments are clearly presented, any independent reviewer can understand and judge the data and the logic underlying any NTGR. Equally important, any independent reviewers will have all the essential data to enable them to replicate the results, and if necessary, to derive their own estimates.

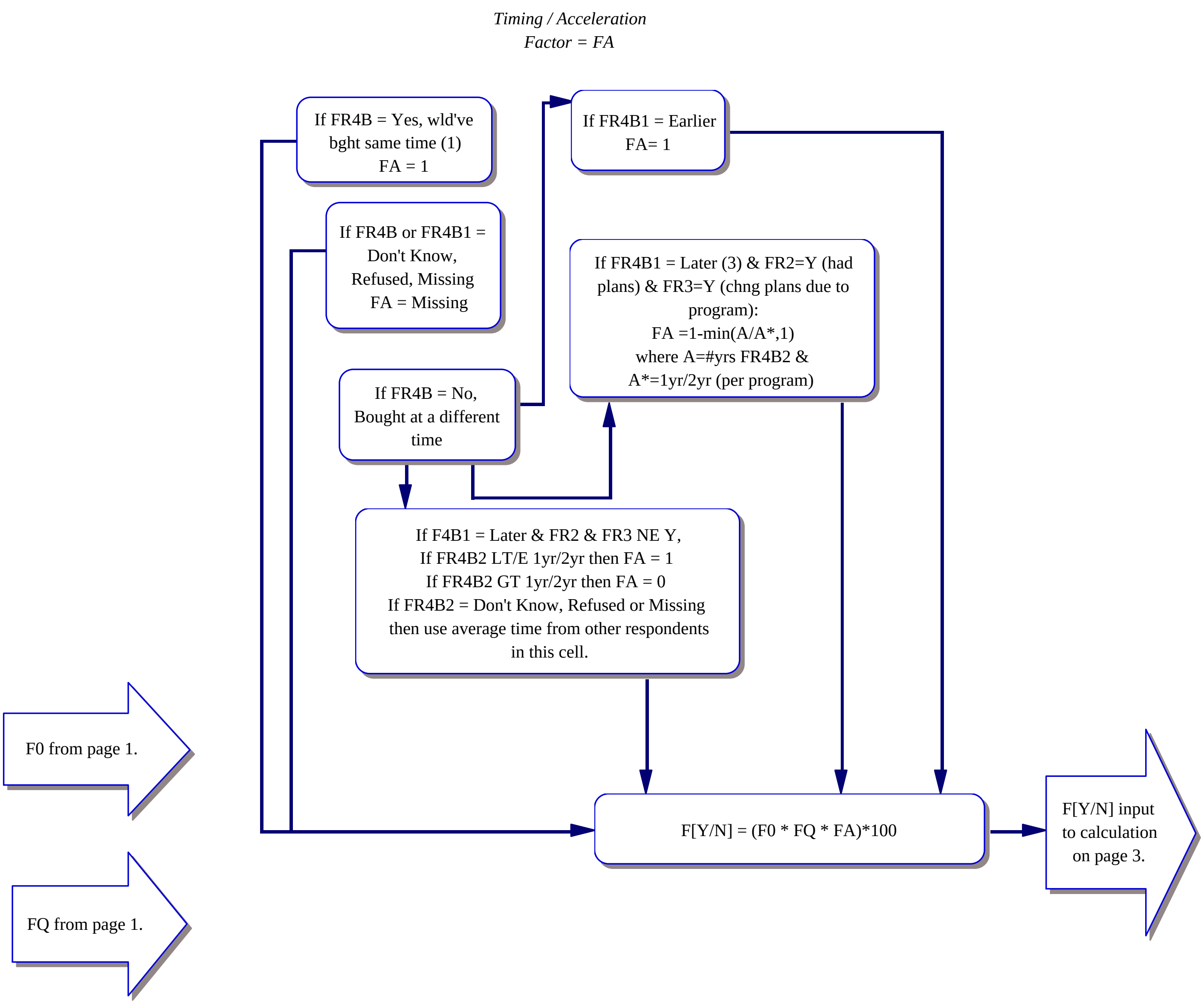
## Qualified Interviewers

For the basic SRA in the residential and small commercial sectors, the technologies discussed during the interview are relatively straightforward (e.g., refrigerators, CFLS, T-8 lamps, air conditioners). In such situations, using the trained interviewers working for companies that conduct telephone surveys is adequate. However, in more complicated situations such as industrial process and large commercial HVAC systems, the level of technical complexity is typically beyond the abilities of such interviewers. In such situations, engineers familiar with these more complicated technologies should be trained to collect the data by telephone or in person.

# W. Simple Residential/Small Commercial Free-Ridership Algorithm



**Simple Res./Small Commercial Free-Ridership Algorithm, July 2009**
**Page 2 of 3 -- Yes/No Series (Continued)**

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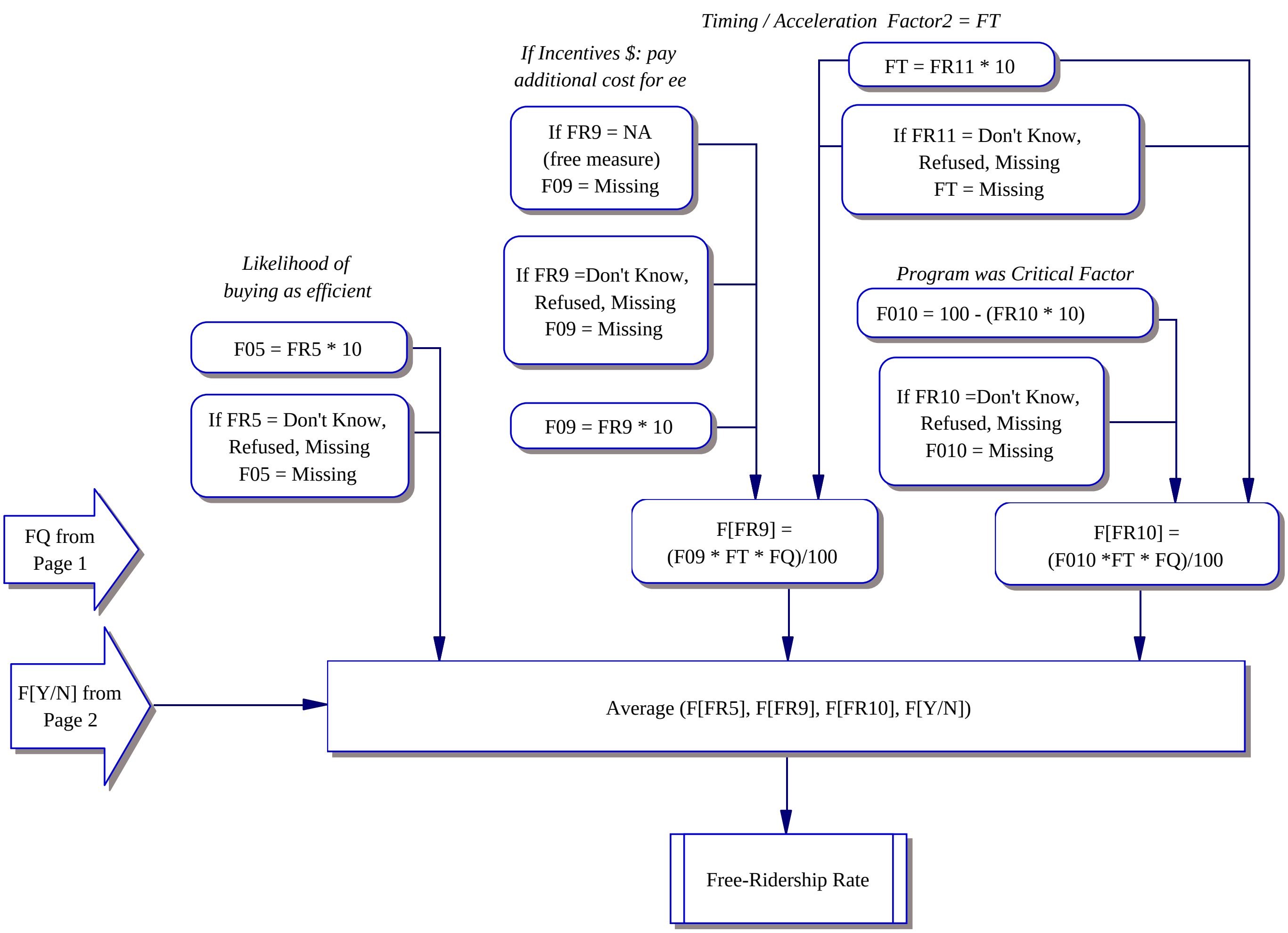
**Simple Res./Small Commercial Free-Ridership Algorithm, July 2009**
**Page 3 of 3**

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# X. Free-Ridership (kWh weighted) Stability Indicators

| 4 Separate Free Ridership Measurements Possible – Number of Respondents Having___* | |
|---|---|
| Zero FR Measurements | a |
| One FR Measurements | bb |
| Two FR Measurements | c |
| Three FR Measurements | ddd |
| Four FR Measurements | eee |
| **Proportion of respondents with an extreme FR ratio** | |
| Proportion with 0 - 0.1 FR ratio | Xx% |
| Proportion with 0.9 - 1 FR ratio | Yy% |

* Some of the four separate free ridership measurements are from one survey question and others are from multiple responses. See the algorithm in the prior Appendix.

| Number and proportion of respondents where changes were made to the FR ratio due to inconsistent responses** | |
|---|---|
| Number | M |
| Proportion | k.l% |
| **FR Ratio without those that had inconsistent responses corrected** | |
| n = vvv | Rr% |
| **Respondents answering they already had installed measure before they learned of the program**** | |
| n = q | Final average FR for these: 9w% |
| **Respondents answering they never would have even purchased equipment type without the program (efficient or inefficient)**** | |
| N = u | Final average FR for these: P% |
| ** These are included in the calculation of that respondent's free ridership and the overall weighted free ridership estimates as stipulated in the algorithm. | |

# Y. Survey Sampling Methods

The survey sampling approach was designed to fully comply with the CPUC's *Evaluation Protocols.*[52] The Energy Division developed the *Guidelines for Estimating Net-To-Gross Ratios Using the Self-Report Approaches (Guidelines).* The following sections provide additional detail regarding sample selection for surveys. These general approaches were followed for other IOU programs. That is, samples were stratified first by climate zone and second by distinguishing program or measure features in order to select a representative sample.

### Sampling Approach for SDG&E 3029 Residential AC Replacement

The evaluators examined the population of residential program participants to determine the most meaningful stratification structure to employ to ensure that the sample was representative of the population.

SDGE assigned deemed per ton savings values, for each measure installed, from the DEER database. While SDGE does serve customers in over four climate zones, the program assigned either CZ 7 DEER per ton savings or CZ 10 DEER per ton savings. Because the data were pre-stratified into two climate zones as part of the program design, the evaluators selected climate zone as the first stratification variable. However, stratifying on climate zone alone would not capture the variability in the sample.

Evaluators then examined other fields such as SEER and equipment type, but focused on replacement status: replace on burnout, early retirement of still functioning equipment, and new construction. Customers replacing a unit due to equipment failure have a different motivation for purchasing high efficiency cooling equipment than those replacing still functioning equipment. Savings expectations are not the same for units replaced on burnout and retired early. A field existed in the utility's internal tracking database which was used as the second stratification variable. (This field was not included in the utility's reporting database).

Therefore, the population was stratified by climate zone and replacement status into six strata as shown below.

[52] TecMarket Works, Megdal & Associates, Architectural Energy Corporation, RLW Analytics, Resource Insight, B & B Resources, Ken Keating and Associates, Ed Vine and Associates, American Council for an Energy Efficient Economy, Ralph Prahl and Associates, and Innovologie. (2004). *The California Evaluation Framework.* Prepared for the California Public Utilities Commission and the Project Advisory Group.

**Table Y-1: Sampling Strata**

| | Replacement Status | | |
|---|---|---|---|
| Climate Zone | Early Retirement | Replace on Burnout | New Construction |
| 7 | 1 | 2 | 3 |
| 10 | 4 | 5 | 6 |

The population of residential participants was assigned to the six strata as follows.

**Table Y-2: Population Assignment to Sampling Strata**

| | Replacement Status | | |
|---|---|---|---|
| Climate Zone | Early Retirement | Replace on Burnout | New Construction |
| 7 | 2426 | 308 | 512 |
| 10 | 1991 | 238 | 209 |

The California sampling protocols specify a minimum sample size of 300 for the net to gross survey. A sample size proportional to each stratum's percent contribution to the population was calculated. The percent contribution to the population and sample size for each stratum was as follows.

**Table Y-3: Sampling Proportional to Participant Population**

| | Replacement Status | | |
|---|---|---|---|
| Climate Zone | Early Retirement | Replace on Burnout | New Construction |
| 7 | 43% | 5% | 9% |
| 10 | 35% | 4% | 4% |

**Table Y-4: Final Survey Sample Targets**

| | Replacement Reason | | |
|---|---|---|---|
| Climate Zone | Early Retirement | Replace on Burnout | New Construction |
| 7 | 128 | 16 | 27 |
| 10 | 105 | 13 | 11 |

These sample points were the minimum number of targeted survey completes for each stratum. Participants were assigned to one of the six strata based on their climate zone and replacement status. Participant data within each stratum was sorted by account number so that all units purchased by one decision-maker would be listed together and no participant would be called more than once. Participants who had more than one unit rebated under the program were asked about the influence of the program on the purchase of all program units.

The following table provides the number of completed NTG surveys per stratum.

**Table Y-5: Completed NTG Surveys**

| | Replacement Reason | | |
|---|---|---|---|
| **Climate Zone** | **Early Retirement** | **Replace on Burnout** | **New Construction** |
| **7** | 131 | 18 | 29 |
| **10** | 107 | 14 | 13 |

**Sampling Approach for SDG&E 3029 Commercial AC Replacement**

Evaluators examined the population of commercial and industrial program participants to determine the most meaningful stratification structure. While SDGE serves customers in over 4 different climate zones, only zones 7 and 10 were used to deem the savings included in the program's E3 calculator. In the IOU's internal program tracking database, all records were assigned to one of these two climate zones to assign the deemed ex ante savings. Therefore, the climate zone field was selected as the first stratification variable. However, stratifying on climate zone alone would not fully represent the units found in the sample.

Next, the evaluators examined other fields such as building type, and focused on equipment tonnage. The population was stratified into 3 tonnage strata based on the following stratum definitions:  5 tons and under; 6 to 19 tons; and 20 tons and greater. Therefore, the population was stratified into six strata as follows as shown below.

**Table Y-6: Commercial Sampling Strata**

| | Replaced Unit Size | | |
|---|---|---|---|
| **Climate Zone** | **5 tons and under** | **6 – 19 tons** | **20 tons and greater** |
| **7** | 1 | 2 | 3 |
| **10** | 4 | 5 | 6 |

The California sampling protocols specify a minimum sample size of 300 for the net to gross survey. However, as part of the larger HIM commercial and industrial HVAC population, the evaluation team assigned survey points proportionally across the IOU, and the overall number of sample points for the NTG survey for SDGE 3029 C&I was 200.

In addition, some SDGE 3029 C&I HVAC participants installed packaged terminal units (PTACs/PTHPs). These units were installed in hotels, and because the decision makers would have had different decision-making process than participants installing large packaged units, the PTAC and PTHP records were segregated from the overall commercial and industrial records. In the final participant database, 768 PTAC/PTHP units were installed by 12 hotels. The evaluators included the census of this population of hotel decision makers in the survey sample. Therefore, the sample size for large packaged units was 188 (200 target sample – 12 PTAC/PTHP).

The population of commercial and industrial participants was assigned to the six strata. For large HVAC installations, the number of sample points assigned to each stratum was proportional to the number of units installed in that stratum. When assigning the sample sizes proportionally for each stratum, the final number of sample points was 191 rather than 188 due to rounding up the number of sample points in several strata.

In the SDGE 3029 C&I HVAC population, there were many participants/decision makers who had installed more than one unit under the program. For the NTG survey, assuming their decision making process would be the same for all units purchased through the program, the evaluators rolled all information relating to one account together (with the account number serving as the closest proxy to a decision-maker), within each stratum. Some customers installed units in multiple strata, either because units were installed in multiple climate zones or multiple tonnage units were installed. The CATI survey system was programmed to only allow the customer to be called once. The sampling targets for each stratum were compared against the number of accounts in each stratum to ensure that there would be enough decision makers to survey.

In addition, records within each stratum were sorted by the account's overall aggregate savings and grouped into two groups: Group 1, those who had installed 10 units or greater, and Group 2, those who had installed less than 10 units. The sample was stratified to prioritize the calls by savings. Customers who had ex ante savings estimates of 10,000 + kWh were called first, remaining customers in Group 1 were targeted next, and finally customers in Group 2 were targeted to reach the final survey quota.

The strata definitions, sampling targets and survey completes are shown in the table below.

**Table Y-7: Survey Targets for Large Packaged HVAC**

| Climate Zone | Tonnage Category | Stratum | Number of Units | Percent contribution to total units | Survey Target Completes | Number of Accounts | Number of Survey Completes |
|---|---|---|---|---|---|---|---|
| 7 | tons < 6 | **1** | 673 | 50% | 94 | 230 | 49 |
| | 6 <= tons < 20 | **2** | 214 | 16% | 30 | 82 | 21 |
| | tons >= 20 | **3** | 68 | 5% | 10 | 27 | 5 |
| 10 | tons < 6 | **4** | 268 | 20% | 38 | 85 | 22 |
| | 6 <= tons < 20 | **5** | 78 | 6% | 11 | 36 | 7 |
| | tons >= 20 | **6** | 55 | 4% | 8 | 10 | 1 |
| | | **Total** | **1,356** | **100%** | **191** | **470** | **105** |

# Z. Residential RCA and Residential Duct Seal Multi-Family Codebook (PGE Example)

| **PGE Duct Test & Seal/Refrigerant Charge and Airflow Program - PGE2000**<br>Survey Codebook |
|---|

NOTES:
1. Variable names are in bold type.
2. A code of -8 means the respondent answere-8     Don’t Know.
3. A code of -9 means the respondent refused to answer the question.
4. A code of -4 indicates a program skip error.
5. Questions were asked of all respondents unless indicated otherwise.
6. Responses marked with ‘*’ are coded from open ended responses.

**Recall of Participation/Identification of Decision Maker (Section 1)**

**S0_1** Did a Heating, Ventilation and Air Conditioning contractor perform a duct test and seal service at your property?

1 Yes (SKIP TO S1)
2 No

**S0_2** Did a Heating, Ventilation and Air Conditioning contractor perform a refrigerant charge and airflow test at your property?

1 Yes (SKIP TO S1)
2 No

**S0A** Is it possible there is someone else at this location might recall a contractor performing this **[measure]**?

1 Yes (BEGIN SURVEY AGAIN WITH NEW RESPONDENT)
2 No (SKIP TO S4)

**S1** Was this work done as part of a PG&E program?

1 Yes.
2 No (SKIP TO S1B)
-8 Don't know (SKIP TO S1B)

*(ONLY IF S1 = NO or DON'T KNOW).*

**S2** Did you receive any assistance, such as a discount, or direct payment for the work performed?

1 Yes
2 No (SKIP TO S4)
-8 Don't know, or don't remember (SKIP TO S4)

**S4** *(IF S0 = NO)* Has there been any work done to your heating, ventilation, or air conditioning since January of 2007?

*(IF S0 = YES)* Was the work part of an air conditioner replacement, furnace replacement or some other HVAC work?

1 Yes, air conditioner replacement
2 Yes, furnace replacement
3 Yes, other HVAC work (Describe)
4 No, just the [measure] test
5 No, it's part of normal maintenance contract
6 Other (SPECIFY)
7 No HVAC work*
8 Both AC and furnace replaced*
-8 Don't know
-9 Refused

*(IF S0 = NO, THANK & TERMINATE)*

**S5** What type of residence do you own/manage?

1 A single-family home detached from any other house
2 A single-family home attached to one or more houses
3 An apartment or condo with 2 or fewer units
4 An apartment or condo with 3 to 4 apartments or less
5 An apartment or condo with 5 or more units
6 A mobile home
7 Other (SPECIFY)
-8 Don't know
-9 Refused

S6 Using a 0 to 10 rating scale, where 0 means not at all important and 10 means extremely important, please rate the importance of each of the following in your decision to implement this specific measure at this time.

For S6_1 to S6_7

0 Not mentioned
1 Mentioned

**S6_1** The age or condition of the old equipment
**S6_2** Availability of financial assistance
**S6_3** Recommendation from a vendor/supplier (If >5, Collect Vendor Info)
**S6_4** General concerns about the environment
**S6_5** Specific concerns about global warming
**S6_6** Specific concerns about achieving energy independence

**Sources of Program Information (Section 2)**

*(ASK ONLY IF "YES" TO S1. IF THEY DON'T KNOW ABOUT ANY PROGRAM, DON'T ASK)*

Q2_1 How did you hear about the PG&E *[program]*? *(DO NOT READ LIST)*

For Q2_1 to Q2_8

0 Not mentioned
1 Mentioned

**Q2_1_1** Bill insert, newsletter, or other mailing
**Q2_1_2** Website
**Q2_1_3** HVAC contractor (SPECIFY)
**Q2_1_4** Friend/Relative/Neighbor
**Q2_1_5** Other (SPECIFY)
**Q2_1_6** Property Manager/Mobile Home Park staff
**Q2_1_7** Don't know
**Q2_1_8** Refused
**Q2_1_9** Utility contact
**Q2_1_10** Radio*
**Q2_1_11** Newspaper*

## NTGR and Spillover (Section 3-4)

FR1 At the time that you first heard about the free service from PG&E for *[Duct Test and Seal/Refrigerant Charge and Airflow]****,*** had you…? *(READ LIST)*

**FR1_1**[53] Already been thinking about paying a contractor for *[Duct Test and Seal/Refrigerant Charge and Airflow]***?**

1 Yes
2 No (SKIP TO FR2)
8 Other (SKIP TO FR2)
-8 Don't Know (SKIP TO FR2)
-9 Refused (SKIP TO FR2)

**FR1_2** Already begun collecting information about *[Duct Test and Seal/Refrigerant Charge and Airflow]*?

1 Yes
2 No (SKIP TO FR2)
8 Other (SKIP TO FR2)
-8 Don't Know (SKIP TO FR2)
-9 Refused (SKIP TO FR2)

**FR1_3** Already decided to buy the *[Duct Test and Seal/Refrigerant Charge and Airflow]* services?

1 Yes

[53] This series (FR1 through FR11) is repeated for both measures and each series is denoted by a suffix. DST is "_1", RCA is "_2".

2	No (SKIP TO FR2)
8	Other (SKIP TO FR2)
-8	Don't Know (SKIP TO FR2)
-9	Refused (SKIP TO FR2)

**FR1_4** Already had a contractor perform *[Duct Test and Seal/Refrigerant Charge and Airflow]*?

1	Yes
2	No (SKIP TO FR2)
8	Other (SKIP TO FR2)
-8	Don't Know (SKIP TO FR2)
-9	Refused (SKIP TO FR2)

**FR1B** So, A contractor performed *[Duct Test and Seal/Refrigerant Charge and Airflow]* before you learned about the free service from PG&E?

1	Yes (SKIP TO FR5)
2	No
-8	Don't Know
-9	Refused

**FR2** Just to be sure I understand, did you have specific plans to have a contractor perform *[Duct Test and Seal/Refrigerant Charge and Airflow]* before learning about the free service available through the PG&E program**?**

1	Yes
2	No (SKIP TO FR4)
-8	Don't Know (SKIP TO FR4)
-9	Refused (SKIP TO FR4)

**FR3** Did you have to make any changes to your existing plans in order to receive this free service through the *[PG&E program]*?

1	Yes
2	No
-8	Don't Know
-9	Refused

If the free service from the *[PG&E program]* had not been available to purchase duct test and seal and refrigerant charge and airflow services, would you still have:

**FR4A** Purchased any *[Duct Test and Seal/Refrigerant Charge and Airflow]* services ?

1	Yes
2	No (SKIP TO FR5)
-8	Don't Know
-9	Refused

**FR4B** Purchased the *[Duct Test and Seal/Refrigerant Charge and Airflow]* services at the same time as you did?

1 Yes (SKIP TO FR4E)
2 No
-8 Don't Know (SKIP TO FR4E)
-9 Refused (SKIP TO FR4E)

**FR4B1** Hired a contractor for *[Duct Test and Seal/Refrigerant Charge and Airflow]* services earlier than you did, or later?

1 Earlier
2 Same Time (REPEAT QUESTION FR4B)
3 Later
-8 Don't Know (SKIP TO FR4E)
-9 Refused (SKIP TO FR4E)

**FR4B_YR** How much *[earlier/later]* would you have hired a contractor for the *[Duct Test and Seal/Refrigerant Charge and Airflow]* services?

__ Years
-8 Don't Know
-9 Refused

**FR4B_MN** How much *[earlier/later]* would you have hired a contractor for the *[Duct Test and Seal/Refrigerant Charge and Airflow]* services?

__ Months
-8 Don't Know
-9 Refused

**FR4E** If the free service from the PG&E program had not been available, would you have done anything else differently?

1. Yes
2. No (SKIP TO FR5)
-8 Don't Know (SKIP TO FR5)
-9 Refused (SKIP TO FR5)

**FR5** On a 0 to 10 scale, with 0 being not at all likely and 10 being very likely, how likely is it that you would have bought the same *[Duct Test and Seal/Refrigerant Charge and Airflow]* services if you had not received any free service from the program?

__ RECORD RESPONSE (0-10)
-8 Don't Know
-9 Refused

*(SKIP TO FR10 IF PROGRAM DOES NOT PROVIDE A FINANCIAL INCENTIVE/SUBSIDY)*

**FR7** Did you receive a financial incentive from the PG&E program either directly or at the time of purchase from the participating contractor to offset the cost of the *[Duct Test and Seal/Refrigerant Charge and Airflow]?*

1 Yes
2 No (SKIP TO FR10)
-8 Don't Know (SKIP TO FR10)
-9 Refused (SKIP TO FR10)

**FR8** What was the dollar amount of the incentive?

__ Dollars
-8 Don't Know
-9 Refused

**FR9** If I had not had any assistance from the program, I would have paid the additional *[FR8]* to pay for the *[Duct Test and Seal/Refrigerant Charge and Airflow]* on my own.

__ Record Response (0-10)
-8 Don't Know
-9 Refused

*(READ ONLY IF FR7-FR9 WAS SKIPPED):* I'm going to read several statements about how you came to choose get *[Duct Test and Seal/Refrigerant Charge and Airflow]* services. On a scale of 0 to 10, where 0 is strongly disagree and 10 is strongly agree, how much do you agree with each statement?

**FR10** There may have been several reasons for my decision to have this work performed. But, the free service from the *[PG&E program]* was a critical factor in my decision to have the *[Duct Test and Seal/Refrigerant Charge and Airflow]* services done.

__ Record Response (0-10)
-8 Don't Know
-9 Refused

**FR11** I would have bought *[Duct Test and Seal/Refrigerant Charge and Airflow]* services within *[a year/2 years]* of when I did even without the free service from the *[PG&E program]**.***

__ Record Response (0-10)
-8 Don't Know
-9 Refused

**C1** Let me make sure I understand you. Earlier, you said *[fill with inconsistency 1]**,*** but that differs from some of your other responses. Please tell me in your own words what influence, if any, the program had on your decision to hire a contractor for *[Duct Test and Seal/Refrigerant Charge and Airflow]* services at the time you did? {RECORD VERBATIM RESPONSE BELOW}

*[SEE RESPONSES LOCATED IN "HVAC SF Open-ends.xls"]*

**C2** **[fill with wording and response categories to the one question which was inconsistent]** {INTERVIEWER; BASED ON VERBATIM RESPONSE TO C1, PLEASE RECORD NEW RESPONSE}

**Participant Like and Unlike Spillover Questions**

**Q6_7** Since January 1, 2005 have you made any other changes to the appliances, equipment or other characteristics of your property that would affect how much energy you are using?

| | | |
|---|---|---|
| 1 | Yes | *[ASK Q6_7a-NSP5 FOR EACH MEASURE INSTALLED BEFORE ASKING Q6_7i]* |
| 2 | No | *[SKIP TO Q6_7i]* |
| -8 | DK | *[SKIP TO Q6_7i]* |
| -9 | Refused | *[SKIP TO Q6_7i]* |

Q6_7 What types of changes did you make? (DO NOT READ. RECORD EACH TYPE OF CHANGE MADE. PROBE: Anything else?)

| | |
|---|---|
| **Q6_7a_1** | Central air conditioner |
| **Q6_7a_2** | Room/wall air conditioner |
| **Q6_7a_3** | Evaporative cooler |
| **Q6_7a_4** | Furnace |
| **Q6_7a_5** | Programmable thermostat |
| **Q6_7a_6** | Fluorescent indoor fixture |
| **Q6_7a_7** | Fluorescent outdoor fixture |
| **Q6_7a_8** | Compact fluorescent bulb |
| **Q6_7a_9** | Compact fluorescent fixture |
| **Q6_7a_10** | Motion sensor |
| **Q6_7a_11** | Dimmer switch |
| **Q6_7a_12** | Clothes washer |
| **Q6_7a_13** | Clothes dryer |
| **Q6_7a_14** | Water heater |
| **Q6_7a_15** | Low Flow showerheads |
| **Q6_7a_16** | Faucet aerators |
| **Q6_7a_17** | Refrigerator |
| **Q6_7a_18** | Freezer |
| **Q6_7a_19** | Range/oven |
| **Q6_7a_20** | Dishwasher |
| **Q6_7a_21** | Swimming pool |
| **Q6_7a_22** | Swimming pool pump |
| **Q6_7a_23** | Swimming pool cover |

| | |
|---|---|
| **Q6_7a_24** | Spa/Jacuzzi |
| **Q6_7a_25** | Floor, wall, ceiling, or attic insulation |
| **Q6_7a_26** | Weatherstripping/caulking/weatherization |
| **Q6_7a_27** | Water heater/pipe wrapping/insulation |
| **Q6_7a_28** | Duct sealing/repair (not cleaning) |
| **Q6_7a_29** | Windows |
| **Q6_7a_30** | Other (SPECIFY) |

**Q6_7b_1 to Q6_7b_30** Did this equipment replace existing equipment/measures or was it new to your property?

For Q6_7b_1 to Q6_7b_30:

1 Replaced existing equipment
2 New to property
-8 DK
-9 Refused

Q6_7ci_1 to Q6_7ci_30 When did this occur? (RECORD MONTH AND YEAR)

**Q6_7cm_1 to Q6_7cm_30** __ Month
-8 Don't know
-9 Refused

**Q6_7cy_1 to Q6_7cy_30** __ Year
-8 Don't know
-9 Refused

**Q6_7cd_1 to Q6_7cd30** Was this before or after you participated in the [**program**]?

1 Before
2 After
-8 DK
-9 Refused

*(ASK 6.7Cd and 6.7Ce ONLY IF BILLING ANALYSIS BEING DONE AND IF Q6_7a = 4, 13, 14, 19, 23)*

**C6_7d_1 to C6_7d_30** What type of fuel does the new [equipment] use?

1 Gas
2 Electric

3 Other (SPECIFY)
-8 DK
-9 Refused

**C6_7e_1 to C6_7e_30** (ASK IF 6.7b = REPLACED) What was the fuel type of the [equipment] you replaced?

1 Gas
2 Electric
3 Other (SPECIFY)
-8 DK
-9 Refused

**Q6_7f_1 to Q6_7f_30** Did you receive a rebate for this [equipment] through a [utility] program?

| | | |
|---|---|---|
| 1 | Yes | *[SKIP TO NEXT EQUIPMENT, IF NONE SKIP TO C6_7i]* |
| 2 | No | |
| -8 | DK | *[SKIP TO NEXT EQUIPMENT, IF NONE SKIP TO C6_7i]* |
| -9 | Refused | *[SKIP TO NEXT EQUIPMENT, IF NONE SKIP TO C6_7i]* |

*(ASK Q6_7g and Q6_7h IF 1-4, 12, 13, 14, 17, 18, 19, 20,  22, 24, 29 IN Q6_7a; ELSE SKIP TO NSP4)*

**Q6_7g_1 to Q6_7g_30** Is the new [equipment] energy efficient?

| | | |
|---|---|---|
| 1 | Yes | |
| 2 | No | *[SKIP TO NEXT EQUIPMENT, IF NONE SKIP TO C6_7i]* |
| -8 | DK | *[SKIP TO NEXT EQUIPMENT, IF NONE SKIP TO C6_7i]* |
| -9 | Refused | *[SKIP TO NEXT EQUIPMENT, IF NONE SKIP TO C6_7i]* |

**Q6_7h_1 to Q6_7h_30** How do you know that this equipment is energy efficient?  (PROBE:  IS IT ENERGY STAR® RATED?)

*[SEE RESPONSES LOCATED IN "HVAC SF Open-ends.xls"]*

(ASK NSP4-5 ONLY IF 6.7f = NO AND 6.7g = YES AND 6.7c = AFTER DATE OF PARTICIPATION)

**NSP4** I'm going to read a statement about the energy efficient equipment that you purchased on your own. On a scale from 0-10, with 0 indicating that you strongly disagree, and 10 indicating that you strongly agree, please rate the following statement.

My experience with the PG&E program in **[2006, 2007, 2008]** influenced my decision to install different types of high efficiency equipment on my own.

__ RECORD RESPONSE (0-10)
D DON'T KNOW
R REFUSED

NSP5 Why did you purchase this high efficiency equipment without going through a PG&E program? {DO NOT READ; INDICATE ALL THAT APPLY}

For NSP5_1 to NSP5_11

0 Not mentioned

1 Mentioned

**NSP5_1** Too much paperwork
**NSP5_2** Takes too long to get approval
**NSP5_3** No time to participate, needed equipment immediately
**NSP5_4** The program had ended
**NSP5_5** The equipment would not qualify {PROBE: WHY NOT?}
**NSP5_6** The amount of the rebate wasn't important enough
**NSP5_7** Did not know program was available
**NSP5_8** There was no program available
**NSP5_9** Other {SPECIFY}
**NSP5_10** DON'T KNOW
**NSP5_11** REFUSED

**Program Satisfaction (Section 5)**

**Q5_3** Have you participated in any other programs offered by PG&E because of your experience with the *[measure]* test you received through PG&E program?

1 Yes

2 No *(SKIP TO Q6_1)*

-8 Don't know *(SKIP TO Q6_1)*

-9 Refused *(SKIP TO Q6_1)*

Q5_5 Which of the following phrases or messages have you heard before today?

**Q5_5A** ENERGY STAR

1 Yes

2 No

3 Other (SPECIFY)

8 Don’t know

-9 Refused

**Q5_5B** Don’t Trash California

1 Yes
2 No
3 Other (SPECIFY)
8 Don’t know
-9 Refused

**Q5_5C** Energy Hog

1 Yes
2 No
3 Other (SPECIFY)
8 Don’t know
-9 Refused

**Q5_5D** Click it or Ticket

1 Yes
2 No
3 Other (SPECIFY)
8 Don’t know
-9 Refused

**Q5_5E** Flex Your Power

1 Yes
2 No
3 Other (SPECIFY)
8 Don’t know
-9 Refused

**Q5_5F** Flex Alert

1 Yes
2 No
3 Other (SPECIFY)
8 Don’t know
-9 Refused

**Q5_5G** Spare the Air

1 Yes
2 No
3 Other (SPECIFY)
8 Don't know
-9 Refused

**Q5_5H** Good Housekeeping

1 Yes
2 No
3 Other (SPECIFY)
8 Don't know
-9 Refused

**Q5_5I** Ahnu ("A – new")

1 Yes
2 No
3 Other (SPECIFY)
8 Don't know
-9 Refused

**Q5_5J** Galley Bay

1 Yes
2 No
3 Other (SPECIFY)
8 Don't know
-9 Refused

**Q5_5K** Hollister Co

1 Yes
2 No
3 Other (SPECIFY)
8 Don't know
-9 Refused

**Property Manager and Site Characteristics (Section 6)**

Now, I'd like to get some background information about you and the multifamily property at [ADDRESS].

**R1** What is your position or job title at &ADDRESS or with the company that manages this property?

1 Owner
2 Property/leasing manager/associate
3 Senior property manager
4 Maintenance supervisor
5 Senior /regional maintenance supervisor
6 Purchasing manager
7 Other [RECORD]
-8 Don’t Know
-9 Refused

**R2** How many years have you been in the business of property ownership and management?

__ Years
-8 Don’t Know
-9 Refused

**R3** How many years have you been in your current position at this property?

__ Years
-8 Don’t Know
-9 Refused

**R4** How many buildings are there at this location?

__ Locations
-8 Don’t Know
-9 Refused

**R5** About how many apartment units are located in the building or buildings at the property?

__ Units

-8 Don’t Know
-9 Refused

**R6** Do you or your firm own the property only, manage the property only, or do you both own and manage the property?

1 Own it only
2 Manage it only
3 Both own and manage it
4 Other
-8 Don’t Know
-9 Refused

**R7** Do you have one or more centralized systems at the property that provide heating to all tenant units? By a centralized system, I mean a system that provides heat to more than one tenant unit.

1 Yes
2 No
-8 Don’t Know
-9 Refused

**R8** Do you have a one or more centralized systems at the property that provide cooling to all units?

1 Yes
2 No
-8 Don’t Know
-9 Refused

**R9** Do you have one or more centralized systems at the property that provide hot water to all units?

1 Yes
2 No
-8 Don’t Know
-9 Refused

**R10** Are the tenants responsible for paying their own utility bills or are the utilities included in the rent?

1 Tenants pay their own bills
2 Utilities are included in rent
3 Tenants pay some utilities while others are included in rent
4 Other [SPECIFY]
-8 Don't Know
-9 Refused

**R11** Is the electricity for the tenant units at this property individually metered or master-metered? In other words, is there one electric meter for several tenants?

1 Individually metered
2 Master metered
3 Other [SPECIFY]
-8 Don't Know
-9 Refused

**R12** Is the natural gas for the tenant units at this property individually metered or master-metered?

1 Individually metered
2 Master metered
3 Other [SPECIFY]
-8 Don't Know
-9 Refused

## Sample variables

**respnum$** Respondent number

**gender** Respondent's gender

**intdate** Interview date

**csid** Case ID number

**city** City

| | |
|---|---|
| **zipco** | Zip code |
| **cz** | Climate zone |
| **sa_id** | Account number |
| **rlwid** | RLW ID number |
| **m1** | DST flag |
| **m2** | RCA flag |
| **pop_DST** | DST measures from population represented |
| **pop_RCA** | RCA measures from population represented |

# AA. Residential RCA and Duct Seal Single-Family Codebook (PGE Example)

| **PGE Duct Test & Seal/Refrigerant Charge and Airflow Program - PGE2000** |
|---|
| Survey Codebook |

NOTES:
1. Variable names are in bold type.
2. A code of -8 means the respondent answered don't know.
3. A code of -9 means the respondent refused to answer the question.
4. A code of -4 indicates a program skip error.
5. Questions were asked of all respondents unless indicated otherwise.
6. Responses marked with '*' are coded from open ended responses.

**Recall of Participation/Identification of Decision Maker (Section 1)**

**S0** Did a Heating, Ventilation and Air Conditioning contractor perform a *[measure]* at your home?

1 Yes (SKIP TO S1)
2 No

**S0A** Is it possible there is someone else in the household that might recall a contractor performing this *[measure]*?

1 Yes (BEGIN SURVEY AGAIN WITH NEW RESPONDENT)
2 No (SKIP TO S4)

**S1** Was this work done as part of a PG&E program?

1 Yes.
2 No (SKIP TO S1B)
-8 Don't know (SKIP TO S1B)

*(ONLY IF S1 = NO or DON'T KNOW).*

**S2** Did you receive any assistance, such as a discount, or direct payment for the work performed?

1 Yes
2 No (SKIP TO S4)
-8 Don't know, or don't remember (SKIP TO S4)

**S4** *(IF S0 = NO)* Has there been any work done to your heating, ventilation, or air conditioning since January of 2007?

*(IF S0 = YES)* Was the work part of an air conditioner replacement, furnace replacement or some other HVAC work?

1 Yes, air conditioner replacement
2 Yes, furnace replacement
3 Yes, other HVAC work (Describe)
4 No, just the [measure] test
5 No, it's part of normal maintenance contract
6 Other (SPECIFY)
7 No HVAC work*
8 Both AC and furnace replaced*
-8 Don't know
-9 Refused

*(IF S0 = NO, THANK & TERMINATE)*

**S5** In what type of residence do you live?

1 A single-family home detached from any other house
2 A single-family home attached to one or more houses
3 An apartment or condo with 2 or fewer units
4 An apartment or condo with 3 to 4 apartments or less
5 An apartment or condo with 5 or more units
6 A mobile home
7 Other (SPECIFY)
-8 Don't know
-9 Refused

S6 Using a 0 to 10 rating scale, where 0 means not at all important and 10 means extremely important, please rate the importance of each of the following in your decision to implement this specific measure at this time.

For S6_1 to S6_7

0 Not mentioned

1 Mentioned

**S6_1** The age or condition of the old equipment

**S6_2** Availability of financial assistance

**S6_3** Recommendation from a vendor/supplier (If >5, Collect Vendor Info)

**S6_4** General concerns about the environment

**S6_5** Specific concerns about global warming

**S6_6** Specific concerns about achieving energy independence

**S6_7** Other (SPECIFY)

## Sources of Program Information (Section 2)

*(ASK ONLY IF "YES" TO S1.  IF THEY DON'T KNOW ABOUT ANY PROGRAM, DON'T ASK)*

Q2_1 How did you hear about the PG&E *[program]*? *(DO NOT READ LIST)*

For Q2_1 to Q2_8

0 Not mentioned
1 Mentioned

**Q2_1_1** Bill insert, newsletter, or other mailing
**Q2_1_2** Website
**Q2_1_3** HVAC contractor (SPECIFY)
**Q2_1_4** Friend/Relative/Neighbor
**Q2_1_5** Other (SPECIFY)
**Q2_1_6** Property Manager/Mobile Home Park staff
**Q2_1_7** Don't know
**Q2_1_8** Refused
**Q2_1_9** Utility contact
**Q2_1_10** Radio*
**Q2_1_11** Newspaper*

## NTGR and Spillover (Section 3-4)

FR1 At the time that you first heard about the free service from PG&E for *[Duct Test and Seal/Refrigerant Charge and Airflow]***,** had you…? *(READ LIST)*

**FR1_1** Already been thinking about paying a contractor for *[Duct Test and Seal/Refrigerant Charge and Airflow]***?**

1 Yes
2 No (SKIP TO FR2)
8 Other (SKIP TO FR2)
-8 Don't Know (SKIP TO FR2)
-9 Refused (SKIP TO FR2)

**FR1_2** Already begun collecting information about *[Duct Test and Seal/Refrigerant Charge and Airflow]*?

1 Yes
2 No (SKIP TO FR2)
8 Other (SKIP TO FR2)
-8 Don't Know (SKIP TO FR2)
-9 Refused (SKIP TO FR2)

**FR1_3** Already decided to buy the *[Duct Test and Seal/Refrigerant Charge and Airflow]* services?

1 Yes
2 No (SKIP TO FR2)
8 Other (SKIP TO FR2)
-8 Don't Know (SKIP TO FR2)
-9 Refused (SKIP TO FR2)

**FR1_4** Already had a contractor perform *[Duct Test and Seal/Refrigerant Charge and Airflow]*?

1 Yes
2 No (SKIP TO FR2)
8 Other (SKIP TO FR2)
-8 Don't Know (SKIP TO FR2)
-9 Refused (SKIP TO FR2)

**FR1B** So, A contractor performed *[Duct Test and Seal/Refrigerant Charge and Airflow]* before you learned about the free service from PG&E?

1 Yes (SKIP TO FR5)
2 No
-8 Don't Know
-9 Refused

**FR2** Just to be sure I understand, did you have specific plans to have a contractor perform *[Duct Test and Seal/Refrigerant Charge and Airflow]* before learning about the free service available through the PG&E program**?**

1 Yes
2 No (SKIP TO FR4)
-8 Don't Know (SKIP TO FR4)
-9 Refused (SKIP TO FR4)

**FR3** Did you have to make any changes to your existing plans in order to receive this free service through the *[PG&E program]*?

1 Yes
2 No
-8 Don't Know

-9 Refused

If the free service from the *[PG&E program]* had not been available to purchase duct test and seal and refrigerant charge and airflow services, would you still have:

**FR4A** Purchased any *[Duct Test and Seal/Refrigerant Charge and Airflow]* services ?

1 Yes
2 No (SKIP TO FR5)
-8 Don't Know
-9 Refused

**FR4B** Purchased the *[Duct Test and Seal/Refrigerant Charge and Airflow]* services at the same time as you did?

1 Yes (SKIP TO FR4E)
2 No
-8 Don't Know (SKIP TO FR4E)
-9 Refused (SKIP TO FR4E)

**FR4B1** Hired a contractor for *[Duct Test and Seal/Refrigerant Charge and Airflow]* services earlier than you did, or later?

1 Earlier
2 Same Time (REPEAT QUESTION FR4B)
3 Later
-8 Don't Know (SKIP TO FR4E)
-9 Refused (SKIP TO FR4E)

**FR4B_YR** How much *[earlier/later]* would you have hired a contractor for the *[Duct Test and Seal/Refrigerant Charge and Airflow]* services?

__ Years
-8 Don't Know
-9 Refused

**FR4B_MN** How much *[earlier/later]* would you have hired a contractor for the *[Duct Test and Seal/Refrigerant Charge and Airflow]* services?

__ Months
-8 Don't Know
-9 Refused

**FR4E** If the free service from the PG&E program had not been available, would you have done anything else differently?

1. Yes
2. No (SKIP TO FR5)
-8 Don't Know (SKIP TO FR5)
-9 Refused (SKIP TO FR5)

**FR5** On a 0 to 10 scale, with 0 being not at all likely and 10 being very likely, how likely is it that you would have bought the same *[Duct Test and Seal/Refrigerant Charge and Airflow]* services if you had not received any free service from the program?

__ RECORD RESPONSE (0-10)
-8 Don't Know
-9 Refused

*(SKIP TO FR10 IF PROGRAM DOES NOT PROVIDE A FINANCIAL INCENTIVE/SUBSIDY)*

**FR7** Did you receive a financial incentive from the PG&E program either directly or at the time of purchase from the participating contractor to offset the cost of the *[Duct Test and Seal/Refrigerant Charge and Airflow]?*

1 Yes
2 No (SKIP TO FR10)
-8 Don't Know (SKIP TO FR10)
-9 Refused (SKIP TO FR10)

**FR8** What was the dollar amount of the incentive?

__ Dollars
-8 Don't Know
-9 Refused

**FR9** If I had not had any assistance from the program, I would have paid the additional *[FR8]* to pay for the *[Duct Test and Seal/Refrigerant Charge and Airflow]* on my own.

__ Record Response (0-10)
-8 Don't Know
-9 Refused

*(READ ONLY IF FR7-FR9 WAS SKIPPED):* I'm going to read several statements about how you came to choose get *[Duct Test and Seal/Refrigerant Charge and Airflow]* services. On a scale of 0 to 10, where 0 is strongly disagree and 10 is strongly agree, how much do you agree with each statement?

**FR10** There may have been several reasons for my decision to have this work performed. But, the free service from the *[PG&E program]* was a critical factor in my decision to have the *[Duct Test and Seal/Refrigerant Charge and Airflow]* services done.

__ Record Response (0-10)

-8 Don't Know
-9 Refused

**FR11** I would have bought *[Duct Test and Seal/Refrigerant Charge and Airflow]* services within *[a year/2 years]* of when I did even without the free service from the *[PG&E program]****.***

__ Record Response (0-10)
-8 Don't Know
-9 Refused

**C1** Let me make sure I understand you. Earlier, you said *[fill with inconsistency 1]****,*** but that differs from some of your other responses. Please tell me in your own words what influence, if any, the program had on your decision to hire a contractor for *[Duct Test and Seal/Refrigerant Charge and Airflow]* services at the time you did? {RECORD VERBATIM RESPONSE BELOW}

*[SEE RESPONSES LOCATED IN "HVAC SF Open-ends.xls"]*

**C2** **[fill with wording and response categories to the one question which was inconsistent]** {INTERVIEWER; BASED ON VERBATIM RESPONSE TO C1, PLEASE RECORD NEW RESPONSE}

**Participant Like and Unlike Spillover Questions**

**Q6_7** Since January 1, 2005 have you made any other changes to the appliances, equipment or other characteristics of your home that would affect how much energy you are using?

| | | |
|---|---|---|
| 1 | Yes | *[ASK Q6_7a-NSP5 FOR EACH MEASURE INSTALLED BEFORE ASKING Q6_7i]* |
| 2 | No | *[SKIP TO Q6_7i]* |
| -8 | DK | *[SKIP TO Q6_7i]* |
| -9 | Refused | *[SKIP TO Q6_7i]* |

Q6_7 What types of changes did you make? (DO NOT READ. RECORD EACH TYPE OF CHANGE MADE. PROBE: Anything else?)

| | |
|---|---|
| **Q6_7a_1** | Central air conditioner |
| **Q6_7a_2** | Room/wall air conditioner |
| **Q6_7a_3** | Evaporative cooler |
| **Q6_7a_4** | Furnace |
| **Q6_7a_5** | Programmable thermostat |
| **Q6_7a_6** | Fluorescent indoor fixture |
| **Q6_7a_7** | Fluorescent outdoor fixture |
| **Q6_7a_8** | Compact fluorescent bulb |
| **Q6_7a_9** | Compact fluorescent fixture |
| **Q6_7a_10** | Motion sensor |
| **Q6_7a_11** | Dimmer switch |
| **Q6_7a_12** | Clothes washer |
| **Q6_7a_13** | Clothes dryer |
| **Q6_7a_14** | Water heater |
| **Q6_7a_15** | Low Flow showerheads |
| **Q6_7a_16** | Faucet aerators |
| **Q6_7a_17** | Refrigerator |
| **Q6_7a_18** | Freezer |
| **Q6_7a_19** | Range/oven |
| **Q6_7a_20** | Dishwasher |
| **Q6_7a_21** | Swimming pool |
| **Q6_7a_22** | Swimming pool pump |
| **Q6_7a_23** | Swimming pool cover |
| **Q6_7a_24** | Spa/Jacuzzi |

**Q6_7a_25** Floor, wall, ceiling, or attic insulation
**Q6_7a_26** Weatherstripping/caulking/weatherization
**Q6_7a_27** Water heater/pipe wrapping/insulation
**Q6_7a_28** Duct sealing/repair (not cleaning)
**Q6_7a_29** Windows
**Q6_7a_30** Other (SPECIFY)

Q6_7b Did this equipment replace existing equipment/measures or was it new to your home?

For Q6_7b_1 to Q6_7b_30:

1 Replaced existing equipment
2 New to home
-8 DK
-9 Refused

Q6_7ci_1 to Q6_7ci_30 When did this occur? (RECORD MONTH AND YEAR)

**Q6_7cm_1 to Q6_7cm_30** __ Month
**Q6_7cy_1 to Q6_7cy_30** __ Year
-8 Don't know
-9 Refused

**Q6_7cd_1 to Q6_7cd30** Was this before or after you participated in the [**program**]?

1 Before
2 After
-8 DK
-9 Refused

*(ASK 6.7Cd and 6.7Ce ONLY IF BILLING ANALYSIS BEING DONE AND IF Q6_7a = 4, 13, 14, 19, 23)*

**C6_7d_1 to C6_7d_30** What type of fuel does the new [equipment] use?

1 gas
2 electric
3 other (SPECIFY)
-8 DK
-9 Refused

**C6_7e_1 to C6_7e_30** (ASK IF 6.7b = REPLACED) What was the fuel type of the [equipment] you replaced?

1 Gas
2 Electric
3 Other (SPECIFY)
-8 DK
-9 Refused

**Q6_7f_1 to Q6_7f_30** Did you receive a rebate for this [equipment] through a [utility] program?

1 Yes *[SKIP TO NEXT EQUIPMENT, IF NONE SKIP TO C6_7i]*
2 No
-8 DK *[SKIP TO NEXT EQUIPMENT, IF NONE SKIP TO C6_7i]*
-9 Refused *[SKIP TO NEXT EQUIPMENT, IF NONE SKIP TO C6_7i]*

*(ASK Q6_7g and Q6_7h IF 1-4, 12, 13, 14, 17, 18, 19, 20, 22, 24, 29 IN Q6_7a; ELSE SKIP TO NSP4)*

**Q6_7g_1 to Q6_7g_30** Is the new [equipment] energy efficient?

1 Yes
2 No *[SKIP TO NEXT EQUIPMENT, IF NONE SKIP TO C6_7i]*
-8 DK *[SKIP TO NEXT EQUIPMENT, IF NONE SKIP TO C6_7i]*
-9 Refused *[SKIP TO NEXT EQUIPMENT, IF NONE SKIP TO C6_7i]*

**Q6_7h_1 to Q6_7h_30** How do you know that this equipment is energy efficient? (PROBE: IS IT ENERGY STAR® RATED?)

*[SEE RESPONSES LOCATED IN "HVAC SF Open-ends.xls"]*

(ASK NSP4-5 ONLY IF 6.7f = NO AND 6.7g = YES AND 6.7c = AFTER DATE OF PARTICIPATION)

**NSP4** I'm going to read a statement about the energy efficient equipment that you purchased on your own. On a scale from 0-10, with 0 indicating that you strongly disagree, and 10 indicating that you strongly agree, please rate the following statement.

My experience with the PG&E program in **[2006, 2007, 2008]** influenced my decision to install different types of high efficiency equipment on my own.

__ RECORD RESPONSE (0-10)
D DON'T KNOW
R REFUSED

NSP5 Why did you purchase this high efficiency equipment without going through a PG&E program? {DO NOT READ; INDICATE ALL THAT APPLY}

For NSP5_1 to NSP5_11

0 Not mentioned

1 Mentioned

**NSP5_1** Too much paperwork
**NSP5_2** Takes too long to get approval
**NSP5_3** No time to participate, needed equipment immediately
**NSP5_4** The program had ended
**NSP5_5** The equipment would not qualify {PROBE: WHY NOT?}
**NSP5_6** The amount of the rebate wasn't important enough
**NSP5_7** Did not know program was available
**NSP5_8** There was no program available
**NSP5_9** Other {SPECIFY}
**NSP5_10** DON'T KNOW
**NSP5_11** REFUSED

## Program Satisfaction (Section 5)

**Q5_3** Have you participated in any other programs offered by PG&E <u>because of your experience with the *[measure]* test you received through PG&E program</u>?

1 Yes

2 No *(SKIP TO Q6_1)*

-8 Don't know *(SKIP TO Q6_1)*

-9 Refused *(SKIP TO Q6_1)*

Q5_5 Which of the following phrases or messages have you heard before today?

**Q5_5A** ENERGY STAR

1 Yes

2 No

3 Other (SPECIFY)

8 Don’t know

-9 Refused

**Q5_5B** Don't Trash California

1 Yes
2 No
3 Other (SPECIFY)
8 Don't know
-9 Refused

**Q5_5C** Energy Hog

1 Yes
2 No
3 Other (SPECIFY)
8 Don't know
-9 Refused

**Q5_5D** Click it or Ticket

1 Yes
2 No
3 Other (SPECIFY)
8 Don't know
-9 Refused

**Q5_5E** Flex Your Power

1 Yes
2 No
3 Other (SPECIFY)
8 Don't know
-9 Refused

**Q5_5F** Flex Alert

1 Yes
2 No
3 Other (SPECIFY)
8 Don't know
-9 Refused

**Q5_5G** Spare the Air

1 Yes
2 No
3 Other (SPECIFY)
8 Don’t know
-9 Refused

**Q5_5H** Good Housekeeping

1 Yes
2 No
3 Other (SPECIFY)
8 Don’t know
-9 Refused

**Q5_5I** Ahnu (“A – new”)

1 Yes
2 No
3 Other (SPECIFY)
8 Don’t know
-9 Refused

**Q5_5J** Galley Bay

1 Yes
2 No
3 Other (SPECIFY)
8 Don’t know
-9 Refused

**Q5_5K** Hollister Co

1 Yes
2 No
3 Other (SPECIFY)
8 Don’t know
-9 Refused

## Homeowner Energy Use (Section 6)

**Q6_1** How often do you use your furnace during the heating season months (November-April)? Would you say it is used…..?

1 Daily
2 A few days a week
3 A few days a month
4 Only on extremely cold days
5 Never
-8 Don't know
-9 Refused

**Q6_2** Throughout the winter months do you heat your house to a certain temperature all the time or do you adjust the temperatures when you're home and/or when you're away?

1 One temperature (Skip to Q6_2A)
2 Adjust temperature when home and away (Skip to Q6_2B)
3 Something Else (SPECIFY) (Skip to Q6_3)
-8 Don't know (Skip to Q6_3)
-9 Refused (Skip to Q6_3)

**Q6_2A** What one temperature?

__ Degrees
-8 Don't know

**Q6_2B** What is the temperature setting when you are at home?

__ Degrees
-8 Don't know

**Q6_2C** What is the temperature setting when no one is at home?

__ Degrees
0 Turned off
-8 Don't know

**Q6_3** Does your furnace fan run 24 hours a day?

1 Yes
2 No
8 Don't know
-9 Refused

**Q6_4** How many central air conditioning systems do you have in your home?

__ Qty
0 None (SKIP TO Q6_6)
-8 Don't know
-9 Refused

**Q6_5** How often do you use your central air-conditioner during the cooling season months (July-September)? Would you say it is used…..?

1 Daily
2 A few days a week
3 A few days a month
4 Only on extremely hot days
5 Never
-8 Don't know
-9 Refused

**Q6_6** How many thermostats do you have in your home?

__ Qty
0 None (SKIP TO Q6_8)
-8 Don't know
-9 Refused

**Q6_7A** Programmable thermostats have digital displays and allow you to “program” them to change the temperature setting automatically based on the times you set. Is/Are your thermostat(s) programmable or manual?

1 Programmable (digital)
2 Manual
3 Both
-8 Don’t know
-9 Refused

*[If S4 <> 1, SKIP TO 7.1]*

**Q6_8** Did your new unit(s) replace an existing air conditioning system, or are you adding air conditioning to your home?

1 Replaced an existing AC unit (one-for-one replacement)
2 Adding AC to home (SKIP TO Q7_1)
-8 Don’t Know (SKIP TO Q7_1)
-9 Refused (SKIP TO Q7_1)

**Q6_9** Did you replace that AC system with a new one that has the same total cooling capacity?

1 Yes
2 No, replaced with new system that has less total cooling capacity
3 No, replaced with new system that has more total cooling capacity
-8 Don't know
-9 Refused

**Q6_10** Was your previous AC unit(s) still functioning or had it failed?

1 Still functioning (early retirement)
2 Equipment failure (replace on burnout)
-8 Don't know
-9 Refused

**Q6_12** How old was the air conditioner(s) you replaced?

__ Years (SKIP to Q6_14)
-8 Don't know
-9 Refused (SKIP to Q6_14)

**Q6_13** Was it…

1 5 years old or less
2 6 to 10 years old
3 11 to 15 years old
4 16 to 20 years old
5 Greater than 20 years old
-8 Don't know

**Q6_14** Did you run your previous air conditioner all the time?

1 Yes
2 No

-8 Don't know
-9 Refused

**Q6_15** Did you have a programmable thermostat(s) to control your previous air conditioner?

1 Yes
2 No
-8 Don't know
-9 Refused

**Q6_16** Since the installation of your new AC unit, did you change your thermostat temperature settings from the setting you used with the prior unit?

1 Yes (SPECIFY)
2 No
-8 Don't know
-9 Refused

**Compliance Knowledge (Section 7)**

**Q7_1** *(IF S4= 1,2 or 3)* Are you aware as to whether or not you or the contractor filed for a building permit for the air conditioner replacement, furnace replacement, or other HVAC work?

1 Not Aware
2 Submitted by Homeowner
3 Submitted by Contractor
-8 Don't know
-9 Refused

**Q7_2** *(IF S4 = 1 AND CLIMATE ZONE 2, 12, 16 ONLY)* Were you aware of the Title 24 requirement to have either a high efficiency furnace installed or duct testing and sealing at the time of air conditioner change out?

1 Yes I was aware
-8 Don't know (SKIP TO Q8_1)
-9 Refused SKIP TO Q8_1)

**Q7_3** *(IF S4 = 1 AND CLIMATE ZONE 2, 12, 16 ONLY)* Which option would you have taken if you had not participated in the program? Would you have . . . .*(READ LIST)*

1 Purchased a High Efficiency Furnace (AFUE 92 or greater)
2 Had Duct Testing and Sealing
3 Did both duct test and a high efficiency furnace
-8 Don't know
-9 Refused

**Q7_4** *(CLIMATE ZONE 9, 10, 11, 13, 14, 15 ONLY)* Were you aware of the Title 24 requirement to have duct testing and sealing at the time of air conditioner change out?

1 Yes I was aware
2 No I was not aware of the requirement
-8 Don't know
-9 Refused

## RESIDENTIAL DEMOGRAPHIC QUESTIONS (Section 8)

These last few questions help us better understand PG&E customers who are utilizing this program.

**Q8_1** Do you own or rent your home?

1 Own
2 Rent
3 Other (SPECIFY)
-8 Don't know
-9 Refused

**Q8_2** In what year was your home constructed?

__ Year (Skip to Q8_3)
-8 Don't know

**Q8_2A** In what year was your home constructed?

1 Before 1970's
2 1970's
3 1980's
4 1990-94
5 1995-99
6 2000-2005
7 2006 or newer
-8 Don't know
-9 Refused

**Q8_3** What is the approximate square footage of your home?

__ SQFT (Skip to Q8_4)
-8 Don't know

**Q8_3A** What is the approximate square footage of your home?

1 Less 1000

| | |
|---|---|
| 2 | 1001-1500 |
| 3 | 1501-2000 |
| 4 | 2000-2500 |
| 5 | Greater than 2500 |
| -8 | Don't know |
| -9 | Refused |

**Q8_4** Including yourself, how many people currently live in your home year-round?

| | |
|---|---|
| __ | People |
| -8 | Don't know |
| -9 | Refused |

**Q8_5** What is the primary language spoken in your home?

| | |
|---|---|
| 1 | English |
| 2 | Spanish |
| 3 | Mandarin |
| 4 | Cantonese |
| 5 | Tagalog |
| 6 | Korean |
| 7 | Vietnamese |
| 8 | Russian |
| 9 | Japanese |
| 10 | Other |
| -8 | Don't know |
| -9 | Refused |

## Sample variables

**respnum$** Respondent number

**gender** Respondent's gender

**intdate** Interview date

**csid** Case ID number

| | |
|---|---|
| **city** | City |
| **zipco** | Zip code |
| **cz** | Climate zone |
| **onsitemm** | On-site month |
| **onsiteyy** | On-site year |
| **meascode** | Measure code<br>1 Duct test and seal service<br>2 Refrigerant charge and airflow test |
| **sa_id** | Account number |

# BB. C&I RCA Codebook (SDGE Example)

| SDG&E Refrigerant Charge and Airflow Program – SDG&E 3043 |
|---|
| **The following measures will be asked about in the survey:** Refrigerant charge test |

**Instrument-specific variables--** The CATI software will automatically fill the appropriate description in the questions.

**[MEASURE]**
Refrigerant charge test
**[ASSISTANCE]**
AC tune up service
**[PROGRAM]**
AC Time Program
**[UTILITY]**
SDG&E
**[AMOUNT OF PROGRAM INCENTIVE/SUBSIDY]**
N/A

**Recall of Participation/Identification of Decision Maker (Section 1)**

**Single Family Rebate Initial Screener**

Hello, my name is ___________, and I'm calling on behalf of the California Public Utilities Commission here at PA Consulting Group.

May I speak with [contact name]?

1 SPEAKING WITH RESPONDENT
2 QUALIFIED RESPONDENT IS NOT CURRENTLY AVAILABLE

The reason for our call today is according to our records you had a Heating, Ventilation and Air Conditioning Contractor perform work on your home at **[address].** The contractor performed a **[measure]** test as part of a SDG&E program.

I'm not selling anything; I'd just like to ask your opinion about this program. I'd like to assure you that your responses will be kept confidential and your individual responses will not be revealed to anyone.

**(Who is doing this study:** The California Public Utilities Commission, which regulates the utilities, is overseeing evaluations of most of California's energy efficiency programs.)

(**Why are you conducting this study**: Studies like this help the State of California and SCE better understand customers' need for and interest in energy programs and services.)

(**Timing**: This survey should take about 20 minutes of your time. Is this a good time for us to speak with you? IF NOT, SET UP CALL BACK APPOINTMENT OR OFFER TO LET THEM CALL US BACK AT 1-800-454-5070)

(**Sales concern**: I am not selling anything; we would simply like to learn about your experience with the [**measures**] you purchased and received a rebate through the program. Your responses will be kept confidential. If you would like to talk with someone from the California Public Utilities Commission about this study, feel free to call Mikhail Haramati at 415-703-1458, or visit their website: www.cpuc.ca.gov/eevalidation**.)**

S0 Did a Heating, Ventilation and Air Conditioning contractor perform a **[measure] or AC tune-up** at your home?

1 Yes (SKIP TO S1)
2 No

S0a Is it possible there is someone else in the household that might recall a contractor performing this **[measure]**?

1 Yes (BEGIN SURVEY AGAIN WITH NEW RESPONDENT)
2 No (SKIP TO S2)

S1 Was this work done as part of a SDG&E program?

1. Yes.
2. No (SKIP TO S1b)

D. Don’t know (SKIP TO S1b)

S1a How do you know that?

(ENTER RESPONSE)

(ONLY IF S1 = NO or DON’T KNOW).

S1b *Our records show that the contractor that provided the [measure] was part of a SDG&E program. The intent of this program was to encourage SDG&E customers to increase the efficiency of their air conditioning systems by offering maintenance and repair services at a free or discounted rate.*

CONTINUE

S2 (IF S0 = NO) Has there been any work done to your air conditioning since January of 2006?

(PROBE: Was the work part of an air conditioner replacement or some other HVAC work?)

(IF S0 = YES) Was the work part of an air conditioner replacement or some other HVAC work?

1 Yes, air conditioner replacement
2 Yes, air conditioner repair
3 Yes, other HVAC work (Describe)
4 No, just the [measure] test
5 No, it’s part of normal maintenance contract
6 Other (SPECIFY)
7 No HVAC work
D Don’t know
R Refused

(IF S0 = NO, THANK & TERMINATE)

S3 How many central air conditioning systems do you have in your home?

__ Qty
D Don’t know
R Refused

ASK IF S3 .1 (MORE THAN ONE UNIT)
S3a How many of these air conditioning systems received the tune-up with refrigerant charge test?

__ Qty

D Don't know
R Refused

S4 Do you have a maintenance contract for your air conditioning system?

1. Yes
2. No
D. Don't know, or don't remember

S5 In what type of residence do you live? (READ LIST IF NEEDED)

1 A single-family home detached from any other house
2 A single-family home attached to one or more houses
3 An apartment or condo with 2 or fewer units
4 An apartment or condo with 3 to 4 apartments or less
5 An apartment or condo with 5 or more units
6 A mobile home
7 Other (SPECIFY)
D Don't know
R Refused

S6 We'd like to know about the influence your contractor had on your decision to purchase the AC tune up or refrigerant charge test. Using a scale of 0 to 10, where 0 is not at all influential and 10 is extremely influential, how influential was the contractor in your decision to obtain AC tune up services?

___________{RECORD RESPONSE} (If >5, COLLECT VENDOR INFO)
D Don't know
R Refused

S7 Did you receive any direct communication such as regular mail, emails or bill inserts or from SDGE about the benefits of performing AC tune ups?

1 Yes [ASK NEXT QUESTION S8]
2 No [SKIP TO S9]
D Don't know [SKIP TO S9]
R Refused [SKIP TO S9]

S8 Again using a scale of 0 to 10, how influential was the SDGE information in your decision to obtain an AC tune up?

___________ {RECORD RESPONSE}
D Don't know
R Refused

S9 Did you visit the SDGE website to look for information about AC tune ups?

1 Yes [ASK NEXT QUESTION S10]
2 No [SKIP TO S12]
D Don't know [SKIP TO S12]
R Refused [SKIP TO S12]

S10 Did you find information on the SDGE website about the benefits of AC tune ups?

1 Yes [ASK NEXT QUESTION S11]
2 No [SKIP TO S12]
D Don't know [SKIP TO S12]
R Refused [SKIP TO S12]

S11 How influential was the SDGE website information in your decision to obtain an AC tune up? Again the same scale of 0 to 10, where 0 is not at all influential and 10 is extremely influential.

___________{RECORD RESPONSE}
D Don't know
R Refused

S12 Did anyone from SDGE contact you directly about the benefits of AC tune ups?

1 Yes [ASK NEXT QUESTION S13]
2 No [SKIP TO FR1]
D Don't know [SKIP TO FR1]
R Refused [SKIP TO FR1]

S13 Using a scale of 0 to 10, how influential was the information from SDGE staff in your decision to obtain an AC tune up?

___________{RECORD RESPONSE}
D Don't know
R Refused

FR6a Did you receive the AC tune up with Refrigerant Charge and Airflow service for free?

1. Yes {skip to 2.1}
2. No
D. Don't Know
R. Refused

**Ask if FR6a <> 1**

FR6 Did you receive a discount or other financial incentive at the time of purchase to offset the cost of the Refrigerant Charge and Airflow service?

1. Yes
2. No {skip to FR8}
D. Don't Know {skip to 2.1}
R. Refused {skip to 2.1}

FR7 What was the dollar amount of the incentive?

__ RECORD RESPONSE
D. Don't Know
R. Refused

FR8 On a scale of 0 to 10, where 0 is strongly disagree and 10 is strongly agree, how much do you agree with this statement? If I had not had any financial incentive, I would have paid the additional [Use FR7 amount of program incentive/subsidy] to pay for the Refrigerant Charge and Airflow service on my own.

__ RECORD RESPONSE (0-10)
D. Don't Know
R. Refused

## Sources of Program Information (Section 2)

**ASK ONLY IF "YES" TO S1. IF THEY DON'T KNOW ABOUT ANY PROGRAM, DON'T ASK**

**2.1** How did you hear about the SDG&E [program]? (PROBE: Did you hear about the program from any other sources?) (DO NOT READ LIST)

**Utility provided information**

1 Bill insert, newsletter, or other mailing
2 Website

**Other**

3 HVAC contractor (SPECIFY)
4 Friend/Relative/Neighbor
5 Other, Specify
6 Property Manager/Mobile Home Park staff
7 Don't know
8 Refused

## NTGR and Spillover (Section 3-4)

FR1 At the time that you first discussed the AC tune up service with your installation contractor had you…? {READ LIST}

1. Already been thinking about paying a contractor for an AC tune up that included Refrigerant Charge and Airflow services?

1 YES
2 NO {SKIP TO FR2}
8 OTHER {SKIP TO FR2}
D DON'T KNOW {SKIP TO FR2}
R REFUSED {SKIP TO FR2}

2. Already begun collecting information about AC tune ups and Refrigerant Charge and Airflow services?

1 YES
2 NO {SKIP TO FR2}
8 OTHER {SKIP TO FR2}
D DON'T KNOW {SKIP TO FR2}
R REFUSED {SKIP TO FR2}

3. Already decided to buy the AC tune up with Refrigerant Charge and Airflow services?

1 YES
2 NO {SKIP TO FR2}
8 OTHER {SKIP TO FR2}
D DON'T KNOW {SKIP TO FR2}
R REFUSED {SKIP TO FR2}

4. Already had a contractor perform an AC tune up with Refrigerant Charge and Airflow services?

1 YES
2 NO {SKIP TO FR2}
8 OTHER {SKIP TO FR2}
D DON'T KNOW {SKIP TO FR2}
R REFUSED {SKIP TO FR2}

FR2 Just to be sure I understand, did you have specific plans to perform a Refrigerant Charge and Airflow tune up before discussing the tune up service with your installation contractor?

1. Yes
2. No {SKIP TO FR4}
D. Don't Know {SKIP TO FR4}
R. Refused {SKIP TO FR4}

FR3 Did you have to make any changes to your existing plans in order to receive this AC tune up service?

1. Yes [Probe for changes]
2. No
D. Don't Know
R. Refused

**FR INFLUENCE INSTRUCTIONS:**

**ASK THE PROGRAM INFLUENCE SERIES IF:**

**(1) PROGRAM HAD INFLUENCE: (S8 > 5; S11>5; OR S13 > 5), OR,**

**ASK THE CONTRACTOR INFLUENCE SERIES IF:**

**(1) ONLY THE CONTRACTOR INFLUENCED DECISIONS (S6 > 5)**

**IF BOTH PROGRAM AND CONTRACTOR HAD LITTLE INFLUENCE, (S6 <5 AND S8 < 5; S11 < 5; AND S13 < 5) ASK THE BATTERY CORRESPONDING TO THE GREATEST INFLUENCE (HIGHEST RATING AMONG THESE QUESTIONS).**

**IF BOTH PROGRAM AND CONTRACTOR HAD INFLUENCE, S6 >5 AND S8 > 5; S11 > 5; AND S13 > 5) ASK THE BATTERY CORRESPONDING TO THE GREATEST INFLUENCE (HIGHEST RATING AMONG THESE QUESTIONS).**

**PROGRAM INFLUENCE SERIES**

READ: In the next set of questions, I'm going to ask about your decision to obtain the AC tune up service.

FR4P If the assistance or information from SDGE about performing AC tune ups had not been available when you made your decision to obtain refrigerant charge and airflow services, would you still have:

FR4PA Obtained AC tune up with Refrigerant Charge and Airflow services?

1 Yes
2 No {SKIP TO FR4PC }
D Don't Know {SKIP TO FR4PC }
R Refused {SKIP TO FR4PC }

FR4PB Obtained AC tune up services at the same time as you did?

1 Yes {SKIP TO FR4PC}
2 No
D Don't Know {SKIP TO FR4PC}
R Refused {SKIP TO FR4PC}

FR4PB1. Obtained the AC tune up service earlier than you did, or later?

1 Earlier
2 Same Time {REPEAT QUESTION FR4PB}
3 Later
D Don't Know {SKIP TO FR4PC}
R Refused {SKIP TO FR4PC}

FR4PB2. How much **earlier/later** would you have obtained AC tune up services?

______ Years {AND/OR} ______Months
D Don't Know
R Refused

IF S5 = 1, SKIP TO FR4PD

FR4PC {IF MULTIPLE UNITS TUNED UP THROUGH THE PROGRAM } Without the assistance or information from SDGE, would you have obtained the same quantity of AC tune ups?

1 Yes {SKIP TO FR4PD}
2 No
D Don't Know {SKIP TO FR4PD}
R Refused {SKIP TO FR4PD}

FR4PC1. How many AC tune ups would you have obtained without the assistance or information from SDGE?

___________ {RECORD NUMBER}
D Don't Know
R Refused

FR4PD If the assistance or information from SDGE had not been available, would you have done anything else differently?

1 Yes
2 No {SKIP TO FR5P}
D Don't Know {SKIP TO FR5P}
R Refused {SKIP TO FR5P}

FR4PE1 What would you have done differently?

________________________ {record response}:

FR5P On a 0 to 10 scale, with 0 being not at all likely and 10 being very likely, how likely is it that you would have obtained AC tune up services if you had not received any **assistance or information** from SDGE?

{RECORD RESPONSE (0-10)} ________ {GO TO FR6}
D Don't Know {SKIP TO FR6}
R Refused {SKIP TO FR6}

**END QUESTIONS FOR PROGRAM INFLUENCE**

**CONTRACTOR INFLUENCE SERIES**

READ: In the next set of questions, I'm going to ask about your decision to obtain the AC tune up with Refrigerant Charge and Airflow services.

FR4C If the assistance or information from the air conditioning contractor about performing AC tune ups had not been available when you made your decision to obtain refrigerant charge and airflow services, would you still have:

FR4CA Obtained AC tune up with Refrigerant Charge and Airflow services?

1 Yes
2 No {SKIP TO FR4CC }
D Don't Know {SKIP TO FR4CC }
R Refused {SKIP TO FR4CC }

FR4CB Obtained AC tune up services at the same time as you did?

1 Yes {SKIP TO FR4CC}
2 No
D Don't Know {SKIP TO FR4CC}
R Refused {SKIP TO FR4CC}

FR4CB1. Obtained the AC tune up service earlier than you did, or later?

1 Earlier
2 Same Time {REPEAT QUESTION FR4PB}
3 Later
D Don't Know {SKIP TO FR4CC}
R Refused {SKIP TO FR4CC}

FR4CB2. How much **earlier/later** would you have obtained AC tune up services?

______ Years {AND/OR} ______Months
D Don't Know
R Refused

IF S5 = 1, SKIP TO FR4CD

FR4CC {IF MULTIPLE UNITS TUNED UP THROUGH THE PROGRAM } Without the assistance or information from the air conditioning contractor, would you have obtained the same quantity of AC tune ups?

1 Yes {SKIP TO FR4CD}
2 No
D Don't Know {SKIP TO FR4CD}
R Refused {SKIP TO FR4CD}

FR4CC1. How many AC tune ups would you have obtained without the assistance or information from the air conditioning contractor?

___________ {RECORD NUMBER}
D Don't Know

R Refused

FR4CD If the assistance or information from the air conditioning contractor had not been available, would you have done anything else differently?

1 Yes
2 No {SKIP TO FR5C}
D Don't Know {SKIP TO FR5C}
R Refused {SKIP TO FR5C}

FR4CE1 What would you have done differently?

________________________ {record response}:

FR5C On a 0 to 10 scale, with 0 being not at all likely and 10 being very likely, how likely is it that you would have obtained AC tune up services if you had not received any **assistance or information** from the air conditioning contractor?

{RECORD RESPONSE (0-10)} _________
D Don't Know
R Refused

**END QUESTIONS FOR CONTRACTOR INFLUENCE**

**ASK if FR6a = 1**
I'm going to read two statements about how you came to choose to get Refrigerant Charge and Airflow services. On a scale of 0 to 10, where 0 is strongly disagree and 10 is strongly agree, how much do you agree with each statement?

FR9 There may have been several reasons for my decision to have this work performed. But, a critical factor in my decision to have the Refrigerant Charge and Airflow services performed was that it was a free service.

__ RECORD RESPONSE (0-10)
D. Don't Know
R. Refused

**ASK if FR6a = 1**
FR10 I would have obtained Refrigerant Charge and Airflow services within **[a year/2 years]** of when I did even if the service was not free.

__ RECORD RESPONSE (0-10)
D. Don't Know
R. Refused

**ASK if FR6 = 1**

I'm going to read two statements about how you came to choose to get Refrigerant Charge and Airflow services. On a scale of 0 to 10, where 0 is strongly disagree and 10 is strongly agree, how much do you agree with each statement?

FR9 There may have been several reasons for my decision to have this work performed. But, the AC tune up discount from the installation contractor was a critical factor in my decision to have the Refrigerant Charge and Airflow services performed.

__ RECORD RESPONSE (0-10)
D. Don't Know
R. Refused

**ASK if FR6 = 1**

FR10 I would have obtained Refrigerant Charge and Airflow services within **[a year/2 years]** of when I did even without the discount from the installation contractor.

__ RECORD RESPONSE (0-10)
D. Don't Know
R. Refused

**Consistency Check & Resolution**

C1 will be asked only for those respondents who have a clear inconsistency between responses (i.e., all but one of the questions are at one end of the spectrum for free ridership while one question is at the other spectrum.) . The question responses that will be used to trigger C1 are:

FR4A
FR5
FR9
FR10

C1. Let me make sure I understand you. Earlier, you said **[fill with inconsistency 1]**, but that differs from some of your other responses. Please tell me in your own words what influence, if any, the program had on your decision to hire a contractor for Refrigerant Charge and Airflow services at the time you did? {RECORD VERBATIM RESPONSE BELOW}

_______________________________________________________________________________
_______________________________________________________________________________
______________________________

C2. **[fill with wording and response categories to the one question which was inconsistent]** {INTERVIEWER; BASED ON VERBATIM RESPONSE TO C1, PLEASE RECORD NEW RESPONSE}

**Participant Like and Unlike Spillover Questions**

6.7 This next question asks about other changes you have made that we haven't already talked about. Since January 1, 2005 have you made any other changes to the appliances, equipment or other characteristics of your home that would affect how much energy you are using?

1 Yes [ASK 6.7a-NSP5 FOR EACH MEASURE INSTALLED BEFORE ASKING 6.7i ]
2 No [SKIP TO 6.7i]
D DK [SKIP TO 6.7i]
R REFUSED [SKIP TO 6.7i]

a. What types of changes did you make? (DO NOT READ. RECORD EACH TYPE OF CHANGE MADE. PROBE: Anything else?)

Heating and air conditioning measures
1 Central air conditioner
2 Room/wall air conditioner
3 Evaporative cooler
4 Furnace
5 Programmable thermostat

Lighting measures
6 Fluorescent indoor fixture
7 Fluorescent outdoor fixture
8 Compact fluorescent bulb
9 Compact fluorescent fixture
10 Motion sensor
11 Dimmer switch

Laundry measures
12 Clothes washer
13 Clothes dryer

Water using measures
14 Water heater
15 Low Flow showerheads
16 Faucet aerators

Kitchen appliances
17 Refrigerator
18 Freezer
19 Range/oven
20 Dishwasher

Pool/spa/jacuzzi
21 Swimming pool
22 Swimming pool pump
23 Swimming pool cover
24 Spa/jacuzzi

Insulation/weatherstripping/sealing
- 25 Floor, wall, ceiling, or attic insulation
- 26 Weatherstripping/caulking/weatherization
- 27 Water heater/pipe wrapping/insulation
- 28 Duct sealing/repair (not cleaning)

Windows
- 29 Windows

- 30 Other (SPECIFY)
- 00 No other changes (SKIP TO C6.7i)
- D Don't know
- R Refused

**b.** Did this equipment replace existing equipment/measures or was it new to your home?

- 1 Replaced existing equipment
- 2 New to home
- D Don't know
- R Refused

**c.** When did this occur? (RECORD MONTH AND YEAR)

_____/______ MM/YYYY

- D Don't know --→Was this before or after you obtained AC tune up services?
  - 1 Before
  - 2 After
  - D Don't know
  - R Refused
- R REFUSED

(ASK 6.7Cd and 6.7Ce ONLY IF BILLING ANALYSIS BEING DONE AND IF 6.7a = 4, 13, 14, 19, 24)

**Cd.** What type of fuel does the new [equipment] use?
- 1 gas
- 2 electric
- 3 other (SPECIFY)
- D Don't know
- R Refused

**Ce.** (ASK IF 6.7b = REPLACED) What was the fuel type of the [equipment] you replaced?
- 1 gas
- 2 electric
- 3 other (SPECIFY)

D Don't know
R Refused

**f.** Did you receive a rebate for this [equipment] through a [utility] program?

| | |
|---|---|
| 1 Yes | [SKIP TO NEXT EQUIPMENT, IF NONE SKIP TO C6.7i] |
| 2 No | |
| D Don't know | [SKIP TO NEXT EQUIPMENT, IF NONE SKIP TO C6.7i] |
| R Refused | [SKIP TO NEXT EQUIPMENT, IF NONE SKIP TO C6.7i] |

(ASK 6.7g and 6.7h IF 1-4, 12, 13, 14, 17, 18, 19, 20, 22, 24, 29 IN 6.7a; ELSE SKIP TO NSP4)

**g.** Is the new [equipment] energy efficient?

| | |
|---|---|
| 1 Yes | |
| 2 No | [SKIP TO NEXT EQUIPMENT, IF NONE SKIP TO C6.7i] |
| D Don't know | [SKIP TO NEXT EQUIPMENT, IF NONE SKIP TO C6.7i] |
| R Refused | [SKIP TO NEXT EQUIPMENT, IF NONE SKIP TO C6.7i] |

**h.** How do you know that this equipment is energy efficient? (PROBE: IS IT ENERGY STAR® RATED?)

________________________________________________

(ASK NSP4-5 ONLY IF 6.7f = NO AND 6.7g = YES AND 6.7c = AFTER DATE OF PARTICIPATION)

**NSP4**. I'm going to read a statement about the energy efficient equipment that you purchased on your own. On a scale from 0-10, with 0 indicating that you strongly disagree, and 10 indicating that you strongly agree, please rate the following statement.

My experience with the AC tune up services in **[2006, 2007, 2008, 2009]** influenced my decision to install different types of high efficiency equipment on my own.

__ RECORD RESPONSE (0-10)
D DON'T KNOW
R REFUSED

**NSP5**. Why did you purchase this high efficiency equipment without going through an SDG&E program? {DO NOT READ; INDICATE ALL THAT APPLY}

1. Too much paperwork
2. Takes too long to get approval
3. No time to participate, needed equipment immediately
4. The program had ended
5. The equipment would not qualify {PROBE: WHY NOT?}
6. The amount of the rebate wasn't important enough

7. Did not know program was available
8. There was no program available
9. Other {SPECIFY}
D DON'T KNOW
R REFUSED

**Program Satisfaction (Section 5)**

5.3 Have you participated in any other programs offered by SDG&E because of your experience with the AC tune up services you received?

1 Yes
2 No *(SKIP TO 6.1)*
D Don't know *(SKIP TO 6.1)*
R Refused *(SKIP TO 6.1)*

**5.4** Which programs did you participate in because of your experience with the AC tune up service? *(RECORD)*

____________________________________________________________

**5.5** Which of the following phrases or messages have you heard before today? (ROTATE STARTING POINT)

A. ENERGY STAR
1 Yes
2 No
3 OTHER (specify)
D Don't know
R Refused

B. Don't Trash California
1 Yes
2 No
3 OTHER (specify)
D Don't know

R Refused

C. Energy Hog

1 Yes
2 No
3 OTHER (specify)
D Don't know
R Refused

D. Click it or Ticket

1 Yes
2 No
3 OTHER (specify)
D Don't know
R Refused

E. Flex Your Power

1 Yes
2 No
3 OTHER (specify)
D Don't know
R Refused

F. Flex Alert

1 Yes
2 No
3 OTHER (specify)
D Don't know
R Refused

G. Spare the Air

1 Yes
2 No
3 OTHER (specify)
D Don't know
R Refused

H. Good Housekeeping

1 Yes
2 No
3 OTHER (specify)
D Don't know
R Refused

I. Ahnu ("A – new")

1 Yes
2 No
3 OTHER (specify)
D Don't know
R Refused

J. Galley Bay

1 Yes
2 No
3 OTHER (specify)
D Don't know
R Refused

K. Hollister Co

1 Yes
2 No
3 OTHER (specify)
D Don't know
R Refused

## Homeowner Energy Use (Section 6)

6.2 How often do you use your central air-conditioner during the cooling season months (July-September)? Would you say it is used…..?

1 Daily
2 A few days a week
3 A few days a month
4 Only on extremely hot days
5 Never
D Don't know
R Refused

6.3 How many thermostats do you have in your home?

__ Qty
0 NONE if no t-stat SKIP TO 6.8
D Don't know
R Refused

6.4 Programmable thermostats have digital displays and allow you to "program" them to change the temperature setting automatically based on the times you set. Is/Are your thermostat(s) programmable or manual?

1 Programmable (digital)
2 Manual
3 Both
D Don't know
R Refused

[If S2 <> 1, SKIP TO 7.1] (work done on HVAC included air conditioner replacement)

6.5 Did your new unit(s) replace an existing air conditioning system, or are you adding air conditioning to your home?

1. Replaced an existing AC unit (one-for-one replacement)
2. Adding AC to home (SKIP TO 7.1)
D. Don't Know (SKIP TO 7.1)
R. Refused (SKIP TO 7.1)

6.6 Did you replace that AC system with a new one that has the same total cooling capacity?

1. Yes
2. No, replaced with new system that has less total cooling capacity
3. No, replaced with new system that has more total cooling capacity
D. Don't know
R. Refused

6.7 Was your previous AC unit(s) still functioning or had it failed?

1. Still functioning (early retirement)
2. Equipment failure (replace on burnout)
D. Don't know
R. Refused

6.8 What was the manufacturer name and model number of the unit(s) you replaced?

6.9 How old was the air conditioner(s) you replaced?

1. [Record response – skip to 6.14]
D. Don't know
R. Refused [Go to 6.14]

6.10 Was it…

1. 5 years old or less
2. 6 to 10 years old
3. 11 to 15 years old
4. 16 to 20 years old
5. Greater than 20 years old
D. Don't know

6.11 Did you run your previous air conditioner all the time?

1. Yes
2. No
D. Don't know
R. Refused

6.12 Did you have a programmable thermostat(s) to control your previous air conditioner?

1. Yes
2. No
D. Don't know
R. Refused

6.13 Since the installation of your new AC unit, did you change your thermostat temperature settings from the setting you used with the prior unit?

1. Yes [record changes]
2. No
D. Don't know
R. Refused

**Compliance Knowledge (Section 7)**

7.1 (IF S2= 1,2 or 3) Do you know if the contractor filed for a building permit for the air conditioner replacement, furnace replacement, or other HVAC work?

1 Not Aware
2 Submitted by Homeowner
3 Submitted by Contractor
D Don't know
R Refused

7.2 (IF S2 = 1 AND CLIMATE ZONE 2, 12, 16 ONLY) Were you aware of the Title 24 requirement to have either a high efficiency furnace installed or duct testing and sealing at the time of air conditioner change out?

1 Yes I was aware
2 No I was not aware (SKIP TO 8.1)
D Don't know (SKIP TO 8.1)
R Refused (SKIP TO 8.1)

7.3 (IF S2 = 1 AND CLIMATE ZONE 2, 12, 16 ONLY) Which option would you have taken if you had not participated in the program? Would you have . . . .(READ LIST)

1 Purchased a High Efficiency Furnace (AFUE 92 or greater)

2 Had Duct Testing and Sealing
3 Did both duct test and a high efficiency furnace
D Don't know
R Refused

7.4 (CLIMATE ZONE 9, 10, 11, 13, 14, 15 ONLY) Were you aware of the Title 24 requirement to have duct testing and sealing at the time of air conditioner change out?

1 Yes I was aware
2 No I was not aware of the requirement
D Don't know
R Refused

## RESIDENTIAL DEMOGRAPHIC QUESTIONS (Section 8)

These last few questions help us better understand SDG&E customers who are utilizing AC tune up services.

8.1 Do you own or rent your home?

1 Own
2 Rent
3 Other (SPECIFY)
D Don't know
R Refused

8.2 In what year was your home constructed?

1 Verbatim______
2 Before 1970's
3 1970's
4 1980's
5 1990-94
6 1995-99
7 2000-2005
8 2006 or newer
D Don't know
R Refused

8.3 What is the approximate square footage of your home?

1 Verbatim SQFT______

2 Less 1000
3 1001-1500
4 1501-2000
5 2000-2500
6 Greater than 2500
D Don't know
R Refused

a. Have you done any remodeling, renovation or additions since performing the AC tune up in [timeframe]?

1 Yes
2 No (SKIP TO D4)
D Don't Know (SKIP TO D4)
R Refused (SKIP TO D4)

b. In what year? [INDICATE ALL THAT APPLY]

1 2006
2 2007
3 2008
D Don't Know
R Refused

c. And what month? [INDICATE ALL THAT APPLY]

1 January
2 February
3 March
4 April
5 May
6 June
7 July
8 August
9 September
10 October
11 November
12 December
13 Winter
14 Spring
15 Summer
16 Fall
D Don't Know
R Refused

d. Did this increase or decrease you home's square footage?

1 Increase
2 Decrease
3 No change
D Don't Know
R Refused

7.4 Including yourself, how many people currently live in your home year-round?

_____ people
D Don't know
R Refused

a. Has the total number of people in your household increased or decreased since you performed the AC tune up in [timeframe]?

1 Yes, increased
2 Yes, decreased
3 No change
D Don't Know
R Refused

b. By how many has your household [increased/decreased]?

1 Record Number______
D Don't Know
R Refused

c. In what year did the number of people in your household change?

1 2006
2 2007
3 2008
D Don't Know
R Refused

d. And what month?

1 January
2 February
3 March

4 April
5 May
6 June
7 July
8 August
9 September
10 October
11 November
12 December
13 Winter
14 Spring
15 Summer
16 Fall
D Don't Know
R Refused

7.5 Which of the following best describes your age?

1 Less than 18 years old
2 18-24 years old
3 25-34 years old
4 35-44 years old
5 45-54 years old
6 55-64 years old
7 65 or older
D Do not know
R Refused

7.6 Do you receive an electric bill directly from SDGE?

1 Yes
2 No (SKIP TO 7.8)
D Do not know (SKIP TO 7.8)
R Refused (SKIP TO 7.8)

7.7 Does this bill only include your home's electric use, or does it include the electric use of other households?

1 Only 1 household
2 Multiple households
D Do not know
R Refused

7.8 What is the primary language spoken in your home? (DO NOT READ)

| | |
|---|---|
| 1 | English |
| 2 | Spanish |
| 3 | Mandarin |
| 4 | Cantonese |
| 5 | Tagalog |
| 6 | Korean |
| 7 | Vietnamese |
| 8 | Russian |
| 9 | Japanese |
| 10 | OTHER (specify) |
| D | Don’t know |
| R | Refused |

# CC. Public Comments and Responses

| | Date | Author | Subject | Section/Page | Attachment |
|---|---|---|---|---|---|
| 1 | 1/9/2010 | Rocky Bacchus | Enalasys Calibration | N/A | view attachment |
| | Comment: | Please see the attached document for Enalasys Calibration as referred to in Comments by Rocky Bacchus. | | | |
| | Response: | N/A | | | |
| | | | | | |
| 2 | 1/9/2010 | Rocky Bacchus | Comments and Request to Replace EM&V | Full Document | view attachment |
| | Comment: | I respectfully request you consider my comments. Please see the attached Word file. | | | |
| | Response: | Attachment is broken into comments further in this document. | | | |
| | | | | | |
| 3 | 1/9/2010 | John Proctor | Actual time | N/A | view attachment |
| | Comment: | See attached screen shot. | | | |
| | Response: | N/A | | | |
| | | | | | |
| 4 | 1/9/2010 | John Proctor | Time clock is off on the CPUC Computer | N/A | |
| | Comment: | Our comments were posted at 11:26 PM on January 8. | | | |
| | Response: | N/A | | | |
| | | | | | |
| 5 | 1/9/2010 | John Proctor | Fundamental Errors in Evaluation | Full Document | view attachment |
| | Comment: | Please see Attachments | | | |
| | Response: | Attachment is broken into comments further in this document. | | | |
| | | | | | |
| 6 | 1/8/2010 | Athena Besa | Overarching Comments | Full Document | view attachment |
| | Comment: | Please refer to the attached comments. (SDGE) | | | |
| | Response: | Attachment is broken into comments further in this document. | | | |

| | Date | Author | Subject | Section/Page | Attachment |
|---|---|---|---|---|---|
| | | | | | |
| 7 | | SCE Company | Simulation Approach | N/A | |
| | Comment: | This study relies heavily on simulations that lack the depth of strong empirical analyses. Simple pre-post metering data are not presented as an alternative to the combination of onsite data collection and the estimation of UES using simulations. Nor is there any evidence of an attempt to perform a statistical regression study, where cooling performance achieved per kWh, with medium-term metering equipment, might be directly estimated. This appears to be an instance of the program evaluation goals being shaped to meet DEER's needs, rather than the needs of the program. This is an instance where the simulation results could have been part of the input to a comprehensive impact evaluation accounting for either metered appliance consumption or billing consumption. The goal of the evaluation should be to estimate net program impacts, not just informing DEER estimates for future ex-ante updates or to be used to update DEER for ex-post purposes. | | | From Brett Close SCE attachment. |
| | Response: | Since the AC replacement measures did include medium-term metering and regression analysis, we assume this comment refers specifically to RCA. The RCA evaluation approach in the high impact measure plan presented the approach of monitoring units pre and post charge adjustment to determine relative changes in efficiency and inputting those efficiencies into energy models to develop 8760 energy savings. Medium term pre and post energy measurements were not feasible under the actual project timeline and the limited number of metered units that could ultimately be used in the analysis precluded robust analyses via regression.<br>Likewise, the timeline did not allow for sufficient post data for a reasonable billing analysis. Past experiences with billing data convinced us that billing analyses can be confounded in many ways, and should only be used where a large number of sample points are available and we are certain that the measure savings are large enough to be discerned from the revenue. | | | |
| | | | | | |
| 8 | | SCE Company | Zero savings site | N/A | |
| | Comment: | An analysis of the actual savings through billing analysis or other regression-based techniques, rather than simply passing parameters to a simulation model, would be able to look for savings that the current analysis assumes to be zero. Using actual metered data, rather than simulations, would allow the analysis to determine the entire effect of the program, including other maintenance performed, which is all part of the effect of the program. | | | From Brett Close SCE attachment. |
| | Response: | The report text has been clarified in the Section 5 introduction as isolating the savings due to refrigerant charge adjustment, which accounted for the major proportion of IOU portfolio savings. The reported savings of attached measures, such as coil cleaning, were not evaluated in the RCA HIM evaluation. | | | |

| | Date | Author | Subject | Section/Page | Attachment |
|---|---|---|---|---|---|
| | | | | | |
| 9 | | SCE Company | Program guidelines | N/A | |
| | Comment: | Throughout the evaluation, installation and gross savings were combined and confused in ways that obscure the results. The evaluation should follow the program guidelines when estimating installation rates, rather than creating different, more stringent requirements. These two elements should be kept separate in order to estimate true impacts, despite the fact that this does not fit as well into the simulation modeling methodology. | | | From Brett Close SCE attachment. |
| | Response: | The definition of installation within some programs may be "some work was done" and the evaluation used a definition of "installed and working properly" which is the CA Protocols definition of verification. The specific criteria applied to all RCA HIMs were that the system superheat or subcooling must be within a target tolerance of five degrees for superheat or three degrees for subcooling. The criterion for all duct leakage HIMs was that after program rebated sealing the total system leakage would be 15% or less of the nominal system flow. Specific exceptions to these criteria are also explicit in the text of these sections. Systems which were within three degrees of the upper and lower limit of the target tolerance were assessed as passing if the nominal measured EER was within 15% of rated EER. For duct leakage, systems which had final measured leakage within 3% of contractor measured final leakage were considered passing. | | | |
| | | | | | |
| 10 | 1/8/2010 | Brett Close | SCE Comments on Specialized Commercial HVAC | Full Document | view attachment |
| | Comment: | Please see attached document. | | | |
| | Response: | See Above and Below. | | | |
| | | | | | |
| 11 | 1/8/2010 | Tom Downey | Installation rate for duct leakage | 7.5 | |
| | Question: | The report states "Generally, the program had a criteria of reducing leakage to a level of 15% total leakage and therefore units measured by the HVAC team with total leakage of 16% or greater were considered failing unless there was a contractor measurement after sealing greater than 15%" Only the PG&E program used the standard referenced and PG&E only used it in 2007 and 2008. The SCE and SDG&E programs and the PG&E program in 2006 required a 15% reduction in overall duct leakage. How was it determined if the unit passed in the case where a 15% reduction was required? How close did the HVAC team measurement have to be to the contractor reported measurement to be considered passing? | | | |

| | Date | Author | Subject | Section/Page | Attachment |
|---|---|---|---|---|---|
| | Answer: | For PGE, the units sampled were predominantly 15% or less final recorded leakage. Units with greater leakage were compared to the final reported leakage. Consistent figures were added comparing evaluated versus contractor leakage measurements including pass/fail outcomes of each point. | | | |
| | | | | | |
| 12 | 1/8/2010 | PG&E Company | All PG&E Comments & Questions | N/A | view attachment |
| | Comment: | PG&E's Cover Letter and Comments/Questions Addressing the Specialized Commercial Program and HVAC Draft Report. | | | |
| | Response: | This comment has been broken up into smaller comments and addressed. | | | |
| | | | | | |
| 13 | 1/8/2010 | PG&E Company | RCA | 3.1/24 | |
| | Question: | Tables 3-1 through 3-5 provide kWh summary savings for the HIMs and the non-HIM group. We would like the same PG&E information reported for kW and Therm savings for all the HIMs and the non-HIM group. While the tables on pages 59 and 109 do report kW, kWh, and Therms at the per unit level across climate zones, we are looking for more information at the summary level (ex-ante Gross savings, ex-post gross savings, Gross RR, NTG, Ex-post net savings across each energy metric). Would it be possible to replicate Tables 3-1 through 3-5 for both kW and Therms across PG&E measures in the final report? | | | |
| | Answer: | Yes, those tables have been replicated to reflect kW and Therm savings and are in Section 3 of the report. | | | |
| | | | | | |
| 14 | | SCE Company | Design | | |
| | Comment: | The evaluators indicated that the pre-post approach could have biased contractor behavior due to the visibility of equipment. It would have been appropriate to add a condition in which monitoring equipment was not left in place, in order to assess this bias. | | | From Brett Close SCE attachment. |
| | Answer: | A bias may exist in the results and was not quantified. The direction of bias would be upward toward additional efficiency gains. The equipment left in place only eliminated all doubt that the unit in question was being sampled to the technician. The coordination with the contracting in order to get to the unit prior to treatment was sufficient to notify the implementation contractor that this site would have been sampled. Once again, removing the equipment would not have resulted in an unbiased sample, only a lesser degree of transparency. Therefore, having a secondary dataset without a dataset from an unbiased sample would have extremely limited value. | | | |

| | Date | Author | Subject | Section/Page | Attachment |
|---|---|---|---|---|---|
| | | | | | |
| 15 | | SCE Company | Gross Savings and coverage of program activity | 5/ | |
| | Comment: | The decision to ignore charge adjustments of +/-5% is arbitrary and appears to be in service to the methodology chosen rather than part of an attempt to identify total savings: whether a small adjustment is appropriate or inappropriate, or difficult to detect in terms of savings, it is part of program activity, and in the context of a savings analysis involving measured consumption, would not have been arbitrarily excluded. | | | From Brett Close SCE attachment. |
| | Answer: | The decision to ignore charge adjustments of +/-5% is by no means arbitrary. In most cases, no savings were claimed for small charge adjustments. More importantly, on average, small charge adjustments show negative efficiency and capacity impacts. Including small charge adjustments would have reduced the evaluated savings. | | | |
| | | | | | |
| 16 | | SCE Company | Verification and possible double discount | 5/ | |
| | Comment: | A second regime involved simple post-only verification. The verification required not only that there be evidence of contractor activity, but that (a) the refrigerant charge be within a percentage of "optimal" as measured by the evaluator, even though an improvement from 40% of optimal to 15% could certainly be an improvement in efficiency, and (b) that data provided by the contractor be reasonable within the evaluator's understanding ("(t)he RCA analysis examined a variety of refrigerant and air conditions to determine whether the contractors' data were thermodynamically possible to achieve the reported savings" – p. 55). This appears to conflate the issue of whether remediation was attempted (installation) and whether it was effective (gross savings). Although the report is not perfectly clear on this, it appears that in the case of both residential and non-residential savings estimation, the pre-post results (after having gone through conversion into average values on three key input "deltas" and run through simulations by prototype and climate zone), are returned in the form of UESs that, if the installation rate is even partially accurate, already include implicit adjustments for what the study calls an installation rate, in the sense that inputs ("performance degradation factors" as in Table 5-4) to the simulations are inclusive of a mix of good and bad remediations. Having estimated gross savings inclusive of what the evaluators might call critical shortcomings in pre-post sample remediation efforts, the study appears to further adjust the gross savings by the verification results – a byproduct of conflating savings and verification. | | | From Brett Close SCE attachment. |

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| | Answer: | In order to be given a definition of passing, the post-only verification used the same criteria as the Program; subcooling or superheating target temperature ranges had to be met and this was not expressed as a percentage from "optimal". From our metered sample, we had an efficiency increase for units that were within target. Alternatively, we did not have an estimate of treated units that were found outside of the target range. Although there could have been some savings, there was enough of a likelihood that there was no savings or even negative savings. The pre-post methodology assumed there would be some upward bias in quality of work due to contractor knowledge of monitoring. The Protocol definition for installation was installed and operated as assumed. The UES developed was assumed to be a best-case scenario or potential for energy savings and units that did not meet specified diagnostic performance targets in separate, randomly sampled verifications would not have achieved the potential savings. The UES developed were for all units which would pass the verification criteria. | | | |
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| 17 | | SCE Company | Summary on grass savings estimate | 5/ | |
| | Comment: | The report states, "The RCA analysis examined a variety of refrigerant and air conditions to determine whether the contractors' data were thermodynamically possible to achieve the reported savings. If these data were available, the analysis used them to best estimate program installation rates, and programs that did not supply data were penalized in that only the field M&V data were used to develop the verification rate." The purpose of the evaluation is to develop the best estimates for net impacts of the HVAC programs, not to penalize the programs based on their data quality. The results of the gross savings estimation effort are so fraught with sampling error and unreliability that they do not provide a good basis for evaluating the RCA program, or for adjusting DEER estimates. It is not even clear that they would provide useful adjusted ex-ante estimates for use in a true impact evaluation in which metered or billing consumption is the dependent variable. | | | |
| | Answer: | All language of penalties are identified and removed since we did not apply any penalties directly to the data. Other comments here are re-iterations of comments. | | | |
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| 18 | 1/8/2010 | PG&E Company | RCA | Sec 5/24 | |
| | Question: | The report results are difficult to assess due to lack of detail. For a more thorough explanation please provide more detail of the RCA methodology in the final report. | | | |
| | Answer: | Detail added to Section 5. | | | |
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| 19 | 1/8/2010 | PG&E Company | HIM | 5.1.2/26 | |

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| | Question: | The RCA evaluation approach had potential for bias since the servicing contractors could see which units were being monitored upon return visit. Please describe the specifics of how evaluation bias was accounted for in the results. | | | |
| | Answer: | A bias may exist in the results and was not quantified. The direction of bias would be upward toward additional efficiency gains. The coordination with the contractors in order to get to the unit prior to treatment was sufficient to notify the implementation contractor that this site would have been sampled. Once again, removing the equipment would not have resulted in an unbiased sample, only a lesser degree of transparency. Therefore, having this secondary dataset without a dataset from an unbiased sample would have extremely limited value. | | | |
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| 20 | 1/8/2010 | PG&E Company | Sample sizes/NTG Methodology | 5.2 Methodology | |
| | Question: | The target sample sizes for the net-to-gross analysis are presented in Table 5-1. However, we found no completed sample sizes for the net-to-gross analysis. Can you please provide net-to-gross survey completed sample sizes by program for the RCA measure in the final report? | | | |
| | Answer: | Yes, achieved sample sizes by program have been added to net-to-gross results tables. | | | |
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| 21 | 1/8/2010 | PG&E Company | Data Collection | 5.2.1/29 | |
| | Question: | Explain precisely why PGE2080 and PGE2000R did not have the appropriate data collected and discuss how this has produced report bias. | | | |
| | Answer: | Certainly a reduction in sample points has negative effects on the precision of the estimate but we did not quantify a bias in any way. An explanation of the timeline and efforts of data collection for these programs was added to the sampling discussion in Section 5.2.1 in the report. | | | |
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| 22 | 1/8/2010 | PG&E Company | Sample Sizes / RCA | 5.2.1/29 | |
| | Question: | While some reference is made to the use of a stratified sample design and planned sample sizes (Table 5-1), no information is provided on the strata and the resultant targets by stratum. Please provide a table showing the stratification scheme used to determine stratum-level and total targets. | | | |
| | Answer: | Sampling details have been added to Section 5.2.1 of the report. | | | |
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| 23 | 1/8/2010 | PG&E Company | Measurement Points & Instrumentation | 5.2.2/33 | |
| | Comment: | Part 1 of 2: We believe that the field monitoring methods employed do not lead to an accurate representation of operating EER. The methods as described fail to ensure accurate results because of insufficient accuracy of measurements in the supply plenum to reliably calculate supply enthalpy. Moreover, the report provides no evidence that the relative humidity measurement in the supply plenum is sufficiently accurate and reliable at the RH levels typically found in the supply plenum to calculate EER. Table 5-2 provides insufficient detail to verify the reliability of measurements. The accuracy rating for some Hobo RH loggers extends to 85% while others extend to a maximum of 90%. The RH in the supply plenum typically well exceeds 90%, and in our experience is an unreliable measurement even with very high quality RH sensors. | | | |
| | Response: | The issues regarding the RH measurement were recognized by the evaluators and the issue was addressed in the ways added to the RCA and AC replacement sections. The Use of RH measurements and EER sensitivity for RCA are presented in Section 5.4.3 of the report. Refer to the response to part 2 of 2 of this comment for a description of how the AC Replacement analysis handled this problem: the full discussion of humidity measurements for AC Replacement is provided in Appendix Section E under heading "Reliability of Relative Humidity Measurements." | | | |
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| 24 | 1/8/2010 | PG&E Company | Measurement Points & Instrumentation | 5.2.2/33 | |
| | Comment: | Part 2 of 2: Without testing and calibration of RH sensors in a saturated salt solution at humidity comparable to that found in the supply plenum, the measurement accuracy is questionable. In addition, even using a very accurate humidity sensor, the supply relative humidity measurement is still unreliable. Laboratory measurement is typically performed with a chilled mirror dew point sensor. A PG&E laboratory study, titled Influence of Expansion Device on the Performance of a Residential Split-system Air Conditioner (Report number 491-01.17, Jan 2001) shows that measuring supply wet bulb temperature method is not accurate and determined that a better method to get an accurate measurement of total capacity is to use condensate drained from the evaporator coil. | | | |

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| | Response: | AC Replacement Treatment of RH Measurements: The tables for the monitoring points included a combination RH /Temperature sensor in the supply plenum. The analysis did use the dry bulb temperature recorded by this sensor but it did not use the recorded RH. The analysis anticipated the problems associated with measuring the RH of the supply airstream, where common RH sensors perform poorly (and often fail) at RH above 90%, a very common condition for the supply air. Yet the supply RH, or equivalent, is absolutely necessary in-order to calculate the supply air enthalpy, and ultimately the thermal output of the unit. Therefore, this analysis uses a two stage process to estimate the supply air enthalpy from sensors considered more reliable, specifically, the return air dry bulb temperature and RH and the supply air dry bulb temperature as follows:<br>a) return air dry bulb temperature and RH are used in a psychrometric function to calculate the return air absolute humidity, and the saturation temperature associated with that absolute humidity is calculated.<br>b) The supply dry bulb temperature is tested, if it is below the saturation temperature than supply enthalpy is estimated is a function of dry bulb temperature only. If the supply dry bulb temperature is greater than the saturation temperature, then the supply enthalpy is calculated via a psychrometric function from the supply air dry bulb temperature and the return air absolute humidity.<br><br>This calculation idealized the situation for the supply air near the saturation temperature by assuming that it was either condensing or not, when in fact the full transition to the condensing state may have taken place more smoothly in the few degrees above the saturation temperature. This ideal construct also assumed that the supply air below the saturation temperature was at 100% humidity when in fact it may have been at only 98% or so. But trial simulations of these differences between the ideal and the actual supply air humidity did not lead to a significant error in the enthalpy or the final savings estimate. The complete discussion of humidity measurements in AC Replacement is provided in Appendix section E under heading "Reliability of Relative Humidity Measurements."<br><br>Two other sources of error in the estimate of the thermal output of the unit were considered:<br><br>a) The return air RH is itself a difficult measurement. Early test runs of the data logging showed many instances when the return air RH increased to well above all other RH measurements. These anomalously high RH measurements only occurred when the fan was off and were due to residual water on the coil or in its drain pan, which were reasonably close to the return air Temperature/RH sensor. Thermal diffusion was strong enough for the water vapor to influence the return air RH sensor when there was no air movement. When the fan was on, the air movement overcame the thermal diffusion and the high RH readings were restored to normal values. Accordingly, the analysis tests all return RH readings and uses only readings during fan-on conditions. | | | |

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| | | b) The assumption that the return air absolute humidity can be used as the supply air absolute humidity only applied when there was no moisture added to or removed from the mixed air stream. This was a reasonable assumption if no outside air was added to the airstream as is approximately the case in residential split system applications. But commercial applications involving RTUs, (roof top units), usually mix a minimum of 10% or more of outside air for ventilation. And much higher fractions of outside air was either be deliberately chosen or accidently used when dampers or economizer were operating incorrectly. In principle this was potentially a complex problem, because the mix fraction of outside air was not known, and the mixed air temperature was not monitored. In a very humid climate this would definitely cause measurement errors. But in the dryer climates associated with this analysis, a review of site monitored data showed that usually the absolute humidity of a range of hypothetical outside air mixes is very close to the absolute humidity of the return air. Trial simulations of the final savings estimates were used to test that the use of the return air absolute humidity in lieu of the unknown mixed air absolute humidity did not lead to significant or disproportionate errors in the final savings result. | | | |
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| 25 | 1/8/2010 | PG&E Company | Onsite Data Collection | 5.2.2/33 | |
| | Question: | Please describe if/how the lack of an industry standard for field measurement techniques produced study bias and, if so, how was it accounted for in the results. | | | |
| | Answer: | The lack of a standard for field measurement does not produce a bias. It does present issues in comparing field measured efficiency with larger uncertainties to laboratory/manufacturer ratings. Since the relative change in EER due to RCA was investigated using the same type of measurement pre- and post-RCA an evaluation standard was used that should not bias the relative impacts. | | | |
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| 26 | 1/8/2010 | PG&E Company | Applied Methods | 5.2.2/34 | |

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| | Comment: | Table 5-3 provides insufficient detail to verify the reliability of measurements. Please provide model numbers for all equipment. In particular please provide evidence that refrigerant line sensors, and methods by which they were applied, obtain accurate results. Without more detail, we question the validity of the data presented in Table 5-3. Many common sensors and methods for applying them can result in significant errors reading the temperature of a refrigerant line. Those errors would result in incorrect superheat and subcooling readings, thereby lowering the calculated program Install Rate. | | | |
| | Response: | Additional specifications of sensors is added to the Appendix as well as adding model numbers where relevant. The thermistor and transducer model numbers will not allow further review without the specification sheets. | | | |
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| 27 | 1/8/2010 | PG&E Company | Methodologies & Experience | 5.2.3 / 34 | |
| | Question: | Will you please provide the specific and detailed CPUC consistent sampling protocol applied in this study. Please provide the training and qualifications of the field personnel? | | | |
| | Answer: | Sample designs in Section 5.2 have been expanded. Training and qualification summaries of staff are added to the data collection description which included EPA certification, project specific training and included field QA/QC and oversight. | | | |
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| 28 | 1/8/2010 | PG&E Company | EER | 5/35-36 | |
| | Question: | Would you please provide specific process and criteria detail regarding the EER Target Screening methodology in the final report? | | | |
| | Answer: | Yes, Section 5.2.3 has been expanded to explain the EER screen test verification. | | | |
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| 29 | 1/8/2010 | PG&E Company | Methodologies & Experience | 5.2.3/36 | |
| | Question: | Will you please provide additional detail regarding the function that only takes outside temperature (with other coefficients set to zero when insufficient return air data points were available)? | | | |
| | Answer: | Yes, addition detail has been added to Section 5 of the report. | | | |
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| 30 | 1/8/2010 | PG&E Company | Methods for determining Savings | 5.2.3/37 | |

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| | Comment: | We are concerned that inaccurate field data may have been used as inputs for DOE2 to determine savings and as a result the data is invalid. The justification for our concern is that data in Table 5-4 (and similar tables appearing later in the report), do not match published studies conducted in the laboratory under very controlled conditions and with very accurate instruments. Table 5-4 shows that at undercharged conditions, Total Capacity is lost at a greater rate than Sensible Capacity (Cap Frac is a smaller number than Sens Cap Frac). The PG&E laboratory data for fixed orifice systems shows the opposite effect: Sensible Capacity is lost at a greater rate than Total Capacity with refrigerant undercharge. That makes sense since undercharge makes the evaporator colder and more likely to condense water. Specifically, please discuss the results of this field study in comparison to Energy Center of Wisconsin report #241-1 "Central Air Conditioning in Wisconsin, a Compilation of Recent Field Research" (See Figures 31 and 32) http://www.ecw.org/resource_detail.php?resultid=289 | | | |
| | Response: | It was recognized that field measurement have greater uncertainty than laboratory studies, but the goal of this study was measurement of the actual efficiency gains through program activity on participating units. The rate of capacity loss of a single unit over a range of laboratory charge conditions could not be directly compared to the mean capacities across units in this field study. The trends cited in the comment are true of fixed-orifice units at particular condenser entering dry bulb temperature and evaporator entering wet-bulb temperature ranges. Actual conditions were often drier than laboratory standard measurements in addition to the variability of sensible and total capacity degradation from unit to unit. The second report cited also covers a non-similar climate and air-conditioning results are not easily comparable for humid and dry conditions. Additional comparisons of this study to other studies were not added to the report. | | | |
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| 31 | 1/8/2010 | PG&E Company | Data for determine RCA | 5.2.3/37 | |
| | Question: | For Table 5-4, and for other similar results appearing later in the report, can you please provide a breakdown of systems from which the results were obtained by refrigerant metering device type. As is well known, TXV systems respond differently to varying refrigerant charge level than do systems which meter refrigerant through an orifice of fixed size. | | | |
| | Answer: | Metering device type was added to the pre-post metering results tables in the Appendix. Ultimate analyses have remained grouped by charge amounts consistent with the program tracking. Most units were non-TXV in the pre-post monitored results. | | | |
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| 32 | 1/8/2010 | PG&E Company | Applied Methodology | 5.2.3/37 | |
| | Question: | Will you please describe more specifically how the lack of a standard data for installation rates were accounted for in the results? | | | |

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| | Answer: | The installation rate reported was derived solely from M&V data and did not use the described data. Other comments by parties will edit the report section. | | | |
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| 33 | 1/8/2010 | PG&E Company | Test methods | 5.2.3/38 | |
| | Question: | From where was the standard target of 10 degrees F derived? | | | |
| | Answer: | The default target was used only for units where specific targets were not obtained from nameplates or manufacturer data. The default was based on average targets across known program units and is listed as a default in some program documentation. A footnote was added. | | | |
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| 34 | 1/8/2010 | PG&E Company | Confidence Rate | 5.3.1/41 | |
| | Question: | We believe that the employed sample size of 300, which represents less than 1% of the total participants in the 2006-2008 RCA program is inadequate to capture valid data given the heterogeneity of the population. We believe that a sample of 2% of the population would have resulted in a more reliable representation of the pass/fail rate. Will you please provide information detailing why this sample size was chosen? | | | |
| | Answer: | The sample size of three hundred is specified in the CA Evaluation Protocols, it is a reasonable sample size for most large programs, i.e. it will meet the precision target for any free ridership or verification statistic to be captured that is pass- fail or 0 to 100%. Essentially, this sample size would achieve 10% relative precision or better where there is a coefficient of variation (CV) of 1 or less. This is true of all samples of large populations where the sample size is less than 1% of the population. | | | |
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| 35 | | SDG&E Company | Sample size deviation | 5 | |
| | Question | The excessively small sample sizes also led the evaluators to deviate from the planned evaluation in a number of ways that compromise the findings of the evaluation. For example, for both RCA and Air Conditioner Replacement evaluations, the evaluators note the following: “The amount of charge correction for the sampled units could not be controlled to be mapped onto the program-level distributions. The result was that the small sample sizes for the charge-removed categories may not well-represent the very large program population of those units. The HVAC team decided to combine the results with all available data, namely the detailed data in similar format used to develop the DEER 2008 measure savings.” Thus, due to data issues and sample sizes the evaluators resorted to using data NOT collected for the program evaluation. How this impacted the findings is unclear but further suggests the results of the evaluation are unreliable and unverifiable. | | | |

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| | Answer: | The modeling results using only evaluated data were produced prior to combining the data with previously collected field performance data and showed lower savings for all categories. Due to the small samples in the worst performing categories and the availability of field collected data for those categories the decision to combine data sets was made. In developing precision estimates of the degradation factors which were added to the report, the precision of the inputs of the M&V data set and the precision of the inputs for the combined set of inputs are expressed. | | | |
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| 36 | | SDG&E Company | Sample Sizes | 5 | |
| | Question: | The extremely high error bounds associated with the RCA and Air Conditioner Replacement evaluations are directly due to sample size issues. In nearly all cases the evaluators were forced to work with samples that were significantly smaller than called for in the original protocols. The small sample sizes not only lead to extremely high error bounds for estimated savings, they also call into question the underlying validity of the results due to nonrandom sample selection. As an example, consider the Commercial RCA field findings. When discussing the sampling issues, the evaluators note that; “For the SCE 2507 Program, of the 31 contractors listed as performing commercial service, six were willing to participate in the metering effort. The cutoff date for installing metering equipment was set at September 28, 2009, to allow for adequate data collection before the cooling season ended. The contractors had a limited number of sites available, as they would not perform RCA testing during the hottest months of summer. The temperatures remained unseasonably hot until late in the season, preventing contractors from pursuing RCA work until near or past the metering cutoff date. The team attempted to install as many meters as possible, which resulted with 42 meter installations. Mechanical issues, such as compressor and metering equipment failures, further reduced the sample size to 36 units in SCE territory. The SDG&E 3043 Pre/Post Program used almost all of its rebate allocation within the first quarter of 2009, which resulted in sites being approved on a case-by-case basis only by the program implementer. Because few contractors participated, the sample size was smaller than expected with 16 meters installed. Due to unit mechanical failures and problems with metering equipment, the final sample size was reduced to 10 units. The PGE2068 Program had few contractors with the capacity and willingness to field M&V sites, resulting in the majority of units needing to be monitored by one contractor. The HVAC team completed 53 unit installations, including several multistage units. These units presented analytical challenges that prevented many from being included in the final evaluation analysis. No units were achieved for the PGE 2080 Program due to unsuccessful coordination attempts.” Thus, across all the IOUs the evaluators were forced to work with significantly smaller sample sizes than originally expected. Furthermore, the samples that were achieved most likely suffer from significant sample selection bias since they are based solely on those contractors that were willing to participate. The small sample size problem is exacerbated because the evaluators then needed to split the sample to estimate energy and demand savings for | | | |

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| | | climate zones and building types. | | | |
| | Answer: | The sources of bias are expressed, but impact on the estimates was not assessed. The reasons for non-cooperation were added in more detail to the report, but there is no hypothesis the evaluators could draw regarding the contractors that were willing to participate in monitoring. Any coordination available had to be pursued under the project schedule. A specific recommendation was added regarding study design embedded in the program as a continuous evaluation of actual energy savings required for all contractors that is well coordinated by the IOUs and evaluators. | | | |
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| 37 | 1/8/2010 | PG&E Company | Sample Sizes | 5.3.2/42 | |
| | Question: | We believe the following sample sizes are too small to effectively evaluate the program: PGE2078 (N=10, shown in table 5-5 and N=6 shown in table 5-13); PGE2000 (N=3, shown in table 5-8 and N=7, shown in table 5-13). Will you please explain why this sample size was used? | | | |
| | Answer: | Verification and metering sample sizes for PGE2078 were minimal given the budget that was allocated to the lower savings programs comprising the HIM for the IOU. PGE2000 sample sizes for pre-post metering were not achieved as shown in the tables and further explanation was added to the sampling chapter. | | | |
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| 38 | | SCE Company | Sampling | 5.5.4, pp 41-42 | |

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| | Comment: | In general, both pre-post and verification samples were difficult to achieve, which the study forthrightly recognizes, as one compares the planned and achieved samples – see for example various problems identified in section 5.5.4, or the various program-related and data-related problems that heavily affected the achieved sample (e.g. Table 5-10). There is no work reported that would suggest that the evaluators took into account how biases in the achieved sample, compared to the vaguely described planned sample (cf. pp 41-42) might have impacted gross savings results (i.e., the performance degradation factor estimates to be fed into the simulations). The study is apparently relying on proportional stratified sampling in ways that are explicit and inexplicit (for example, the residential versus non-residential splits in verification and pre-post designs, or the multifamily versus single family splits that emerge without discussion). Ad hoc cluster sampling in at least the multifamily and possibly the commercial cases appears to have happened, and would have had effects on study accuracy that are probably dwarfed by issues with the plan as stated, unaccounted biases emerging in the achieved sample, and the propogated unreliability inherent in the many steps along the way to achieving the gross savings estimates. The study assumes an error ratio of 0.5 based on operating efficiencies of appliances (rather than an expected delta in operating efficiency) in lieu of planning based on the expected savings (available in tracking data), for some reason assuming that this was an enhancement: "the system efficiencies were subject to less variation than total usage or total savings leading to smaller required sample sizes and thus more rigorous M&V and innovative field approaches were justified (p. 28)." This appears to be a case of wanting to appear accurate on something, even if it isn't what the study is estimating. Since the last point at which anything relating to the sample points is visible before being incorporated into the simulation work involves the three degradation factors, these would seem to be the real criterion variables of interest. With the presumptive error ratio in place, expected relative precisions (on something that may in fact be more related to the distribution on pre-program efficiencies than savings) are offered in tables 5-5 and 5-6. It is not clear why one would bother to do anything other than a methodology pilot with samples as planned that, ignoring other factors that worsen the picture, were going to provide 90/26 relative precisions – even if these were truly related to savings. The achieved sample savings precision, after all the legitimate recruitment and mixed-legitimacy data quality difficulties faced by the study, are of course a bit worse than expected (Table 5-13), and, surprisingly, still seem to based on the same error ratio of 0.5. Actual program results of some sort should be used in calculating the error ratio. This should include both the variation in the savings estimates and uncertainties from the modeling exercise. As is, the confidence intervals are essentially meaningless. | | | |
| | Answer: | Precision estimates of degradation factors were added. The ex-ante values used the same energy modeling process as the ex-post results. The ex-ante precision of the modeling process should be equivalent to the ex-post precision of that same process. The precision estimates of the final ex-post inputs is better than those of the ex-ante inputs. The modeling process uncertainty was not quantified by this study. Tables showing ex-post precision of savings using ex- | | | |

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| | | ante error ratios was removed. | | | |
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| 39 | 1/8/2010 | PG&E Company | Sample Sizes | 5.2.1/28, 42 | |
| | Question: | The report indicates (pp. 28) that an error ratio for system efficiencies was used rather than system savings because "system efficiencies [are] subject to less variation than total usage or total savings leading to smaller required samples sizes..." The planned precision levels presented later in (Tables 5-5 and 5-6), however, are cast in terms of savings. How can precision levels determined by the variability of one variable be applied directly to confidence intervals for another variable that has inherently greater variability? | | | |
| | Answer: | See Above - Actual precision of the degradation factors was added. | | | |
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| 40 | 1/8/2010 | PG&E Company | Sample Sizes | 5.3.2/43. | |
| | Question: | Tables 5-7 and 5-8 raises questions about the sampling plan for multi-family units. According to the report, sampling was done at the unit, rather than the site level. If sampling was random, we would expect that this approach would yield a fairly large number of sites. However, for PG&E2000, one site accounted for all 11 units included in the final metered sample. For SCE2507, three sites accounted for 78 metered units. Was cluster sampling (rather than random sampling) used here? If not, what accounts for all of the metered units falling into one site? If cluster sampling was used, how were the precision levels adjusted to account for this method? | | | |
| | Answer: | The Multifamily program activity verification sample was a random sample. Due to time constraints, some clustering of the metered sample was utilized to increase the sample size. We looked at the units at the site level and determined that sites with multiple units in the sample had a similar variability as the rest of the sample, and could not bias the results as they did not, by themselves, pull down the mean treated efficiency. | | | |
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| 41 | 1/8/2010 | PG&E Company | Sample Sizes | 5.3.2/45 | |
| | Question: | The relative precision levels presented in Table 5-13, which deals with achieved precision, are framed as percentages of ex ante savings. Given the fact that ex post estimates are far lower than ex ante values, this appears very misleading. Can you please present the achieved precision levels as percentages of ex post savings? | | | |
| | Answer: | See Above - Actual precision of the degradation factors was added. | | | |

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| 42 | 1/8/2010 | PG&E Company | Response and Non-Response Bias | 5.3.1/41-45; 5.4.3/47-49 | |
| | Question: | As indicated in Sections 5.3.1 and 5.3.2, there were substantial differences in planned and actual samples by program for RCA. The total planned sample size for pre-post sample was 390 units, while the achieved sample amounted to only 133 units. These differences are particularly dramatic for PG&E2000 (with 90 sites planned and only 7 sites achieved) and PG&E2080 (where no sites were achieved). While Section 5.4.3 lists some general procedures used to minimize non-response, the extent of non-response is still significant. Given this poor success rate, what is the likely general level of non-response bias present in the estimates? | | | |
| | Answer: | Precision is reduced and ways to mitigate bias were explained, but a specific estimate of bias was not added to the report. | | | |
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| 43 | 1/9/2010 | Rocky Bacchus | Enalasys Calibration | Figure 5.4 | view attachment |
| | Comment: | We are not able to reconcile the above statement with the fact that the calibration of the instruments chosen by the team was so much less than AHRI specifies and so much less than Enalasys, the largest volume VSP. The results shown in the reports figures 5-4 is simply wrong. | | | |
| | Response: | Laboratory testing and some rigorous case studies have well established the potential energy savings from refrigerant charge adjustment under tightly controlled conditions. The actual performance of measures in the field as applied by the rebate programs was the evaluation goal for unit energy savings. The uncertainty of cooling delivered measurements based on the actual field instrumentation used was added to the report. | | | |
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| 44 | 1/8/2010 | PG&E Company | Field Measurement | 5.4.3/49 | |
| | Comment: | As stated in the report, "Technical leads placed limits on the maximum number of units to be sampled per site." However, the report later states that "in the case of pre-post monitoring, coordination of sites was changed to allow as many units to be monitored per site as feasible." We believe it was inappropriate to ignore the established per-site limit for pre-post monitoring. | | | |
| | Response: | Keeping the limits would have led to much smaller ultimate samples. | | | |
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| 45 | 1/8/2010 | PG&E Company | Demographic Findings | 5.5.1.1/50 | |

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| | Comment: | CORRECTION: Table 5-15 should be changed to reflect the fact that PG&E does not offer RCA incentive to participants in Climate Zone 3. Only Climate Zones, 2, 4, 11, 12, and 13 are eligible for the residential RCA rebate. | | | |
| | Response: | Measures were installed in climate zone 3 according to the tracking database as shown in the report. | | | |
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| 46 | | SDG&E Company | Pre and post energy usage | 5.5.1 | |
| | Comment: | Another example of the problems associated with the implementation of the evaluation can be seen in the Residential RCA Field Findings (Section 5.5.1). There, the evaluators note that:"In some cases, a majority of runtime data were collected at relatively similar temperature conditions in both pre- and post-maintenance cases. In other cases, the pre- and post conditions covered very different temperature or occupancy patterns. For the units where the performance covered similar pre and post conditions, the average condition was used, as presented in summary tables in Appendix E, to represent the capacity and unit efficiency. For units where the post-maintenance conditions were generally different, the conditions relative to the standard curve were used to calculate a representative capacity and efficiency value for the temperature and humidity conditions seen before maintenance." For a valid comparison of pre and post energy usage, the evaluators need to make certain that the only difference between the pre and post period is the change in the RCA. That is, they need to design as close as possible a controlled experiment so that other explanations for differences in energy utilization rates can be ruled out. As the paragraph above illustrates this was far from the case. In many cases the pre and post conditions varied significantly in terms of temperature and occupancy patterns. This significantly reduces the reliability of the findings. Furthermore, the solution to this issue appears ad hoc in nature. Why did the evaluators believe that "the conditions relative to the standard curve" would be representative of the capacity and efficiency value for the temperature and humidity conditions seen before maintenance?" At the very least, the evaluators need to present sensitivity analysis that provides some indication of the impact of this assumption on estimated savings. | | | |
| | Answer: | The temperature and occupancy conditions of pre and post field measurements cannot be controlled. Temperature normalization is often used in comparisons of EER at differing conditions. The study goal was to assess the relative change in performance for individual units thus systems were not all normalized to a single standard condition, but rather they were normalized to a condition present in both the pre- and post-RCA periods. For cases where the post period did not contain any of the pre- conditions, the standard method of normalization of applying EER curves was used only to extrapolate results to a condition of comparison. | | | |

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| 47 | 1/8/2010 | PG&E Company | Savings Calculations | 5.5.2.1/59 | |
| | Question: | In Table 5-30 for PGE2000, how were the UES and total savings weighted? Section 5.5.2.1 stated that 94.6% are multifamily units in CZ12 while 65.6% are in CZ13. What was the percentage for other CZs? Finally, since the 2008 DEER does not have impacts for multifamily units, how were the savings calculated? | | | |
| | Answer: | Distributions for all CZ can be shown in the table. See above, the DEER multifamily models were run for the analysis (even if not included in 2008 DEER). | | | |
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| 48 | 1/8/2010 | PG&E Company | UES and ex post | 5.5.2.1/60 | |
| | Question: | In Table 5-32 for PGE2078, how were the ex-post UES and total savings calculated? | | | |
| | Answer: | The savings for the mobile/manufactured home building type were applied to the total program tonnage in each of the charge categories. | | | |
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| 49 | 1/8/2010 | PG&E Company | HIM install rate | 5.5.3.3/69 | |
| | Question: | In Table 5-46, using only 11 units to determine the HIM install rate for PGE2080 is insufficient, especially considering that PG&E offers rebates to customers in five different Climate Zones (2, 4, 11, 12, 13). Evaluators should have had a much larger sample and then weighted the data by climate zone. Similarly, at 19 units, the sample size for PGE2068 is too small. Why wasn't this methodology used to gain a more accurate calculation? | | | |
| | Answer: | The sample design for each program was by climate zone, but the PGE2080 units had no physical identification or tracked serial numbers making most sample units unidentifiable for field testing. The PGE2068 sample included testing of units that were found not to be program participants according to the third-party tracking data and those tests were dropped resulting in the ultimately smaller sample. The original sample designs by climate zone were added to the report along with additional explanation of the reasons for achieved samples. | | | |
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| 50 | 1/8/2010 | PG&E Company | Weighted Savings / C&I RCA | 5.5.2.1/ 62 ; 5.5.3.4/ 73 | |

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| | Question: | Tables 5-35 and 5-54 present RCA results by program for the residential and commercial sectors. Ex post savings are obtained by multiplying ex ante gross savings by a realization rate, then by an installation rate. The relationship between these two rates is unclear. The installation rate presumably indicates the percentage of cases where the measure was installed properly. However, for a measure like RCA isn't the lack of proper installation already taken into account in the realization rate? That is, if a unit is found not to have been adjusted appropriately, isn't this already reflected in low realized savings (as expressed by column B for these tables)? Please explain how column B of these two tables was calculated, and why this calculation doesn't reflect the lack of savings from units where RCA was considered to be non-installed. | | | |
| | Answer: | The UES estimates were intended to represent potential in-field savings from the RCA measure when properly applied. The difference between the ex-ante and ex-post estimates of performance increases due to application of RCA were reflected in the realization rate. Random samples of program participating units were used in a separate effort to rate of proper installations. Since contractors had knowledge of which units were being monitored it was assumed that only proper installations would be applied to the pre-post units. Units in the pre-post study that would not have passed the post verification were not included in the modeling inputs, thus the UES estimated are representative of passing units which the installation rate is applied to. | | | |
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| 51 | 1/9/2010 | Rocky Bacchus | Enalasys Calibration | Figures 5.7 through 5.11 | view attachment |
| | Comment: | Report reflects "Good Data" on reports 5-7 through 5-12. The ratio of "Good Data" is as low as 27%. If the team had only 27% "Good Data", isn't that a strong indicator that non of the data they kept was truly good. | | | |
| | Response: | The data used passed numerous levels of quality control and events like no charge adjustment or lack of data on charge adjustment were part of the "good data" rate. The term "good data" has been changed and the ratio of units passing data quality control to the original sample size is not an indicator of the quality of the data used. | | | |
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| 52 | | SCE Company | Verification rate estimation | 5/ | |

| | Date | Author | Subject | Section/Page | Attachment |
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| | Comment: | The verification rate is based on a mixture of inspection, measurement, and activities carried out on a sample intended to be of the same size as the pre-post sample -- presumably free of whatever (very possible partial) impact that the visibility of evaluator monitoring equipment might have on the RCA remediation. Setting aside both the fact that multiple activities and measurements contribute to the sampling variance of the “acceptable” verification rate, and that multifamily samples are subject to inefficiencies due to clustering (relative homogeneity of contractor behavior within complexes), the sample sizes are far too small to offer reasonable precision on the rate. For example, the simple unweighted proportion verification rate for SCE residential 2507 (Tables 5-28 and 5-35) is approximately 57% (over a total of 51 units. The standard error for this estimate is 7%, so that the 90/10 precision achieved is 57% +/- 12%. | | | From Brett Close SCE attachment. |
| | Answer: | The verification rate is based only on measurements. There was a loss of precision associated with sample sizes that did not meet the planned sample size, but the precision of verification rates was not added. | | | |
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| 53 | 1/9/2010 | Rocky Bacchus | Enalasys Calibration | Section 5/Realization Rate | view attachment |
| | Comment: | If the programs did not require data, then it is inappropriate for an EM&V program done up to 2.5 years later to fault the program for data that was not specified as being required at the time. The team knew there was a requirement for appropriate data loggers and failure to provide adequate accuracy is the fault of the team. | | | |
| | Response: | All this language has been identified and removed since we did not apply any penalties directly to the data. | | | |

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| 54 | 1/9/2010 | Rocky Bacchus | Enalasys Calibration | Section 5/Realization Rate | view attachment |
| | Comment: | Since the instantaneous instruments were used to verify the time-series instruments, the inaccuracy of the instantaneous instruments was multiplied in the time series instruments. The accuracy of the instantaneous instruments was only 20% (1F not 0.2F) of the accuracy required for an AHRI test. | | | |
| | Response: | The Use of RH measurements and EER sensitivity for RCA are presented in Section 5.4.3 of the report. | | | |

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| 55 | 1/9/2010 | Rocky Bacchus | Enalasys Calibration | Section 5 | view attachment |
| | Comment: | There were no cross checks for "energy balance" as is done for AHRI certified tests. | | | |
| | Response: | Laboratory testing and some rigorous case studies have well established the potential energy savings from refrigerant charge adjustment under tightly controlled conditions. The actual performance of measures in the field as applied by the rebate programs was the evaluation goal for unit energy savings. Laboratory testing criteria were not applied to the field study. | | | |

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| 56 | 1/9/2010 | Rocky Bacchus | Enalasys Calibration | Section 5 | view attachment |
| | Comment: | For the program PG&E2000 there were only 7 "good data" out of 272,164 measures which is 0.0000000257%. There is no reasonable reviewer that can attribute statistical accuracy to this. | | | |
| | Response: | The pre-post sample sizes should not be included relative to the program population since only the randomly sample verification units were drawn from program records. The few units were not directly applied to program level savings but were included in the pooled degradation factors and the low sample size resulted from coordination difficulties as explained in the revised report. | | | |

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| 57 | 1/9/2010 | Rocky Bacchus | Enalasys Calibration | Section 5 | view attachment |
| | Comment: | Report reflects that Programs were "Penalized" for lack of data. | | | |
| | Response: | All this language was identified and removed since we did not apply any penalties directly to the data. | | | |

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| 58 | 1/9/2010 | Rocky Bacchus | Enalasys Calibration | Section 5 | view attachment |
| | Comment: | Report reflects negative therms, which is essentially impossible for a refrigerant charge program to cause. | | | |
| | Response: | This error has been identified and the tables have been updated. | | | |

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| 59 | 1/9/2010 | Rocky Bacchus | Enalasys Calibration | Tables 5.30 through 5.34 | view attachment |
| | Comment: | There are dramatic inconsistencies in the savings per unit for the same climate zones, see tables 5-30 to 5-34 | | | |
| | Response: | Program UES is dependent on measure distributions of charge and building type. | | | |

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| 60 | 1/9/2010 | Rocky Bacchus | Enalasys Calibration | Section 5 | view attachment |
| | Comment: | The report says, "No units were achieved for the PGE 2080 Program due to unsuccessful coordination attempts." However, PGE2080 was penalized with the worst realization rate of just 20%. How does the team justify the worst rating with an 80% cut when they achieved no units evaluated? This seems simply punitive! | | | |
| | Response: | Program UES is dependent on measure distributions of charge and building type and the same base UES values are applied to all programs even those with no achieved metering sample. | | | |

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| 61 | 1/9/2010 | Rocky Bacchus | Enalasys Calibration | Section 5 | view attachment |
| | Comment: | The "Install Rate" implies that the measures were not installed, but actually this was an evaluation of how close the program came to meeting some charging targets. These targets were NOT PART of the PROGRAM and therefore are | | | |

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| | | an inappropriate cut. | | | |
| | Response: | Targets are part of the diagnostics embedded in the programs. Without targets charge adjustments can be made with negative energy impacts. | | | |

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| 62 | 1/9/2010 | Rocky Bacchus | Enalasys Calibration | Section 5 | view attachment |
| | Comment: | Duplicate cut: Non charged units were not billed and therefore should not be part of the program cut. Charged units adjusted to be actual energy savings in cut #1 should be a "double dip" cut. This work does not try to determine actual savings - it arbitrarily eliminates units that have actual savings. | | | |
| | Response: | Non-charged units were not sampled. In order to be given a definition of passing, the post-only verification used the same criteria as the Program; subcooling or superheating target temperature ranges had to be met. From our metered sample, we had an efficiency increase for units that were within target. Alternatively, we did not have an estimate of treated units that were found outside of the target range. Although there could have been some savings, there was enough of a likelihood that there was no savings or even negative savings. The pre-post methodology assumed there would be some upward bias in quality of work due to contractor knowledge of monitoring. The Protocol definition for installation was installed and operated as assumed. The UES developed was assumed to be a best-case scenario or potential for energy savings and units that did not meet specified diagnostic performance targets in separate, randomly sampled verifications would not have achieved the potential savings. The UES developed were for all units which would pass the verification criteria. | | | |
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| 63 | 1/8/2010 | PG&E Company | NTG | 5.2.4/39 | |
| | Question: | When were the SRA surveys done? In certain cases, was it two or three years after the participants got their units serviced and incentives? Phone surveys should have been made to the participants three months after the service. | | | |
| | Answer: | Surveys for PGE programs were administered in 2008 and 2009. The range of timing was 3 months to 2.5 years. | | | |
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| 64 | | SCE Company | NTG | 5.2/ | |

| | Date | Author | Subject | Section/Page | Attachment |
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| | Comment: | In the HVAC studies, contractor surveys supplemented end-use customers (program participant) surveys "where applicable." The NTGR via SRA is a minimally documented, incorrect, and highly consequential estimate. | | | From Brett Close SCE attachment. |
| | Answer: | Specific comments have been addressed in Section 5 of the report. | | | |
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| 65 | | SCE Company | NTG | 5.2/ | |
| | Comment: | The CPUC's SRA approach is based on an unjustifiable set of steps involving a series of arithmetic operations performed upon ordinal variables. Only one of the 0-10 variables used in the effort to calculate an overall NTGR score really asks the respondent to respond in a quantitative fashion – the item reflecting the likelihood of purchase absent the rebate. The other variables involved are 0-10 ordinal rankings, in which (a) scores may mean different things to different people, and (b) one unit score differences between different levels may mean different things to the same person. Included in the effort are operations contingent upon auxiliary variables, which diminish any "reliability" enhancements that are provided by summing from 1-4 ordinal variables, each with its own unreliability, sampling error, differential meaning between and within respondents. At one point in the development of this procedure, there were contingent subtractions involving combinations of these ordinal variables. The point is not to denigrate the use of ordinal variables in certain circumstances. The problem here is that despite the lengthy and helpful description of quality assurance and reliability enhancement strategies in the SRA document (an appendix to the Specialized Commercial report), and the evidence regarding internal consistency that has been offered in a recent webinar, the approach fails completely when it is interpreted as a measure of free ridership, which when averaged *over individuals* should estimate the proportion of energy efficiency measure-takings that would have occurred absent the program. | | | From Brett Close SCE attachment. |
| | Answer: | The issue or ordinal variables and the anchoring and scales of questions are presented in the file "Res&SmallCommSRA_Response" posted to www.energydataweb.com/cpuc | | | |
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| 66 | | SCE Company | NTG | 5.2/ | |
| | Comment: | Averaging responses for the multiple NTG questions will bias the result downward. This is absolutely incorrect because it degrades the importance of more significant influence with the other less important influences. A more appropriate method would consider the strongest influences on a participant as paramount and then look at the ways multiple influences combined to further influence decision-making. | | | |

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| | Answer: | The issue or ordinal variables and the anchoring and scales of questions are presented in the file "Res&SmallCommSRA_Response" posted to www.energydataweb.com/cpuc | | | |
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| 67 | 1/8/2010 | PG&E Company | NTG | 5.2.4/40 | |
| | Comment: | We are concerned that there was too much time between unit servicing and the verification. Ideally phone surveys should have been completing within a few months after unit servicing. | | | |
| | Response: | Surveys for PGE programs were administered in 2008 and 2009. The range of timing was 3 months to 2.5 years. The issue or ordinal variables and the anchoring and scales of questions are presented in the file "Res&SmallCommSRA_Response" posted to www.energydataweb.com/cpuc. | | | |
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| 68 | 1/8/2010 | PG&E Company | NTG | 5.2.4/41 | |
| | Question: | We believe that the decision to utilize participant and non-participant contractor interviews to determine if the end-use customers were aware of the incentive and if the service was available outside the program was incorrect. Since virtually no contractor would admit to not doing a job correctly (such as adjusting refrigerant charge or sealing ducts), we believe that data from non-participating contractors should be excluded from the analysis because it was not verified. | | | |
| | Answer: | Clarification, non-participant contractors were not surveyed. | | | |
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| 69 | 1/8/2010 | PG&E Company | NTG | 5.3.1/41 | |
| | Question: | Since the evaluation conducted verification only in two climate zones (12 and 13), we are concerned that omitting PG&E's other climate zones (specifically, 2, 4, and 11) that also produce a higher savings per unit and high activity levels result in incorrect estimates Can you please explain why PG&E was omitted? | | | |
| | Answer: | The actual sample sizes by climate zone which included those listed as omissions are presented in an added table in the sample design section. | | | |

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| 70 | 1/8/2010 | PG&E Company | DEER data used for Results | 5.5.1.2/54 | |
| | Comment: | We are concerned about the accuracy of these data because the 2008 DEER underestimated cooling hours. | | | |

| | Date | Author | Subject | Section/Page | Attachment |
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| | Response: | The only data changed between the ex-ante and ex-post results were the degradation factors. If the efficiency impacts from RCA were the same as the ex-ante the UES realization rate would be 100%. The usage patterns of systems was thus assumed to be the same for both ex-ante and ex-post results. | | | |
| 71 | 1/8/2010 | PG&E Company | Impact Calculation Methodology | 5.5.1.2/54 | |
| | Question: | If an eQuest simulation was used to calculate realized UES, what was the equipment's operation schedule? Note that the 2008 DEER under-estimates cooling hours. Was this fact considered when you calculated impacts? | | | |
| | Answer: | The only data changed between the ex-ante and ex-post results were the degradation factors. If the efficiency impacts from RCA were the same as the ex-ante the UES realization rate would be 100%. The usage patterns of systems was thus assumed to be the same for both ex-ante and ex-post results. | | | |
| 72 | 1/8/2010 | PG&E Company | Use of DEER data | 5.5.1.1/55 | |
| | Comment: | We believe that the use of 2008 DEER data to calculate multifamily unit impact values resulted in inaccurate measurements. We believe that 2005 DEER data should have been used since it includes multifamily units. | | | |
| | Response: | Multifamily prototypes were used in the residential analysis. The only data changed between the ex-ante and ex-post results were the degradation factors. If the efficiency impacts from RCA were the same as the ex-ante the UES realization rate would be 100%. The usage patterns of systems was thus assumed to be the same for both ex-ante and ex-post results. | | | |
| 73 | 1/8/2010 | PG&E Company | NTG | 5.6.1/76 | |
| | Question: | We believe the finding of 91% free ridership for residential building types in the PGE 2000 RCA program is highly inflated. The report does not provide an explanation for the data to support this finding, specifically steps taken to verify its reliability, or a discussion explaining why the methods used to produce this result for this particular segment of the program population are credible. Can you please clarify the report so that it provided a detailed explanation? | | | |
| | Answer: | Clarification of decision maker identification has been added in the form of survey instruments in the Appendix. Only knowledgeable participants were included in NTG calculations. The tables and text have been revised. | | | |
| 74 | 1/8/2010 | PG&E Company | NTG | 5.6.1/77 | |

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| | Comment: | As shown in Table 5-55 for res RCA, the procedure for determining valid respondents knowledgeable about multifamily initiatives was flawed and resulted in NTG ratios that are inaccurate. M&V evaluators should sample only amongst the persons actually applying for the rebate, rather than including any multifamily property manager they can talk to, many of whom will be not be aware of participation in the program. | | | |
| | Response: | Clarification of decision maker identification has been added in the form of survey instruments in the Appendix. Only knowledgeable participants were included in NTG calculations. The tables and text have been revised. Participant knowledge of measures was often limited compared to multifamily property managers for this segment. | | | |

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| 75 | 1/8/2010 | PG&E Company | NTGR | 5.6.1/77 | |
| | Question: | The net-to-gross ratios presented in Tables 5-55 and 5-56 vary sharply across programs. For residential programs, for instance, PG&E2000R has a NTGR of only 9%, whereas SCE2507 and the CMMHP programs have NTGRs of 77% and 78%. The report indicates that this is because the PG&E program is dominated by multi-family (MF) installations, and the MF NTGR is 0%. What is it in the program designs and/or customer characteristics that accounts for this result? How large is the survey sample in terms of unique decision-makers (not in terms of units covered)? What is it about MF that it gets such a low NTGR? Did you assume that if they had a 'service contract" they had zero NTGR? How many customers were interviewed for the MF NTGR? Please explain how you categorized an entire customer class in this way. | | | |
| | Answer: | Clarification of decision maker identification has been added in the form of survey instruments in the Appendix. Only knowledgeable participants were included in NTG calculations. The tables and text have been revised. Participant knowledge of measures was often limited compared to multifamily property managers for this segment. | | | |

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| 76 | 1/8/2010 | PG&E Company | NTGR | 6.5.4.3 | |
| | Question: | The AC Replacement Net-to-Gross ratios presented in Table 6-36 are counterintuitive. For instance, the NTGR for SCE's C/I AC Replacement program is 96%, whereas the NTGR for SDG&E's same program is 4%. What aspect of the program designs or customer bases explains this? | | | |
| | Answer: | See additional report material provided with revised Table. The difference is not necessarily in the program design, but in the survey instrument and respondent. | | | |
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| 77 | | SDG&E Company | NTGR | 6.5 | |

| | Date | Author | Subject | Section/Page | Attachment |
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| | Comment: | The calculated NTGRs vary significantly across IOUs and across programs, even when the programs are providing similar services. For example, consider the Air Conditioner Replacement program NTGR results listed in the table below. Both SCE 2507 and SDG&E 3029 were programs that provided C&I AC Replacement. However, the estimated NTGR for the SCE 2507 program was 96% whereas the estimated NTGR for the SDG&E program was 3%. Thus, two programs offering the same service obtained polar opposite NTGR estimates. One has to wonder ***how such radically different findings could arise?*** While the designs of the programs differed in some ways, it seems extremely unlikely that two programs offering essentially the same service could have exactly opposite NTGR estimates. Results such as this call into question the validity of the NTGR evaluation procedure implemented by the evaluators. Similarly perplexing results for the NTGR ratios exist in the RCA program. For example, for residential RCA, the estimated NTGR for PG&E's 2000R program was 9% while the estimated NTGR for SCE's 2507 program was 77%. Both program provided similar services and yet ended up with radically different NTGR estimates. | | | From Athena Besa, SDG&E Attachment |
| | Answer: | See additional report material provided with revised discussion of NTG. The variation here was driven by the survey method and survey audience, i.e., end-user vs. vendor survey. | | | |
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| 78 | 1/8/2010 | PG&E Company | NTGR | 6.5.4.3 | |
| | Question: | There are no sample sizes given for the AC Replacement NTGR findings in Table 6-36. Can you please provide these sample sizes--in terms of unique sites as well as unique decision-makers--for each program? | | | |
| | Answer: | Please see revised Table in the report. We based sample sizes on account level data. Contact lists were often incomplete, unavailable, or had errors and there were limited means to determine which utility accounts had the same decision maker. One decision maker might have multiple accounts, as noted, but we do not have counts of the number of unique decision makers or the number of sites (expressed by different utility account numbers) to which they were associated. | | | |
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| 79 | 1/8/2010 | PG&E Company | NTGR | 6.5.4.3 | |
| | Question: | The report indicates that the NTG survey attempted to determine "whether the contractor influenced the end-user's decision to purchase a high-efficiency air conditioner, or whether the end-user's decision was influenced by the program." Are these options mutually exclusive? Couldn't the contractor's recommendation be based at least partly on the availability of the program? | | | |
| | Answer: | The influence is not mutually exclusive. The battery of questions looked at influence from a number of sources and the respondent could indicate more than one influence. The dominant influence was recorded. | | | |
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| 80 | | SCE Company | NTGR | 6/ | |
| | Comment: | Finally, we note that this study looked more deeply than others into the SRA net-to-gross method's application. The study appendices contain a number of tables and figures that do not remove the central difficulties with the actual translation of ordinal variables into a defensible probability-of-free-ridership interpretation. The study relied heavily upon vendors as proxy participants. Note that the study itself, while not engaging with the fundamental ordinal measurement translation issue, does at least provide a commonsense critique based on SDG&E C/I customer results (which eventuated in a 9.7 average score, translated to a NTGR of .03):"O)f the the 90 respondents, 31% reported their purchase decision was influenced by the program, and 69% reported their purchase decision was influenced by their HVAC contractor (p. 122)." Since the contractor is essentially a part of the program from the standpoint of delivering savings (and possibly knowledge) to the customer, the report points out that contractor influence (and perforce the program design) is not being correctly analyzed: "Half of those reporting the contractor influenced their decision were classified as 100% free riders using the NTG algorithm (31/62). Since the contractor influenced their decision, it is unlikely that the business was a total free rider (p. 122). " It is also puzzling to find that the ROB and burnout conditions are not considered in disaggregate fashion, since the decision conditions are considerably different. Finally, note that the sample sizes for the NTGR do not come close to providing for reasonable precision (even in the relative sense supported by the Energy Division): if viewed as a binomial (since no information is available on variances and covariances of the ordinal variables involved in constructing averages), the 90% relative precision of the SDGE C/I result is 99%. | | From Brett Close SCE attachment. |
| | Answer: | Questions about the NTG policy were directed to the NTG working group. Regarding sampling: the residential surveys met their sampling targets per the protocols. The commercial sample targets were initially set using the same general approach as residential, i.e, a one-to-one relationship between units and decision-makers. In the commercial sector, however, there are multiple units per decision maker; this is why the sample was stratified by installed tonnage and ex ante savings rolled up to the customer account level. The FR and NTG scores are ex ante savings-weighted, giving more influence to larger participants with larger savings expectations. Regarding the influence battery: the commercial programs were initially upstream programs but evolved over time so that some end-users knew they participated in a program and others did not. In addition, some contractors chose to tell customers they provided a discount because of the program, and other contractors did not. So that no customers felt that they missed out or should have received something they did not, we designed the survey to identify the primary influence and determine whether they knew they "participated." The survey questions led to the specific set of FR questions asked respondents and scored. The influence factor itself was not an element of the FR score. The statement made in the report resulted from examination of the data regarding free ridership. | | |

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| 81 | 1/8/2010 | PG&E Company | NTG | 7.6 | |
| | Question: | The NTG ratios shown in Table 7-12 vary quite a bit across programs, which seems odd for similar programs. What program or customer features account for this variation? What were the sample sizes (in terms of distinct decision makers and unique sites) for the estimation of NTGR for each of these programs? | | | |
| | Answer: | Clarification of decision maker identification has been added in the form of survey instruments in the Appendix. Only knowledgeable participants were included in NTG calculations. The tables and text have been revised. Participant knowledge of measures was often limited compared to multifamily property managers for this segment. | | | |
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| 82 | 1/8/2010 | PG&E Company | Installation Rate | 7.5.2 | |
| | Question: | Table 7.8 indicates an installation rate of 50.9% for commercial duct repair, while Figure 7-3 shows that the ratio of verified to program leakage reductions was 72.7%. Since the installation rate is used to scale program savings, wouldn't the results of Figure 7-3 be a better choice for the installation rate? | | | |
| | Answer: | The original Figure 7-3 compared two ex-post measurements performed at the same site. A new figure was added explaining the installation rate results compared to contractor results. | | | |
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| 83 | | SCE Company | NTG | 7/ | |
| | Comment: | The difference between the PG&E and SCE programs in terms NTG is quite large. The report points out that PG&E had a large number of multifamily units in their program, but SCE's was 78% multifamily and ended with quite a high NTG. This seems unlikely to be a real difference. There is a similarly large dispersion between the C&I programs. | | | From Brett Close SCE attachment. |
| | Answer: | Clarification of decision maker identification has been added in the form of survey instruments in the Appendix. Only knowledgeable participants were included in NTG calculations. The tables and text have been revised. Participant knowledge of measures was often limited compared to multifamily property managers for this segment. | | | |
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| 84 | 1/8/2010 | John Proctor | | NTG | |
| | Comment: | The method of establishing the Net to Gross ratio has produced grossly incorrect and wildly varying net to gross ratios that do not stand the "sniff" test. Specifically the RCA program causes contractors to use proper adjustment techniques. Proper adjustment techniques are virtually never used in standard practice and customers are totally unaware of the difference between a "tune-up" and a proper RCA adjustment. It is impossible for an RCA program that causes contractors to use the proper adjustment techniques can have 100% free riders or any free ridership in excess of a few | | | From the John Proctor Attachment |

| | Date | Author | Subject | Section/Page | Attachment |
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| | | percent, given the current state of the HVAC trade. | | | |
| | Response: | Clarification of decision maker identification has been added in the form of survey instruments in the Appendix. Only knowledgeable participants were included in NTG calculations. The tables and text have been revised. Participant knowledge of measures was often limited compared to multifamily property managers for this segment. | | | |

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| 85 | 1/8/2010 | John Proctor | | Multiple | |
| | Comment: | Specifically the evaluator used a non industry standard for the location of the suction line temperature for testing Superheat, while the technicians used the industry standard location. This fact alone makes the conclusions on installations incorrect. | | | From the John Proctor Attachment |
| | Response: | Evaluators used the industry standard location used by technicians of suction line temperature measured near the service port of the outdoor unit. Section 5.2.3 has been edited. | | | |

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| 86 | 1/8/2010 | PG&E | | NTG | |
| | Comment: | KEMA estimated net-to-gross ratios using a self-report survey developed by a statewide working group for large nonresidential customers. The contractor attempted to survey decision-makers from all of the sites included in the gross saving analysis. However, the response rates for this program were highly irregular (0.09 to 0.97% for RCA; 0.03 to 0.95% for AC replacement; 0.40 to 0.85% for Duct Seal). These response rates are of high concern, in that there may be some systematic non-response bias in the NTGR estimates. While Appendix O (p. 181) provides a detailed assessment of NTG methodologies, the document fails to provide adequate detail of the applied methodology. | | | From the PG&E Cover letter attachment |
| | Response: | Clarification of decision maker identification has been added in the form of survey instruments in the Appendix. Only knowledgeable participants were included in NTG calculations. The tables and text have been revised. Participant knowledge of measures was often limited compared to multifamily property managers for this segment. Additional detail is presented in the file "Res&SmallCommSRA_Response" posted to www.energydataweb.com/cpuc. | | | |

| | Date | Author | Subject | Section/Page | Attachment |
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| 87 | 1/8/2010 | PG&E | | NTG | |
| | Comment: | The overall NTGR methodology ignores what may be a primary benefit of the program on behavior in this sector - free-ridership. While this may be the general practice in this round of evaluations, it seems unwarranted and unwise, especially for programs that can be expected to have market effects over and above the direct impacts on participants. The commercial HVAC HIM programs are a good case in point. They offer on-site analysis, sizing (engineering) support, and specialized education to decision makers. The AC replacement program works with equipment vendors, distributors and other market actors who act as decision influencers. These program activities could clearly have free-ridership effects that ought to be considered in any evaluation. | | | From the PG&E Cover letter attachment |
| | Response: | The CPUC policy is to not count spillover in 2006-2008. See Finding of Fact 27 of D. 05-04-051, "27. The speculative nature of any attempts to quantify spillover effects significantly reduces their applicability as an analytical tool at this time. Moreover, discounting the accounting of free-ridership through "spillover," as PG&E proposes, would make it particularly difficult to attribute indirect program benefits to education and information programs, without double-counting those benefits. " Also, in the non-residential NTGR survey, equipment sellers and installers who might have been involved in helping the customer decide to install the energy efficiency measure were interviewed. That is, the evaluation attempted to count both the direct and indirect effects of PG&E efforts. See additional report material provided with revised Tables and the file "Res&SmallCommSRA_Response" posted to www.energydataweb.com/cpuc. | | | |
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| 88 | 1/8/2010 | Karen des | PGE2068 - Vol 2 | NTGR/Appendix/Multiple | |
| | Question: | The report appendices do not appear to include copies of the NTG survey instruments used to determine NTGR scores for small commercial participant sites and, if applicable, their contractors. PECI requests copies of the instruments. | | | |
| | Answer: | Instruments were added | | | |
| 89 | 1/9/2010 | Rocky Bacchus | Enalasys Calibration | NTGR | view attachment |
| | Comment: | These programs were eliminating "free riders" by not claiming savings for units that did not require remediation. It is illogical to then do a "self report" survey and reduce savings because the owners and/or contractors said they would have done the work. | | | |
| | Response: | Free ridership does not apply to units without claimed savings. Only units with charge adjustments had claimed savings which defined the population from which samples were drawn. | | | |
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| 90 | 1/8/2010 | PG&E Company | Methodology | 6.2/85 | |

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| | Question: | As we understand it, the metering sample was stratified by climate zone, and then stratum-specific sample sizes were determined by allocating the total sample across strata in proportion to ex ante savings. Does this approach optimize the precision of the overall sample? Please provide a table showing the final stratification scheme after the application of this approach. | | | |
| | Answer: | Additional detail added to section 6.2. | | | |
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| 91 | | SCE Company | Stratification | 6/ | |
| | Comment: | Findings are based on a small number of monitored appliances, although it is difficult to perfectly identify the actual sample sized involved for SCE, as one sifts through Tables 6-16, 6-17, 6-20, and 6-21. In part this is due to lack of documentation on strata (ROB/early replacement by climate zone). Note that stratification is not only unclear in the relevant tables, but that there may or may not be other stratification underlying the participant A/C samples that is not unveiled in the text: "(W)herever sampling efficiency could be improved using additional information from the program population, the samples were stratified based on additional parameters, such as climate zone, tonnage, and replacement type." | | | From Brett Close SCE attachment. |
| | Answer: | Additional detail has been added to section 6.3 of the report. | | | |
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| 92 | 1/8/2010 | PG&E Company | Methodology | 6.2.3 | |
| | Question: | It is noted that "the quantified measured savings are restricted only to the savings attributable to the higher efficiency features of the replacement unit and not to the resizing and duct repairs that may be associated with a preemptively replaced unit." If the program incentives induced early replacement, why wouldn't the full effects of replacement (including steps taken to comply with code) be included as a program impact? How soon after treatment were these sites assessed? They could have had a higher initial realization rate, and this is a persistence issue. It would be important to know if realization rates as a function of time post treatment were examined – this would begin to shed light on how duct seals deteriorate and enable programs to optimize treatment over time to maintain low leakage rates. Were there correlations between size of home (and presumably size, length, and number of corners/registers of ducts) and realization rates? | | | |
| | Answer: | The savings due to duct repairs are discussed in Chapter 7. The AC Replacement monitoring was specific to the unit itself and could not resolve any effects that would have been present from a change in duct work. The decision to focus on the savings due to the efficiency alone is discussed in the answer to question 70. | | | |
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| 93 | 1/8/2010 | PG&E Company | Planned Confidence & Precision | 6.3.1 | |
| | Question: | The relative precision levels presented in Table 6-14 and 6-15 are based on planned sample sizes. Can you provide an additional table based on actual sample sizes? | | | |
| | Answer: | The achieved precision from actual sample sizes and calculated results is discussed at length in section 6.5.3. | | | |
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| 94 | 1/8/2010 | PG&E Company | Metered Sample | 6.3.2.1 | |
| | Question: | Table 6-16 suggests that these planned sample sizes are based on numbers of units. Was the actual sampling done at the unit level or the site (customer) level? | | | |
| | Answer: | Additional information about the sample selection will be added to Section 6 of the report. | | | |
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| 95 | 1/8/2010 | PG&E Company | Metered Sample Achieved | 6.3.2.1 | |
| | Question: | Table 6-16 indicates that the actual completed metering sample was 278 sites/units, whereas the targeted number of sites was 410. Why weren't refusals replaced by alternate sites? Also, please verify the total of the last column and explain why it is not the sum of the sample sizes. Do the total numbers of completed installations for the two SDG&E programs (Table 6-16) overlap? Footnotes are indicated, but couldn't be found. | | | |
| | Answer: | Refusals were replaced by the next highest priority site in the sample. Populations in each cell are mutually exclusive in Table 6-16. | | | |
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| 96 | 1/8/2010 | PG&E Company | Residential AC Replacement | 6.4.3 | |
| | Question: | The report indicates that the baseline for early AC replacements was derived from an analysis of 20 units drawn from one utility's RCA program. To what extent would this sample be representative of the pre-replacement units AC Replacement Programs? | | | |

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| | Answer: | The RCA units used for the base case were post the RCA correction to represent the performance of a unit of medium age that had reasonably proper operation, charge and airflow. This was intended to lead to savings estimates that did not include the savings benefits that would proceed from improper charge, airflow, or other malfunctions associated with very old units. This choice leads to a conservative estimate of savings. Undoubtedly there may have been sites with existing units showing very poor operation, and these would have lowered the baseline performance and thereby increased the observed savings. But in fact we knew nothing about the existing equipment, and chose (conservatively) to claim only the minimum reasonable savings. A comparison of the EER of the RCA base case to another recent study is addressed in Appendix section E under heading "Check Points." | | | |
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| 97 | 1/8/2010 | PG&E Company | Residential AC Replacement | 6.4.3 | |
| | Question: | Table 6-22 presents residential monitoring results for only six climate zones. Were there results for the others? | | | |
| | Answer: | All residential metering was done in zones 6, 7, 8, 9, 10, and 15: the sample targets were based on program participant size in the climate zone and even though there were units in other zones, the population size in those other zones was so small that metering was not performed. Note that in the current, updated version of Table 6-22 there are also estimates presented for zones 13 and 14. These were generated by driving unit models of zone 10 sites with zone 13 or zone 14 typical meteorological year temperatures as part of a reanalysis process, the full discussion of which is included in sections 6.4.3, 6.4.4, and Appendix section E under heading "Total Cooling Energy." | | | |
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| 98 | 1/8/2010 | PG&E Company | Residential AC Replacement | 6.4.3 | |
| | Question: | Figure 6-3 shows a few sites with negative savings. Since this relates to early replacement, where the base case was the pre-existing unit, what does this mean? | | | |

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| | Answer: | The negative savings sites observed represent monitored units running at a severely low efficiency. There were a small number of metered units that simply drew lots of power and delivered very little cooling. Upon finding no obvious reasons to question the validity of the data on these sites they were included and the low efficiency was attributed to possible refrigerant side problems. To clarify on the assertion that performance outliers were included as long as the data were well behaved: some examples of clues that were used to reject sites on the basis of data problems were unrealistic air handler temperatures such as 90 degree return and 70 degree supply; return and supply temperatures that did not follow compressor operation; supply or return temperatures that "floated" instead of remaining relatively constant, an example of which would be the return temperature gradually increasing from 75 to 85 during compressor operation; compressor operation that did not follow outdoor temperature; unreasonable outdoor temperature readings. If no problems of this nature were observed in the data then the site was included as a legitimate and physically meaningful unit, even it appeared to be malfunctioning. | | | |
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| 99 | | SCE Company | Base case early replacement | 6/ | |
| | Comment: | Some thoughtful work goes into developing proxy base cases in both the residential and non-residential, and the burnout and early replacement scenarios. However, since no observations are made on the pre-existing equipment, the early replacement base cases are by definition somewhat arbitrarily derived, despite for example, the study's deliberate efficiency "deterioration" of SEER. One obvious result of this is the persistent pattern of gross realization rates – in which, across all climate zones and both sectors, realization rates for burnout/new construction are always substantially higher than those for early replacement, where the baseline is constructed from an availability sample (of unknown nature) from RCA-optimized appliances. | | | From Brett Close SCE attachment. |
| | Answer: | The information used from the 20 RCA sites to estimate baseline energy usage was EER performance as a function of outdoor temperature. Obviously the energy savings and hence the realization rates for early replacement units is dependent on the EER performance of those units—both the representativeness of the units used and the variability introduced by taking a single average EER function from 20 different units. However, the energy savings are also dependent on annual cooling usage, and the early replacement savings claimed are often not in agreement with observed annual cooling. The claimed savings appear to use similar baseline efficiencies but applied to a much greater annual cooling load than was observed in the evaluation. The ex ante estimates imply savings in the range of 50-100% of this well known cooling load, while the observed estimates of savings are in the range of 25-35% of load. The pattern of low realization rates for residential early replacement units is almost entirely a function of the ex-ante assumed cooling load: this is discussed in section 6.5.1. Also, the EER from the RCA base case was checked for reasonableness against a recent, similar study: this is discussed in Appendix section E under heading "Check Points." | | | |

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| | | In the commercial case the realization rates tended to be higher for the early replacement base case, so it is assumed that this question was only in reference to the residential results. | | | |
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| 100 | 1/8/2010 | PG&E Company | Commercial AC Replacement | 6.4.4 | |
| | Question: | It is unclear exactly what Figure 6-5 shows. The caption notes that it is commercial savings per ton, but this seems dubious. It looks like a frequency distribution of annual cooling usage. Please clarify. | | | |
| | Answer: | This is in fact a frequency distribution of annual cooling usage that was incorrectly labeled. The title of this graph has been fixed. | | | |
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| 101 | 1/8/2010 | PG&E Company | Residential Savings | 6.5.1 | |
| | Question: | According to Table 6-26, the realization rates on early replacement are considerably lower than those on replace on burnout. To what extent is this attributable to the use of the sample of 20 RCA sites to simulate baseline energy use for early replacements (p. 98)? Given the low realization rate, were other approaches used to validate this approach? | | | |
| | Answer: | For the first part of this question refer to Question 99.<br>The other approach considered for assessing the operational efficiency of the replaced unit was to use DEER performance bi-quadratics for a SEER 10 unit. This approach was ultimately abandoned in favor of the more empirical method ultimately used, as the DEER expectations for performance proved much higher than the field performance observed in this evaluation. Using the empirical method was itself a check on very low calculated energy savings that resulted from using from the DEER unit performance functions. | | | |
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| 102 | 1/8/2010 | PG&E Company | Commercial Savings | 6.5.2 | |
| | Question: | Tables 6-29 through 6-32 indicate commercial realization rates for SCE and SDG&E. Are there results for PG&E? | | | |
| | Answer: | For the PG&E 2080 program, a complete description of participant tonnage by climate zone was not available. The evaluation had detailed information regarding a subset of the program population, and the proportion of tonnage by climate zone in this subset was assumed to represent the proportion of tonnage by climate zone in the entire program. Using this distribution of tonnage, a weighted average unit savings was taken based on calculated climate zone unit savings and the estimated proportion of program tons in each climate zone. This weighted average was applied to all program tonnage. Due to the lacking data, however, it was not possible to present detailed tables of savings by climate zone for the PG&E 2080 program. Overall savings for PG&E are listed in Table 6-33. | | | |
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| 103 | 1/8/2010 | PG&E Company | Commercial Savings | 6.5.2 | |
| | Question: | Tables 6-29 through 6-32 indicate that commercial realization rates are lower for replace on burnout than for early replacement. In general, what accounts for this? | | | |
| | Answer: | The unit energy savings used by the evaluation change more widely between replacement types than those used in the ex-ante claimed savings. For example, in Zone 10 the average energy savings claimed were 285 kWh/ton for early replacement and 223 kWh/ton for replace on burnout. However, the evaluated average energy savings were 370 kWh/ton for early replacement and 172 kWh/ton for replace on burnout. The evaluated savings for early replacement were more than twice the evaluated savings for replace on burnout in Zone 10, whereas the claimed savings were only slightly larger. It appears that the ex-ante savings assumed similar baseline efficiencies for the two replacement types, while the evaluation used a much larger difference between code-level efficiency and the efficiency of an average early replacement-qualifying unit. | | | |
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| 104 | 1/8/2010 | PG&E Company | Residential Achieved Precision | 6.5.3.1 | |
| | Question: | Table 6-34 presents estimated residential percentage 90-10 precision levels ranging from +21% to +131%. How do these values comply with CPUC evaluation standards? What is the overall precision level for all climate zones and both decision types? | | | |

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| | Answer: | To address the issue of low precision, a reanalysis was performed using the broadest possible applicability of the method presented. In the reanalysis, the unit model from each monitored unit was used to drive savings calculations not only for the climate zone it was metered in, but also for zones of similar climate and occupant behavior patterns. A discussion of this process has been added to report sections 6.4.3 and 6.4.4, and a comprehensive explanation and justification has been added to Appendix section E under heading "Total Cooling Energy." This process slightly modified the savings numbers computed and those most current savings estimates are presented in report section 6.5. Although these changes did not significantly affect the realization rates, the precision of the results dramatically improved due to the increased number of individual savings estimates in each stratum.<br>Overall precision levels across all climate zones and replacement types have since been computed by program and are presented in Tables 6-36 to 6-43. | | | |
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| 105 | 1/8/2010 | PG&E Company | Commercial Achieved Precision | 6.5.3.2 | |
| | Question: | Table 6-35 presents commercial estimated precision levels ranging from +37% to +77%. How do these values comply with CPUC evaluation standards? What is the overall precision level for all climate zones and both decision types? | | | |
| | Answer: | To address the issue of low precision, a reanalysis was performed using the broadest possible applicability of the method presented. In the reanalysis, the unit model from each monitored unit was used to drive savings calculations not only for the climate zone it was metered in, but also for zones of similar climate and occupant behavior patterns. A discussion of this process has been added to report sections 6.4.3 and 6.4.4, and a comprehensive explanation and justification has been added to Appendix section E under heading "Total Cooling Energy." This process slightly modified the savings numbers computed and those most current savings estimates are presented in report section 6.5. Although these changes did not significantly affect the realization rates, the precision of the results dramatically improved due to the increased number of individual savings estimates in each stratum.<br>Overall precision levels across all climate zones and replacement types have since been computed by program and are presented in Tables 6-36 to 6-43. | | | |
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| 106 | | SCE Company | Precision results | 6.5/ | |

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| | Comment: | The study is forthright about the sources of error that are or could be contributing to the variances of these estimates, and indicates that further analysis will be forthcoming. However, the sampling-related precision results as displayed in tables 6-34 and 6-35 indicate that the precision bounds often include ex ante estimates. The sampling precision estimates do not take into account the sampling error related to the complex processes that lead to the baseline estimates, let alone various kinds of measurement error contributing to baseline estimates. | | | From Brett Close SCE attachment. |
| | Answer: | Note that the precision results have changed as explained in the response to Question 78.<br>To clearly show where ex-ante savings fall within calculated error bounds and where they do not, Tables 6-36 through 6-43 have been added to explicitly compare the evaluated savings, lower bound of evaluated savings, upper bound of evaluated savings, and ex-ante savings for each utility, climate zone, and replacement type.<br>An analysis and discussion of uncertainty on the unit level, as affected by measurement accuracy and modeling error, has been added in section 6.4.1. | | | |
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| 107 | | SDG&E Company | Achieved Precision Levels | 6 | |
| | Comment: | The evaluators note that the goal of the “overall verification and net savings sampling strategy was to achieve 10% precision at the 90% confidence level for each measure by utility.” Unfortunately the evaluators did not come close to meeting that goal. The point is illustrated in the tables below, which show the achieved level of precision for the RCA and Air Conditioner Replacement evaluations. In Table 5-13 (RCA measures), achieved levels of precision vary between 13% and 34% with one program having no level of precision because the sample size was zero (PG&E2080). Of the nine measures, six had precision levels of 26% or higher (with one of those having no estimate due to a sample size of zero). Table 6-34 and 6-35 display a similar lack of precision for Air Conditioner Replacement measures. In the residential sector, the confidence bands around the estimated savings range from +/-131% to +/-21% with the majority being larger than +/-30%. As illustrated in Table 6-35 the lack of precision was even worse for commercial measures. The precision levels achieved in this study are so far from the original protocols, that they essentially make the savings estimates reported in the evaluation useless. | | | |
| | Answer: | Note that the AC Replacement precision improved upon a reanalysis as discussed in response to Question 78. Details of these most current results can be found in section 6.5.3. | | | |
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| 108 | 1/8/2010 | PG&E Company | Application of DEER data | 7.2/127 | |

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| | Comment: | We believe there is some confusion concerning whether 2005 DEER or 2008 DEER data were employed. The standard unit for Duct test and seal (DTS) based on the 2008 DEER is per household and not 1000 square foot of conditioned space as listed. The 1000 square feet was used on the 2005 DEER database. Unless all assumptions were based on 2005 DEER for the UES calculation, then the 2008 DEER standard units should be used for consistency. | | | |
| | Response: | Units clarified in the text of section 7.2 | | | |
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| 109 | 1/8/2010 | PG&E Company | DTS Sample Sizes | 7.2.1 | |
| | Question: | Section 7.2.1 suggests that the sample design was based on estimating leakage rates, rather than the energy savings associated with reducing these rates. The supposed benefit of this was to target a variable with less variation allowed smaller sample sizes to achieve the target precision. But does this design yield the required precision for the variable of ultimate interest: savings? | | | |
| | Answer: | The precision presented were for the installation rate given the lack of ex-post UES estimates. Thus the precision is ultimately on the pass fail of the estimated leakage rates and no error is assumed for the ex-ante UES values that were passed through.. | | | |
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| 110 | 1/8/2010 | PG&E Company | Planned Precision | 7.3.1 | |
| | Question: | The discussion of planned precision focuses on electricity savings. How were gas savings treated in the sample design? | | | |
| | Answer: | The UES ex-ante estimates for gas savings had similar variation as the electric savings. The samples focused on verification rate applied to electric savings as those parameters defined the measure as a HIM for the PG&E portfolio. | | | |
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| 111 | 1/8/2010 | PG&E Company | Savings Correction kWh | 7.3.2/131 and 7.5.1/136 | |
| | Question: | Table 7-4 for PGE2000R shows an overall 2006-8 kWh savings of 7,095,797 kWh, however on table 7-7, it shows an ex-ante and ex-post kWh savings of 6,148,183 kWh. Could you please correct this discrepancy? | | | |
| | Answer: | Yes, the discrepancy has been corrected and is reflected in the tables. | | | |
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| 112 | 1/8/2010 | PG&E Company | Duct Leak Verification | 7.5.1 | |

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| | Question: | The criterion for "passing" the post-sealing duct leakage verification was that total leakage was reduced by 28 percentage points. This would correspond to a reduction from, say, 40% of fan flow to 12% of fan flow. Were the DEER estimates used for the utility ex antes based on this DEER scenario? | | | |
| | Answer: | The criterion for passing units was that final leakage was 15% or less. The leakage reductions in the ex-ante estimates included both the 28% and 12% reduction scenarios. | | | |
| | | | | | |
| 113 | 1/8/2010 | PG&E Company | Leakage Results | 7.5.1 | |
| | Question: | Are the results shown in Figure 7-1 based on only post-sealing verification, or on the smaller pre- and post-metering samples? If the former, how were pre-post reductions determined? Were the contractors' estimates of pre-sealing leakage rates taken as given? | | | |
| | Answer: | The Figure was meant to illustrate that the failing leakages generally had very different measurements than the recorded leakage of 15% or less. Failing units were predominantly not close to the 15% level and if the verified post leakage was subtracted from the recorded pre-sealing leakage, the leakage reductions were generally much smaller than assumed reductions in the ex-ante UES estimate. | | | |
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| 114 | | SCE Company | Installation estimation | 7/ | |
| | Comment: | The 15% evaluated threshold is arbitrary in the installation estimation. It appears that there were units put at around 15% in the tracking data, but were evaluated at around 17% and was considered not to have been installed. This 17% may be a difference of measurement and at the very least may represent a significant decrease in leakage from what existed previously. | | | From Brett Close SCE attachment. |
| | Answer: | This Figure was changed to illustrate the failing leakages generally had very different measurements than the recorded leakage of 15% or less. Failing units were predominantly not close to the 15% level and if the verified post leakage was subtracted from the recorded pre-sealing leakage, the leakage reductions were generally much smaller than assumed reductions in the ex-ante UES estimate. | | | |
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| 115 | 1/8/2010 | PG&E Company | Installation Rate | 7.5.1 | |

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| | Question: | The derivation of the final installation rate for duct sealing is apparently based on the post-only metering results depicted in Table 7-5. If duct leakage is lowered from 40% to, say, 17%, but the contractor records a post value of 15%, is it considered to fail, and thus become a 0 installation case? How reliable is it to base installation rates (and hence realized savings) strictly on the post-installation results? Using the pre- and post-installation sample, it was found that the average evaluation reduction in leakage was 18%, whereas the DEER assumption was 28%. Wouldn't this indicate a 64% effective "installation rate"? | | | |
| | Answer: | This Figure was changed to illustrate the failing leakages generally had very different measurements than the recorded leakage of 15% or less. Failing units were predominantly not close to the 15% level and if the verified post leakage was subtracted from the recorded pre-sealing leakage, the leakage reductions were generally much smaller than assumed reductions in the ex-ante UES estimate. | | | |
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| 116 | 1/8/2010 | PG&E Company | EER | App Table D-4 | |
| | Comment: | We question the EER values as presented because they are unusually low and do not follow expected trends. For example, the values in the tables don't follow expected trends in charge adjustment vs. EER. There are small charge adjustments which produced relatively large % changes in EER (such as SCE-MF-H312) and there are large charge adjustments which produced very small changes in % EER (such as SCE-MF-PT231). In one case, correcting a 64% undercharge resulted in slightly lower EER (SCE-MF-CC239). The EER reported for SCE-MF-PT131 is either a large measurement error or a typo. In another example, SCE-MF-PT231 saw a 44% undercharge correction which reduced capacity, significantly reduced sensible capacity, and resulted in a slightly higher EER. | | | |
| | Response: | Previous field studies used for the DEER estimates have shown similar non-intuitive trends in the efficiency gain from charge improvements for individual units compared to laboratory tests. This was especially true of the C&I results as well as those units identified in the comment. The values of absolute EER are lower than rated values due to measured airflows being lower than nominal values for units with low nominal EER compared to newer units. Note that all measured EER across HVAC HIMs showed low field operating EER relative to rated efficiencies even considering the uncertainty bands of field measurements relative to laboratory measurements. A few cases showed high EER values beyond the rated efficiency of the units which were the result of lower than expected compressor power draw and ideal cooling performance. | | | |
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| 117 | 1/8/2010 | Karen des | PGE2068 - Report | Section 5.7, Table 5-57 | |

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| | Comment: | The Air Care Plus Program collects actual unit performance with direct connection to rooftop gages and sensors to a data collection device, so the actual final test out result after service is verified in a way that cannot be ‘gamed’ by the contractor. For PGE2068, only units that pass the test receive savings credit and incentives for the service. Given that, PECI would expect the pass rate at the time of service to be 100%. KEMA's install rate may not reflect the actual results due to the following factors: 1) PECI and KEMA used different methods to determine a “pass” on correct charge. The evaluators used a common method based on superheat (SH) and subcooling (SC) while PECI uses a method that research (K. Temple, 2004 & 2006) has shown to be superior which is based on additional factors and a compressor map model; the evaluator method is expected to fail more units than the program method. 2) The measurements were made more than one year after service. During that time there could have been charge leakage, degradation, or other adjustments to the charge after the date of the initial service. | | | |
| | Response: | 1) The RCA diagnostic measurements were selected due to the applicability to all HVAC HIMs. Diagnostically calculated system performance using compressor maps and other methods were considered, but ultimately a non-proprietary method for diagnostic calculation was unavailable to the evaluation. A specific recommendation should be added to follow and potentially support open-source protocols for system diagnostic and efficiency measurements which could be used directly or used to benchmark methodologies such as the method referenced.<br>2) The HIMs were assumed to be one-time service corrections resulting in efficiency improvements for a specified number of years. The effective useful life of the measure was not part of the M&V evaluation. | | | |
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| 118 | 1/8/2010 | Karen des | PGE2068 - Report | Table 5-50 | |
| | Question: | In Table 5-50, how is the "unit" defined? PECI requests a copy of the eQuest/DOE-2 model with the inputs used to calculate the values in columns A (kW/unit), B (kWh/unit) and C (Therms/unit). | | | |
| | Answer: | The units are defined in the revised report. Information regarding models and calculation process is available at www.deeresources.com. The degradation factors which were the primary data changed between the DEER estimates and the evaluation is presented in the report. | | | |
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| 119 | 1/8/2010 | Karen des | PGE2068 - Report | Report Section 3.1, Table 3-1, Section 5.7, Appendix Table D-15 | |

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| | Question: | The discussion that relates to Appendix Table D-15 indicates that the evaluation adjusted the 68.4% pass rate upwards to 75% based on a review of program data. However, the current version of the evaluation draft final report lists 68.4% in Table 3.1 and Table 5-57 (Volume 1). This suggests the upward adjustment in the program pass rate discussed in Appendix for Table D-15 was not properly applied to the Program ex-post gross savings estimate (Column E in Table 5-57 ), resulting in an understatement of the gross ex-post savings estimate. PECI requests the update of all tables and references to show the 75% figure documented in Appendix Table D-15. Further review of draft final report identified several other instances where in-text references did not match values listed in the referenced tables. For example: SCE2507 has 72% and 77% in Appendix D text and 67% in Table 3-1 and SDGE3043 has 60% in Appendix D and 67% in Table 3-1. | | | |
| | Answer: | The adjustment and penalty for data availability was in error and has been removed from the Appendix and the reference in the report mentioned in other comments. | | | |
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| 120 | 1/8/2010 | Karen des | PGE2068 - Report | Section 5.1.2 | |
| | Comment: | PECI agrees with the evaluation findings that pre conditions for RCA should be documented through the use of a diagnostic tool that automates data entry and transmission and thus greatly improve data integrity and accuracy by reducing human error. Review of the data set provided to KEMA for the purpose of this evaluation confirmed that PECI provided comprehensive data sets for all sites including pre and post data capture of key refrigerant charge and airflow measurements. It is PECI's understanding that none of the required data series were missing. If KEMA found evidence of the contrary, PECI requests information regarding the type and frequency of this issue. | | | |
| | Response: | The recommendation has been expanded to say that additional measurements of pre-conditions including factory, charge adjustment, power draw, and airflow should be included with diagnostic parameters on at least a representative sample of program units. | | | |
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| 121 | 1/8/2010 | Karen des | PGE2068 - Report | Section 5.3.2, Table 5-11 | |
| | Question: | The evaluation report documents significant attrition in the sample size from the pre-post metered units (53 units) to the 'good data' (37 units). PECI requests documentation on the specific criteria and methodology (process) used to identify 'good data' points. Specifically, what were the required data fields and to what degree did PECI's data set fail to provide these data? In addition, PECI requests information regarding the reasons for disqualification of the 16 metered sites that were not deemed 'good data' for the purpose of the evaluation. PECI seeks to use this data to inform future improvements to the Program delivery processes as well as to ensure the necessary data are available for future | | | |

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| | | evaluations. | | | |
| | Answer: | General descriptions are provided in the Appendix of system dispositions that were not included in analyses. Data protocols were added as an Appendix. | | | |
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| 122 | 1/8/2010 | Karen des | PGE2068 - Report | Multiple | |
| | Comment: | The evaluation report documents that staff turn over rates and site staff's ability to recollect Program details 2 or more years after measure installation was a significant barrier to achieving the targeted samples and/or collecting accurate and comprehensive customer feedback. PECI agrees with KEMA that conducting M&V in a more timely matter would contribute to reducing these problems. In addition, PECI concurs that the implementation contractor should educate site staff regarding the likelihood and importance of EM&V follow-up at a later date. | | | |
| | Response: | Does not need to be addressed. | | | |
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| 123 | 1/8/2010 | Karen des | PGE2068 - Report | Multiple | |
| | Comment: | PECI agrees with the CPUC/KEMA HVAC evaluation recommendation that C&I HVAC Programs should have M&V conducted early in the program cycle. In general, PECI agrees that larger data samples are necessary to make meaningful inferences regarding program performance and impact. Specifically, PECI concurs with KEMA that due to the limited samples underlying the study, the presented evaluation data lack sufficient statistical rigor to justify any adjustments to the RCA measure assumptions in the 2008 DEER database. PECI also agrees with the evaluation finding that more EM&V findings require stratification by climate zone. | | | |
| | Response: | Does not need to be addressed. | | | |
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| 124 | 1/8/2010 | John Proctor | | Multiple | |
| | Comment: | The method of estimating the effect of refrigerant charge adjustment is unreliable and contradicts established and more accurate methods performed by EPRI, Texas A&M, Purdue Herrick Labs, Pacific Gas and Electric Company, and others in tightly controlled laboratory settings . | | | From the John Proctor Attachment |

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| | Response: | Laboratory testing and some rigorous case studies have well established the potential energy savings from refrigerant charge adjustment under tightly controlled conditions. The actual performance of measures in the field as applied by the rebate programs was the evaluation goal for unit energy savings. | | | |
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| 125 | 1/8/2010 | John Proctor | | Multiple | |
| | Comment: | Specifically the Duct sealing program causes contractors to seal ducts. Duct sealing is an emerging technology that except for a very few exceptions is never done on existing duct systems. Even when faced with the Title 24 mandate to seal duct systems on AC replacement, the contractors in California fail to seal the ducts and choose to hide this practice from the building inspectors by not pulling permits. | | | From the John Proctor Attachment |
| | Response: | Duct sealing retrofits that were not part of AC replacements were the focus of the HIM evaluation. | | | |
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| 126 | 1/8/2010 | John Proctor | | Multiple | |
| | Comment: | It is extremely likely that this error is due to a lack of “measure specificity” . It is questionable whether there are questions that can be sufficiently measure specific for measure (such as RCA) that is unknown and unintelligible to the customers. | | | From the John Proctor Attachment |
| | Response: | The influence path and decision maker identification are included in the survey instrument added to the Appendix. | | | |
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| 127 | 1/8/2010 | John Proctor | | Multiple | |
| | Comment: | Neither the RCA or the Duct Sealing evaluations used vendor/contractor surveys to attempt to address deficiency in specificity. Even if the contractors had been surveyed, the results would have been heavily biased by the fact the contractors know they “should” be using the proper charge method and they “should” be sealing ducts. | | | From the John Proctor Attachment |
| | Response: | Contractor surveys are included in the Appendix. | | | |
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| 128 | 1/8/2010 | John Proctor | | Multiple | |

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| | Comment: | The methods of determining the installation rates of refrigerant charge adjustment and duct sealing are in error because they make numerous assumptions that are not supported by known facts. | | | From the John Proctor Attachment |
| | Response: | Specific comments are addressed. | | | |
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| 129 | 1/8/2010 | John Proctor | | Multiple | |
| | Comment: | Specifically the evaluators assume that because they find a unit somewhat out of specification by their measurement that the technician did not make an adjustment to the unit that improved its efficiency. In fact changes in location of temperature and humidity sensors have a significant impact on the readings whether they are performed by the evaluator or the RCA technician. For example if a unit is tested and shows a significant amount of undercharge and the technician adds refrigerant, the savings occur whether or not the evaluator at a later date tests the unit and agrees that the superheat or subcooling is exactly within the specified range. | | | From the John Proctor Attachment |
| | Response: | It is agreed that measurement location plays a significant role in measurements. Measured deviations in actual diagnostics were in some cases large and outside the range of measurement location error. The post RCA verification was only able to assess unit performance after the adjustments and assumed units would perform similar to immediately after RCA adjustment. | | | |
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| 130 | 1/8/2010 | John Proctor | | Multiple | |
| | Comment: | Specifically the evaluators assume that their default target for subcooling was what the technicians were using in spite of the fact the evaluator's target was different from some of the program standards and that the technician might have had additional information from the manufacturer on the target subcooling. | | | From the John Proctor Attachment |
| | Response: | The default target is only for units where specific targets were not obtained from nameplates or manufacturers. The default is based on average targets across program units and is added to the descriptions | | | |
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| 131 | 1/8/2010 | John Proctor | | Multiple | |
| | Comment: | Specifically the evaluators assume that ducts were not sealed when their tests indicate a final leakage greater than 16% of nominal AC airflow. However that is not supported by the facts. For example, if the technician found a duct system with any amount of leakage and sealed ducts, then savings occurred even if the evaluator measured the final duct leakage in excess of 16%. Furthermore the program standards were different for different programs and 15% final duct leakage was not the standard for all the programs or all the years. | | | From the John Proctor Attachment |

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| | Response: | Figure 7-1 was meant to illustrate the failing leakages generally had very different measurements than the recorded leakage of 15% or less. Failing units were predominantly not close to the 15% level and if the verified post leakage was subtracted from the recorded pre-sealing leakage, the leakage reductions were generally much smaller than assumed reductions in the ex-ante UES estimate. | | | |
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| 132 | 1/8/2010 | John Proctor | | Multiple | |
| | Comment: | The estimates of precision and reliability are not supported by the actual data from monitored sites nor can the installation verification and estimates of free ridership be considered precise or reliable given the problems with the methods used. Evaluators used an assumed, rather than measured error ratio to estimate the precision of their estimates. | | | From the John Proctor Attachment |
| | Response: | The modeling results using only evaluated data were produced prior to combining the data with previously collected field performance data and showed lower savings for all categories. Due to the small samples in the worst performing categories and the availability of field collected data for those categories the decision to combine data sets was made. In developing precision estimates of the degradation factors which will be added to the report, the precision of the inputs from each data set and the precision of the inputs for the combined set of inputs will be expressed in the report. Precision estimates for achieved measurements in the revised report text does not use assumptions. | | | |
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| 133 | 1/8/2010 | John Proctor | | Multiple | |
| | Comment: | The evaluators ended up with only 42 out of 210 planned residential RCA monitored units that they considered reliable enough to include in the report . The situation is even worse when looking at data for individual programs or individual utilities. | | | From the John Proctor Attachment |
| | Response: | Data used passed numerous levels of quality control and events like no charge adjustment were part of the "good data" rate. "Good data" is a bad term and has been revised. | | | |
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| 134 | 1/8/2010 | John Proctor | | Multiple | |
| | Comment: | The evaluators incorrectly considered multiple units at a single site to be independent data. In fact the same contractor, the same technician, and similar or identical units are most likely found at a single location. In the case of the PG&E2000 Pre-Post metering only one multi family site was involved and only 3 single family sites were involved. | | | From the John Proctor Attachment |

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|  | Response: | The programs were comprised of a majority of multi-unit locations and the limited samples mentioned were due to coordination issues described. |  |  |  |
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| 135 | 1/8/2010 | John Proctor |  | Multiple |  |
|  | Comment: | The verification sample for the PG&E2000 was intended to be 120 multi family units and 30 single family units. In the final analysis data from only 32 multi family sites and 21 single family sites . |  |  | From the John Proctor Attachment |
|  | Response: | Multiple units per site were allowed in the sample design. |  |  |  |
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| 136 | 1/8/2010 | PG&E |  | AC Replacement |  |
|  | Comment: | Documentation of this analysis methodology is also weak. There are a variety of apparent holes in the draft report that leave out specific methods or criteria. For instance, it is noted "the quantified measured savings are restricted only to the savings attributable to the higher efficiency features of the replacement unit and not to the resizing and duct repairs that may be associated with a preemptively replaced unit." (p.18). If the program incentives induced early replacement, it is not clear why the full effects of replacements (including steps taken to comply with code) are not included as a program impact. |  |  | From the PG&E Cover letter attachment |
|  | Response: | The methodology provides additional detail not included in the primary report. Regarding this specific question about ducts, the focus of this evaluation was on the high impact measure, that is, the AC replacement itself. Likewise, the analysis methodology was designed to examine unit performance. |  |  |  |
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| 137 | 1/8/2010 | Karen des | PGE2068 - Vol 2 | Appendix/Table D-7 and Table D-8 |  |
|  | Question: | PECI requests information regarding the climate zones each of the 23 (18) metered units were located in? |  |  |  |
|  | Answer: | Data has been provided in the Appendix. |  |  |  |
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| 138 | 1/8/2010 | Karen des | PGE2068 - Vol 2 | Appendix/Table D-7 and Table D-8 |  |
|  | Question: | Appendix D lists data for only 18 units but the reports suggests there is data for 23 units. PECI requests data for the 5 missing units? |  |  |  |
|  | Answer: | Data has been provided in the |  |  |  |

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| | | Appendix. | | | |