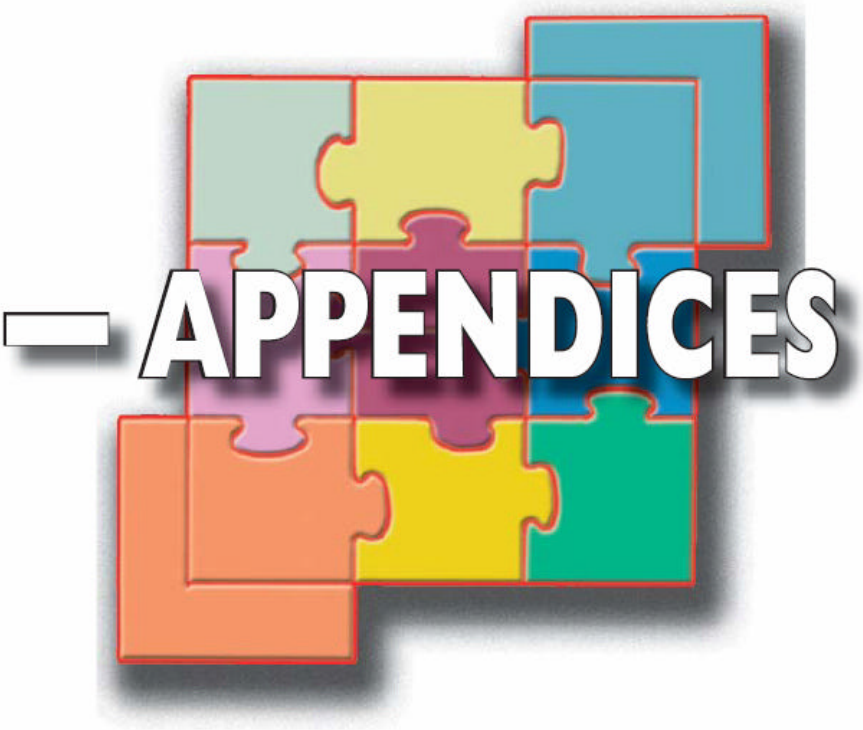
Technical Assistance in Determining Options for

ENERGY EFFICIENCY in EXISTING BUILDINGS



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Technical Assistance in Determining Options for Energy Efficiency in Existing Buildings Appendices

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Technical Assistance in Determining Options for Energy Efficiency in Existing Buildings
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APPENDIX A: EXISTING RESEARCH REVIEW

Research conducted for this project included a review of the available literature that focused on five general topic areas:

1 Evaluation reports from California public goods charge energy efficiency programs conducted during program cycle 2002-2003.
2 Overarching studies covering market analysis, market effects and energy efficiency potential conducted under contract to California Investor Owned Utilities (IOUs) and compiled by the California Measurement Advisory Council (CALMAC).
3 General literature on residential and commercial technologies.
4 Efficiency program evaluations and best practices studies from out-of-state sources.
5 Behavioral and social science literature.

The literature review effort was allocated to each member of the project team according to topic area. The general topic area assignments are as follows:

Contractor	Topic Area
AEC	Evaluation reports from California public goods charge energy efficiency programs conducted during program cycle 2002-2003.
Tecmarket Works	Evaluation reports from California public goods charge energy efficiency programs conducted during program cycle 2002-2003 and general market analysis and market effects literature compiled by California IOUs.
Davis Energy Group	Residential technologies
Mort Blatt	Commercial technologies
RLW Analytics	Out of state program evaluations and best practices
Lutzenhiser Associates	Behavioral and social science literature

Findings compiled from the existing research review are summarized in this section, with the exception of findings from the behavioral and social science literature review, which are compiled in Appendix D. This appendix summarizes existing research on the following topics:

- Energy efficiency savings potential for residential and nonresidential buildings
- Efficiency program characteristics and energy savings goals for the 2004-2005 program cycle

- Efficiency program gaps
- Successes and lessons learned from the evaluations of the 2002-2003 program cycle programs and relevant out-of-state programs

Efficiency Potential

A series of studies conducted by Xenergy (Rufo and Coito, 2002; Coito and Rufo, 2003a, Coito and Rufo 2003b) address energy efficiency potential for electricity and gas in residential and commercial markets. The following sections summarize the estimated efficiency potential and the energy savings projected for current efficiency programs operated for the CPUC by utility and non-utility implementers.

Potential for Energy Savings in Residential Buildings

The residential sector study by Xenergy looked at the technical and economic potential of 35 common residential energy efficiency measures such as compact fluorescent lamps, high efficiency appliances and HVAC, pool pumping, and high performance windows. The list of measures addressed in the studies, sorted by energy, demand and gas savings potential is shown in Table 1.

Table 1. Residential Building Efficiency Technical Potential

Energy Savings Potential			
Measure	GWh/yr	percent total	cum percent
CFLs	6,523	33.1 %	33 %
Refrigerator Early Repl	4,313	21.9 %	55 %
Pool pump and motor	1,152	5.8 %	61 %
Refrigerator	1,077	5.5 %	66 %
2 pane low e window	976	5.0 %	71 %
Clothes washer	654	3.3 %	75 %
Heat pump water heater	622	3.2 %	78 %
Central AC	468	2.4 %	80 %
Sunscreen	420	2.1 %	82 %
Heat pump	419	2.1 %	84 %
Fluorescent lamp	324	1.6 %	86 %
Ceiling insulation	276	1.4 %	87 %
Solar hot water	261	1.3 %	89 %
Wall insulation	214	1.1 %	90 %
Whole house fan	206	1.0 %	91 %
Energy Star dishwasher	199	1.0 %	92 %
Direct evap cooling	197	1.0 %	93 %
Freezer	181	0.9 %	94 %
HVAC test/repair	175	0.9 %	95 %
Clothes dryer	173	0.9 %	96 %
Thermostatic exp valve	127	0.6 %	96 %
Water heater blanket	126	0.6 %	97 %

Demand Savings Potential			
Measure	MW	percent total	cum percent
2 pane low e window	1,295	23.0 %	23 %
Central AC	571	10.1 %	33 %
CFLs	570	10.1 %	43 %
Refrigerator Early Repl	560	9.9 %	53 %
Sunscreen	555	9.8 %	63 %
Direct evap cooling	281	5.0 %	68 %
HVAC test/repair	223	4.0 %	72 %
Pool pump and motor	205	3.6 %	76 %
Thermostatic exp valve	162	2.9 %	78 %
Whole house fan	155	2.7 %	81 %
Refrigerator	140	2.5 %	84 %
Clothes washer	120	2.1 %	86 %
Cool roof	111	2.0 %	88 %
Duct repair	104	1.8 %	90 %
Ceiling insulation	99	1.8 %	91 %
Attic ventilation	68	1.2 %	93 %
Heat pump water heater	60	1.1 %	94 %
Room AC	55	1.0 %	95 %
Wall insulation	51	0.9 %	95 %
Programmable Tstat	47	0.8 %	96 %
Duct insulation	37	0.7 %	97 %
Fluorescent lamp	28	0.5 %	97 %

Natural Gas Savings Potential			
Measure	Mth per year	percent total	cum percent
Solar hot water	820	35.5 %	35 %
Clothes washer	340	14.7 %	50 %
Condensing furnace	200	8.7 %	59 %
Wall insulation	180	7.8 %	67 %
Water heater blanket	120	5.2 %	72 %
Ceil insulation	100	4.3 %	76 %
Energy Star dishwasher	90	3.9 %	80 %
Water heater	90	3.9 %	84 %
Floor insulation	90	3.9 %	88 %
HVAC test/repair	75	3.2 %	91 %
Duct repair	50	2.2 %	93 %
Lo flow showerhead	50	2.2 %	95 %
Aerators	25	1.1 %	97 %
Pipe wrap	25	1.1 %	98 %
Programmable Tstat	20	0.9 %	98 %
Duct insulation	20	0.9 %	99 %
Boiler control	5	0.2 %	100 %
Boiler	5	0.2 %	100 %
Infiltration reduction	5	0.2 %	100 %
Clothes dryer	1	0.0 %	100 %

Energy Savings Potential			
Measure	GWh/yr	percent total	cum percent
Cool roof	107	0.5 %	97 %
Water heater	97	0.5 %	98 %
Duct repair	87	0.4 %	98 %
Attic ventilation	67	0.3 %	99 %
Programmable Tstat	50	0.3 %	99 %
Lo flow showerhead	45	0.2 %	99 %
Room AC	36	0.2 %	99 %
Duct insulation	28	0.1 %	99 %
Aerators	28	0.1 %	100 %
Pipe wrap	24	0.1 %	100 %
Floor insulation	23	0.1 %	100 %
Ceiling fan	18	0.1 %	100 %
Infiltration reduction	16	0.1 %	100 %
Total	19,709		

Demand Savings Potential			
Measure	MW	percent total	cum percent
Solar hot water	25	0.4 %	98 %
Clothes dryer	25	0.4 %	98 %
Freezer	25	0.4 %	99 %
Energy Star dishwasher	17	0.3 %	99 %
Water heater blanket	12	0.2 %	99 %
Ceiling fan	12	0.2 %	100 %
Infiltration reduction	10	0.2 %	100 %
Water heater	9	0.2 %	100 %
Lo flow showerhead	4	0.1 %	100 %
Aerators	3	0.1 %	100 %
Pipe wrap	2	0.0 %	100 %
Heat pump	0	0.0 %	100 %
Floor insulation	0	0.0 %	100 %
	5,641		

Natural Gas Savings Potential			
Measure	Mth per year	percent total	cum percent
	2,311		

Note the top five residential measures in each category (energy, demand and gas) account for 82 percent of energy, 73 percent of the demand and 72 percent of the gas technical savings potential in the residential sector. This list of twelve measures and their respective energy savings potentials are shown in Table 2 below:

Table 2. Top Five Residential Measures for Energy, Demand and Gas Savings

Measure	Electricity Consumption Technical Potential (GWh/yr)	Electricity Demand Technical Potential (MW)	Gas Consumption Technical Potential (Mtherm/yr)
CFLs	6,523	570	0
Refrig Early Repl	4,313	560	0
Pool pump and motor	1,152	205	0
Refrigerator	1,077	140	0
2 pane low e window	976	1,295	0
Clothes washer	654	120	340
Cent AC	468	571	0
Sunscreen	420	555	0
SDHW	261	25	820
Wall insul	214	51	180
WH blanket	126	12	120
Condensing furnace	0	0	200
Total	16,184	4,104	1,660
Pct total potential	82.1 %	72.8 %	71.8 %

Note the data shown here focus on technical potential rather than economic potential, thus some measures may not achieve wide adoption under current economic conditions. However, the data do point to technologies that should be considered given the broad mandate of the AB 549 project to consider market interventions that may improve the adoption of various technologies under market-based and mandatory interventions.

Additional Residential Technologies

A literature search was performed to identify currently available and emerging technologies that could improve energy efficiency and peak demand in existing residential buildings in California. The project team examined several key studies that outline the efficiency potential of mainstream efficiency technologies, and focused significant effort on new technologies and overlooked technologies that were not currently being addressed to full advantage with current market interventions.

With the review of existing studies on mainstream efficiency measures as a starting point, the AB549 residential technologies literature review focused on areas that are currently not well understood. Two main areas are highlighted in this summary:

- The potential impacts of building commissioning and whole house remediation efforts
- Ventilation and air conditioner pre-cooling of homes

The following sections describe the literature reviewed in these two areas.

Building Commissioning and House as a System Remediation

Expanding the reach of the "house as a system" concept is an important concept for exploration under the AB549 project. Currently just a handful of California contractors are using a systems approach towards improving the performance of existing buildings. A PIER-funded project is underway that established the California Building Performance Contractors Association as a means to develop a whole house performance contractor industry in California. The concept of developing a "one stop" shopping approach for homeowners is critical to achieving maximum energy benefits (and IAQ and health & safety) and to streamlining the process from the homeowner perspective. One barrier for the contractor is a significant investment in diagnostic equipment and the need for specialized staff training.

A preliminary sample of 27 whole house retrofit jobs in California and New York indicate an average energy savings of $.70 per ft2 per year for every $10 in remediation cost (Davis Energy Group, 2002; NYSERDA, 2004). Generally poor "traditional" economics is the fundamental problem with the house as a system approach. Since the standard utility TRC approach does not adequately value non-energy benefits, it is important to recognize the comfort, health, and aesthetic benefits of whole house remediation.
An LBNL commissioning study (Matson, et al., 2002) evaluated the potential energy benefits of residential commissioning and implementation of other retrofit remediation options. A wide range of input data (field research, house testing, etc) was used to drive the detailed simulation models used to generate savings projections. Commissioning improvements include envelope and duct "tightening", duct insulation, and air handler airflow and refrigerant charge. For existing homes projected commissioning electric savings were estimated at 14-18 percent (typical) to 20-28 percent (poor performing homes). Projected natural gas savings are estimated to range from 18-21 percent (typical) to 33-36 percent (poor). Opportunity improvements (insulation installation, upgraded windows, HVAC with thermostatic expansion valve (TXV), electronically commutated motor (ECM) and 90 percent AFUE furnace efficiency) are projected to result in 60-75 percent HVAC savings.

The LBNL study did not address the commissioning or retrofit "opportunity" costs, but it did document a $6,000-$15,000 diagnostic test equipment cost for the whole house commissioning contractor. Currently the primary barriers are lack of awareness from homeowners and lack of commissioning and remediation industry infrastructure.

A 2002 study of geothermal heat pump performance in Sacramento and Truckee, California (Davis Energy Group, 2002) provided quantitative data on the potential performance impacts of whole house remediation efforts. In this study, a total of 22 sites were monitored for three to four months during the 2001-2002 winter heating season. Eight of the sites had remediation work undertaken part way through the monitoring to facilitate comparison of heating energy use during both the pre- and post-remediation periods. The five sites in Truckee provided the most instructive results, since the climate is severe enough to provide sufficient temperature differences to resolve the effect of the remediation work.

Half way through the monitoring period, a diagnostic evaluation was performed at the five Truckee sites to assess the building and determine measures that could be cost effectively implemented. Remediation work was done at each of the five houses including adding insulation, repairing insulation and air barrier defects, reducing duct and envelope leakage, and improving system airflow. Post-monitoring continued allowing for direct measurement of the energy savings benefit of the remediation work.

The cost of the remediation work at the five sites ranged from $2100 to $2800, not including $500 per site for the initial diagnostic assessment. These costs may be lower than typical costs for remediation since work occurred on five consecutive days and there was no marketing cost. Projected full season heating savings, extrapolated from the pre- and post- monitoring data, averaged 16 percent (ranging from 0 percent to 31 percent). Projected heating energy savings amounted to 1340 kWh annually, or $2750 of benefit (at $2.06 per life-cycle kWh).

For this severe heating climate, projected remediation benefits were found to be roughly equal to the remediation costs. This indicates that this type of work must be carefully screened to maintain cost effectiveness. Post remediation survey comments from the homeowners indicated a generally high degree of satisfaction with the work and the energy/comfort impacts. (Note that the project paid for the remediation, not the homeowners). The major value of this project was a quantitative measurement of the energy savings of the remediation work. The key lesson learned was that even in a severe climate such as Truckee's, the remediation benefits were marginally cost effective, on average.

Mechanical Night Ventilation and Vapor Compression Pre-Cooling

One currently underutilized area that could potentially offer significant energy and demand benefits is ventilation and vapor compression pre-cooling. Although California IOU's offer incentives for whole house fans, more sophisticated pre-cooling technology options exist. Integrated ventilation cooling products, such as SmartVent and NightBreeze, offer more reliable performance since system operation occurs independent of the homeowner. The following section discusses potential benefits of integrated ventilation cooling and air conditioner pre-cooling.

Phase V of the PIER-funded Alternatives to Compressor Cooling project (Springer, et al., 2004) completed development of the hydronic-based NightBreeze unit which uses a damper system (shown in Figure 1 below) and sophisticated controls to provide

night ventilation cooling, as well as scheduled fresh air ventilation. The damper configuration shown will operate either in conventional return air mode, or in NightBreeze mode where the return damper diverts air to the attic relief, and outside air is supplied to the duct system.

The project's main goal was to address the high peak demand impact of residential air conditioning (~45 percent of residential peak load, but only 7 percent of annual residential energy use) through the application of NightBreeze and intelligent building design. Although primarily a new construction measure, NightBreeze does have potential in the retrofit market, particularly in sizable remodels where proper design can accommodate the system.

Projected NightBreeze cooling demand savings from calibrated simulation modeling range from 5 percent (in the hottest zone) to 65 percent in the milder zones (Bay Area and mountain regions). Typical savings in transitional climates and the inland valley average about 25 percent and range from 15-45 percent. Energy savings range from zero in the mildest zones, to 40 percent in the transitional and inland valley zones (in the hottest zone, the reduced potential for ventilation cooling results in only about 10 percent annual cooling energy savings). The ability to downsize air conditioner capacity represents an additional benefit.

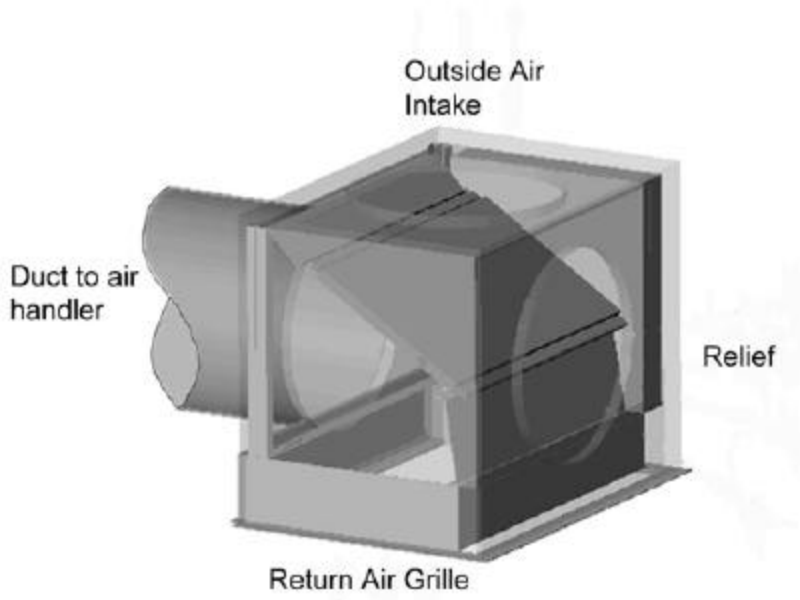

Figure 1 NightBreeze Damper

Several barriers addressed in the report include the high cost of the NightBreeze system (currently not produced in volume), the lack of a gas furnace based NightBreeze unit, and the lack of Title 24 recognition of night ventilation cooling benefits. A PIER-funded project is currently underway which will integrate the NightBreeze hardware and controls with ECM motor equipped gas furnaces. This project will be completed in 2005.

A second PIER-funded project entitled “Residential Hydronic Radiant Cooling and Heating Assessment” summarizes results of detailed monitoring of an advanced HVAC system installed on a house in Winters, California, approximately 30 miles from Sacramento (Smith, et al., 2003). The installed HVAC system was a combined hydronic heating system with the capability of delivering heat to the first floor slab. In cooling mode, the air-cooled condensing unit was coupled with a refrigerant-to-water heat exchanger to deliver hydronic cooling to either the fan coil or to the slab directly. In addition, the NightBreeze night ventilation system was integrated with the HVAC system operation.

The average hourly demand in each of the three modes of operation is plotted in Figure 2. The most significant highlight is the dramatic shift of cooling energy consumption from daytime hours to early morning hours with Modes 2 and 3. This demonstrates the value of off-peak cooling (both ventilation and vapor compression) and thermal mass in the Sacramento climate.

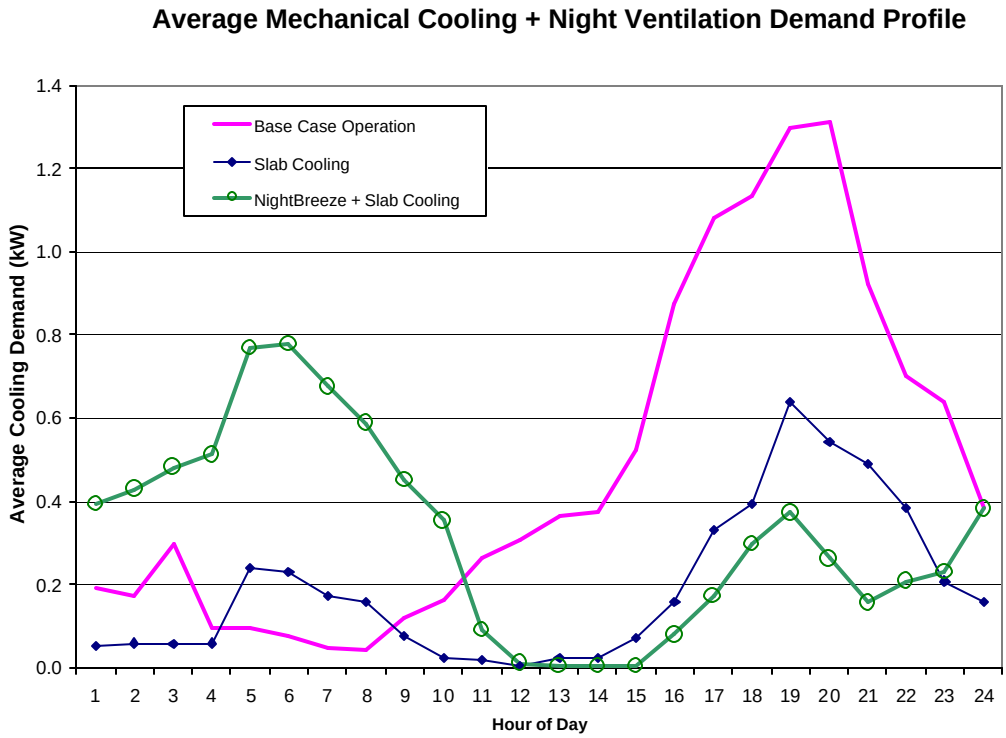

Figure 2 Building Demand Profile With and Without Precooling

A third study, commissioned by Beutler Heating and Air of Sacramento, California, evaluated the energy and operating cost implications of off-peak air conditioner pre-cooling in Sacramento and Fresno climates (Davis Energy Group, 2003). The primary goal was to evaluate various house pre-cooling strategies based on avoiding PG&E’s noon to 6 PM peak period. The methodology involved developing DOE-2 house models validated with detailed 15-minute interval field monitoring data, and determining base case cooling profiles. The various pre-cooling strategies were then

evaluated by varying the pre-cooling target setpoint temperature (70, 72, and 74F) and also the length of the pre-cooling period (ranging from 6 AM to noon, to 10 AM to noon). Results of the study indicate the following:

- In both Sacramento and Fresno climates the preferred pre-cooling control strategy was found to be a 72°F setpoint for the period of 6 AM to noon. This generated savings of approximately $120 to $170 per year under current E-7 TOU rates, resulting in a meter cost payback of about two years (note savings will be higher with high use customers who have significant usage in the highest electric rate tiers).
- The pre-cool strategy avoided ~75 percent of on-peak air conditioning use in both climates. Annual cooling energy usage increased 10-20 percent with the pre-cooling approach, although this increase may look favorable from a time dependent valuation (TDV) perspective where the energy value of on-peak energy consumption is higher than off-peak consumption.

As shown in the prior AEC study, Smart Vent or NightBreeze night ventilation systems work well in conjunction with the mechanical pre-cooling strategy. Homeowner operating cost savings under the E-7 rate more than double with the night ventilation strategies and the combined “vent + pre-cool” approach generates projected energy savings of 20-50 percent.

Potential for Energy Savings in Commercial Buildings

The Xenergy commercial sector study looked at the technical and economic potential of common commercial efficiency measures such as interior lighting, exterior lighting, cooling, ventilation, refrigeration and office equipment electricity improvements.

The list of measures addressed in the studies, sorted by energy, demand and gas savings potential is shown in Table 3.

Table 3. Commercial Building Efficiency Technical Potential

Energy Savings Potential			
Measure	GWh/yr	percent total	cum percent
T8/electronic ballast	2,539	17.2 %	17 %
Perimeter dimming	1,696	11.5 %	29 %
Refrig. compressors	1,222	8.3 %	37 %
Occupancy sensors	1,104	7.5 %	45 %
Office Equip Pwr Mgt	1,019	6.9 %	51 %
T8/elec ballast, reflector	1,010	6.9 %	58 %
CFL	724	4.9 %	63 %
Chiller	478	3.2 %	67 %
Refrigeration Controls	458	3.1 %	70 %
Ventilation fan VSD	453	3.1 %	73 %
DX air conditioning	445	3.0 %	76 %
Refrig. case covers	350	2.4 %	78 %
Ext HP sodium lamps	319	2.2 %	80 %
Cooling system tune-ups	308	2.1 %	82 %
Halogen lamps	295	2.0 %	84 %
Programmable Tstat	277	1.9 %	86 %
Metal halide lamps	273	1.9 %	88 %
Ext. lighting control	236	1.6 %	90 %
Energy Mgt System	227	1.5 %	91 %
Window Film	224	1.5 %	93 %
Cool Roof	193	1.3 %	94 %
Evap. pre-cooler	170	1.2 %	95 %
LCD Monitor	165	1.1 %	96 %
Vent motor	156	1.1 %	97 %
Off. Eq Nite Shutdown	113	0.8 %	98 %

Demand Savings Potential			
Measure	MW	percent total	cum percent
Perimeter dimming	769	20.9 %	21 %
T8/electronic ballast	485	13.2 %	34 %
Chiller	315	8.6 %	43 %
Occupancy sensors	290	7.9 %	51 %
DX air conditioning	246	6.7 %	57 %
T8/elec ballast, reflector	202	5.5 %	63 %
Cooling system tune-ups	186	5.1 %	68 %
Refrig. compressors	151	4.1 %	72 %
Energy Mgt System	147	4.0 %	76 %
CFL	124	3.4 %	79 %
Window Film	124	3.4 %	83 %
Cool Roof	95	2.6 %	85 %
Evap. pre-cooler	95	2.6 %	88 %
Office Equip Pwr Mgt	86	2.3 %	90 %
Chiller Pumps	73	2.0 %	92 %
Halogen lamps	55	1.5 %	94 %
Metal Halide lamps	51	1.4 %	95 %
Programmable Tstat	46	1.3 %	96 %
LCD Monitor	29	0.8 %	97 %
Vent motor	28	0.8 %	98 %
Ventilation fan VSD	26	0.7 %	99 %
Refrig. controls	18	0.5 %	99 %
Refrig. commissioning	15	0.4 %	99 %
Refrig. case covers	10	0.3 %	100 %
Refrig. misc	6	0.2 %	100 %

Natural Gas Savings Potential			
Measure	Mth	percent total	cum percent
Solar water heater	184	26.1 %	26 %
Furnace/Boiler	103	14.6 %	41 %
water heater	97	13.7 %	54 %
Infrared fryer	61	8.6 %	63 %
2 pane low e window	50	7.1 %	70 %
Infrared conv oven	45	6.4 %	76 %
Energy Mgt System	31	4.4 %	81 %
Water htr. tank insul	30	4.2 %	85 %
Infrared griddle	23	3.3 %	88 %
Convection oven	18	2.5 %	91 %
Pwr burner fryer	13	1.8 %	93 %
Pwr burner oven	12	1.7 %	94 %
Pool cover	7	1.0 %	95 %
Faucet Aerator	5	0.7 %	96 %
Solar pool heater	5	0.7 %	97 %
Instantaneous WH	5	0.7 %	98 %
Pool heater	4	0.6 %	98 %
EMS optimization	4	0.6 %	99 %
Pump timer	4	0.6 %	99 %
Duct insulation	2	0.3 %	100 %
low flow shower	1	0.1 %	100 %
Boiler tune-up	1	0.1 %	100 %
Pipe insulation	1	0.1 %	100 %
Air-air heat exchanger	0	0.0 %	100 %
Ceiling insulation	0	0.0 %	100 %

Energy Savings Potential			
Measure	GWh/yr	percent total	cum percent
Refrig. commissioning	112	0.8 %	99 %
Chiller Pumps	110	0.7 %	100 %
Refrig. Misc	45	0.3 %	100 %
Total	**14,721**		

Demand Savings Potential			
Measure	MW	percent total	cum percent
Ext HP sodium lamps	3	0.1 %	100 %
Ext. Lite Cont.		0.0 %	100 %
Off. Eq Nite Shutdown		0.0 %	100 %
	3,675		

Natural Gas Savings Potential			
Measure	Mth	percent total	cum percent
	706		

Note: the top five nonresidential measures in each category (energy, demand and gas) account for 58 percent of energy, 64 percent of the demand and 70 percent of the gas technical savings potential. These twelve measures with their respective energy savings potentials are shown in Table 4 below:

Table 4. Top Five Commercial Measures for Energy, Demand and Gas Savings

Measure	Electricity Consumption Technical Potential (GWh/yr)	Electricity Demand Technical Potential (MW)	Gas Consumption Technical Potential (Mtherm/yr)
T8/electronic ballast	2,539	485	0
Perimeter Dimming	1,696	769	0
Refrig. Compressors	1,222	151	0
Occupancy Sensor	1,104	290	0
Office Equip Pwr Mgt	1,019	86	0
Chiller	478	315	0
DX air conditioning	445	246	0
Solar water heater	0	0	184
Furnace/Boiler	0	0	103
Water heater	0	0	97
Infrared fryer	0	0	61
2 pane low e window	0	0	50
Total	8,503	2,342	495
Pct total potential	58 %	64 %	70 %

Note: The data shown here focuses on technical potential rather than economic potential, thus some measures may not achieve wide adoption under current economic conditions. However, the data do point to technologies that should be considered given the broad mandate of the AB 549 project to consider market interventions that may improve the adoption of various technologies under market-based and mandatory interventions.

Additional Commercial Technologies

A literature search was performed to identify currently available technologies that could improve energy efficiency and peak demand in existing commercial buildings in California. The effort focused on new technologies and overlooked technologies that were not currently being addressed to full advantage with current market interventions.

Information was gathered, reviewed and synthesized from a number of sources including emerging technologies in the Energy Commission (Energy Commission) Public Interest Energy Research program (PIER), previous work done by contractors for the Energy Commission in support of AB549, a recent survey (August and

October 2004) performed by the American Council for an Energy Efficient Economy (ACEEE), proceedings of an Emerging Technologies in Energy Efficiency Summit in October 2004 and information obtained from a cool storage manufacturer, compressor manufacturers, and the Green Buildings Initiative. The review identified hardware, software and service technology opportunities that were sorted by technology type (lighting, heating and cooling, refrigeration, office equipment, building envelope, controls, components, and services) and then analyzed to determine which promising technology elements might be more aggressively deployed.

The following technology elements were deemed worthy of additional attention:

- Emerging lighting technologies (including dimmable electronic ballasts for integrating ambient lighting with day lighting and with task lighting, retrofit fluorescent downlights, and integrated classroom lighting)
- Cool storage
- High efficiency variable-speed chiller compressors
- Automated diagnostics, sensing, fault detection, control
- Retro commissioning
- Improved installation and repair of small HVAC systems in the field
- Improved power supplies

Dimmable Ballasts

The use of task lighting affords the opportunity to focus light on the work surface, thereby permitting the use of lower levels of ambient (overhead) lighting. Potential and energy savings of 600 GWh are possible if the full market potential of task lighting is realized in commercial buildings in California (Sachs, et al, 2004a). Energy savings for perimeter daylighting are on the order of 1700 GWh, with demand reduction benefits estimated at 770 MW. Daylighting is a resource that is most available when peak demand periods often occur; during hot summer afternoons. As such daylighting is a technology that could improve utility load factors by reducing peak demand to greater extent than the corresponding energy use reduction. Integration of task lighting and ambient lighting and integration of daylighting and ambient lighting have a common need for low-cost, efficient dimmable ballasts to be more cost effective. Experience with LBNL efforts on the NY Times project (Pederson, 2004 and Selkowitz, 2004) showed that in this project alone ballast costs were reduced by more than 50 percent lower than had been initially expected due to the size of the project. Additional large projects will help bring the costs down as would purchase mandates for government buildings, for example (in Federal buildings and in California and other state buildings).

Emerging Lighting Technologies

An assessment of the demand reduction potential of emerging lighting technologies showed that load shed ballasts, compact fluorescent downlights and classroom

photosensors had attractive peak demand reduction costs. Only market ready or soon to be market ready technologies were considered. This eliminated LED task lighting and portable work station lighting, for example.

Load shedding ballasts were studied by the Lighting Research Center as a demand response tool that could quickly respond to a utility signal for reduced power demand, although retrofit technology is not currently cost effective at projected costs. Also no manufacturer had been found as of the date of the last inquiry.

Classroom photosensors (with a desktop commissioning tools and a sliding set point control algorithm) provide the means for controlling the ambient lighting when using bi-level fixtures or dimmable ballasts in combination with daylighting. The product could be used in other commercial building environments in addition to classrooms. More study is needed to determine market potential and desired market actions needed to achieve this potential.

Cool storage

Cool storage, once a mainstay of utility load management efforts to move load from on-peak to off-peak periods have taken a back seat to energy efficiency technologies that reduce electricity use relatively uniformly over the course of a day. Careful design and installation can permit deployment and operation of cool storage units with similar or reduced installed costs and energy requirements compared to non-storage systems (MacCracken, 2003). More careful documentation of these energy use and installed cost assertions is needed but it is clear that cool storage can cost-effectively reduce peak demand compared to other technologies. A modest incentive of around $250 per avoided peak kW combined with time-of-use rates that adequately account for time-dependent utility generation costs are elements that would encourage the deployment and operation of this technology. A guarantee that rates of this type would be in place for an extended period sufficient to permit recovery of any incremental cost or risk would also be advisable. Aggressive publicity would also be needed to make potential adopters aware of the opportunity. Modular units are available to readily fit into commercial building retrofit situations. Trigger events for adoption of cool storage could be that the existing cooling equipment is expensive to maintain or unreliable, or that the building cooling requirements have increased due to additions or tenant changes. Changes in rates would have to very dramatic to get the attention of the building owner.

High-efficiency, variable speed, oil-free centrifugal compressor with magnetic bearings

A high-efficiency, variable speed, oil-free centrifugal compressor with magnetic bearings provides significant energy savings when replacing older less-efficient small compressors. Units are available in 60 ton to 150 ton sizes. Energy savings potential for these machines could be as much as 1400 to 2100 GWh/yr in California if they replaced existing older compressors (with efficiencies of about 50 percent of these new compressors). Peak demand savings potential in a retrofit scenario is on the order of 1000 MW, based on data supplied by the manufacturer (Danfoss, 2004).

These new compressors appear to have considerable energy savings potential when compared to older units that they may be replacing. Demand savings are somewhat lower proportionally than energy savings, making the load factor less desirable than if the demand savings fraction exceeded the energy savings fraction. Moreover when the new magnetic bearing, oil-free, variable speed, centrifugal compressors are compared to new, more conventional small high-efficiency compressors this undesirable load factor is exacerbated.

Further studies of these compressors should be undertaken with independent laboratory testing and field demonstration to confirm the performance information provided by the manufacturer and to assess the benefits provided by the technology compared to other available cooling technologies.

Integrated Building Environmental Communications Systems (IBECS).

The Integrated Building Environmental Communications System (IBECS) is a communication network developed by Lawrence Berkeley National Laboratory. IBECS is useful for economically controlling 0-10 VDC dimmable fluorescent lamp ballasts in commercial buildings using the existing wiring infrastructure. These communication systems are designed to be low-cost units ranging from $1-2 when produced in mass quantities. The overall goal of the IBECS utility is to provide appropriate automation of lighting systems to increase energy efficiency, improve building performance, and enhance occupant comfort and satisfaction. The IBECS utility also uses internet-based tools to manage building electrical loads, while allowing occupants control of local lighting. The IBECS utility can also take advantage of load shedding by coupling dynamic control of lighting with real-time monitoring of electric lighting power through the internet-based protocol.

There has not been a study conducted to calculate the estimated savings in California, however, such lighting devices have the potential to save 1.6 quadrillion BTUs a year in commercial lighting systems nationwide. Trigger events for these devices are major lighting retrofits and building renovation projects. Since re-wiring is a major barrier for technologies to be adopted, wireless technologies may provide a means to increase the penetration of the technology in the future.

Retro commissioning

Retro commissioning refers to a systematic series of tests and procedures designed to identify and correct performance deficiencies in existing buildings. Design flaws, construction defects, malfunctioning equipment, deferred maintenance, and sub optimal operating and control strategies contribute to energy waste in existing buildings. Along with energy waste, indoor air quality, occupant comfort and equipment life may also be affected. A meta-analysis of the costs and benefits of commissioning new buildings and retro commissioning existing buildings concluded that retro commissioning may offer greater energy savings at lower costs than traditional hardware programs (Mills, et al., 2004). The study examined commissioning reports from 150 buildings, representing 22 million square feet of floor

space in 15 states. About 25 percent of the projects were located in California. The costs and benefits of retro commissioning are summarized in Table 1 below:

Table 5. Retro-commissioning Costs and Benefits

Performance Metric	Median value
Commissioning cost	$0.27/ft2
Energy savings	15 % of whole building consumption
Simple payback	0.7 years
Electricity savings	1.7 kWh/ft2
Average demand savings	0.6 W/ft2
Natural gas savings	6.5 kBtu/ft2
Thermal energy savings (steam, chilled water, hot water from central plant)	64 kBtu/ft2
Non-energy benefits	$0.18/ ft2

Problems relating to HVAC systems and controls were most prevalent. Actions taken included design changes, installation modifications, replacing failed components such as control sensors and actuators, revising control strategies, calibrating control systems and performing needed maintenance. The study concluded that retro commissioning is more effective that new building commissioning, with a six fold greater median energy savings at a four fold lower cost.

The study recommends that retro commissioning not be considered a ”one-time” activity, but be integrated with traditional operations and maintenance activities. Market drivers to increase the acceptance of retro commissioning include risk management, where uncertainty in energy costs are reduced and along with potential liabilities from inadequate indoor air quality or lack of occupant comfort. Green building certification programs such as the U.S. Green Building Council Leadership for Energy and Environmental Design (LEED) are also important market drivers for retro commissioning. Energy efficiency programs are recognizing retro commissioning as an important resource acquisition strategy. Education programs for building operators and owners to increase the service capacity and awareness are needed.

Another study, the Commissioning in Public Buildings Project was conducted by the Building Commissioning Association – Northwest (BCA-NW) for the Northwest Energy Efficiency Alliance. Specific objectives of the project include: Educating facility and project managers, administrators, and business managers on the benefits of commissioning; demonstrating commissioning and analyzing results; establishing state requirements and model policies for commissioning for local governments and schools; and disseminating commissioning results and model policies. Within the demonstration projects, the estimated energy savings ranged from 0.0 to 1.53 kWh per square foot per year for retro-commissioning, depending on the building type at an average cost of $0.24 per square foot. In discussing the benefits of commissioning, a number of owner representatives mentioned that a big change for them is that ”the buildings work” without having to call the contractor back countless times and disrupt operations while problems are resolved (Quantum Consulting, 2003).

Improved installation and repair of small HVAC systems in the field

Several studies have documented pervasive problems with small HVAC systems in commercial buildings. Felts (2001) found 50 to 75 percent of economizers installed on small packaged rooftop units were malfunctioning. A study of recently constructed buildings for the Energy Commission PIER program (AEC, 2003) inspected 215 rooftop units to understand fan flow and power, economizer operation, and refrigerant charge. Items investigated included thermostat set point, fan controls, economizers (64 percent failure), distribution systems, supply fan power (20 percent too high), unit air flow (39 percent with inadequate air flow), and refrigerant charge (46 percent were improperly charged). Correcting the air flow provided 9 percent savings and properly charging the units yielded 5 percent savings. Measures were taken to bring each item into acceptable performance ranges and cumulative electricity savings of 8.4 percent, gas savings of 30.2 percent, demand savings of 6.1 percent and overall savings of $0.26/ft2 were computed. Poor installation and maintenance practices observed included: missing filters, dirty coils, faulty wiring, incompatible curbs, and exhaust and intakes poorly located.

Leaky ductwork is a common problem plaguing small commercial systems. A recent study of 350 small commercial HVAC systems in Southern California found that 85 percent of the systems tested had excessive duct leakage (Modera and Proctor, 2002). The average combined supply and return leakage in these systems exceeded 35 percent of the total air volume, causing energy waste and poor thermal comfort. Energy benefits from duct tightening are estimated to be about 20 percent of the annual cooling consumption in buildings where duct systems are located in an unconditioned space. Peak demand savings are greater due to higher ambient temperatures during summer peak hours. Comfort in buildings with tight ducts is expected to improve, since the HVAC systems will be better able to serve the loads in the space. In commercial buildings, where the HVAC systems supply continuous ventilation air, leaky and poorly insulated duct systems can actually contribute to warming the space during the cooling season by supplying air that is warmer than room temperature. In this case, duct tightening can improve comfort during building ventilation.

Several commercially available programs exist to improve the operation of small commercial rooftop HVAC systems, including CheckMe (Proctor Engineering), Air Care Plus (Portland Energy Conservation, Inc.), and Verify-RCA (Robert Mowris and Associates). Specialized tools such as the Honeywell Service Assistant (Honeywell) are available to assist HVAC technicians in rooftop unit diagnostics and tune-up. Aeroseal (Carrier) is a product that seals leaky ductwork using an aerosol sealant injected into a duct system.

The programs mentioned above have been used as efficiency resource acquisition strategies in California and elsewhere. Market drivers for improving the operational efficiency of small commercial HVAC systems include information and training for building owners, operators and service technicians to increase awareness of the issue and improve the capability of trade allies to deliver better quality service. Model service contracts provide language to differentiate high-quality service procedures. The PIER study mentioned above recommends upstream interventions aimed at

manufacturers to improve the reliability, maintainability and fault tolerance of small commercial HVAC systems. A current PIER project is underway involving the Energy Commission, several HVAC unit manufacturers, the Consortium for Energy Efficiency (CEE) and others to create a national specification for an advanced packaged rooftop unit (AEC, 2005).

Power Supplies

Studies sponsored by the Energy Commission PIER program (Ecos Consulting and EPRI PEAC, 2004) are addressing the opportunity to increase the efficiency of internal and external power supplies. There are two main power supply technologies, linear and switching. Linear technologies, akin to magnetic ballasts, are bulky with efficiencies of 20 percent to 70 percent. Switching designs are more compact and energy efficient, switching on and off rapidly like an electronic ballast. They are typically 60 percent to 90 percent efficient. Power supplies can be found inside electronic products (internal power supplies) or externally in separate enclosures that plug into an electrical outlet (external power supplies or “wall warts”). External power supplies typically drive lower wattage products than internal power supplies and are more likely to be linear designs. Confining high voltage to an external circuit simplifies heat dissipation as well as the UL approval process for electronic equipment. Internal power supplies often require active cooling which can be burdensome in applications where space and power constraints are an issue. As such internal power supplies having efficiencies greater than 90 percent are available for applications where minimum space and cooling requirements are important. Highly efficient external power supplies are also available in markets such as cell phones and laptop computers where customers will pay a premium for portability and efficiency.

High efficiency external and internal power supplies are available at only a modest cost premium to less efficient products. While the cost of upgrading external power supplies to high efficiency technology seems small for an external power supply ($.30 to $1 per unit) but this low absolute cost is often a large fraction of the product cost ($1 to $3). If all answering machines, cordless phones, internet boxes, video cameras and cordless tools in California were upgraded to use the best available power supplies, the lifetime savings would be 564 GWh (Caldwell, et al., 2002).

The average desktop computer uses five times more energy than the average laptop (570kWh/yr vs. 100kWh/yr) (Foster, et al., 2003). Part of this savings is attributable to improved power supplies used in laptops. Typical desktop power supplies are 55 percent - 70 percent efficient. The most advanced new desktop power supplies are more than 80 percent efficient and often do not require a cooling fan. A $5 increment in first cost for a better power supply could save $25 in energy cost over the life of the computer. The 80+ program, currently being promoted to electric utilities for inclusion in their incentive programs, offers a manufacturer a $5 buy down for each 80+ computer made (Sirkin, 2004a). The program goals are more ambitious than the Intel specification being considered by EPA. Utilities are being recruited to adopt the 80+ program and to thus extend the envelope of highly efficient power supply specifications beyond what EPA has been considering (Sirkin, 2004b). If the 80+ program was in place in California and all existing desktops were eventually

upgraded to 80+ units, the resulting energy savings are shown in Table 6 (Ecos Consulting, 2004):

Table 6. Statewide Energy Savings from Improved Computer Power Supplies.

Desktops	Energy Savings/Unit (kWh/yr)	Units	Energy Savings(GWh/yr)	Demand Savings per Unit (W)	Demand Savings (MW)
Residential	75	6,435,000	480	22	142
Commercial	88	19,305,000	1700	16	309
Total			2180		451

The 80+ program seems to be well grounded in logic and appears to be both aggressive and realistic. Support by California utilities as encouraged by the Energy Commission would be a major boost for the program. Encouraging California State purchasing agents to specify 80+ desktop computers would also be valuable in vitalizing this effort.

Current Energy Efficiency Programs

The efficiency program portfolio for the 2004-2005 program cycle consists of close to 100 distinct programs offered by a combination of the state's four investor owned utilities (IOUs), partnerships between the IOUs and local governments, and non-utility program implementers. Funding for these programs comes from the public goods charge (PGC) fund and procurement funding provided by the IOUs. Total funding for all programs exceeds $741 million. Annual electricity savings are expected to be on the order of 3,900 GWh, peak demand savings are expected to be on the order of 790 MW, and annual gas consumption savings are expected to be on the order of 56 Mtherms. According to the efficiency technical savings potential established by the Xenergy Residential and Commercial Efficiency Potential Studies, this represents about 11 percent of the technical electricity savings potential, 8.5 percent of the demand savings potential, and 1.8 percent of the natural gas savings potential.

Market Sectors Targeted

A program characteristics database was created by members of the project team for the CPUC Master Evaluation Contractor Team (MECT)[1]. The MECT database was queried to develop information about the portfolio of programs offered during the current program cycle. The number of programs addressing the residential, commercial, institutional, agricultural and industrial market segments is shown in Figure 3 below. The majority of programs serve multiple market segments. Programs serving individual markets are spread fairly evenly across the residential and commercial sectors.

[1] The Master Evaluation Contractor Team consists of Tecmarket Works, Megdal Associates, Architectural Energy Corporation, B&B Resources and Ken Keating.

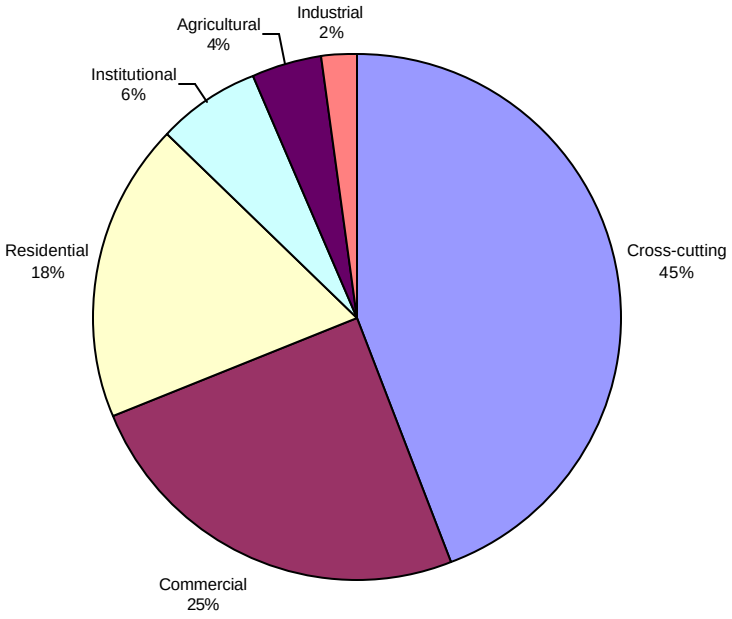

Figure 3. CPUC Efficiency Programs by Market Sector

Program Strategies

The number of programs offering various types of services is summarized in Figure 4 below:

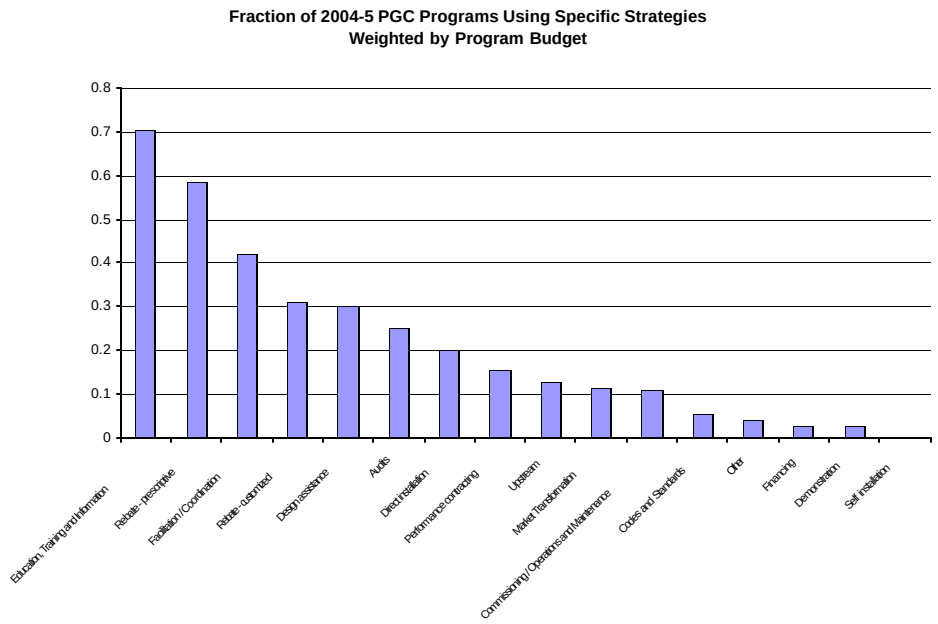

Figure 4. Program Strategies

Note, most programs offer some education, training or information component. Audits, rebates, direct installation of measures, and design assistance are traditional program strategies commonly used in the current portfolio of programs. Commissioning services and/or operations and maintenance services are offered in 10 percent of the programs. Innovative financing and upstream market interventions are the least used strategies in the portfolio; strategies which are under consideration for the AB 549 project.

Market Actors Targeted

The market actors targeted by the programs are summarized in Figure 5 below:

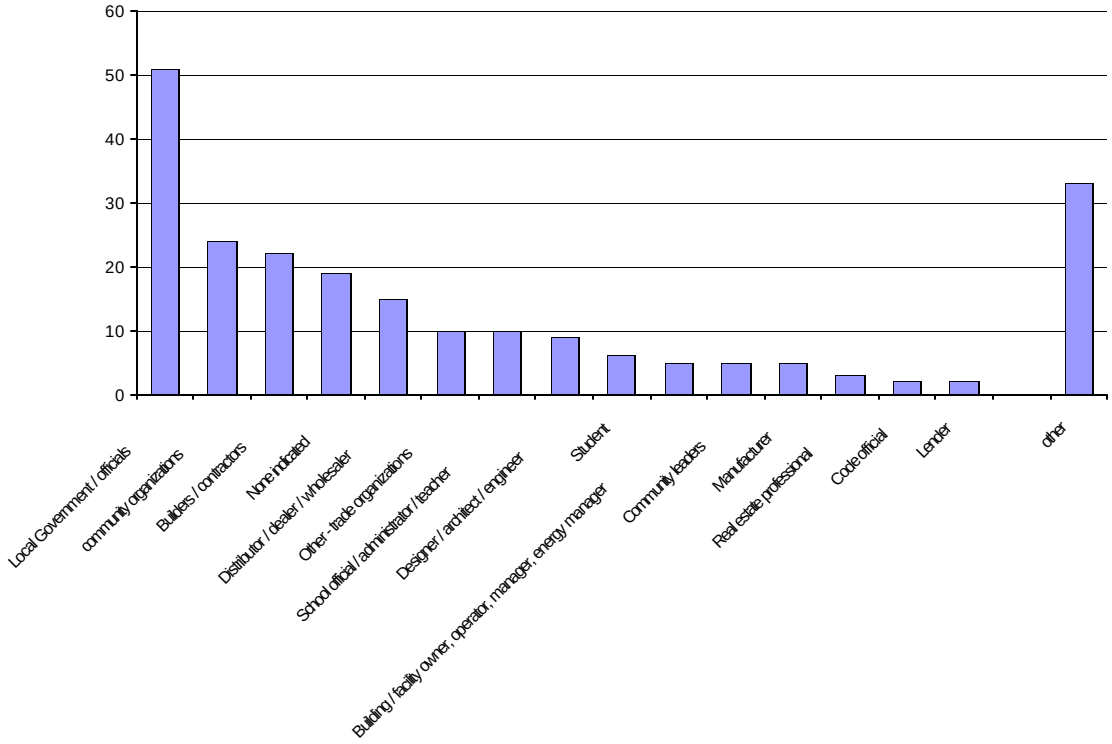

Figure 5. Market Actors Targeted

Note, local governments, and community organizations are targeted by a number of programs, reflecting the presence of IOU/Local government partnership programs and programs targeting hard-to-reach (HTR) customers. However, manufacturers, real estate professionals, and lenders are not targeted very often by these programs.

The market events targeted by the programs are shown in Figure 6 below.

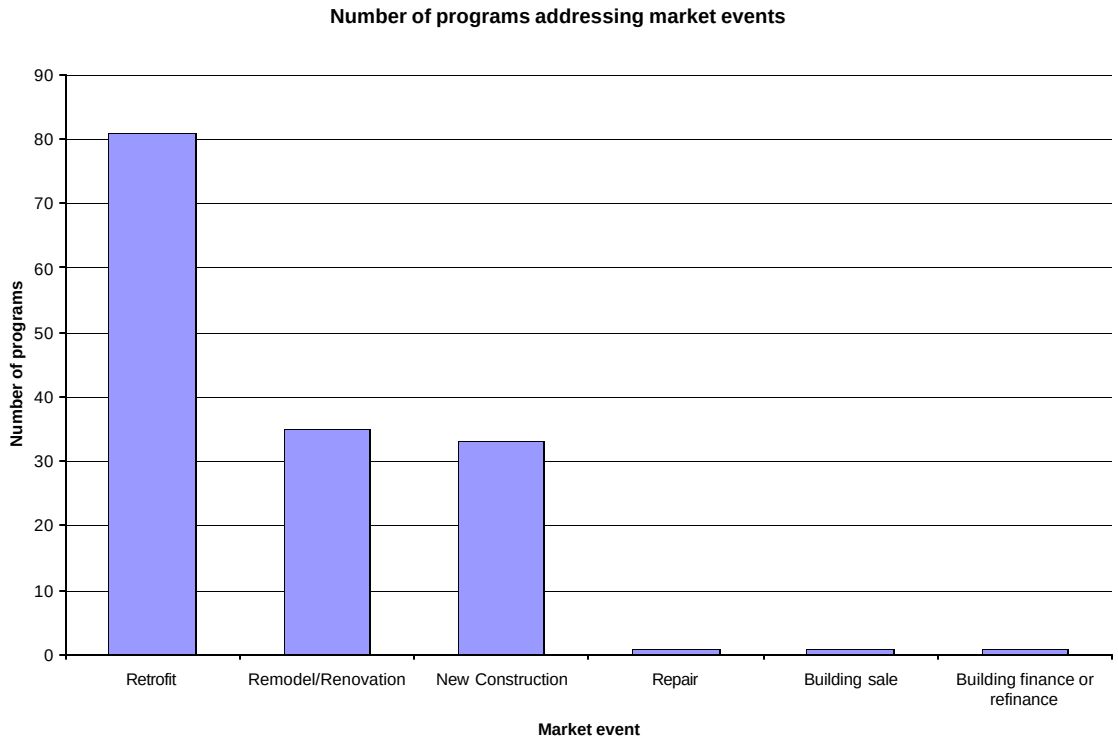

Figure 6. Market Events Targeted by Programs

The majority of programs target retrofits, which may or may not be tied to any particular market event. Programs targeted at repair, building sale and building finance/refinance market events are rare.

Measures Promoted

Program implementation plans submitted by each program implementer in the 2004-2005 program cycle were examined to identify the measures promoted and expected savings associated with each measure. The program portfolio includes IOU and non-utility programs funded through the Public Goods Charge (PGC) mechanism, and additional procurement funding supplied by the IOUs. The PIPs list the ex-ante savings expectations and expected program accomplishments over the two year program cycle. A series of tables were constructed from the PIP workbooks that summarize the expected energy savings from several perspectives, including savings by customer class, savings by measure for all programs, and savings by measure disaggregated into residential and commercial programs. The expected accomplishments are also compared to the estimated technical potential from the Xenergy studies.

Table 7. 2004-2005 Program Portfolio Savings by Customer Class

Customer class	MW	GWh	MTherm	percent total MW	percent total GWh	percent total Mtherm
Agricultural	2	13	1	0.2 %	0.3 %	1.6 %
Large commercial (> 500 kW)	166	1,024	9	21.0 %	26.2 %	15.7 %
Medium commercial (100 – 500 kW)	151	685	10	19.1 %	17.5 %	18.2 %
Residential	330	1,526	22	41.6 %	39.0 %	39.3 %
Very small or small commercial (< 100 kW)	143	665	14	18.1 %	17.0 %	25.3 %
	792	3,913	56			

Table 8. Estimated Electricity Consumption, Demand and Natural Gas Savings for the 2004-2005 Program Portfolio by Measure Category for All Customers

Measure Category	MW	GWh	MTherm	percent of total kW	percent total kWh	percent total Mtherm
Shell	25.5	41.4	4.1	3.2 %	1.1 %	7.4 %
Appliances	28.0	158.6	5.5	3.5 %	4.1 %	9.9 %
HVAC	103.5	259.6	18.8	13.1 %	6.6 %	33.8 %
Lighting	422.8	2,516.1	0.0	53.4 %	64.3 %	0.0 %
Foodservice	2.3	15.7	1.5	0.3 %	0.4 %	2.6 %
Motors	7.1	98.1	0.3	0.9 %	2.5 %	0.6 %
Water heating	0.9	3.7	15.1	0.1 %	0.1 %	27.0 %
Refrigeration	20.4	147.1	0.0	2.6 %	3.8 %	0.0 %
Other	181.4	673.0	10.4	22.9 %	17.2 %	18.7 %
Total	792.0	3,913.4	55.7			

Table 9. Estimated Electricity Consumption, Demand and Natural Gas Savings for the 2004-2005 Program Portfolio by Measure for All Customers

Measure Category	Measures	MW	GWh/yr	Mtherm/yr	percent of total MW	percent total GWh	percent total Mtherm
Shell	2 pane low e window	9.5	7.0	1.02	1.2 %	0.2 %	1.8 %
	Attic insulation	6.6	7.2	1.57	0.8 %	0.2 %	2.8 %
	Cool roof	4.8	7.1	0.00	0.6 %	0.2 %	0.0 %
	Wall insulation	1.4	1.1	0.50	0.2 %	0.0 %	0.9 %
	Window film	3.3	18.9	0.00	0.4 %	0.5 %	0.0 %
	Infiltration reduction	0.0	0.0	0.00	0.0 %	0.0 %	0.0 %
	Other shell	0.0	0.0	0.99	0.0 %	0.0 %	1.8 %
Appliances	Clothes washer	0.8	5.8	4.55	0.1 %	0.1 %	8.2 %
	Dish washer	0.3	3.1	0.94	0.0 %	0.1 %	1.7 %

Measure Category	Measures	MW	GWh/yr	Mtherm/yr	percent of total MW	percent total GWh	percent total Mtherm
	Freezer	2.0	10.7	0.00	0.3 %	0.3 %	0.0 %
	Office Equip Pwr Mgt	0.0	4.5	0.00	0.0 %	0.1 %	0.0 %
	Refrigerator	23.2	133.2	0.00	2.9 %	3.4 %	0.0 %
	Room AC	1.8	1.3	0.00	0.2 %	0.0 %	0.0 %
HVAC	Boiler	0.0	0.0	3.58	0.0 %	0.0 %	6.4 %
	Boiler control	0.0	0.0	1.50	0.0 %	0.0 %	2.7 %
	DX AC	33.9	49.0	0.00	4.3 %	1.3 %	0.0 %
	Chiller	5.5	35.9	0.00	0.7 %	0.9 %	0.0 %
	Commissioning	3.3	17.3	0.53	0.4 %	0.4 %	1.0 %
	Tune-ups	21.8	56.1	1.47	2.8 %	1.4 %	2.6 %
	Duct sealing	2.0	2.6	0.21	0.3 %	0.1 %	0.4 %
	EMS	2.6	8.6	0.18	0.3 %	0.2 %	0.3 %
	Evap AC	6.6	6.8	0.00	0.8 %	0.2 %	0.0 %
	Furnace	0.0	0.0	0.62	0.0 %	0.0 %	1.1 %
	Heat pump	0.2	0.1	0.00	0.0 %	0.0 %	0.0 %
	Heat recovery	0.3	1.1	0.30	0.0 %	0.0 %	0.5 %
	Programmable Tstat	21.9	78.3	10.46	2.8 %	2.0 %	18.8 %
	Whole house fan	5.3	3.9	0.00	0.7 %	0.1 %	0.0 %
Lighting	CFL	245.4	1,606.6	0.00	31.0 %	41.1 %	0.0 %
	Comprehensive Lighting	89.4	473.6	0.01	11.3 %	12.1 %	0.0 %
	Other lighting controls	0.0	1.0	0.00	0.0 %	0.0 %	0.0 %
	Daylighting	6.0	19.3	0.00	0.8 %	0.5 %	0.0 %
	Exit signs	2.1	17.2	0.00	0.3 %	0.4 %	0.0 %
	HID	6.5	35.5	0.00	0.8 %	0.9 %	0.0 %
	Induction lamps	0.0	0.1	0.00	0.0 %	0.0 %	0.0 %
	LED fixtures	0.6	5.4	0.00	0.1 %	0.1 %	0.0 %
	Linear fluorescent	60.0	305.1	0.00	7.6 %	7.8 %	0.0 %
	Occupancy sensor	11.7	38.9	0.00	1.5 %	1.0 %	0.0 %
	Photocell	1.0	5.1	0.00	0.1 %	0.1 %	0.0 %
	Time clock	0.2	8.2	0.00	0.0 %	0.2 %	0.0 %
Foodservice	Broiler	0.0	0.0	0.21	0.0 %	0.0 %	0.4 %
	Fryer	0.0	0.0	0.27	0.0 %	0.0 %	0.5 %
	Griddle	0.0	0.0	0.08	0.0 %	0.0 %	0.1 %
	Holding Cabinets	2.2	12.3	0.00	0.3 %	0.3 %	0.0 %
	Oven	0.0	0.0	0.69	0.0 %	0.0 %	1.2 %
	Steamers	0.1	3.4	0.00	0.0 %	0.1 %	0.0 %
	Other foodservice	0.0	0.0	0.21	0.0 %	0.0 %	0.4 %
Motors	Motor	6.9	89.9	0.26	0.9 %	2.3 %	0.5 %
	VSD	0.2	8.1	0.09	0.0 %	0.2 %	0.2 %
Water heating	Faucet aerator	0.0	0.1	0.08	0.0 %	0.0 %	0.2 %
	Low flow showerhead	0.1	0.3	0.27	0.0 %	0.0 %	0.5 %
	Pipe insulation	0.0	0.3	1.64	0.0 %	0.0 %	2.9 %
	Spray valve	0.0	0.0	8.38	0.0 %	0.0 %	15.0 %

Measure Category	Measures	MW	GWh/yr	Mtherm/yr	percent of total MW	percent total GWh	percent total Mtherm
	Water heater	0.5	2.1	0.72	0.1 %	0.1 %	1.3 %
	Water heater blanket	0.0	0.0	0.03	0.0 %	0.0 %	0.1 %
	Other water heating	0.3	0.9	3.95	0.0 %	0.0 %	7.1 %
Refrigeration	Case cover	1.1	1.8	0.00	0.1 %	0.0 %	0.0 %
	Case doors	0.1	1.2	0.00	0.0 %	0.0 %	0.0 %
	Compressor	0.5	3.9	0.00	0.1 %	0.1 %	0.0 %
	Condenser	0.4	2.4	0.00	0.0 %	0.1 %	0.0 %
	New case	1.6	12.1	0.00	0.2 %	0.3 %	0.0 %
	Refrigeration commissioning	0.0	0.3	0.00	0.0 %	0.0 %	0.0 %
	Refrigeration Controls	1.3	22.3	0.00	0.2 %	0.6 %	0.0 %
	Other refrigeration	15.4	103.1	0.00	1.9 %	2.6 %	0.0 %
Other	Misc measures and process	181.4	673.0	10.4	22.9 %	17.2 %	18.7 %
Total		792.0	3,913.4	55.71			

Table 10. Residential Program Savings by Measure

Measure	GWh	percent total GWh	Measure	MW	percent of total MW	Measure	MTherm	percent total Mtherm
CFL	1,161.6	78.6 %	CFL	158.9	56.8 %	Programmable Tstat	7.10	37.8 %
Refrigerators	132.7	9.0 %	Refrigerators	23.1	8.3 %	Clothes washer	3.92	20.8 %
Programmable Tstat	45.3	3.1 %	Programmable Tstat	21.8	7.8 %	Attic insulation	1.57	8.4 %
Linear fluorescent	29.0	2.0 %	Central AC	16.7	6.0 %	Boiler control	1.48	7.9 %
Pool pump	20.8	1.4 %	Pool pump	10.4	3.7 %	2 pane low e window	1.02	5.4 %
Whole building	19.5	1.3 %	2 pane low e window	9.5	3.4 %	Dish washer	0.94	5.0 %
Central AC	11.9	0.8 %	Attic insulation	6.6	2.4 %	Boiler	0.70	3.7 %
Freezer	10.7	0.7 %	Evap AC	6.5	2.3 %	Furnace	0.54	2.9 %
Attic insulation	7.2	0.5 %	Whole house fan	5.3	1.9 %	Wall insulation	0.50	2.7 %
2 pane low e window	7.0	0.5 %	HVAC test/repair	4.1	1.5 %	Water heater	0.34	1.8 %
Evap AC	6.6	0.4 %	Linear fluorescent	3.7	1.3 %	Low flow showerhead	0.27	1.4 %
Clothes washer	5.8	0.4 %	Cooling system tune-ups	2.6	0.9 %	Duct sealing	0.21	1.1 %
HVAC test/repair	3.9	0.3 %	Duct sealing	2.0	0.7 %	Faucet aerators	0.08	0.4 %
Whole house fan	3.9	0.3 %	Freezer	2.0	0.7 %	HVAC test/repair	0.06	0.3 %
Dish washer	3.1	0.2 %	Whole building	1.8	0.6 %	Pipe insulation	0.02	0.1 %
Duct sealing	2.6	0.2 %	Room AC	1.8	0.6 %	Whole building	0.02	0.1 %
Cooling system tune-ups	2.2	0.1 %	Wall insulation	1.4	0.5 %	Water heater blanket	0.01	0.0 %
Room AC	1.3	0.1 %	Clothes washer	0.8	0.3 %	Infiltration reduction	0.00	0.0 %
Wall insulation	1.1	0.1 %	Dish washer	0.3	0.1 %	Other	4.10	21.8 %
Water heater	0.4	0.0 %	Heat pump	0.2	0.1 %	Total	18.80	
Low flow showerhead	0.3	0.0 %	Low flow showerhead	0.1	0.0 %			
Heat pump	0.1	0.0 %	Water heater	0.0	0.0 %			
Faucet aerators	0.1	0.0 %	Faucet aerators	0.0	0.0 %			
Infiltration reduction	0.0	0.0 %	Infiltration reduction	0.0	0.0 %			
Water heater blanket	0.0	0.0 %	Water heater blanket	0.0	0.0 %			
Photocell	0.0	0.0 %	Pipe insulation	0.0	0.0 %			
Pipe insulation	0.0	0.0 %	Photocell	0.0	0.0 %			

Measure	GWh	percent total GWh	Measure	MW	percent of total MW	Measure	MTherm	percent total Mtherm
Other	54.3	3.7 %	Other	59.2	21.2 %			
Total	1,478.7		Total	279.7				

Table 11. Comparison of Estimated Residential Program Savings to Technical Potential by Measure

Measure	Technical potential GWh/yr	2004-2005 Program GWh/yr	percent of total	Measure	Technical potential MW	2004-2005 Program MW	percent of total	Measure	Technical potential Mth per year	2004-2005 Program Mth	percent of total
CFLs	6,523	1,161.6	17.8 %	CFLs	570	158.9	27.9 %	Programmable Tstat	20	7.10	35.5 %
Refrigerator	5,390	132.7	2.5 %	Refrigerator	700	23.1	3.3 %	Clothes washer	340	3.92	1.2 %
Programmable Tstat	50	45.3	90.6 %	Programmable Tstat	47	21.8	46.4 %	Ceil insulation	100	1.57	1.6 %
Fluorescent lamp	324	29.0	8.9 %	Central AC	571	16.7	2.9 %	Boiler control	5	1.48	29.7 %
Pool pump	1,152	20.8	1.8 %	Pool pump and motor	205	10.4	5.1 %	dishwasher	90	0.94	1.0 %
Central AC	468	11.9	2.5 %	2 pane low e window	1,295	9.5	0.7 %	Boiler	5	0.70	14.0 %
Freezer	181	10.7	5.9 %	Ceiling insulation	99	6.6	6.7 %	Condensing furnace	200	0.54	0.3 %
Ceiling insulation	276	7.2	2.6 %	Direct evap cooling	281	6.5	2.3 %	Wall insulation	180	0.50	0.3 %
2 pane low e window	976	7.0	0.7 %	Whole house fan	155	5.3	3.4 %	Water heater	90	0.34	0.4 %
Evap cooling	197	6.6	3.3 %	HVAC test/repair	223	4.1	1.9 %	Lo flow showerhead	50	0.27	0.5 %
Clothes washer	654	5.8	0.9 %	Fluorescent lamp	28	3.7	13.1 %	Duct repair	50	0.21	0.4 %
HVAC test/repair	175	3.9	2.2 %	Duct repair	104	2.0	2.0 %	Aerators	25	0.08	0.3 %
Whole house fan	206	3.9	1.9 %	Freezer	25	2.0	8.0 %	HVAC test/repair	75	0.06	0.1 %
Dishwasher	199	3.1	1.5 %	room AC	55	1.8	3.2 %	Pipe wrap	25	0.02	0.1 %
Duct repair	87	2.6	3.0 %	Wall insulation	51	1.4	2.7 %	Water heater blanket	120	0.01	0.0 %
Room AC	36	1.3	3.6 %	clothes washer	120	0.8	0.6 %	Infiltration reduction	5	0.00	0.1 %
Wall insulation	214	1.1	0.5 %	Dishwasher	17	0.3	1.7 %	Other	931	4.12	0.4 %
Water heater	97	0.4	0.4 %	Heat pump	0	0.2		Total	2311	21.878	0.9 %
Lo flow showerhead	45	0.3	0.6 %	Lo flow showerhead	4	0.1	1.5 %				
Heat pump	419	0.1	0.0 %	water heater	9	0.0	0.4 %				
Aerators	28	0.1	0.4 %	Aerators	3	0.0	0.7 %				
Infiltration reduction	16	0.0	0.1 %	Infiltration reduction	10	0.0	0.1 %				
Water heater blanket	126	0.0	0.0 %	Water heater blanket	12	0.0	0.0 %				

Measure	Technical potential GWh/yr	2004-2005 Program GWh/yr	percent of total	Measure	Technical potential MW	2004-2005 Program MW	percent of total	Measure	Technical potential Mth per year	2004-2005 Program Mth	percent of total
Pipe insulation	24	0.0	0.0 %	Pipe wrap	2	0.0	0.0 %				
Other	1,846	70.7	3.8 %	Other	1,055	54.4	5.2 %				
Total	21,555	1,526.0	7.1 %	Total	6,696	329.5	4.9 %				

Table 12. Commercial and Industrial Program Savings by Measure

Measure	GWh	percent GWh	Measure	MW	percent MW	Measure	Mtherm	percent Mtherm
Comprehensive Lighting	454.1	19.1 %	Comprehensive	87.6	19.0 %	Spray valve	8.38	25.4 %
CFL	444.8	18.7 %	CFL	86.4	18.8 %	Programmable Tstat	3.36	10.2 %
Linear fluorescent	276.0	11.6 %	Linear fluorescent	56.3	12.2 %	Boiler	2.88	8.7 %
Comprehensive HVAC	120.8	5.1 %	Comprehensive HVAC	35.6	7.7 %	Pipe insulation	1.62	4.9 %
Whole building	104.5	4.4 %	Whole building	27.1	5.9 %	Heating system tune-ups	1.40	4.3 %
Motor	89.7	3.8 %	DX AC	17.2	3.7 %	Whole building	0.84	2.6 %
Cooling system tune-ups	49.7	2.1 %	Cooling system tune-ups	15.1	3.3 %	Oven	0.69	2.1 %
Industrial Refrigeration	40.3	1.7 %	Occupancy sensor	11.6	2.5 %	Clothes washer	0.63	1.9 %
Occupancy sensor	38.3	1.6 %	Motor	6.7	1.5 %	Commissioning	0.53	1.6 %
DX AC	37.2	1.6 %	Industrial Refrigeration	6.0	1.3 %	Water heater	0.37	1.1 %
Chiller	35.9	1.5 %	Daylighting	6.0	1.3 %	Heat recovery	0.30	0.9 %
Programmable Tstat	33.0	1.4 %	Chiller	5.5	1.2 %	Fryer	0.27	0.8 %
HID Lighting	24.1	1.0 %	HID Lighting	5.1	1.1 %	Comprehensive HVAC	0.22	0.7 %
Refrigeration Controls	22.3	0.9 %	Cool roof	4.8	1.0 %	Broiler	0.21	0.6 %
Daylighting	19.3	0.8 %	Commissioning	3.3	0.7 %	EMS	0.18	0.5 %
Window film	18.9	0.8 %	Window film	3.3	0.7 %	VSD	0.09	0.3 %
Commissioning	17.3	0.7 %	Energy Mgt system	2.6	0.6 %	Furnace	0.08	0.2 %
Exit signs	16.1	0.7 %	Holding Cabinets	2.2	0.5 %	Griddle	0.08	0.2 %
Holding Cabinets	12.3	0.5 %	Exit signs	1.9	0.4 %	Water heater blanket	0.02	0.1 %
New refrigerated case	12.1	0.5 %	New refrigerated case	1.6	0.4 %	Boiler control	0.02	0.1 %
Ext HID Lighting	11.2	0.5 %	Refrigeration Controls	1.3	0.3 %	Other measures and process	10.54	32.0 %

Measure	GWh	percent GWh
Compressed Air	8.8	0.4 %
Energy mgt system	8.6	0.4 %
Time clock	8.2	0.3 %
VSD	7.9	0.3 %
Cool roof	7.1	0.3 %
LED Lighting	5.4	0.2 %
Photocell	5.1	0.2 %
Office Equip Pwr Mgt	4.5	0.2 %
Steamers	3.4	0.1 %
Compressor	3.4	0.1 %
Condenser	2.4	0.1 %
Case cover	1.8	0.1 %
Water heater	1.7	0.1 %
Case doors	1.2	0.1 %
Other lighting controls	1.0	0.0 %
Refrigerator	0.5	0.0 %
Refrigeration commissioning	0.3	0.0 %
Pipe insulation	0.3	0.0 %
Evap AC	0.2	0.0 %
Induction lighting	0.1	0.0 %
Clothes washer	0.0	0.0 %
Other measures and process	428.6	17.8 %
Total	2,374.4	

Measure	MW	percent MW
Case cover	1.1	0.2 %
Photocell	1.0	0.2 %
Compressed Air	0.7	0.2 %
LED Lighting	0.6	0.1 %
Water heater	0.5	0.1 %
Compressor	0.4	0.1 %
Condenser	0.4	0.1 %
Time clock	0.2	0.0 %
VSD	0.2	0.0 %
Evap AC	0.1	0.0 %
Steamers	0.1	0.0 %
Programmable Tstat	0.1	0.0 %
Case doors	0.1	0.0 %
Refrigerator	0.1	0.0 %
Refrigeration commissioning	0.0	0.0 %
Pipe insulation	0.0	0.0 %
Induction lighting	0.0	0.0 %
Clothes washer	0.0	0.0 %
Other lighting controls	0.0	0.0 %
Office Equip Pwr Mgt	0.0	0.0 %
Exterior HID Lighting	0.0	0.0 %
Other measures and process	66.7	14.5 %
Total	460.9	

Measure	Mtherm	percent Mtherm
Total	32.97	

Table 13. Comparison of Estimated Commercial Program Savings to Technical Potential by Measure

Measure	Technical potential GWh/yr	2004-2005 Program GWh/yr	percent Tech potential	Measure	Technical potential MW	2004-2005 Program MW	percent Tech potential	Measure	Technical potential Mth /yr	2004-2005 Program Mth/yr	percent Tech potential
CFL	724	444.8	61.4 %	CFL	124	86.4	69.7 %	Furnace/Boiler	103	3.0	2.9 %
T8/electronic ballast	2,539	276.0	10.9 %	T8/electronic ballast	485	56.3	11.6 %	Pipe insulation	1	1.6	161.6 %
Cooling system tune-ups	308	49.7	16.1 %	DX air conditioning	246	17.2	7.0 %	Convection oven	18	0.7	3.8 %
Refrig. Misc	45	42.0	93.3 %	Cooling system tune-ups	186	15.1	8.1 %	Water heater	97	0.4	0.4 %
Occupancy sensors	1,104	38.3	3.5 %	Occupancy sensors	290	11.6	4.0 %	Infrared fryer	61	0.3	0.4 %
DX air conditioning	445	37.2	8.3 %	Refrig. controls	18	6.1	34.2 %	Energy Mgt System	31	0.2	0.6 %
Chiller	478	35.9	7.5 %	Perimeter dimming	769	6.0	0.8 %	Infrared griddle	23	0.1	0.3 %
Programmable Tstat	277	33.0	11.9 %	Chiller	315	5.5	1.7 %	Water htr. tank insul	30	0.0	0.1 %
Metal halide lamps	273	24.1	8.8 %	Metal Halide lamps	51	5.1	10.1 %	Other	364	26.8	7.4 %
Refrigeration Controls	458	22.3	4.9 %	Cool Roof	95	4.8	5.0 %	Total	706	33.0	4.7 %
Perimeter dimming	1,696	19.3	1.1 %	Window Film	124	3.3	2.6 %				
Window Film	224	18.9	8.4 %	Energy Mgt System	147	2.6	1.8 %				
Ext HP sodium lamps	319	11.2	3.5 %	Refrig. misc	6	1.3	21.6 %				
Energy Mgt System	227	8.6	3.8 %	Ext HP sodium lamps	3	1.3	43.1 %				
Ventilation fan VSD	453	7.9	1.8 %	Refrig. case covers	10	1.1	10.9 %				
Cool Roof	193	7.1	3.7 %	Ext. Lite Cont.		1.0					
Refrig. compressors	1,222	5.8	0.5 %	Refrig. compressors	151	0.8	0.5 %				
Ext. lighting control	236	5.1	2.2 %	Ventilation fan VSD	26	0.2	0.7 %				
Office Equip Pwr Mgt	1,019	4.5	0.4 %	Programmable Tstat	46	0.1	0.2 %				
Refrig. case covers	350	1.8	0.5 %	Refrig. commissioning	15	0.0	0.2 %				
Refrig. commissioning	112	0.3	0.3 %	Office Equip Pwr Mgt	86	0.0	0.0 %				
Other	12,702	1,280.6	10.1 %	Other	1,370	235.2	17.2 %				
Total	14,721	2,374.4	16.1 %	Total	1,938	460.9	23.8 %				

Compact fluorescent lamps (CFLs) represent almost 79 percent of the expected savings electricity from residential programs. Residential programs also favor refrigerator replacements programmable thermostats and efficient clothes washers. Programmable thermostat electricity savings estimates are on the order of 90 percent of the estimated technical potential for this measure, indicating potentially that this measure is approaching market saturation. Lighting measures are also dominant in commercial building programs representing about 50 percent of the energy savings. Lighting measures include comprehensive lighting retrofits, CFLs, linear fluorescent (principally T-8 retrofits), comprehensive HVAC upgrades, high efficiency DX air conditioning unit replacement, efficient motors and cooling system tune-ups. Prominent commercial gas measures include low flow spray valves in foodservice applications, programmable thermostats, high efficiency boilers and pipe insulation upgrades.

Program Gaps

Program characteristics from the MECT database and the expected savings by measure were examined to identify program strategies and measures that could be emphasized in this project. In general, most measures (with the exception of programmable thermostats) have significant remaining potential. Measures with the lowest contribution to portfolio kWh and therm savings include:

- Residential building shell upgrades, such as wall and ceiling insulation, high performance windows, and infiltration sealing.
- Residential HVAC measures, such as night ventilation, evaporative cooling, AC tune-ups and duct sealing.
- Residential high efficiency water heaters and water conservation measures
- Commercial refrigeration systems for grocery stores, including refrigerated case improvements, efficient compressor and condenser systems and refrigeration system control improvements.
- Commercial office equipment efficiency is generally not addressed by programs, and offers a significant savings opportunity
- Commercial building commissioning is starting to be addressed, but represents less than 1 percent of the portfolio kWh savings.
- Commercial foodservice equipment is also addressed, but the savings represent less than 5 percent of the gas savings portfolio.

Program strategies that were least frequently used by the current portfolio were also identified:

- The majority of programs target retrofits, which may or may not be tied to any particular market event. Programs targeted at repair, building sale and building finance/refinance market events are rare.

- Current programs tend to emphasize information and incentives targeted at end-users. Upstream market actors such as manufacturers, real estate professionals, and lenders are not targeted very often by the programs.
- Innovative financing and upstream market interventions are some the least used strategies in the existing CPUC program portfolio.

Program Successes and Lesson Learned

Program evaluation reports from the 2001-2002 program cycle and program manager interview responses[2] were examined to identify important program successes and lessons learned relevant to this project. A report review template was created, and data for each report were collected according to the template. Within the template, a section on program successes and lessons learned was provided. Each report reviewer entered impressions on the successes and lessons learned based on the information provided by the report authors. Information compiled for this section was taken generally from the process evaluation sections of the program evaluation reports. Thus, the metrics used to measure program success were chosen by the evaluation contractors according to the objectives of the evaluation project. Evaluators took a variety of approaches; many of which were severely constrained by the available budget. Although the primary focus was on estimating the ex-post energy savings, demand savings, and program cost effectiveness, many studies were able to include process evaluations that addressed program effectiveness and overall levels of performance and success at some level. These findings formed the basis of the data collection conducted for this project. Likewise, the interview guide directed the interviewee to discuss successes and lessons learned from their experience in operating the program. The successes and lessons learned from the evaluation report reviews and interviews were compiled and discussed by the full project team during a series of teleconferences. The results of the discussions are summarized below:

Residential Audit programs

Residential audit programs have achieved fairly high measure implementation rates, even without incentives. Consumers, when presented with credible information have shown a willingness to invest their own resources to save energy.

- The Statewide Home Energy Efficiency Survey Program consisted of mail-in and on-line audits. The mail-in was available in all four IOU service territories and distributed to customers through customer requests, via direct mail, at county and regional fairs, and other major events. The on-line audit was available to customers through the internet and provided immediate, short and long-term recommendations to improve energy efficiency in the home based on data they shared on their current energy consumption. Adoption ratios (of recommended upgrades) raged from 40 to 54 percent, with the overall ratio being 47 percent.

[2] Program manager reviews are summarized in Appendix C.

Respondents reported that the recommended measures cost money, but the vast majority of measure implementations were not funded by alternate sources (utility programs for example). For the small portion of the population that did use alternate funding to make the upgrades, most came through utility rebates. Other sources included bank loans and manufacturer rebates. No one got assistance through a retailer rebate. Considering that participants still took action suggests that the barrier of first cost or lifetime payback was not as significant a barrier, and/or that linking participants with rebate programs would increase the rate of implementation. (Ridge, 2004).

- The GeoPraxis Time-of-Sale (TOS) Home Inspection Program trained and equipped home inspectors to integrate a streamlined energy audit into the traditional Time-of-Sale home inspection. The program provided Northern California ratepayers with timely access to key information to help them improve the energy efficiency, comfort, and resale value of their homes. In addition to recommending comprehensive whole-house energy efficiency improvements and generating leads to the many rebate programs available, the TOS program also directly provided a free ”kit” of energy efficiency measures to participating homeowners. The study verified a measure adoption ratio of 46 percent (Mowris, 2004).
- The 2002 SDG&E Local Residential In-Home Audits Program provided in-home audits to residential customers in the SDG&E service territory. The program evaluation found that approximately 50 percent of program participants state they made physical modifications as a result of their energy audit, approximately 50 percent of program participants state they made behavioral modifications as a result of their energy audit, and approximately 25 percent of program participants state they participated in other SDG&E energy efficiency programs since participating in the In-Home Audits Program. Participants found audit recommendations to be reasonable and believed that the recommendations could result in energy savings (RLW Analytics, 2002).

Time of Sale

Findings related to residential time of sale programs and energy improvement mortgages are listed below:

- Charles Segerstrom, a program manager with PG&E indicated that time of sale energy retrofits are a good strategy. So far most of that effort has been market based; he would like to see the effort to be more regulatory based. Program should use a ”triage test” to determine the basic energy efficiency of the home. If the home is below a minimum requirement for efficiency, conduct a home energy rating of the building to establish which measures are cost effective and then require the installation of these measures. Incorporate the cost of these measures into financing or rebates.
- Tom Conlon, project manager for the GeoPraxis Time-of-Sale (TOS) Home Inspection Program indicated that 81 percent of existing home sales use home inspector. Avoiding risk of litigation and real estate disclosure laws are a primary

motivator. From the purchaser's perspective, the home inspector is the most trusted entity in transaction. Realtors generally recommend or hire the home inspector.

- Several interviewees indicated that time of sale upgrades to residential buildings are appropriate, as long as the process is simplified. One program manager suggested imposing a "reasonable requirement" at time of sale would help in putting a more appropriate energy efficiency burden on the existing home market. Examples of some of the measures to be required would be R30 ceiling insulation, HVAC replacement and duct sealing for equipment over a certain age. An energy improvement mortgage facilitator recommends a focus on duct testing, HVAC upgrades, new windows, and upgraded insulation. The energy improvement mortgage option should be introduced during the purchase order to get an early start on the process.

Energy Improvement Mortgages

Energy improvement mortgages (EIMs) have been in existence for many years, yet have not gained wide acceptance in the market. These mortgage products allow the home buyer to qualify for additional financing of cost-effective energy upgrades under the first mortgage. The benefits include long-term financing at lower interest rates than consumer debt financing.

- The Pacific Gas and Electric's (PG&E's) Time of Sale Energy Renovation (TOSER) Program addresses energy improvement mortgages for homes, primarily when existing homes are being resold. Evaluation of the program indicated that the cost of a home energy rating was a barrier to participation, and recommended that energy inspections should cost less and be paid through the mortgage process (Xenergy, 2001).
- Tamara Eutsler, an energy improvement mortgage facilitator advised providing more advertising or education to get the word on energy improvement mortgages out to the public. Currently buyers are not informed by real estate agents about EIM's so they do not have an opportunity to use them. The lending options for EIMs are also limited. FHA EIM is most popular product, but housing prices in California exceed FHA limits. Freddie Mac and Fannie Mae programs cannot use adjustable rates. Conventional loan products often do not offer EIM options. Layers in the lending industry a can inhibit EIM support. While a retail broker might favor an EIM, wholesale brokers and secondary loan market may oppose these products.
- Tom Conlon, project manager for the GeoPraxis Time-of-Sale (TOS) Home Inspection Program indicated that realtors generally work closely with a particular lender. If an EIM could be used, it might not be offered through that lender, and the buyer may not be made aware of the option.
- Below market financing and incentives lenders and dealers were mentioned in the Statewide Manufactured Housing Market Characterization Report, a project to characterize the manufactured homes market to assist the California utilities and

policy makers in developing an effective program for new manufactured housing. Below market financing that would enable customers to finance the additional cost of energy efficiency upgrades with minimal impact on their monthly payment (Quantum Consulting and Xenergy, 1999).

Information Quality and Customer Support

Onsite audits containing well-presented information customized to each particular customer are a desirable component of nonresidential audit programs.

- The 2002 Nonresidential Audit Program provides five audit instruments (mail, online, CD-Rom, on-site, and phone). According to the evaluation report, more on-site audits should be conducted, as some Program Managers feel these are the most effective way to reach customers. Little distinction was found between the phone and on-site audit reports. According to the evaluators, "If on-site audit recommendations were more distinct in character from the phone audit, participants might appreciate the additional customization available from an on-site professional auditor. The SCE MCD audit, directed at larger customers, and shown to be effective in previous analyses, has a broad scope of recommendations and evidence of appropriate customization across size and business type. This type of audit together with the larger target customer group is more appropriate use of on-site resources" (Quantum Consulting and Ridge & Associates, 2004).
- The Statewide Small/Medium Nonresidential Customer Needs and Wants Study documented a wants and needs assessment on small/medium customers to identify potential program elements that could assist these customers in making decisions regarding energy efficiency and increase participation in IOU programs. Results of interviews and focus groups of customers that make up California's under 500 kW population indicate that they want more reliable information that is customized to their business (Quantum Consulting and Xenergy, 2001).

Customer support through the process is key. Some programs attribute their success to the fact that they provide turn-key services, from initial audits, to help with contractor selection, financing, and measure installation inspection.

- The Vermont Energy Improvement Mortgage Service (EIMS) offers turn-key services to home buyers to incorporate energy improvements into their mortgage. Energy rated homes of Vermont (ERH-VT) rates the home, writes up work specifications, puts them out for bid, assembles the rating package with firm, fixed bids, coordinates with the lender for financing (available through Freddie Mac, Fannie Mae, FHA, VA or Vermont Housing Finance Agency), implements contracts with chosen contractors, oversees the work, performs final inspection and re-rates the house. ERH-VT charges $800+ for this service, which can be financed under some programs. Vermont has one of the highest rankings of completed ratings per capita of all states (Plympton, 2000).
- The Energy Smart Grocer (ESG) Program implemented by Portland Energy Conservation, Inc. (PECI) provides information, technical assistance, and financial

incentives for independent grocers to purchase and install energy efficient lighting, HVAC, and refrigeration systems. The program is delivered to independent food retailers in the territories of PG&E, SCE, and SDG&E. The process evaluation found a program that was well received by independent grocers, by the major wholesaler targeted by the program, and by vendors. A key finding has been the pivotal role played by the ESG Program's Energy Experts, who have become key players both in the delivery of the program and in the development of relationships between independent grocers and vendors who deliver energy efficiency measures. The computerized audit tool used by the program and the output it produces have contributed to the credibility of the Energy Experts; store owners repeatedly cited the high quality of both the findings and the format in helping to educate and empower them with regard to energy efficiency (Quantum Consulting, 2004). According to an interview with the program manager, the program is a "high-touch" program, providing lots of contact and education. Energy Experts are seen as knowledgeable and non-biased. Face to face contact is best for achieving the trust necessary. This level of involvement can be risky for program implementers.

- A similar note of caution was offered by David Jump, program manager for the Building Tune up program, a non-utility program providing retro commissioning services. Building Tune-ups are a hands-on process which entails a lot of risk on the provider.
- Trade allies need support too. The Enhanced Automation Initiative is a local program offered by KEMA-Xenergy that promotes investments in enhanced automation and control technologies through more sophisticated use of energy management systems (EMSs), including demand response capabilities. The program provides incentives to controls contractors to upgrade the control systems. According to an interview with Dan Thomas, the program manager, energy savings calculations required by the program are beyond the capability of most controls contractors, and are performed by the program implementer.

Upstream programs and partnerships

Flexibility and working directly with manufacturers can create powerful partnerships.

- The Northwest Energy Efficiency Alliance's (NEEA) Energy Star Windows project increased the market share for high-performance windows by helping manufacturers produce qualifying products. Program contractors worked with the manufacturers to find inexpensive and easy ways to Energy Star standards through changes in product design and/or production changes that were compatible with their existing production practices. The program initially targeted "market share hungry" manufacturers to create competition for share within the market. Energy Star window market penetration improved to 66 percent; exceeding the project goal of 54 percent market penetration (Quantec, 2002).
- The PG&E Foodservice Technology Center (FSTC) operated by Fisher-Nickel Inc. for PG&E promotes energy efficiency in the commercial and institutional foodservice market. The FSTC provides third party information on commercial

cooking appliances, kitchen ventilation, refrigeration, and sanitation appliances. The FSTC develops ASTM test protocols and provides testing services for commercial cooking equipment production and efficiency. According to an interview conducted with Don Fisher, FSTC director, the FSTC has been instrumental in establishing Energy Star listings for commercial cooking equipment. The FSTC has active manufacturer support, resulting in quick introduction of new products meeting Energy Star specifications.

- An interview with Francis Rubenstein, a lighting researcher at Lawrence Berkeley National Laboratory (LBNL), indicated that incentives may be better placed with the manufacturers. Incentives offered to bid down first-costs created a consumer expectation of price that manufacturers may not be willing to market at. A "golden carrot" program similar to the super efficient refrigerator program may be more appropriate.

Upstream programs targeted at the appropriate market actor can be very effective.

- The SDG&E High Efficiency Appliance and Lighting (HEAL) program created a situation where Energy Star dishwashers became virtually a standard feature by focusing on the builder as the key decision maker (Quantec, 2004).
- According to an interview with Charles Segerstrom, program manager at PG&E, the bottom line is that information needs to be at hand and needs to be at the purchase location. The contractor is at the point of decision making and can either sell the program or not. They are very influential. For "do-it-yourselfers" the people in the hardware store and the information that is provided on the units has the greatest influence on the purchase decision

Role of Non-Energy Benefits

Non-energy benefits (NEBs) play an important role in the acceptance of certain measures.

- The NightBreeze nighttime ventilation system, developed with PIER funding, is designed to reduce peak demand from air conditioning systems in residential buildings. Projected NightBreeze cooling demand savings range from 5 percent in hot desert areas to 65 percent in milder climates. Commercialization partner Beutler Heating and Air Conditioning is currently selling several thousand units a year to the new construction market primarily based on the benefits of fresh air ventilation (Springer, 2004).
- According to an interview with Don Fisher, from the Foodservice Technology Center (FSTC), independent laboratory tests of commercial cooking equipment evaluate multiple performance factors, including production rates, cooked product quality and energy efficiency. The tests have established a link between efficiency and these important non-energy benefits. Efficient commercial cooking equipment is sold more on improved production rates and cooked product quality than energy savings.

- ComfortWise is a residential new construction certification program operated by ConSol. The program focuses on high performance glazing, HVAC system design, and third-party inspections of construction quality. Homes built to ComfortWise specifications qualify for Home Performance with Energy Star certification. An interview with a company principal indicated that key reasons why buildings sign up for the program are market differentiation, reduced mechanical system callbacks and reduced legal liability. For home buyers, comfort is the most important issue, followed by reduced fading of interior finishes due to high performance glazing.
- Several interviewees mentioned that energy efficient homes are safer homes. Dr. Evan Mills from Lawrence Berkeley National Laboratory indicated that white roofs may reduce urban heat death during heat waves. Homes with double paned windows are a safer place to be during a disaster. Nehemiah Stone, a program manager working in the multi-family housing market also mentioned the health connection. Inability to afford utility bills leads to chronic health problems. The biggest weather related killer is heat waves where many victims are elderly living in affordable housing.
- Building retro commissioning projects also provide important non-energy benefits. David Jump, program manager for the Building Tune-up program mentioned reduced maintenance and longer equipment life as important benefits of retro commissioning programs.
- The National Weatherization Assistance Program, sponsored by the U.S. Department of Energy (DOE) and implemented by state and local agencies throughout the United States, weatherizes homes for low-income residents in order to increase their energy efficiency and lower utility bills. A study of the NEBs of these programs was conducted by Oak Ridge National Laboratory. The non-energy benefits included lower bad debt write-off, fewer emergency gas service calls, water and sewer savings, property value benefits, reduced need to relocate, avoided air emissions and avoided unemployment benefits. The value to society of the NEBs is on the order of $4400/participant (Schweitzer, et al., 2003).

Marketing to Hard-to-Reach customers

Foreign language materials and community spokespersons aid measure adoption in hard-to-reach communities.

- The SCE Energy$mart Thermostat pilot program provided small commercial customers in the SCE service territory with two-way programmable thermostats for peak load curtailment. Each participant received a free thermostat and a $300 annual incentive per thermostat for participating in the pilot program. The program received a North America 2002 Demand Response Awards from the Peak Load Management Alliance (PLMA). The program was viewed as “an excellent example of outreach to the area's critically important, but hard to target and multi-ethnic small business population. The program was promoted in Spanish, Chinese, Vietnamese and Korean as well as English, generating a truly inclusive customer education program that allowed the stated objectives to be realized via strong

penetration." The program was also recognized by the Association of Energy Services Professionals (AESP) for developing a non-traditional marketing approach for customer sign-ups, layering ethnic media and outreach on top of traditional direct mail, enhanced with community-based partnerships and door-to-door sales. (Wright et al., 2004).

- The Chinese Language Efficiency Outreach Program (CLEO) was operated as an information only program targeted at Chinese language speakers. CLEO held seminars in the Chinese language that provided information about investor owned utility energy efficiency rebate programs. Seminar attendees were largely pleased with the knowledge they received during the presentations, and conveyed this information to others who were not in attendance. Forty-one percent of seminar participants have contacted utility rebate programs, and 64 percent of those have received rebates from those programs (ASW, 2003).
- Don Woods, a low income weatherization program manager for SDG&E advised that face to face contact using trusted community based organizations is best, especially with customers who have limited contacts with society. Improvements need to be directly installed at no cost.

Understand the Business Environment of Trade Allies and Market Actors

Several program evaluations mentioned problems with program designs resulting from incompatibilities with the program theory and the realities of the business environment of key trade allies and market actors.

- Prices paid for providing audits and energy ratings that are set to induce consumer participation may be set too low for service providers. Providers find it hard to do much custom analysis or make a business out of providing audits, and generally provide these as a value added service component to their regular business. Fees paid for audit services range from $35 for a basic audit and report to more than $800 per site, when turnkey services are provided.
- Realtor cooperation has been a barrier in some time-of-sale audit programs. According to an interview conducted with Tom Conlon, incentives can be developed that are effective in securing the cooperation of realtors. Examples include delivering a package of low-cost energy efficient measures (CFLs, showerheads, faucet aerators) through the realtor as a closing" gift." Energy efficiency tips developed during a time-of-sale audit can be used to develop customized post-sale follow-up and communication opportunities. Realtor training should be targeted at the time available; excessive training time is seen as a barrier to participation.
- The California Building Performance Contractors Association is a PIER-funded project directed towards developing a whole house performance contractor industry in CA. The program promotes the concept of "whole house" contractors, who sell their services as a complete package (marketing, selling the inspection, performing the inspection, projecting savings, completing a work plan with cost

estimate, selling the job, doing the work, and final testing). Since homeowners are typically seeking out this kind of work, there is significant potential sales value in having a single business entity for the homeowner to interact with. The concept of developing a" one stop" shopping approach is critical to achieving maximum energy benefits and to simplifying the process from the homeowner perspective. Despite high quality training and mentoring, few of the trained contractors have been able to move strongly (and exclusively) into the whole house building performance business. Even the most active, committed and successful contractors find themselves struggling to grow their whole house business and mesh it with their other business requirements (Lutzenhiser, 2005). The program manager estimates that less than 10 percent of the trainees who have gone through the training are pursuing the house as a system business model.

- Energy Rated Homes of Colorado (ERHC) provides Colorado homeowners with an accredited home energy rating system (HERS), and access to energy efficient mortgages. ERHC offers its services to Colorado through a network of independent, qualified home energy raters throughout the state. Evaluation of the program recommended that ERHC figure out a better potential "point of entry," such as when a homeowner plans to remodel, instead of when they plan to sell or buy. ERHC must broaden its focus away from ratings only, and become the source of information for consumers, lenders, developers, architects and builders on energy efficiency. ERHC must demonstrate to raters as independent business owners that it adds value to their enterprise, but in forms other than direct subsidies (CHFA, 2000).
- The willingness or ability to perform work after normal business hours can be an important consideration for small business owners. This barrier was cited in the evaluation of the ADM Mobile Energy Clinic and the Richard Heath Associates (RHA) Small Nonresidential Energy Fitness (SNEF) programs. Twenty percent of non-participants in the SNEF program did not participate due to lack of time or scheduling problems, but three fourths of these would have participated if someone else could have been present while RHA performed the work or if the work could be performed after normal business operating hours (Mowris, 2004a, 2004b).

Remodeling as a trigger event

Remodeling was mentioned as an important trigger event in two major studies.

- California Residential Remodeling / Renovation Market Study (Primen, 2001). The California Residential Remodeling/ Renovation Market Study provides an understanding of the characteristics of this market and the factors that influence customer decision-making and satisfaction in home remodeling in order to identify opportunities to promote energy efficiency. According to the study, energy efficiency is a significant consideration in about half of remodeling projects. Most typical remodeling projects involve major energy uses in the home, and represent a significant event in which the energy efficiency of a home can be substantially improved. The study reveals a definite priority in key steps undertaken in

remodeling (from highest to lowest) – information gathering, materials and equipment selection, contractor selection, and financing. Less than 30 percent of remodelers seek financing, most choose to finance out of pocket. While substantial numbers of respondents indicated no need to undertake one or more of these steps (especially finding a contractor or financing), many indicate that lack of time or money are major barriers to completing them. Remodeling is motivated mostly by comfort and appearance, but most commonly affect areas that are high-energy use parts of the home, such as kitchens, windows, bathrooms, hard-wired lighting, insulation, roofing, and HVAC systems. Remodeling projects install at least one energy efficiency measure 81 percent of the time. The study recommends tailoring energy efficiency programs specifically to the residential remodeling market. Specific recommendations include:

1. Specialized remodeling "Energy Guide," with advice about key remodeling steps, contractor selection, and information about non-energy-related cost and performance characteristics of equipment and materials.
2. Pre-audit of home that includes review of remodeling plans and recommendations on how to improve energy efficiency
3. Home energy rating after remodeling, follow-up to pre-audit.
4. Training of remodeling contractors and designers promoting use of Energy Guide, pre-audit, and home energy rating.
5. Certification of remodeling contractors on energy efficiency practices linked to home energy rating.
6. While financing is not a significant concern to most remodelers, energy efficient construction loans, linked to pre-audit and home energy rating may attract those who do find financing relatively difficult.
7. Rebates for efficient appliances and materials targeted through suppliers normally used by remodelers.

- A similar study was conducted to look at the nonresidential remodeling and renovation market. According to the study, in the first half of the 1990s, nearly 25 percent of all construction dollars went for alterations and another 20 percent for additions. The study projected that by 2010 the market for work on existing buildings will be even larger than for new construction. The primary driver for remodeling and renovation is a change in tenant, or a tenant changing their operation. Other reasons included general updating of the building, and upgrading the quality or functionality of the space. Most commercial remodeling and renovation is completed in building occupied by firms leasing space. Sixty eight percent of survey respondents said remodeling and renovation projects were in buildings occupied by lessees, and completed for lessees. Working with leasing agents who specialize in commercial lease space may help implementers to identify space that is coming into the market in sufficient time to promote energy efficiency when changes to space are being made (ADM and Tecmarket Works, 2002).

Quality control

Quality control is important to insure measure performance. From simple measures, such as CFL replacements to more complex HVAC measures, problems relating to product quality and installation practices reduce energy savings and customer satisfaction. Customers are generally not immediately aware of installation problems, and assume the job is done right.

- The Statewide Energy Star New Homes program provides incentives and education and training for both single family and multifamily new construction. Once builders have prepared the designs they submit the plans to a Title 24 Consultant for compliance documentation. If the builder decides to build above and beyond minimum requirements to meet Energy Star Standards the must submit these plans in an application to the IOU. If approved, the builder will have an incentive reserved. After approval, the utility sends the plans to a plan check agency that re-verifies title 24 and Energy Star compliance. After construction, a third party inspector verifies the existence and installation quality of the energy efficiency features. The builder is paid once the measure installation has been verified. Verification inspections, cited by non-participants as a barrier, were not judged to be cumbersome by participant builders (RLW Analytics 2004).
- Compact fluorescent lamps represent a large fraction of the expected savings from the 2004-2005 program portfolio. However, problems with early failures and poor lighting quality have plagued several programs promoting CFLs. The Statewide Multifamily Rebate program relies on the Energy Star label to qualify product for use. The Energy Star listing primarily considers efficiency, but the EPA has delisted several products due to poor reliability ratings from the Program for Evaluation and Analysis of Residential Lighting (PEARL). Since PEARL only evaluates product available through retail outlets, bulk purchased products may not be screened effectively (Wirtshafter Associates, 2002). Evaluation of the Energy Star Residential Lighting program in the Northwest indicated a drop in customer satisfaction with CFLs. This finding underscores the critical importance of continued support for product quality testing and assurance programs (ECONorthwest, 2004).
- Programmable setback thermostats also are expected to provide a large fraction of the expected savings from the 2004-2005 program portfolio. However, several studies have indicated that occupant behavior with respect to room temperature setpoints and setback schedule is essentially the same regardless of thermostat type. Occupants of homes with manual thermostats use essentially the same setpoints and setback schedules as those with programmable thermostats, with no significant energy savings attributable to the presence of a programmable thermostat (Nevius, 1999; Cross and Judd, 1997; Connor, 2001; Robison, 2002). One study showed increased consumption and demand in homes with setback thermostats, since occupants with manual control were willing to use more severe setback temperatures than those with programmable thermostats (Parker, 2000). These studies indicate a need to perform impact studies on these devices, rather than simply relying on engineering estimates of savings.

- Early feedback to program implementers through program evaluation efforts can provide an important quality control function. The Mobile Home Energy Efficiency and Education Program is a non-utility program providing no-cost energy efficiency improvements to 12,000 mobile homes in PG&E, SCE, and SCG territories. Nearly 83,000 measures were performed/installed in this program with over 60 percent of the measures being CFL retrofits. Others measures included duct test & seal, AC tune-up/airflow, and low flow showerheads and faucet aerators. Evaluation of the program included inspections of measure installations and post-treatment testing of duct sealing and AC tune-up effectiveness. Early problems with these measures were identified and corrected as a result of the program evaluation effort (Blankenship, 2004).
- Air conditioning systems can be especially problematic. A summary paper examined field measurements of 4,168 air conditioners (both with and without TXV's). Approx 72 percent of the air conditioners were found to have improper refrigerant charge (+/- 5 percent of spec) and 44 percent had improper airflow. Average energy savings for correcting refrigerant charge and airflow (RCA) was found to be 12.6 percent. Efficiency gains of 21 percent were found for TXV units and 17.1 percent for non-TXV systems. Average energy savings are estimated at 270 kWh/year and average peak savings are estimated at 0.32 kW. Industry rules of thumb have not lead to consistent installation and refrigerant charging practices (Mowris, 2004).
- The CheckMe program provides contractor training and quality control services focusing on correcting residential HVAC installation problems (primarily incorrect refrigerant charge and low airflow). The CheckMe system provides a computerized support system for contractors to diagnose and airflow and refrigerant charge problems. Prior "AC service calls" would lead to unknown impacts due to the inaccuracy of the measurement techniques used by many contractors. With this approach, the technician can perform proper verification. The CheckMe procedure has been implemented during over 13,000 field service calls. Quality control data collected in the field indicates the average performance of residential air conditioners is at least 17 percent below the design performance. If charge and airflow problems in residential AC systems were corrected, seasonal efficiencies would increase an average of 16 percent. A major barrier is inadequate technician training. Much of their training has evolved into simple rule of thumb approaches that are not accurate enough to provide good information to the technician on whether refrigerant charge and airflow are within specification. Although manufacturer's approved methods for diagnosing refrigerant charge levels exist, they are rarely used. Less than 5 percent of CheckMe trained technicians claimed to use these methods prior to training (Downey and Proctor, 2002).
- ComfortWise is a residential new construction certification program operated by ConSol. The program focuses on high performance glazing, HVAC system design, and third-party inspections of construction quality. Homes built to ComfortWise specifications qualify for Home Performance with Energy Star

certification. According to the program manager, the third party inspection is the most important aspect of the program.

Training and education

Training and education programs for contractors, installers and service technicians are needed. These programs can be very effective in changing behavior of trainees.

- The New York Home Performance with Energy Star program seeks to create a "one-stop shopping" experience for consumers looking to make energy efficiency improvements to their homes by requiring the contractor that provides the home energy assessments to also develop the scope of work and install the energy efficiency measures. Contractors audit each home employing the" house as a system" approach, recommending a package of measures. Contractors, to become eligible to provide these assessments, must be certified by the Building Performance Institute. Program managers recognized that special training was critical in helping participating contractors become proficient with the more sophisticated mathematics and computer technology that are necessary to perform the home energy assessments. (NYSERDA, 2004).
- The Building Operator Certification Program provides training and certification testing to building operators, who have long been identified as critical components for the efficient operation of commercial and industrial buildings, yet are often among the least educated about energy issues and among the least valued of staff in a company. The program was responsible for changing operator behavior resulting in improved energy efficiency in 90 percent of the trainees. Energy savings estimates exceeded program planning estimates by a factor of 6 (Peters and McRae,)

Hands-on training can enhance training effectiveness:

- The market progress evaluation of the Building Commissioning Association recommends that training should have a greater hands-on component to provide trainees with a better idea of real-world commissioning situations (Quantum Consulting, 2004).
- The Pacific Gas and Electric's (PG&E's) Time of Sale Energy Renovation (TOSER) Program addresses energy efficient mortgages (EEMs) for homes, primarily when existing homes are being resold. Training of real estate agents, lenders and appraisers is one aspect of the program. A barrier to wider adoption of EEMs is the perception of the extra time required to complete an EEM. Training participants suggested that trainees witness the preparation of an EEM to gain a first-hand perspective on the level of effort involved (Xenergy, 2001).
- According to Charles Segerstrom, manager of PG&E's Stockton training center, hands on training is increasingly important. Literature just is not as effective as face to face, hands-on practice.
- The Statewide Manufactured Housing Market Characterization project recommended training for operators and dealers to inform them of benefits from

energy efficient manufactured homes, and training for lenders and dealers on how to effectively process the paperwork for energy efficient financing (Quantum Consulting and Xenergy, 1999).

Whole Building Diagnostic Testing

Whole building diagnostic testing can provide significant energy savings. Cost effectiveness of whole building diagnostic testing programs may be suspect, especially in mild climates. These programs can deliver significant non-energy benefits (NEBs), which factor prominently into the value of the program to the participants.

- A study conducted by LBNL evaluated the potential energy benefits of residential commissioning and other retrofit remediation options. Commissioning improvements include envelope and duct "tightening", duct insulation, and air handler airflow and refrigerant charge. For existing homes projected commissioning electric savings were estimated at 14-18 percent (typical) to 20-28 percent (poor performing homes). Projected natural gas savings are estimated to range from 18-21 percent (typical) to 33-36 percent (poor performing homes). Commissioning was recognized as a critical factor in achieving expected building performance (Matson, et al., 2002).
- Whole house performance programs provide significant energy and non-energy benefits, but the service can be costly. From a customer value perspective, the NEBs are the most attractive feature. From a program cost effectiveness perspective, the non-energy benefits (NEBs), are not considered in the cost effectiveness calculation according to current CPUC policy, which is constrained by conditions set on the use of the Public Goods Charges (Thomas et al., 2004).
- The state of Wisconsin Home Performance with Energy Star Program has a Whole Building Component, focusing on whole building diagnostic testing of existing buildings. Evaluation of the program found that NEBs rather than energy savings are the most important reason for participation. Forty-two percent of homeowners suggested that problems with the home, such as ice damming and comfort issues, prompted them to have work done on the home, while 28 percent said they were promoted by energy efficiency or saving money (Sabo and Wilson, 2003).
- Whole building performance programs can alleviate problems that carry significant potential risk to the structure and its occupants, such as moisture damage, mold, indoor air quality, and combustion appliance ventilation. Where insurance risk can be reduced should result in reduced insurance premiums. (Mills, 2004).
- The California Building Performance Contractors Association (CBPCA) is a non-profit organization that trains HVAC, insulation, and remodeling contractors in the process of whole building diagnostic testing. According to Rick Chitwood, the program technical co-leader, homeowner participation is largely driven by concerns over IAQ and health & safety issues. The hot button issues are IAQ and health & safety (asthma, mold). Other benefits are improved comfort and

durability. The interview also indicated that time of sale will be a difficult trigger event for this type of service.

Uncertainties in program funding

Uncertainties in program funding and lack of continuity in program offerings are a barrier to the development of a healthy market infrastructure to provide efficiency services. Lack of funding, funding uncertainties, and quick exhaustion of available funds were cited as barriers by customers, contractors and service providers.

- For example, according to the Statewide Manufactured Housing Market Characterization Report, industry members noted that it would be essential to provide some certainty about the program so the industry could plan its investments accordingly. They wanted a program designed to be a multi-year effort that could be fine-tuned based upon what was learned in preceding years. An important element in any program should be a planned exit strategy. The failure to have one in place when the program ended created initial industry consternation and disrupted the cooperative spirit that had been developed over several years. Manufacturers and dealers are likely to be more willing participants if they can plan with some certainty (Quantum Consulting and Xenergy, 1999).

Advertising

Lack of advertising is a problem, especially in non-utility programs. Most non-utility programs have small advertising budgets, which limits customer awareness of the program.

- For example, 70 percent of non-participants surveyed for the evaluation of the SESCO Mobile Home Efficiency Program would have participated if they had known about the program (Blankenship, 2004).
- Evaluation of the Mobile Energy Clinic (MEC) program indicated that better advertising through landlord, telephone, email, mail, newspapers, or television will likely increase participation. Advertising should explain how small commercial businesses can take advantage of no-cost energy efficiency improvements offered by the program. (Mowris, 2004).

Cooperation and coordination

Lack of cooperation and coordination among complementary programs limit their effectiveness. Audit and information programs could be more effective in linking their products to other programs providing incentives for installing recommended measures.

- For example, the evaluation of the NYSERDA Flextech commercial audit program found a weak link between FlexTech and other incentive programs (NYSERDA, 2003).

- Similarly, evaluation of the Statewide Home Energy Efficiency Survey program (Ridge, et al.,) found that few participants were aware of utility sponsored efficiency programs and few took advantage of financial assistance or rebates.
- Evaluation of the PG&E Time-of-Sale Energy Retrofit (TOSER) program found a weak link between the program and energy efficient mortgage information (Xenergy, 2001).
- Program overlap can create confusion for customers and trade allies. Multiple programs serving a single customer (such as commercial and industrial) require multiple applications and other paperwork. Consolidating programs to create a single, customer focused approach can create efficiencies and improve customer satisfaction (Fagan, et al.).
- Savings by Design, the statewide nonresidential new construction program provides design assistance and incentives to new construction and major remodeling and renovation projects. The program has low penetration rates in the remodeling and renovation market, possibly because the marketing message is geared to new construction, and people are not aware that the program can also apply to renovation (ADM Associates and Tecmarket Works, 2002).
- The Energy Smart Grocer (ESG) Program implemented by Portland Energy Conservation, Inc. (PECI), works in partnership with grocery wholesalers to provide information, technical assistance, and financial incentives for independent grocers to purchase and install energy efficient lighting, HVAC, and refrigeration systems. The program is delivered to independent food retailers in the territories of PG&E, SCE, and SDG&E. Lighting was originally expected to offer the greatest opportunities for energy savings in this segment, but the program implemented fewer lighting upgrade projects than expected. Lighting retrofits were often conducted through other programs that were able to offer higher rebates than provided by the ESG program. For part of the time the ESG program was in effect, the Statewide IOU Express Efficiency program was offering double rebates for lighting retrofits. More recently, the local Small Business Energy Alliance program has been offering significantly higher rebates (Quantum Consulting, 2004b).
- According to Don Woods, Low Income program manager for SDG&E, state law stipulates that the landlord shall provide heating and hot water to tenants, effectively preventing these types of programs from providing free replacements of furnaces and water heaters.

Commercial Leasing

Split incentives that exist in commercial lease agreements are a barrier to efficiency program participation. Several studies mentioned this barrier, but saw potential for lease agreement conditions that reduce this barrier.

- The Small Commercial Needs and Wants Study explored opportunities for small commercial customers to participate in efficiency programs. Renters make up about 40 percent of the under 500 kW population in terms of annual energy

consumption. Self-reported efficiency program participation is 40 percent below the population average. Renters are probably one of the most widely recognized segments as being hard-to-reach, due to the significant split incentives barrier that exists between owners and renters. Revising lease language for renters can make energy efficiency more palatable to them and to the building owners. There is a significant opportunity for programs to work with both building owners and renters to cooperate and share in the costs and benefits of energy efficiency investments. Renters are least likely to install energy efficiency measures because of lease obligations and limitations. Two thirds of renters have leases that were at least 5 years in length – long enough to realize benefits from energy efficiency upgrades. Seventy nine percent of renters were willing to help the building owner pay for energy efficiency improvements for measures with a payback period of 1 year or less. Sixty two percent were willing to help if the measure payback was equal to the number of years left in the lease. (Quantum Consulting and Xenergy, 2001).

- Evaluation of the Richard Heath Associates (RHA) Small Nonresidential Energy Fitness (SNEF) programs indicated that 25 percent of the non-participants did not participate due to not owning the building (Mowris, 2004).

Demand Response

Demand response programs have had low response from customers, due to confusing marketing, risk of cost increases and moderate rewards for participation.

- In the Evaluation of Oregon Demand Response programs, the evaluation team noted that most customers on a demand response rate are saving money, but the savings are negligible. Incentives that exceed bill savings from curtailing loads are required for sizable response. Programs that only pay participants when the utility calls a curtailment event may not elicit sufficient enrollment unless curtailment payments are very high. Customers should be able to predict their costs for participating and their resulting electricity bills and paybacks. A much greater degree of customer education and hand-holding, including energy audits and help in reducing energy use and demand is desired in an integrated package of services. A broad array of options is desired, including emergency and price-responsive load programs, offered under a single program brand. Different facilities owned by the same company may require different program options (Schwartz, 2003).
- An interview with Mike Messenger, from the Energy Commission on his experience with the Energy Commission demand response pilot program offered similar observations. He made a distinction between reliability programs and price response programs. Reliability programs are mandatory curtailment programs, and customers have no override capability. Since only a few customers can afford to give up operational control, it is hard to recruit customers. Price response programs use a pricing strategy that varies with system load, and send a pricing signal to participating customers. Curtailment is optional, but there are cost implications. For residential price response programs, the single most important item driving the participation decision is the belief that participation will result in

lower utility costs and provide the utility with demand relief. Cost savings currently are on the order of the additional meter costs, so there is little incentive to participate, especially for low income customers. For commercial price response programs, participants worry about effect on their customers. For programs to be effective, the control needs to happen automatically and not affect business or customers. Participants want demand response programs to give them more control over their energy costs rather than less control. Demonstrations, case studies, risk free trials, education efforts, and feedback systems so that people know what impact they are having on the system may be required to get broad participation.

- A well-designed demand response program can provide demand savings with high customer satisfaction. The process evaluation of the SCE Energy$mart Thermostat pilot program indicated that most customers had positive experiences with the program. When customers were asked to rate their overall satisfaction with the program, the average was 7.4 on a 1 to 10 scale, with 10 being very satisfied. Seventy eight percent of the customers would recommend the program to similar establishments; 35 percent of the customers said their energy use with the new thermostat decreased. Only 64 percent of the customers were aware of any curtailments during the past summer. Over two-thirds of these customers believed that the number of curtailments, the duration, and the temperature increases were 'About Right' (RLW Analytics, 2004). Peak demand reduction for the program was estimated at 9.3 MW, exceeding the program goal of 4 MW.

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APPENDIX B: SAMPLE INTERVIEW AND PANEL DISCUSSION GUIDES

Key Informant Interview Guide

Interviewee:

Interview Topic:

Introduction:

You have been identified as having experience and knowledge of [INTERVIEW TOPIC] in residential markets. In our preliminary research related to AB549, several specific barriers have been identified which would seem to validate greater use of [INTERVIEW TOPIC].

I would like to use this interview to get your impressions of these preliminary findings and gather additional information as to the potential role of [INTERVIEW TOPIC] and what policy interventions or practices could make them more successful.

Barriers and Trigger Events

Let us start with the list of identified barriers. Please stop me if you need more clarity on any of these, then I have several questions related to the barriers listed and ones that are not on the list.

Identified Barriers

§ [BARRIER IDENTIFIED IN PHASE I RESEARCH].

1. a. Do you agree that this [restate the barriers] is a barrier?

[If Yes] Are these important or significant barriers to the success of California energy efficiency programs and energy savings objectives?

[If No], Why not?

2. Are there other key barriers not listed above that can be addressed through the use of [INTERVIEW TOPIC]? What are they?

3. Please list these barriers in order of their significance, starting with the strongest barrier.

4. Are there key trigger events or times in which a [INTERVIEW TOPIC] initiative would be most effective? What are these?

Recommended Initiatives and Effectiveness

5. What are your recommendations for how this initiative should be structured, how can this be structured to have the greatest effect? How should this initiative be developed and deployed?

6. AB549 Phase I research [PRELIMINARY RECOMMENDATION] Do you agree or disagree with this finding?

7. a. What kinds of caveats would you place on this finding?

b. Are there circumstances associated with providing [INTERVIEW TOPIC] that would affect this finding? What are they?

8. a. If California were to establish a statewide [INTERVIEW TOPIC], would these efforts be useful in reducing the market barriers identified above?

b. What level of effort would be required for a [INTERVIEW TOPIC] to significantly overcome these barriers?

c. Within what timeframe could they be implemented?

d. How should this be structured in order to get this service into the hands of decision makers at the right time?

e. How much money would be required to do this well at the statewide level?

9. In your expert opinion, what would be your best estimate of the increase in participation rates if there were a statewide initiative to provide consumers with [INTERVIEW TOPIC]? That is, give us an idea of what you would expect to see in the market in terms of an annual percent change in the number of homes that would use this service if California were to launch a statewide [INTERVIEW TOPIC] that would be provided to all requesting consumers? We are looking for your best estimate of the percent change in use of this service; we are looking to get numbers to see if you think this initiative would have an effect on residential acceptance and use of this service and what those rates would be. We are not looking for certainty, but your best estimates.

Market Actors, Stakeholders and Behavior

10. In order to develop an effective [INTERVIEW TOPIC], what market actors or stakeholders are important to work with? Why?

11. a. Which of these market actors and stakeholders are key to doing this?

b. What would be their role in these efforts?

12. What are some of the key consumer behaviors and beliefs that would affect the success of this initiative; providing those that would increase the success and that would decrease the success?

13. What do you think will be some of the different types of consumer reactions to this initiative and why will they have those reactions?

14. How should consumer reactions to the initiative tend to effect how the initiative is rolled out or structured?

15. What can be done to overcome consumer reactions that would have a negative effect on the initiative?

Policy Recommendations

16. Do you think that new legislation or new policies would help develop effective [INTERVIEW TOPIC]?

17. What are they? Describe what legislation you would suggest. Describe what policies or regulations you would suggest that would help develop an effective [INTERVIEW TOPIC] in California.

Program Manager Interview Guide

Introduction

This protocol is provided to guide interviews with energy efficiency program managers or program sponsors to be conducted as part of the AB 549 project. The purpose of the interviews is to obtain the experience, advice and guidance of experienced professionals regarding the factors affecting the success of energy efficiency programs in achieving energy savings and recommend to the Energy Commission new policies, programs or legislation that will promote energy and demand savings in existing buildings in California. This guide is provided to assure that important information is collected consistently during each interview and that participants have an opportunity to elaborate on their experiences and provide useful responses.

Interviews will be held with from _date_ to _date_ with experienced program managers that have a good understanding of energy efficiency program approaches and markets for existing buildings. The interviews will focus on California markets and market conditions. However, the interviews will not be limited to those living in California. Program managers who are familiar with the California markets, but who live and work elsewhere will also be interviewed. Likewise, the interviews will also focus on key individuals who have extensive experience in enabling technologies and market and/or behavioral analysis.

This guide presents the subject areas that will be discussed during the interviews. The interviews will be semi-structured, allowing participants to move across subject areas as needed to keep the discussions moving and productive. This format is being used because clients are generally more responsive to less structured interviews and less bias is introduced by the interviewer. This is an information collection interview designed to identify how and when intervention strategies can be successfully employed at key trigger events in the life of a building. The interviews will be conducted by staff at AEC and Tecmarket Works. Following the interviews, the interview responses will be coded and categorized for subsequent analysis. The questions will be e-mailed to all interviewees prior to the interview so that they are provided time to consider their responses. We find the best interviews occur when people are informed about the interviews, are knowledgeable about their content prior to the interview and understand the purpose for the interview.

Energy Commission Task Support Needed

The interviews may rely to a limited extent on the involvement and support of the Energy Commission project manager. This involvement includes:

- Help in identifying key individuals that the Energy Commission project manager wants included in the interview effort.
- Describing the nature and purpose of the research effort when contacted by interviewees that wish to confirm the nature and scope of the interview.

Scheduling the Interview

Prior to the interview the interviewee will be contacted by a member of the interview team to invite the interviewee to participate. The interview scheduler will indicate that the interview may take 20 or more minutes depending on the level of detail the interviewee would like to provide. After the interviewee has agreed to participate, it will be scheduled to meet the timing considerations of the interviewee. These interviews will be conducted during normal working hours, however some interviewees may request that the interviews be conducted after or before standard working hours. The interview team will make itself available to meet the scheduling conditions of the interviewee.

Introductions

The interviewer will contact the interviewee at the scheduled time for the interview. The interviews will open with introductions and a brief explanation of the research effort and an explanation of how the information will be used. The interviewer will also ask the interviewee if they have any questions that need to be addressed prior to the start of the interview. Interviewee questions will be addressed at this time. Once questions or issues are addressed the interview will begin.

Energy Efficiency Program Manager Interview

Date:

Interviewer Name:

Interviewee Name:

Energy Efficiency Program Name:

We would like to start the interview by asking a few questions about your experiences with the <fill in program name or type of program or program areas> program. We would like to focus on the aspects of the program that were instrumental in achieving energy savings.

Program Characteristics

1. What characteristics of this program worked well in achieving energy savings and why?

2. What would you suggest be done differently in this program if it was to be redesigned or re-implemented and why?

Market Actors

3. Who were the most important parties involved in this program and what part did they play in making the program a success?

4. What do you think motivated these parties to participate in and support the program?

5. Were there parties that opposed the program and if so, what were their concerns?

6. What do you think motivated these parties to oppose or not participate in the program?

Market Barriers

There are a number of barriers that may keep potential participants from taking energy efficient actions. These barriers can be related to the energy efficient product and product provider (such as high first costs, inadequate payback, lack of product technical expertise or support), the participant and their decision processes (lack of awareness of problem, lack of authority to make purchase decision), and marketplace (split incentives, non-availability of the product in the marketplace) and so on.

7. What barriers do you think are the most important to overcome to improve participation in your program?

8. What suggestions or recommendations do you have that you think would help overcome the barriers you identified?

Non-Energy Benefits

9. What non energy benefits (such as improved comfort, productivity, property value, and so on) do you think were realized by the name of program?

10. Which parties involved with you program do you think highly valued the fill in the type of non energy benefit?

Policy and Legislation

11. What type of policy decisions or legislation do you think would be helpful for increasing the success of your program?

Efficiency Strategies and Trigger Events

Next, we would like to explore you opinion on energy efficiency strategies and when they can be incorporated into existing buildings.

12. Based on your experience, what types of energy efficient measures offer the largest energy savings for the least cost?

13. What strategies do you think can be used to increase the likelihood that these measures will be incorporated into the building?

Trigger events are events that provide an opportunity for improving the energy efficiency of a specific type of equipment or a component of a building. For example, when a water heater goes out and needs to be replaced, this is a trigger event since it is an opportunity to affect the energy efficiency of the heater. Likewise, when a building is sold, there is an opportunity to finance energy efficiency during the mortgage process. We are interested in hearing your ideas about different trigger events and how successful you think a program can be if it were designed to take advantage of trigger events to introduce energy efficiency technologies or services into the building.

14. What type of trigger events do you think offer the best opportunity to improve building energy efficiency?

15. What types of energy efficiency measures and programs would be best suited to these trigger events?

16. Are there any reports or studies on improving energy efficiency in buildings that you think we should review to better understand trigger events or different types of market interventions that can be used during specific types of trigger events?

17. Lastly, if you were to recommend your top three strategies that you think have the highest potential for saving energy and demand in California that need to be addressed (via new legislation or new programs) what three strategies would you recommend?

1. _____

2. _____

3. _____

Other Comments?:

Expert Panel Discussion Guide

This document is designed to guide the expert panel facilitator through the issues and questions to be addressed during the expert panels. The panels will start with a short discussion of the barriers identified in the Phase I research and then present the intervention description to the panel so that everyone is familiar with the intervention strategy that will be addressed by the panel members. Then the facilitator will guide the discussion to address as many of the guiding questions that can be covered in the panel session.

The results of each panel will be summarized in a panel document and analysis database and provided to the evaluation team and the Energy Commission project managers. These documents and the database will be used to guide the analysis efforts.

Intervention Description

<Insert a brief description of the intervention>

Guiding Questions

1. General discussion about this overall intervention strategy. Does it make sense? Will it work in California? What about this do you like? What do you dislike? Should it be developed? Why or why not?

2. If this intervention strategy were to be developed or expanded (if now partially developed) how would it need to be implemented? What structural characteristics would need to be incorporated into the initiative? Over what timeframe would this need to be developed? Over what timeframe would it need to be offered and pushed to get established in the market or to create enough demand to make it successful?

3. What do you think would be the level of demand for this type of intervention if it was done well and we used some of the strategies we have discussed? What types of market segments would benefit most and why? Which market segments would benefit least and why?

4. What do you see as the key barriers that would have to be overcome to successfully implement this intervention? And what would you suggest be done to help overcome these implementation barriers?

5. What techniques would you use to market and promote this initiative? How would you incorporate it into or coordinate it with other programs services now offered?

6. Who are the key market actors and stakeholders that would support this initiative and serve as development allies? Who are the key market actors and stakeholders that would resist this initiative in California and why would they resist? What can be done to overcome this resistance and how effective would this effort be?

7. If this initiative was successfully designed and launched statewide, what do you think would be the level of interest and participation from the target market(s)?

8. In your opinion, what would be an appropriate annual budget for this initiative to cover the upfront planning and development efforts and also the annual implementation costs? What is the budget range that would be needed for this initiative?

APPENDIX C: PRIMARY RESEARCH

Program Manager Interviews

The program manager interviews reflected the views of several types of stakeholders, from government agencies to private contractors, on a variety of program and market types. The interview instrument allowed for a high level overview of the topics of program characteristics, market actors, market barriers, non-energy impacts, recommended policy and legislation, recommended research resources, and finally their assessment of the top three issues that need to be addressed in energy efficiency programs.

The key findings from these interviews are organized by the topic on which they were commenting, such as program characteristics, barriers, market actors etc. and then by the expertise of the interviewee, such as in benchmarking, commercial programs, demand response, etc. Similarities across respondent categories are noted in the first finding of the topic heading.

Program Characteristics

The program characteristics, successful or recommended, noted by the individuals interviewed varied significantly. The program characteristics were unique to the type of program being discussed. The only program characteristic that was widely noted was the need to work closely with existing market actors.

Benchmarking

1. Benchmarking tools need to start providing recommendations.

The benchmarking tools that are currently available are primarily providing feedback to building owners and facility mangers, but the benchmarking tools could be more useful in developing recommendations for future improvements in their ratings. It is important to remember that benchmarking is only a starting point, those being provided the information need to be able to follow up on that information.

Commercial Programs

2. Focusing on retro-commissioning is a cost effective approach to acquiring energy savings.

Optimizing the systems and existing technologies of buildings often have paybacks of less than a year. However, programs need to ensure that they allow enough time for the installation procedures so everything can get done.

3. Information only programs can also be very effective.

The Energy Efficiency in Commercial Food Service program is information only but it has multiple venues for providing customers with information. They have food

service equipment testing and work on ASTM test protocol development, education and on-site audits. In addition to collaboration efforts, they have been able to establish Energy Star designations for food service equipment, and promote low flow spray heads.

4. The focus should be on markets, not technologies, for some programs.

The Energy Smart Grocer program had success with building relationships with customers through contacts and education. On-site auditors were very credible, and computerized audits were able to provide site-specific analysis. Strong relationships with contractors and equipment suppliers were very important and developed through strong follow up efforts.

5. Programs should attempt to work with the existing market actors to get the most out of the programs.

The Enhanced Automation Initiative works with utility account representatives and with control contractors. This program could be even better if it was endorsed by the utilities.

The commercial food service programs have worked closely with the EPA Energy Star program, the Energy Commission in setting appliance standards, and SoCal Gas on rebates for gas food service equipment. The program even has a national advisory board that is made up of food service equipment manufacturers. Improvements could be made to do more outreach and increase advertising.

6. Risk management and energy management should be addressed in a more comprehensive manner.

The relationship may not always be positive, but program managers need to be aware of the risk issues they introduce to participating firms, both positive and negative. Building commissioning is one way to manage the risk of the un-attainment of savings by ensuring that savings are being achieved. The un-attainment of savings is a risk not only for the participant but also for the implementer, and the program sponsor. Another method is to have better diagnostic training for maintenance professionals. Financial risk can also be addressed through insurance programs that insure participants against non-attainment of savings, and hold the entity promising savings responsible. Improving the safety of the building, which may be a non-energy benefit of improved efficiency, is another form of risk management. All of these factors could be included in program offerings in the commercial sector and could also be applied to the residential sector.

Demand Response

7. As a reliability program, customers must relinquish control of their energy use to the utility, and the amount of power that can be provided is fixed.

Customers have to be well aware of this situation and accept that they have no over-ride capabilities. However, systems operators will have a clear idea of how much energy they will get when the pre-determined threshold is reached.

8. Price response programs offer customers the opportunity to respond to price signals and generate benefits for themselves.

These programs should only be launched after the rate structure has been well defined and the rules are clear and stable. Any changes in the rules or the rates will cause dissatisfaction and distrust. Interruptions that occur will have to be clearly explained to the participants, and not blamed on the rate structure. These programs need to be well automated and provide ongoing feedback to customers, so that the benefits are visible and real. Commercial customers have to be able to participate with zero impact on their own customers.

Energy Improvement Mortgages

9. Energy improvement mortgages are successful when the benefits are clear to the buyer.

If the buyer can make the improvements through a tax-deductible loan payment, and if the savings are greater than the incremental cost of the improvements, they will be interested in taking advantage of such an opportunity. Third party verification can also ensure that the buyer is achieving the savings promised.

10. Getting the word out about energy improvement mortgages could be improved by providing the information directly to buyers.

If buyers had this information at the point of sale, it would allow them to act on the opportunity. Currently, real estate agents are not getting the word out, and it is difficult for programs to reach the hundreds of new loan officers and real estate agents entering the market every year. The public needs to be better informed through advertising and education campaigns.

11. Traditional loan offerings are not flexible enough to accommodate energy improvement mortgages.

Freddie Mac and Fannie Mae programs are not flexible and cannot use adjustable rates; they need to be modified to accommodate energy improvement mortgages. Increasing the use of the popular multiple loan products from the FHA and VA and other conventional loan products with energy improvement mortgages would make them more commonplace.

Lighting

No comments were made on successful or recommended program characteristics for lighting programs.

Low-Income Programs

12. Low-income programs are more successful when they collaborate with existing community organizations and reach out to individuals.

Collaborating with these organizations can assist in identifying potential participants, and lend trust to the effort. It also provides a venue for outreach as people look for

other assistance. Potential participants should be visited, at which time a preliminary assessment can be done.

13. Coordination with federal weatherization assistance makes low-income programs more effective.

The LIHEAP application provides a good opportunity to reach potential participants. There should be more integration of LI programs with the state's federally funded program, and there should be better integration of information across the state for LI programs.

14. Policy changes of the various stakeholders can potentially make a difference to low-income programs.

If the CPUC adopts a policy where the utilities can make a profit off of energy programs, this would present an interesting paradigm shift and utility management would take notice of the issue. The policies of low-income housing authorities have the longest lasting effect on efficient, affordable housing. Mandating weatherization at the point of sale may also be a policy change that can increase energy efficient improvements. Voluntary programs are there, but they still require someone to volunteer.

15. Low-income programs must be incentive-based with certain controls.

Economic incentives must be properly set. Incentive budgets need to be sufficient to affect change, and limits per participant can ensure that funds will be available for target regions. Performance contracting can also be used to ensure that savings are achieved.

16. Low-income programs must have strong marketing budgets.

Getting the word out about potential savings will make a significant difference in the level of participation.

Purchase Decision Intervention

17. Customers need to easily be able to identify an energy efficient product or service, distinguish it from others, and understand how to implement it.

Upstream market actors could be encouraged to package products together that will increase efficiency, so the retail associate or the customer does not have to figure out which components go together to maximize efficiency. Customers need to have good information at the time of their purchase decision, so they know how this equipment compares to others. Finally, there needs to be a simple process guide for the acquisition of rebates, or any other necessary follow up.

Residential Construction

18. Proper installation of measures is critical and needs to be insured by programs.

Third party inspection can help ensure that the measures have been properly installed and that the energy savings are likely to be achieved. Providing detailed

protocols for contractors to follow can also contribute to higher rates of proper installation. More detailed training with periodic refresher courses can also increase the skills of participating contractors.

19. Builders need to be allowed to make their own decisions.

Point systems that establish the ultimate goal of efficiency by installing certain measures allows the contractor to make decisions that would maximize efficiency for each building. . Mandatory installations generate frustration and minimize participation. Positive encouragement, which can be done through a point system, will have more sustainable impacts on the market over the long term. However, some mandatory efforts, like window ratings, have promoted construction defect avoidance.

20. Builders need support to educate consumers.

Consumer education and funding through PGC could offset costs to builders.

Time of Sale Audits

21. Audit programs should be voluntary, and work closely with the customers through home inspectors.

Home inspectors are already part of the home buying process. They provide trusted advice, and can work one-on-one with the customer to explain the necessary energy improvements.

22. Audit programs need to have incentives to off set the cost of the added inspection elements for energy efficiency, and they need to try to get realtors on-board.

The added costs for doing an energy inspection should be subsidized by a program. Making this service free for customers will increase the number of inspections done, and the number of improvements made. Customers are hesitant to pay for this service on their own because they do not yet recognize the value.

Real estate agents need to be given incentives to get them involved as well. One strategy would be to offer free CFLs and water conservation measures through the realtor, which they could give as a closing gift.

Market Actors

Nearly all interviewees recognized importance in working with a variety of existing market actors. Obstacles to working with these market actors came from a lack of interest, lack of recognition of a problem, or a fear of administrative burden.

Benchmarking

23. Support for benchmarking comes from building energy managers and benchmarking tool developers.

Building managers are looking for ways to distinguish their buildings as better than others. Benchmarking tool developers see it as an important tool to stimulate action.

24. Opposition to benchmarking has come out of the difficulty of generating rational comparisons.

Energy Star has been criticized for comparing a building in San Diego to one in Alaska. There are many climate factors that play into any benchmarking scheme.

Commercial

25. Support for commercial programs has come from facility operators, building owners, program implementers, manufacturers, trade associations, utilities, energy experts, and contractors.

Facility managers see value in free engineering services and reports. Many building owners can also recognize the value of improved efficiency to the bottom line. The most important parties in the Enhanced Automation Initiative were the PGE account representatives who wanted to provide good services to customers, and the controls contractors in the SCE territory who were profit motivated.

The commercial food service program found support from the EPA Energy Star program, the National Association of Foodservice Equipment Manufacturers (NAFEM), National Restaurant Association (NRA), which provides co funding. They appreciate getting unbiased information to their members. The utilities and the CPUC also provide funding ASHRAE provides research and development support for commercial kitchen ventilation (CKV) research. These parties appreciate getting independent test data to evaluate products and energy savings.

Manufacturers were the key actors in the commercial food service program since most equipment is sold direct to the end-user. Manufacturers were really looking for research and development support because they are so small, and they get a market for their up scale products through Energy Star branding.

In the Energy$mart Grocers program, the energy experts who provided customer service and support were vital to the success of the program. Contractors who did the work were very important and were motivated by getting more work through the program. Manufacturers who supplied the equipment were interested in selling more equipment, but also offered design assistance particularly for refrigeration units.

26. Opposition can come from these same parties (except it is usually from program implementers) and additional parties.

Some do not see the value in energy efficiency programs because they feel that most improvements are already being made “in-house”. In some instances utilities have opposed certain programs because they conflict with other commercial program offerings. Some “old school” manufacturers are reluctant to provide Energy Star products simply due to inertia or the lack of research and development resources.

27. There are many stakeholders that are trying to manage risk with respect to energy management issues.

Contractors, end users, utilities and the PUC are all important actors that face risk with energy efficiency programs. Those involved with research and development also need to include risk management in their assessment of new technology opportunities, which directly affects the risk of efficiency programs. Insurance companies want to minimize risk, and participants are their clients. Private companies have risk managers that are responsible for avoiding liabilities. Between the energy manager and the risk manager in a company, the risk manager will have more clout. Any project that goes against his or her primary goal of reducing risk is not going to get into the field. The real estate community is risk averse to energy price volatility, when prices spike it affects the profitability of owning buildings. If the business case can be made to avoid price shocks through improved efficiency, participation may increase. These multiple interests in risk that are related to energy management present both opportunity and challenges to the greater implementation of energy efficiency measures.

Demand Response

28. Meter vendors, market researchers, consultants and focus groups were among the important market actors in the demand response pilot program.

Meter vendors who installed and ensured the monitoring equipment was operating were very important to the demand response pilot. They were motivated to sell their product and protect their name with proper installation. Researchers and consultants who set up the demand response pilot to learn from it were also very important. The marketing and focus group information was essential in developing pilot projects for demand response.

29. Opposition to the demand response pilot came from the meter reader union, those uncertain of how a demand response rate will affect their bill, and those that feared the cost of the monitoring equipment would outweigh the benefits of participating.

Unions of meter readers were opposed to the demand response pilot because they were afraid of losing their jobs to automated meters. There may be a group of people opposed to market pricing for demand response, but want an average price that is constant, reliable and assured. This stems from their uncertainty of how their bill will look on demand response rates. Opposition to demand response also came from low usage customers who would have to pay for the meters and did not expect that their savings would offset the cost of the meter.

Energy Improvement Mortgages

30. The Energy Improvement Mortgage facilitator or service company, HERS raters, lenders, realtors, and buyers are all important market actors.

The EIM facilitator or service provider assists the lender and borrower in securing the EIM; the lender tells the consumer that the EIM is available, and consumers demand the product. The motivation for the facilitator or lender is an interest in doing the right thing by their customers and wanting them to have the opportunity for

greater comfort and saving money. Consumers are motivated to get an EIM because it is the only convenient method for financing energy improvements. There are benefits from an EIM for both buyers (a secure loan and higher property value) and lenders (increased appraised value and loan amount without a second appraisal).

31. Opposition to energy improvement mortgages can come from these same parties due to a fear of increased workload, delays in the loan approval process, or lack of interest in energy improvements.

The perception of extra workload keeps people from pursuing EIM, although the additional information can in some cases only take a day to gather. Lenders may be opposed to the EIM because there is not much of a financial incentive for them. Real estate agents are primarily concerned that pursuing an EIM will hold up the closing process. Consumers will not pursue the EIM if they are more concerned with other home repairs not involving energy improvements.

Lighting

32. Utility assistance to bring down first cost of innovative lighting technologies can concern lighting manufactures that want to make a profit as these technologies enter the competitive market.

Lighting manufacturers may be concerned about profit margin for dimmable ballasts, which are not yet mainstream technology, if it becomes a competitive market. Since utility companies must be able to provide incentives to bring down first cost, they are mandated to provide a certain portion of the PGC funds as incentives. These incentives establish the market price, and when the incentive is gone manufactures will still have to provide the product to the market at that price. This is one example of the relationship between two of the primary market actors in the diffusion of lighting technology.

Low-Income

33. Some of the market actors involved in low-income energy efficiency programs include the USDOE, local governments, community organizations, utilities, affordable multifamily developers, and some private contractors.

The US Department of Energy funds the low-income weatherization program and used to run them through counties and community action agencies. This works well because these groups are already involved in the community and can provide wrap around services. Community organizations and government agencies are motivated to participate to meet their organizational goals and responsibilities. They are also interested in addressing issues of equity through these programs. Utilities are motivated by altruism and profit both of which can be used to the benefit of energy efficiency programs. Affordable Multifamily developers are important; those that see the value of the program will report this to the housing authorities and encourage greater incorporation of energy efficiency into existing policies. These developers are also interested in reducing their tenant's energy costs, so they are in a better

position to meet their rent obligations, but most developers are more interested in improving the comfort of low-income families.

34. Market actors that may oppose or not be interested in energy efficiency programs include public housing authorities and large developers.

The public housing authorities are not interested in energy efficiency programs because they will take more time to implement. These organizations face budget constraints as the low-income population grows in California. Large developers are typically not interested because they do not have a particular interest in working with low-income families. Other opposition to low-income energy efficiency programs stem from a lack of awareness of the benefits.

Purchase Decision Interventions

35. Contractors and customers are among the most important players in the decision-making process for residential energy equipment.

Contractors are important because they are a very influential source of information to customers at the point of decision-making. The demand and supply of energy efficiency equipment is push pull: there needs to be motivated customers and motivated market actors. Programs have experienced opposition from contractors because of the administrative burden introduced by the program or because they have had a bad experience. They consequently do not promote the programs to their customers.

Residential Construction

36. Some of the key players with respect to residential construction and retrofit programs are the buyer, contractor, operations managers, trainers, seller, realtor, and sales and marketing teams.

Buyers or homeowners participate because of concerns about indoor air quality/safety as well as the energy savings. Builders are motivated by an opportunity for training and an opportunity for market differentiation and favorable reviews that will promote their business. Builders should be the focus of any construction related program. The sales and marketing teams that work with the builder’s sales staff are important parties in the program by helping sell the product. In the retrofit market the buyer, seller, and realtor are key.

37. Opposition to residential construction or retrofit programs has come from these same parties.

If the customer or the contractor cannot see a value in pursuing the energy efficiency improvements, or the costs associated are too high, this will limit participation. One interviewee noted that consumers could not care less if their home is energy efficient and that builders oppose programs generally because they are not a good fit with the public's interest. Builders and consumers are concerned about airtight homes, and about the safety and quality of installation of these measures.

Builders sometimes do not participate because the learning curve is sometimes steep, the cost for diagnostic equipment is prohibitive, and training costs for employees may also be prohibitive. One respondent noted that less than 10 percent who do the training end up following through with using the house as a system approach in their daily work. One interviewee felt that the Energy Commission supports products that are not of good quality, like fiberglass insulation. They generally lack the ability to lead and provide un-biased information and are consequently are not looked at favorably in the industry, which creates opposition to programs in general. In addition, if builders see an initiative as being mandatory, they will oppose because they do not feel that approach works.

Time of Sale Audits

38. Home inspectors are the most important market actor since they are they are selling the audit service to the homeowners.

Home inspectors are motivated to participate to expand their own skill set, or to meet continuing education requirements that are needed to be certified with the American Society of Home Inspectors (ASHI). Skilled professionals are typically interested in learning more about energy efficiency and being seen as knowledgeable in the field, while new inspectors are usually more concentrated on meeting their continuing education requirements.

39. Realtors and homeowners are the parties more likely to oppose the audit program.

Both parties are not fully aware of the benefits of the audit. Homeowners are consequently reluctant to spend the extra money to have the audit done. Realtors typically have auditors that they work with on an ongoing basis and like this control of the information process. New information may disrupt the sale. Even if realtors are aware of the benefits, they may already have established ties with a lending institution, which may or may not have a loan product that could be of help. Taking the extra time to establish new contacts and get that information may not be worth it to them.

Real estate agents are a very important party to get involved, because they have control of the sales process; they typically recommend the home inspector to the homeowner. Home inspectors will have a difficult time selling the energy inspection service on their own for this reason.

Market Barriers

Awareness was a commonly cited barrier for existing programs. Cost barriers were also noted in several cases. Infrastructure development, specifically the availability of services and marketing skills of service providers, were also noted as barriers to greater energy efficiency improvements.

Benchmarking

40. The barriers to benchmarking are finding a balance between simplicity and technical robustness.

For benchmarking, new approaches must be developed so information can be used at a simple level and become more detailed for those people who wish to pursue it.

Commercial and Risk Management

41. There is a lack of awareness of opportunities available and the benefits of energy savings or non-energy impacts, possibly because participants have a hard time taking a broader view of their operations.

Potential participants are not fully aware of the opportunities available to save energy or what that may mean for their firm. Strong case studies may be able to address this barrier. Participants seem to have a hard time taking a broader view of their operations, but there is not a lot of documentation as to why that is the case. Risk management and its relationship to energy management is one area firms have not seemed to consider. Bringing new stakeholders into the energy efficiency discussion, like risk managers, may help to integrate the decision making process. Promoting the risk mitigation benefits in addition to the energy benefits will help. Misperceptions can also stem from the lack of awareness, so adequate analysis and demonstration through case studies needs to be used to address barriers of accurate information.

42. Cost and risk are important considerations for firms and integrating the two to leverage external funding from insurance companies may help address these barriers.

Cost is always a factor. Instead of direct incentives from the implementing agency, if insurance companies could provide discounts for making improvements that mitigate risk, that may help by mobilizing external resources and addressing both parties interest in minimizing risk.

43. The implementation of efficiency programs also faces certain barriers associated with their limited vision of energy efficiency.

Energy implementation is often solely focused on promoting energy savings. This is the largest barrier to greater participation. Risk mitigation benefits, for example, should be incorporated in the overall ”sell” of the program, and can be done by educating the various stakeholders. From the R&D perspective, there is a tendency toward the “stove-piping effect” where a team is committed to one technology and often misses the secondary impacts of integrating that technology into a building system. This can only be addressed by taking a whole system approach from the very beginning of the product development process, which can be incorporated into program design. There is also a general unwillingness to talk about the adverse effects of energy improvements, but addressing these issues directly can serve to make programs stronger and better match participant expectations. However, energy savings should not be excluded from the discussion, programs can still be promoted from this perspective.

44. The process for getting food service equipment added to Energy Star is slow, and chain restaurant operators are first-cost driven and bound by store prototype design and equipment specifications.

In the commercial food service industry one of the barriers to improving energy efficiency is that the process for adding equipment to the Energy Star list is slow. Chain restaurant operations also present the barriers of mostly using first cost as their purchasing criteria. Some (about 10 percent) use life cycle cost criteria, but that number is increasing. These cost issues can be addressed through incentives to cover the incremental cost of equipment, and also training and education on the value of lifecycle costing. Stores are also designed around prototypes that have pre-determined equipment specifications, so energy efficient equipment needs to be put into these prototype specifications. Operators need to know that they will achieve savings and they will get a return on their investment.

45. When working with independent commercial firms, like grocers, it can sometimes be difficult to make the initial contact with decision makers.

Independent grocers need to be contacted directly and they tend to screen their calls fairly heavily. Getting access to the appropriate decision makers can be a real challenge that may be addressed through an advertising campaign to raise awareness among storeowners.

Demand Response

46. The primary barriers faced by demand response programs include customer expectations of fixed prices, their lack of experience in making price response decisions, or familiarity with the monitoring equipment, as well as a history of not understanding their bill.

People have been conditioned to expect fixed prices, which is a barrier to a new pricing strategy. This can be addressed through education on the value of adding the dimension of time to energy bills. Given this lack of experience with variable pricing, customers need to be educated in how to make price response decisions that will make a difference in their bills, for example identifying which appliances are high energy users. Other barriers that have been faced stem from a lack of experience with the monitoring equipment needed for demand response programs. There is a mistrust of the control equipment, as people fear that it may be used against them, or used to collect personal information from them. In addition all of the traditional new product resistance and new innovation barriers also play out in demand response programs.

In addition to education, customers should be offered a risk-free trial period with the demand response program technologies and the billing approach so they can see if this system will work for them.

Energy Improvement Mortgage

47. Real estate agents and lenders need to be educated in the opportunities of energy improvement mortgages and encouraged to provide this information to customers.

The lack of education among real estate and lending agents is really the biggest barrier to greater use of the EIM. There is a misperception amongst these parties, especially the real estate agents, that the process requires additional time, although this is false. Simply requiring that the EIM be part of the purchase order would force these entities to take notice of this opportunity and disclose it to customers. Education and awareness should start by collaborating with a regional or local realtor association, not statewide, and let the program grow as benefits are realized.

48. The availability of HERS raters may present a barrier.

HERS raters are independent of facilitators, lenders and contractors and there is a low demand for their services, making it difficult for them to sustain their business. If demand increases it will be good for their business, but if EIMs took off quickly there may be a supply shortage of raters in the short term.

49. Existing lending tools should be modified to allow for the EIM.

The variant requirement should be eliminated to allow all lenders to participate, because full participation in the lending industry is necessary for the EIM to work properly. The FHA/EIM is the most popular variation on the EIM, but housing prices often exceed the FHA price limit, eliminating this option for many homeowners. These limits need to be adjusted to reflect the current situation and allow room for inclusion of the EIM funds. Other conventional loan products are limited or cannot be used for various reasons. Finally, the multiple layers in the lending industry can impede the use of the EIM. A broker may advocate while a secondary loan market may oppose. Without industry support up and down the supply chain, the use of the EIM will be limited.

Lighting

50. For establishing innovative lighting technologies in the market, first cost is the greatest barrier.

First-cost is the greatest barrier to customers. Providing incentives will establish the market cost at a level affordable to consumers, and manufacturers will have to continue to market them at that price when the incentive is gone. This is good for consumers but can generate concern among manufacturers with respect to the profitability of the technology. This is what happened when the market moved from magnetic to electronic ballasts.

Low-Income

51. Low-income programs face several cost issues including the availability of discretionary spending, program cost to reach the remaining population, and the perception of the value returned from improving efficiency.

Discretionary income for low-income populations to make energy efficiency improvements is just not available; programs in this area require 100 percent incentive. One interviewee pointed out that the high first cost is a market condition and not a market barrier, but that the actual or perceived value for a particular cost is a barrier.

Since low-income programs have been in existence for roughly 23 years, there has been pretty strong saturation. As a result, the low-income market for energy efficiency is facing some diminishing returns; it costs more to reach the remaining populations than the savings that may be achieved. To exacerbate the overall situation, affordable housing resources in general are diminishing.

52. Multiple social barriers, like isolation and negative past experiences, make energy efficiency a harder sell in the low-income market.

Many low-income populations face a general isolation from society. The elderly and illegal immigrants are prime examples. For this reason, working through faith-based and community based organizations can help address this barrier because they are organizations these people can trust. Overall, the low income market is fragile; they are facing multiple barriers and may be difficult to convince to participate, based on their past experiences. Again, focusing on local contacts and networking through local programs is the best way to reach the low-income populace.

53. The organizational structure of low-income housing also may impede the implementation of energy efficiency efforts.

Affordable housing projects suffer from a fear of HUD. Housing authorities will not act without written approval from HUD, and HUD is reluctant to provide such approval. Programs have been trying to work with the HUD energy liaison to raise awareness and overcome this barrier.

54. Housing authorities still do not generally recognize the value of the utility allowance structure.

Housing authorities still do not generally recognize the value of the utility allowance structure. Case studies may help to verify the savings.

Purchase Decision Intervention

55. Lack of information and awareness are the most significant barriers for consumers making a purchase decision and can be addressed through greater education and face-to-face training.

Education training and communication efforts need to drive the program. While energy crises significantly raise awareness, the message needs to be kept alive in the interim. Face-to-face, hands-on education has been successful in doing that, in effect taking the message “on the road”.

Residential Construction

56. Barriers to builders or contractors include a lack of support for marketing energy efficient homes, cost and added value of these homes, and insufficient installation training.

Builders often first see the barriers of the additional cost and perceived value of energy efficient homes. Additional support of builders to overcome these barriers could include more marketing tools to promote these homes. Using more rating systems like CHEERS, instead of mandatory compliance, would give builders more incentive and a tool to promote their high quality homes. Installers need more technical education because without proper installation energy savings will not be achieved.

57. Reaching homeowners presents the barriers of their home improvement priorities, a lack of education as to the opportunities for greater energy efficiency, and misperceptions of how to achieve energy savings.

First, homebuyers typically do not see energy efficiency as a priority, party due to lack of education. Homeowners also are not aware of the energy efficiency opportunities, especially with older homes. Another issue is homeowner's expectations that just purchasing energy efficient equipment will result in energy savings without consideration for the whole system. People also tend to view Title 24 as housing built to maximum standard not minimum.

With better information, homeowners would be able to make better decisions. One way to reach them may be through high profile demonstrations. Consumer education will drive demand; and training needs to keep up with this demand, so it is best to start promotions in moderately sized towns.

Time of Sale Audits

58. Awareness among realtors and homebuyers of the benefits of service were the key market barriers to time of sale audits.

The benefits of the energy audit are not evident to many realtors or homebuyers. For homebuyers, if the benefits are not clear, cost also presents a barrier. Realtors are afraid of jeopardizing the sale with new information.

To overcome these barriers, training, education and marketing should be used. It should be targeted at realtors and homebuyers to stress the value of the audit in identifying home improvements. Once realtors are on board, inspectors will come because inspectors rely on realtor referrals. If realtors do not disclose all of the building defects, they risk litigation. Home warranties have been used to a certain extent as a consumer protection measure but they are not sufficient to cover energy efficiency issues. If defaults can be identified prior to sale, financing through a program or an energy improvement mortgage could be sought out.

Energy Efficiency Strategies and Trigger Events

The strategies and trigger events identified were very dependent on the type of program the interviewee was discussing. Trigger events include a variety of change of ownership, renovation, purchasing and design events, which present opportunities for intervention.

Benchmarking

59. Building commissioning is an important and cost effective measure, and its greater use could be stimulated by effective case studies and cost benefit data.

Making case studies and cost benefit data available to firms would highlight the benefits of building commissioning to identify opportunities for improving efficiency.

Commercial and Risk Management

60. Facility assessments and several specific technologies were identified as having continued potential in the commercial market.

It is important to target the building manager or engineer when doing facility assessments, and provide them with detailed engineering analysis and modeling to increase the likelihood of adoption. Maintenance personnel should also be targeted in these efforts.

Several specific technologies were cited as being measures that could provide energy savings at the least cost. For retro commissioning, re-enabling economizers or using them correctly and variable speed drives. Energy efficient lighting, controls (like demand controls, ventilation and restarts) and HVAC were also cited as having significant potential.

Another suggestion for a market that has significant potential is in labs, clean rooms and data centers. They are great targets because they have high potential savings per square foot, and the value of energy benefits is very important. They are very focused on energy quality issues.

The commercial food service markets can still benefit from improvements to pre-rinse spray heads, cook line equipment, commercial kitchen ventilation hood design, demand controlled ventilation, intelligent kitchens (where demand controls are tied to EMS), water heater efficiency, hood makeup air unit efficiency and control and rooftop unit efficiency. All of these components are being addressed by the FSTC (Food Service Technology Center).

Grocery stores could still benefit from lighting improvements, strip curtains, door gaskets, operations and maintenance changes, anti-sweat heater controls. Low cost upgrades should be the initial focus, but by maintaining a relationship with the owner more comprehensive upgrades could be made in the future.

61. There are multiple trigger events that were identified for the commercial markets.

When energy prices are high, firms will be looking to re-evaluate their entire energy system, and may be more willing to make changes. Other events beyond a crisis include changes in the facility management team. When a new chief engineer comes aboard, or when buildings have a change in tenancy there may be new opportunities to make upgrades. Equipment failure was also identified as a good intervention opportunity when discussing controls. Building commissioning can happen in the design phase for new construction, and when existing buildings are tuned up.

Other venues for intervention that were noted were getting involved in the education process at technical colleges, as professionals are getting ready to enter the field. Getting these parties on board will promote best practices into the long run. Certification processes through programs like LEED or Energy Star also present opportunities to get these measures installed.

With respect to incorporating risk management, insurance companies could get involved at the point of sale to address safety issues. Energy savings insurance or guarantees for savings should be done at the point of the upgrade. R&D is another important stage; because many risks could be avoided by taking a whole system perspective during the design phase. Disaster resilience issues, that also have energy benefits, should be addressed during re-construction events.

Timing issues are very important in the commercial food service industry. Design time is about six weeks once a project is real, and the actual renovations are even quicker. It is not common for renovations to be of an entire kitchen at once. Since the timing is so important, upstream interventions may be one of the best strategies in this market. Another is to intervene in the development process of chain store prototypes, or the establishment of equipment purchasing specifications.

In the grocery industry there two key trigger events: the end of life of equipment, and store buyouts. Equipment contractors, for refrigeration for example, know when the equipment will be reaching the end of its life since they have ongoing service contracts, and this would be a key time to intervene. When a store is being sold, there is commonly a remodeling event that is associated with the sale. Contact should be made with new owners in the early stage of this process.

Demand Response

62. Well operating technologies including programmable and smart thermostats and a good system of education are the key measures and strategies for promoting demand response programs.

Technologies that are used in demand response programs need to be problem free to avoid customer frustration with equipment. Programmable and smart thermostats that can respond to price or that have settings that respond to price conditions can provide energy savings for the least cost, but should be coupled with education programs to lay the foundation. Programs that incorporate case studies, risk free trials, education, and feedback communication systems will likely find greater acceptance in the market.

63. Demand response interventions that correspond to a customer's monthly evaluation of their bill or when there are changes in rate schedules may heighten awareness and induce action on the part of the customer, beyond crises events.

Of course neighborhood blackouts and other crisis events are good opportunities to bring attention to demand response alternative rates. But on a more ongoing basis, people should be made aware of the opportunities to get on a demand response rate through information provided in their monthly bills. If this information can be structured to be as specific to their situation as possible, that would help. Shadow bills, where the current rate is shadowed by a demand response rate would allow customers to get a feel of how they would be affected by the demand response rate before they are obligated to pay it.

People should also be given information about various opportunities for demand response when their monthly bills go out. An analysis that applies to their situation would be very helpful. Shadow bills of a demand response rate would be very helpful. Changes in rate schedules are also opportunities for promoting demand response, because customers are trying to determine their best options.

Energy Improvement Mortgage

64. Home envelope measures, heating and cooling equipment, and windows were identified as very cost effective measures, but not always the most attractive to customers.

While sealing up the building envelope, insulation, and duct testing were identified by both interviewees as the most cost effective improvements, they also noted that these measures are not the most appealing to customers. Consumers prefer more tangible yet more expensive measures like double pane windows and heating and air conditioning equipment. Heating and air-conditioning equipment, windows, whole house fans, insulation for attics and walls are the most popular measures for EIM.

65. The key trigger events identified for energy improvement mortgages included the home inspector's report, the buyers visual inspection, the home warranty process, or other purchase and refinance events.

The home inspectors report should include the status of insulation and mechanical equipment. Buyers can visually recognize measures like windows upon their inspection. General home improvements are opportunities to implement an EIM. Purchase and re-finance are the key trigger events because the cost of the measures can be financed in a loan with no out of pocket expense; the more measures that can be done at once the better. Real estate agents may be influenced by the inclusion of energy equipment in the home warranty; they are sometimes sued for equipment failure even though it is claimed to be a "pre-existing" condition. Generally speaking, equipment replacement is not a good trigger event because the shock causes people to look for the cheapest solution or a quick fix.

66. Education of the real estate and lending institutions is one of the key strategies to broadening the use of EIM.

To raise awareness and educate this market sector, short videos for lending and real estate offices may help to explain the benefits of an energy improvement mortgage to them and to the buyer. The focus should be on creating alliances with regional realtor associations to get the program started, not a statewide effort. Among the benefits that should be highlighted are increases in home values since they open up more opportunities for portfolio loans, investor loans, and private investment. Central reporting and tracking are essential to make the case of savings to the buying and lending community.

67. Customer education is also an important strategy to broaden the use of the EIM.

Homeowners, especially those with older homes given the greater energy savings potential, should be educated of all the programs available to them including energy efficiency measures in home improvement projects. Rehabilitation programs should include energy efficiency, not just paint and carpets.

Lighting

68. New wireless and dimmable ballast lighting technology should be supported in the market with strong incentives and purchase contracts.

Wireless technology for lighting will minimize the disruption and cost of upgrading lighting systems. Lighting technologies should be supported with a strong incentive, and a guaranteed purchase contract will help get these technologies into the market. Wireless dimming ballasts include centralized dimming where the circuit breakers are connected to the central dimming panel and to the Internet to integrate daylighting. In addition, Title-24 should include switch replacement for lighting. These measures as well as controls for HVAC are best suited to trigger events where there are major renovations in ceilings.

Low Income

69. Insulation, appliances, controls, windows heating and cooling systems and building envelope measures were all identified as cost effective for low income programs. The most effective strategies or measures to pursue in the low income markets are ceiling insulation, refrigerators, domestic hot water controls, or central water heating with controls, weather stripping, tightening up ducts, and R-30 roofs. Windows alone are not cost effective to replace for energy efficiency, but if they're being replaced anyway the minimal additional cost to put in efficient windows is worth it. Trends to install solar are also positive. Administratively it is important to be able to replace units in rental property, especially refrigerators and furnaces, but there are some times limitations.

70. The key trigger events for these measures were noted as equipment replacement events, point of sale, refinancing, and point of construction for low-income properties.

The key trigger events are the replacement of equipment, sale and refinancing of affordable housing. Mandatory compliance with Title 24 and Title 20 at the point of

sale may be a good strategy. In addition intervention in new construction is important. Programs like Savings by Design, which intervene at the design stage, should also be applied to residential affordable housing.

71. Some other strategies offered for low-income programs included better training for the efficient housing market, more case studies and demonstrations, and strong verification program elements.

One interviewee noted that training for the efficient housing market would be the most important strategy to work on. Another cited the importance of case studies to demonstrate to the market the success of competitors, which may in turn motivate more to improve their efficiency. Verification, it was noted, needs to be strong to ensure that owners and developers are getting the savings they expect.

Purchase Decision Intervention

72. Lighting, appliances, building envelope and mechanical installations were noted as important measures that could be best implemented with mandatory time of sale retrofits.

Measures that provide the largest savings for the least cost are lighting and appliances (moderate savings at least cost), then building envelope and mechanical installations (HVAC, AC, etc.). Duct testing and sealing should also be included. Times of sale retrofits are a good time to get these measures in place, and they should be done with regulatory efforts. At time of sale the customer has a little bit of leverage to bargain with their lender to pay for the improvements. To truly be effective the program would have to be a combination effort that includes an audit at a time of sale. The state should establish a minimum efficiency requirement.

Residential Construction

73. Whole building and envelope measures were cited as being the most cost effective in the residential construction and retrofit markets.

Whole building, house as a system approach has great potential, and is cost effective for 50 percent of existing houses. This should incorporate insulation, and HVAC change outs that have duct tightening and refrigerant airflow checks included.

74. Implementation of these measures could be triggered at the time of sale, remodeling events, equipment replacement or at the design stage.

Upgrades could be mandated through legislation at the time of sale, but it may be a more difficult trigger event than remodeling or equipment replacement events. Title-24 effectively addresses retrofits. Mandatory measures for construction may be best introduced at the design stage.

75. Consumer education, rewards for homebuilders that do things well, and better training and certification would help getting these measures installed, and commissioning follow up would also help.

Better educated consumers on how their house operates would drive more demand for energy efficient upgrades. Homebuilders should also be rewarded for installing

these measures well. Training and certification to prepare them for this would also help to get these into the market. On-line training may be effective for some measures. Marketing should also be part of the training for builders and architects. A program with building commissioning and testing for the final rating would help distinguish efficient homes from inefficient homes.

Time of Sale Audits

76. A few select measures were responsible for the majority of savings from measures that were implemented.

The electrical savings came from hardwired fluorescents, outdoor CFLs, HVAC tune-ups, additional insulation, infiltration sealing. Thermal savings were the result of insulation, HVAC tune-ups, infiltration reduction, Energy Star furnace and programmable thermostats. The likelihood of installing these measures after they were recommended in the audit depended on follow up from the realtors and also the presence of the homebuyer at the inspection.

77. In addition to time of sale, time of remodel also presents opportunities for the energy audit.

Time of sale is the most important trigger event, but remodeling events may also allow for an audit.

Non-Energy Impacts

Most interviewees noted that non-energy benefits were the primary selling point for the upgrades, more important than the energy savings. Improvements in health and safety, performance and property value were the primary issues driving decision makers.

Benchmarking

78. The key non-energy impact to having a benchmark is the effect on property value, which would be of value to real estate analysts and portfolio managers.

When property owners can be shown the benefits of improving energy efficiency in the bottom line of their property value, it is a powerful motivation.

Commercial and Risk Management

79. Improving the operations of buildings with energy efficiency will cut down on maintenance, improve comfort, air quality, and may improve tenant retention.

Retro commissioning will cut down on maintenance, which is a direct benefit to facility operators, and building owners eventually realize this value too. Improved comfort, improved air quality, and the improved reliability of equipment are valued by tenants and property managers, and it will probably result in a greater retention of tenants. In many cases the non-energy impacts are a more important component than the energy savings.

80. Efficient food service equipment is mostly sold on performance not energy savings.

Efficient equipment has a better surface temperature and cooked product uniformity. The productivity and throughput with this equipment is better. These are the primary sales features, not energy savings. Performance is also an issue with high performance kitchen ventilation systems. Designers want to know if smoke and grease are captured in hoods; and comfort is also an issue. These benefits are realized by end-users and manufacturers alike.

81. Grocers value longer product shelf lives, reduced equipment maintenance, and a more attractive shopping environment that are created through efficiency upgrades.

Product shelf life can be extended with improved refrigeration. Better refrigeration also reduces equipment maintenance. New cases and lighting upgrades can improve merchandizing. The latest lighting design trends for grocery stores are very compatible with energy efficiency and include lower general lighting levels, and more use of task and accent lighting, which all serve to “clean up the look” of the stores.

Demand Response

82. Demand response has the secondary benefits of increasing system reliability, and people may feel in more control of their bills.

Demand response will contribute to increased system reliability, which is a benefit for utilities, the transmission and distribution system, and customers if their reliability is improved. With demand response, people feel more in control of their bills, and will see a cost reduction if it is done correctly.

Energy Improvement Mortgage

83. Safety, comfort, and increased property value are among the secondary benefits of doing efficiency upgrades with an EIM.

Safety is an important benefit of the process of securing an EIM. During the HERS rating, hazards like insufficient breaker boxes or un-insulated walls are revealed. Changes of personal choice to property they are purchasing are often more important than safety (EIM). The benefits of comfort and aesthetics as defined by the homeowner are also the primary reasons for doing the upgrades, as long as the upgrades can be justified in terms of cost effectiveness (for an EIM). Property value is an important non-energy benefit and has been demonstrated through the Performance4 program, where simple audits are recorded by the county and incorporated into the official appraisal report.

Lighting

84. The non-energy impacts for lighting measures include improved comfort and control, which benefits building managers and occupants.

Better lighting leads to improved productivity and the comfort of the environment. They also have more control of the lighting available, which is also beneficial.

Low Income

85. The non-energy impacts for the low-income programs include health and safety, comfort, community development, and greater financial security.

The poor and elderly are increasing the health, safety and comfort of their homes and they are increasing their awareness about energy use. Heat waves and blackouts have a devastating effect on the elderly.

Communities benefit from participation because agencies that assist with low-income programs pull individuals from the community to provide jobs, income, and skill sets that will help their individual situation, and build human capital for the community. If these programs increase property value that is also very important.

Payment certainty increases when tenants have lower energy costs, they are more likely to have money to pay their rent. Landowners appreciate these benefits. Lowering utility bills can also minimize price shocks for tenants.

Purchase Decision Intervention

86. Comfort, productivity, property value, health and safety are the key non-energy benefits and they need to be emphasized to promote programs.

In addition to comfort, productivity, and property value, health and safety are benefits that need to be highlighted to find success. Customers are the primary beneficiaries of these non-energy benefits, but they can also help building performance contractors sell their services.

Residential Construction

87. Comfort, health, and safety are among some of the benefits of improving energy efficiency.

Comfort and indoor air quality are the most important issues. Some customers will also be sold on protecting rugs; and drapes and furnishings can also be selling points for high efficiency windows. Indoor Air Quality (IAQ) and health and safety are very important issues to homeowners. The improved durability of homes can also be a selling point.

88. There are no non-energy benefits, only problems.

One interviewee had strong views that there are not any non-energy benefits generated through these programs. Downsizing mechanical units has caused problems for the consumer because it may have to run longer, and consumers do not see that as a value. The new lighting standards require everything to be fluorescent, but people do not like it because it is mandating a lifestyle change. People like bigger homes and are not ready to give up their choices for lifestyle. The assumption that more insulation is better is a false one. There are no increases in

property value; at least homeowners are not seeing the increases. Increased efficiency in homes creates a liability for builders, because energy efficient homes are not necessarily the most comfortable.

89. Pollution reduction, occupant health and comfort are the biggest selling points for the energy efficiency improvements.

The biggest selling points for the audit are not the energy savings but the benefits that can come from improved indoor air quality, and occupant health and comfort. Homebuyers have a lot of pride in their homes and want to do the right thing for the environment; these sentiments can also be leveraged to increase participation. The relationship between the efficiency improvements and increases in the value of the property should be avoided.

Policy and Legislation

Policy and legislative recommendations also varied significantly based on the program being discussed. Many interviewees noted caution in any legislative recommendations and ore often favored support for voluntary initiatives. Others had very specific suggestions for policy or legislative changes.

Benchmarking

90. It is too premature to recommend legislation for benchmarking.

No recommendations were offered for benchmarking because the interviewees felt it was too early in the planning stages to attempt legislation.

Commercial and Risk Management

91. The third party implementers should continue to be the main approach to program implementation, and larger incentives should be provided to customers.

Third party program implementers should continue to be supported through program funding. They should also get more support for retro-commissioning activities because it is a hands-on process that entails risk for the provider. Incentives for participation should be increased.

92. To better integrate risk management with energy management, research and development policy should include risk assessment, quality assurance should be improved, and alliances should be built with insurance industries.

To avoid problems that come out of the technology development process, R&D policy should always and automatically include proactive risk assessment and course correction. All programs should better integrate quality assurance into their program offerings, to minimize the risk of non-attainment of savings. Insurance agencies should be pulled into the risk discussion, possibly by defining a role for them in regulatory policy.

93. Voluntary programs are more likely to garner favor among manufacturers, but there are some specific policy changes that could improve efficiency.

With respect to commercial food service, more equipment should be covered under the Energy Star label. Title 20 should establish minimum efficiency standards for food service appliances and commercial kitchen ventilation should be covered under Title 24.

A revision of the CPUC policy rules on fuel switching and renewables was also noted as being beneficial to the Energy Smart Grocers program.

Demand Response

94. Some existing laws like AB-1X need to be removed, and then a dynamic response rate should be made the default rate for everyone.

The AB-1X law needs to be removed. This law fixes prices for customers who use 130 percent of baseline usage. A better approach to allow for demand response rates is to reword the law to say utilities can offer new rates as long as it does not increase the total bill. The default rate should be a dynamic response rate, from which customers can opt out of should they decide to. Once a system is in place, program credits should be provided for reserve margins so customers get benefits for staying in or below their reserve-margin credit for demand.

Energy Improvement Mortgage

95. Energy improvement information should be included in the sales transaction either through mandatory audits or reporting of upgrades on the purchase order.

To varying degrees, interviewees recommended that home audit information should be included in the real estate transaction. Some suggested audits as mandatory for homes built before 1978; others felt that the purchase order should include information on the energy improvement mortgage. Another suggested approach was to offer continuing education credits for the real estate industry and educate the lending industry.

Lighting

96. Incentives and purchase order contracts should be coming from the utilities or the state to promote innovative lighting technology.

To move lighting technologies to the market, purchase contracts from either utility companies or the state should be negotiated for dimmable ballasts as an incentive to the manufacturer, or utilities should be required to offer incentives for dimmable ballasts.

Low Income

97. Several policy changes could help low income programs, including: development of a statewide database, mandatory point of sale weatherization, strengthened verification, stabilized funding for low income programs, and collaboration with HUD.

A statewide database of low-income energy programs would be very helpful to coordinate programs and avoid overlap. Federal and utility programs cover the low-income market very well; there is really no need for the Energy Commission to focus on it too. Mandating point of sale weatherization will really get people involved, as long as landlords are given proper resources to comply. Work with HUD to write separate utility allowance guidelines for energy efficiency projects. Verification letters are signed without detailed measurement, and they should work to improve these loose verification requirements. Another approach would be to have programs require third-party verification such as a HERS rating. Stable funding for low-income housing authorities will help make sure the suite of programs will be available to this population.

Purchase Decision Intervention

98. Programs need to focus more on mandatory action, since market based programs have been around for a long time.

Time of sale seems to be a good time to intervene if the intervention is free, like an audit, but required before the transaction can move forward.

Residential Construction

99. If mandatory measures are to be put in place, they should be minimal and reasonable, and at the time of sale.

The retrofit market needs reasonable requirements at the time of sale. Ceiling insulation and HVAC replacement are examples, but the list should be short.

Mandatory compliance components should be minimized and homebuilders should be given options within programs or even title 24. Provide opportunities for higher quality to equate to a higher rating of a home.

100. The issue of performance and verified savings needs to be addressed, possibly through bill tracking, but energy ratings are not good.

One interviewee felt that energy efficiency has to move from paper performance to verified performance because existing energy ratings do not work, they need to be based on proper installation and calibrated with bills. He suggested that legislation should require tracking of bills and compare them based on climate, homebuilder, floor space, etc. (i.e. benchmarking), and this information should be made public.

Time of Sale Audits

101. Legislation was not recommended in the short run for time of sale audits.

Market transformation, through voluntary programs with incentives to stimulate the market, is a better approach for the time being. Marketing, training and education for homebuyers and realtors is fundamental. Once the market is ready, inspections could be made mandatory.

Top 3 Recommendations for the California Legislature

Interviewees were asked what their top three recommendations to the legislature would be, and very little consistency emerged between their responses, but they were very consistent with the flow of the prior questions. Their recommendations are listed below.

Benchmarking

1. Mandate performance monitoring and benchmarking

2. Support the necessary commissioning

3. Work on implementation on advanced controls

Commercial and Risk Management

Respondent #1:

1. Continued third party PUC funding.

2. Benchmarking or percent increase of building intensity during sale or major renovation.

3. Deregulation of electric markets. Eliminate price subsidies so people start feeling the real prices of electricity. Then people might start becoming energy efficient.

Respondent #2:

1. Requiring conversion of lighting before a certain date.

2. Requiring upgrading HVAC systems before a certain date.

3. Promote wider use of variable speed drives.

Respondent #3:

1. Commissioning of new and existing buildings.

2. Solid-state lighting, white LED lighting.

3. Integrated building controls and operations.

Respondent #3:

1. Expand Energy Star coverage to include more foodservice equipment types.

2. Increase advertising and promotion of efficient foodservice equipment.

Respondent #4:

1. Increase energy prices and rebate amounts.

2. More programmatic focus on O&M and less on widgets.

3. Take a long-term point of view; promote more education and marketing.

Demand Response

1. Customer education about what electricity costs at various points in time.

2. Give customers information about what appliances consume the most on peak power and drive the bill up.

3. Provide on-bill financing for smart thermostats.

Energy Improvement Mortgage

Respondent #1:

1. The realtor should inform the buyer about EIMs at time-of-sale

2. Develop the relationship with the realtor association in a specific area

3. Training video for real estate professionals presented to them so they can incorporate EIMs in their businesses

Respondent #2:

1. Make a HERS rating mandatory on older homes

2. Educate consumers directly bypassing the opposed real estate industry

3. Incentive for real estate industry such as discounted interest rate. EIM is a benefit to all and it should be a better loan than the average loan.

Lighting

1. Golden carrot for dimmable ballasts.

2. Drop in Title-24 switch replacement that combines various lighting technologies.

3. Control panel for day lighting and controls, connected to the Internet for demand response.

Low Income

Respondent #1

1. Small business, we’re not getting out to them enough.

2. Military bases, there is huge potential that could be paid for by the bases and save /make everyone lots of money.

3. Local governments also need to be a focus of attention of programs.

Respondent #2

1. Training program: Commission money to address the special needs of the multifamily market such as a higher degree of altruism among those involved and increasing desire for energy efficiency.

2. Code opportunities: Develop a separate Title 24 code for multifamily which is unlike low-rise residential and commercial.

3. Expand EAH program: The program cannot reach all housing authorities, which are more abundant than those initially identified.

Purchase Decision Intervention

1. Retrofit energy conservation ordinances

2. Completion of HERS regulations for existing housing (see success with new homes)

3. Continue to support building performance contracting.

Residential Construction

Respondent #1:

1. Getting utilities to publicize bills

2. Demonstration projects (both new houses and retrofits)

3. Make utility rates real (Energy prices should reflect the real cost of energy and include societal costs, military costs for protecting oil, environmental impacts, etc.)

Respondent #2:

1. Focus on training at the architect and installer level and improve products already on the market.

2. De-emphasize product specific elements – like fluorescent lighting or SEER.

3. Allow variability so home owners and designers have the opportunity to install average components exceptionally well instead of just high efficiency components that are installed poorly.

Respondent #3:

1. Develop legislation that would require intervention at time of sale (keep it simple) ceiling insulation, ducts, and equipment.

2. Low interest loan program like that of the early to mid 1990's. Using a turnkey approach and easy (low-cost) payment are very attractive features.

3. Public awareness campaign (expensive, but effective)

4. HERS rating is a missing piece that could be useful; The Energy Commission should complete HERS2 rulemaking.

Time of Sale Audits

1. Work within friendly markets to promote energy inspections.

2. Provide case studies and success stories to soften realtor opposition.

3. Update state regulations on home inspectors to require energy inspections as part of the home inspection process once the market is ready.

Key Informant Interviews

Researchable Issues

The researchable issues were developed from the Phase I research and interviews. These researchable issues were organized into twenty-one topic areas for both residential and nonresidential market sectors. The list of these topic areas and the number of interviews completed are listed in Table 14.

Table 14. Research Topics - Phase II Interviews

Research Topics	Number of Interviews
Audits, Energy Rating, Nonresidential	1
Audits, Energy Rating, Residential	1
Benchmarking	2
Branding, Nonresidential	2
Branding, Residential	2
Certification Programs, Nonresidential	1
Certification Programs, Residential	1
Commissioning, Tune-ups and O&M	2
Demand Response, Nonresidential	2
Demand Response, Residential	2
Demonstration and Case Studies, Nonresidential	1
Demonstration and Case Studies, Residential*	1
Energy Efficient Commercial Leasing	1
Interagency Coordination	1
Purchasing Standards and Programs	2
Residential Equipment Tune-ups and O&M Services	1
Technical Training Grants for Trades and Professionals	2
Third Party Verification	1
Upstream Partnership Programs	2
Whole Building Diagnostic Testing	1
Whole House Residential Diagnostic Testing	1

**This interview was conducted, but the interviewee was not an expert on the topic, and the results were not instructive. The findings are not included in this summary.*

Interview Guide

The interview guide was designed to engage the interviewee in a discussion about this topic area with specific attention to the existing market barriers, the potential trigger events; their recommendations for overcoming these barriers; and the potential effectiveness of those recommendations. Within each of these sections, the interviewee was asked to provide commentary and recommendations on the barriers that were identified through the Phase I research and provide their preferred recommendations. Interviewees were also asked about the key market actors and stakeholders, and customer behaviors relative to their topic area. Finally they were

asked to identify legislation or other policy recommendations that would have a significant impact in improving the environment for energy efficiency in the state of California relative to their area of expertise. While the interview guide was relatively structured, interviewers were free to modify and probe in open discussion with the interviewee. All interviews were conducted by telephone.

A general example of the interview guide can be found in Appendix B.

Interviewees

The interviewees for the Phase II interviews were identified in collaboration with the California Energy Commission as experts on their respective topics. For some topics the expert was the same for both residential and nonresidential markets. Two interviewees were available for some topic areas while only one was available for several topics. The number of interviewees is noted in Table 1. Names of the experts are not disclosed. Interviewees provided their perspectives in confidence, and in the interest of protecting their organizations from taking policy positions their names are not included in this summary.

Key Findings

The following key findings are organized alphabetically by interview topic and have been paraphrased and summarized from the interview documentation. To the extent possible, these findings accurately reflect the perspectives of the expert interviewees. In such cases as there was more than one interviewee, direct discrepancies in their views have been noted or cited as separate key findings. Otherwise their views have been consolidated into one general finding.

Audits, Energy Rating, Residential

1. There is a lack of information for homeowners at times of repairs, remodeling or other upgrades about energy efficiency opportunities. They do not have specific information about what needs to be done or who may be able to help. All of these factors limit the penetration of energy saving improvements.

People really need to have an audit done on their home. With more information, advertising and program support coming from the utilities, the most trusted source of energy information, people would be more apt to have an audit done. People concentrate on windows because there has been a tremendous advertising effort, despite the sometimes limited efficiency gains that can be made.

2. Customers are no longer sold on energy savings but need to be made aware of the other benefits of comfort and quiet.

Energy savings no longer motivates customers, but the other benefits are major motivators. Good information and advertising needs to be available to customers on an ongoing basis so when they decide to make home improvements they will access this information and act upon it.

3. One page, simple energy audits should be offered through the utility, and performed by a large group of trained professionals.

The audit would be partially or fully funded by the utility, as well as promoted and advertised by the utility to build confidence in the effort. Certified and trained auditors would meet this demand after a one-week intense training course. The audit would include duct testing, insulation, energy efficiency and age of the furnace, air conditioning and water heater. The audit would only take an hour and would be summarized on a single page (HERS and CHEERs ratings are too long and complicated). The auditor identifies all of the things that could be improved in the home and walks the customer through it, then provides the customer with a nice four-page brochure to further explain specific upgrades, how they're done and the potential impacts. The program or the contractor then needs to follow up right away offering a package of what it would take to make those improvements. The motto would be "test before you invest". The Performance4 program is designed this way and could be expanded to a statewide level.

4. Time of sale audits may not be met with cooperation from real estate agents, but appraisers could be influenced if the audit information is properly documented and recorded.

Real estate agents are primarily concerned with closing the deal, and are leery of introducing additional information into the process without a legislated mandate. Appraisers however, have made use of the Performance4 audit information in re-sale situations. The one-page audit summary is filed with the County record, at the time of sale; the appraiser is given this information and can incorporate it into the appraised value of the home. Participants are rewarded with a higher appraised home value, which is more valuable to homeowners than the energy savings achieved.

5. This project could be launched in a matter of years, and would cost millions, but it would have a profound impact.

The prototype for the program is the Performance4 program. Expanding that to a statewide level would mostly require training or auditors. Tens of thousands of homes would do audits followed by upgrades. If this was coupled with a low interest home improvement loan product, it could really make a difference.

6. While the customer is the most important market actor, lenders, realtors, and the auditor also play important roles.

The customer drives demand for the audit services. The auditor provides those services. Lenders and realtors can either facilitate or inhibit the process.

7. Customers have a genuine interest in improving their home but are unclear of their options.

With good information on what is exactly ailing the home, what they can do, and who can do it, they can take action to improve their home. A good website, focused on education and promoted by utilities would help address this problem. Their intuition to improve their home is rewarded with tangible benefits in the appraised value of their home, in addition to greater comfort, etc.

8. Legislation that requires an audit at the time of sale would be an important move forward. This information should be recognized by appraisers in the value of the home.

An audit at time of sale, linked with an opportunity to roll those costs into the home loan would be very helpful. For any audit, the core measures should be required to be done first, to keep people from focusing only on windows. The information from the audit should be recorded or certified and disclosed to appraisers at the time of sale. Appraisers should be obliged to recognize these improvements in the uniform appraisal report, which already includes a section "increased appraised value based on energy efficiency". The section exists but appraisers rarely use it.

Audits, Energy Rating, Nonresidential

9. There is a lack of information for homeowners at times of repairs, remodeling or other upgrades about energy efficiency opportunities. They do not have specific information about what needs to be done, or who may be able to help. All of these factors limit the penetration of energy saving improvements.

The lack of information at trigger points is true for both residential and nonresidential markets. Customers do not clearly understand their bill beyond the bottom line, "it's high", and often need help in problem solving to decide what should be done about it. With respect to those that may be able to help, customers are not clear on who it is, but also there is a lack of people providing these services. These services have not been successfully incorporated into the business plans of contractors providing upgrade services.

10. Other barriers include the lack of understanding of the value of energy efficiency, and financing for small businesses.

Even though lighting retrofits, for example, have a payback of a year or less, people are not told and do not think on their own to look there for energy savings. The importance of improving equipment is not being sold to the customer through contractors. This is partly due to poor information that the contractors have. They are often based on national averages (furnaces for example), which are not usually applicable in California. Even the default energy costs are not usually adjusted to California, which serves to underestimate the payback of improvements. Most importantly, businesses are busy running their businesses, not managing energy.

Financing can be a hurdle for small businesses. Current financing options are very complicated and they just do not have a routine source of capital funding for anything, much less energy efficiency improvements. Split incentive issues also factor into the equation.

11. Programs can be designed to generate a trigger event, and follow up with an audit and other improvements once the customer is on board with the concept.

In providing a direct install program, this can trigger an evaluation of other energy needs. Once a few items are installed, an audit can be done to identify other opportunities because the customer is interested. A financing package should also be available to small businesses. For example, a restaurant could be retrofitted with

a low flow rinse wand, exit signs, and a renovated lighting system. These measures would have tangible benefits right away and may lead into more interest and concern for improving other energy elements in their business.

12. Building sale and remodeling events are potential times to influence the decision making process.

When buildings are sold, there may be an interest in looking at the energy use, but buildings differ significantly and energy consumption will depend on the building use as much as anything. Remodeling events also represent opportunities for efficiency upgrades, especially if they coincide with approval for a permit. Title 24 does get enforced and it results in a good audit. Moving beyond Title-24 is more difficult. Title-24 establishes the minimum, but building owners or tenants may want to move beyond that, getting them there is the challenge.

13. Establishing an audit and rating service could best capture attention in the summer or during a crisis event.

The summer or during crisis events is when people are most concerned about their energy use.

14. Establishing an audit and rating service would take a substantial effort over five to ten years.

The home inspection industry would have to undergo some major developments to keep up with demand for such a program. Education resources through the web could be a powerful program tool. The cost of the program is unclear until the program design is developed. Penetration of the program would depend to a large extent on the effectiveness of the new Title 24 requirements for 2005, but right now market penetration for retrofits are practically zero.

15. The market actors in an audit program would be the realtor, inspectors, local governments, architects, and engineers.

The realtor is the key player because they are responsible for disclosing information to the buyer. They will likely not support greater disclosure because of a fear that it will take time and may jeopardize the closing process. They could be placated with a time limit on the part of the inspector; if the audit is not completed in a certain time frame it can be bypassed. With new construction, remodeling or rehabilitation projects, architects and engineers will be involved, and they may be able to provide some disclosure if they are liable for not meeting standards. The key is disclosing the information to the buyer. Enforcing Title-24 is also an important role for the building inspectors and local officials.

16. Promotional messages should come from local programs or cities, which are more trusted than utilities.

Highlighting the success stories is a powerful marketing tool. Sentiment for the environment will motivate some parties, and messages should be tailored for various segments of the population. Another selling point, from the perspective of local governments, is that saving energy keeps money local when is an important community development strategy.

17. Appropriate legislation or policy changes would be a retrofit ordinance and resale ordinance; homeowner insurance provisions for energy efficiency improvements.

When buildings are planning for a retrofit or resale both transactions have a permitting process. At this time an energy audit can be done which is in the public interest to minimize fire risk and other hazards. Homeowners insurance also is concerned with these issues, and incorporating energy efficiency improvements into this approval process could add value to the customer, and minimize risk for the insurance company.

Benchmarking

18. Lack of awareness of building performance and a lack of detail in billing information hindering recognition of necessary improvements to building performance are barriers to improving building performance but may not be able to be addressed with benchmarking.

Understanding energy use is not the only element that will lead firms to take action to improve their efficiency. A benchmark alone is not going to create energy savings, but lack of awareness is a big barrier. The lack of awareness of best practices is also an important barrier, because that is where the building manager can take action. Benchmarking can give building owners more confidence in recommendations from a contractor, because the benchmark is seen as coming from an objective source.

19. Utility bills may not be a viable option for providing benchmarking information, but historical building use may be more easily provided through this venue.

The information that could be provided in a bill is not necessarily going to be useful to building owners, because there are multiple climate zones, building types and occupancy schedules that influence a building's energy consumption. It is unrealistic to expect that a utility could synthesize all of these elements into a customer's bill to provide a benchmark. It may be possible in residential markets but not commercial markets.

A useful benchmark takes more information than just how much energy the building used in the last billing cycle. The utilities do not have the proper information to put together a benchmark that could be included in a bill, and getting that kind of information would be nearly impossible.

A building's historical use would be a useful measure, and is more easily reflected in a utility bill. Comparing a building's use over time will cause owners to go through a thought process, and irregularities would be noticed.

The other problem is that billing information does not typically go to building managers who may be able to act on this information. Instead it goes to the accounting office where it is just paid.

20. Several additional barriers impede greater energy efficiency, but they may or may not be able to be addressed with benchmarking, including a lack of organizational commitment, lack of standardized metric, and a lack of follow up.

Business management is not concerned with energy management issues. Without their support, no action will be taken on the benchmarking information that is provided. A standardized metric for building performance would go a long way in raising awareness. The current measures like energy use per square foot really do not say much about how a building compares, the metric must be normalized by various characteristics to provide a valid comparison. Furthermore, the actual definition for energy efficiency in a building is not standardized.

Once a building owner or operator gets the benchmarking number there must be follow up to help them through the question “what do I do next?”. The number only tells them they have high or low energy use, but they need to know why. A follow up assessment of the whole building should be part of this process. Even given the benchmarking number, there is no guarantee that there is room for efficiency improvements, which depends on the building and the manager’s knowledge of practices; benchmarking itself does not address this issue.

21. There are several trigger events in which benchmarking information would be valuable, including: building permitting activity, time of sale, time of lease, contracting for energy services, establishing company policy, building design, and other educational efforts.

Incorporating benchmarking into Title-24 requirements could be done, but a clear definition of the benchmark would have to be developed, and a lot of information would have to be gathered to develop the benchmarks.

At the point of sale, owners and buyers should have a benchmark available as a point of reference or comparison, same with time of lease. This strategy could be a double-edged sword. Since half of the buildings would be in the upper half and the other half would be in the lower half, by definition an equal number of buildings would have an advantage as a disadvantage.

When contracting energy services, a commercial building owner should know where they are starting. When the service is completed, another measure should be taken to see how much they improved.

In establishing company policy for real estate management companies, a benchmarking requirement could be included, as well as an obligation to improve their efficiency over time. CALSTERS has incorporated this into their building management policy and given that they own a lot of property it will have a significant influence over time.

In the process of building design, the targeted energy use should be established and affirmed when the building is completed.

Benchmarking information can be incorporated into multiple educational efforts, like association meetings, trainings, green building workshops, etc. It is an important time to get information out to people.

22. Benchmarking needs to be complementary to other program offerings like audits for initial follow-up and commissioning and retro-commissioning programs.

Benchmarking is not a stand-alone program. It must be integrated with other initiatives that address the barriers to acting on the energy efficiency information. Commissioning and retro-commissioning need to be part of the program, as well as auditing programs, because establishing the benchmarking data will require facility surveys.

23. Benchmarking information needs to be gathered with some active participation on the part of the customer and be provided on an ongoing basis either through utilities or billing services if it is to stimulate any follow-up action.

Building ownership has to be involved in the collection of information. Information has to be provided to the customer on an ongoing basis, but it is very difficult to do this. Utilities are not really able to do it; they would be better suited to promoting the use of the benchmark and perhaps providing an incentive to get a benchmark through an existing program. Billing service agencies may be able to provide a benchmarking service, and some already are.

24. An effective benchmarking strategy for California should work with existing efforts like the Energy Star Program, but also try to incorporate regional needs into that plan to make for an effective comparison.

Linking in with existing efforts, like Energy Star, will give the program more leverage. However, the Energy Star program must be modified to meet regional needs. National comparisons are not as valuable as regional ones primarily because of differences in climate. State standards like Title-24 in California should also be considered in the creation of the benchmark. Starting a new benchmarking initiative is probably not recommendable, but the national benchmarking program needs to be revised significantly to make the comparisons meaningful.

25. Semi-annual or annual benchmarking data would be the most useful to customers.

This would provide the information continuously, and if it were on a semi-annual basis it would capture seasonal differences. Monthly data may introduce too much variation, and annual may be too averaged. If information was collected on a monthly basis, it should only be presented to the customer in a semi-annual or annual format.

26. The level of effort required for a benchmarking program would depend significantly on the way the program was designed.

Tapping into an existing effort would not require much additional effort, but connecting it to existing programs to move businesses toward action will take a significant amount of effort, and could be implemented right away. The cost would depend on how much existing programs are incorporated.

On the other hand, since existing programs may need quite a bit of modification, launching this effort may be the equivalent of any new program. Providing incentives for the benchmark would require more effort, in terms of administration. Each utility

would have to assign someone to this full time. Putting pressure on Energy Star to develop regional benchmarks would also take some time and effort. This type of effort would take a year to eighteen months once you got started. The effort would probably take a few million dollars, including a pilot program. A rough estimate would be about $5000 per building benchmarked, higher for larger buildings and lower for smaller buildings.

27. The penetration of a benchmarking program would really be measured by how many people are led to action, which is a very difficult number to pin down given variable reasons to take action in the first place.

EPA has been benchmarking in the market for 4-5 years, and have 21,000 buildings benchmarked nationally, but they do not have information on how much of that information has led to action. Only 2,000 have been given the Energy Star rating, and these buildings continue to improve their efficiency each year. Based on their experience, there can be quick and good penetration, and that is from a distal national position, a local effort could do even better.

On the other hand, many of the people that would take action or volunteer to be benchmarked are already planning to make improvements or are interested in the concept. A firm's rating may motivate them to action, cause them to feel they are efficient enough, or make them feel apathetic. So a benchmark can be a double-edged sword.

28. Building owners are the most important market actor, but utilities, state programs, service providers, and financial stakeholders also play important roles in a benchmarking initiative.

The building owners of course are the beneficiaries of the information, and will make the decision to act or not act on that information. Trade associations for building owners and managers are also important, as they can raise awareness and promote benchmarking as a best practice. State programs can support the benchmarking effort by providing the follow-up incentives and programs to help them through the upgrade process. The existing Energy Star benchmarking program is also important to build on. Utilities have strong relationships with customers, which can be used to get the information out; the same is true of trade associations of the businesses targeted (like the restaurant association). Those providing the goods and services will obviously play a key role in the follow up process.

29. Key consumer behaviors that would influence a benchmarking initiative are the belief that energy is not important, or is an uncontrollable expense, and their need to deal with their business interests first.

Many organizations believe that energy is not important or is an uncontrollable expense; saving energy does not seem to make a difference. Customers are primarily concerned about the success of their business. If they can be convinced that their buildings will function better for their intended purpose then they will be more interested in taking steps to improve their building. The second factor is if they can be convinced that their building is worth more money if it is energy efficient.

30. Some reactions to the initiative have come out of surprise from the building's rating.

Someone who thought his building was efficient gets a marginal or poor rating, even though he just got a lighting upgrade. The lack of understanding of the multiple factors that affect building performance is evident in these types of reactions. Poor ratings can cause some tension in a business.

31. Policy changes may be helpful, but legislation, with the exception of program support, is probably not appropriate at this time.

Policies like the governor's executive order to improve building efficiency by 20 percent is a good start as it sets a goal and allows you to start the tracking process. Other organizations can set similar policies. Having organizations make benchmarking a priority would be better than making it a law. A benchmark should be something people want to see prior to making a transaction decision, demand for the information should drive benchmarking efforts; awareness is vital.

Overtime, once benchmarking is established it could be considered under Title-24, but that should not be done for about two cycles or about 6 years. Legislation may be appropriate in sponsoring programs, and the Energy Commission and CPUC could recognize the importance of benchmarking. Existing programs are stretching public funds already, but if benchmarking is established as a priority the legislature may be able to find support for it. Policy to pressure Energy Star to develop regional benchmarks would also be worth the effort.

Branding, Residential

32. The key barrier to more energy efficient homes is the lack of energy efficiency service providers.

Customers are not really aware of the option of a whole system approach to energy efficiency for their homes and consequently are lacking confidence in contractors, because contractors are not providing these services. They lack the skills to take this approach, the market is not sophisticated enough to address the whole system approach. Contractors could be adding value to their services by identifying all of the reasons for making changes; they are not offering full solutions right now. People are not asking for these services because they do not realize it is an option, but there is ample market potential from people with allergies to those who are concerned about safety. This could all be addressed with qualification and training either through the Building Performance Institute or improved HERS ratings.

33. When looking at branding whole house performances, remodeling events, heating or cooling system change-outs, or window upgrades, all of these present opportunities for a whole house evaluation.

All of these changeover events are times at which the home can be evaluated and contractors could put any Energy Star recommendations for proper system performance into action.

34. New branding initiatives for the residential sector are not recommended, given the role of existing brands and the cost of developing competing brands.

Energy Star has been effective as it currently has 64 percent awareness after fourteen years of activity. That is after many people have worked very hard, and a lot of resources have been expended. Creating a new brand would not be cost effective and would duplicate national efforts.

35. Concerns about the stringency or upgrading of energy efficiency standards should be addressed by providing incentives for Tier Two products.

Energy Star attempts to label products after they can be made by a few manufacturers, so the label is not just supporting one manufacturer. Raising the standards too quickly may have the effect of singling out certain manufacturers, and relying on one manufacturer opens the label to greater risk of product failure or recall. This situation also may present supply restrictions. If a program really does only want to promote the highest efficiency products, they can use the Tier Two specifications to identify products for which it will provide incentives, but should only be done in markets where Energy Star is an established brand. If it is not established it may hurt consumers.

36. New initiatives should focus on building loyalty and market share for existing brands.

Any initiative should work with the existing CEE (Consortium for Energy Efficiency) Tiers. Building on loyalty through existing programs like Flex Your Power is a good idea. Promoting it through LEED may be more difficult given where they're at with performance guarantees. Using the Energy Star Tier Two ratings would provide an opportunity for differentiation between the higher efficiency Energy Star products.

37. Statewide standards have raised the bar for product promotion and the state may begin to face diminishing returns.

Since the state has been so aggressive in pursuing codes and standards, they are already taking the top 15 percent of equipment, which also affects the room for branding initiatives. If they become more aggressive, there may be diminishing returns on the programs. Improving efficiency will at some point have to move to greater investment in research and development to make any more efficiency gains.

38. The greatest opportunity for a residential branding initiative is by working through Energy Star and partnering with local entities.

More opportunities lie right now in whole building performance (including duct sealing, HVAC performance, etc.) branding than in equipment specifications, but as far as technology specifics there is still quite a bit of potential in lighting fixtures and the heat pump water heater. Working with Energy Star can help get these programs the biggest "bang for the buck". Partnering with local governments and other entities can also help promote the initiative. Advertising can promote the whole suite of Energy Star products and then just provide incentives for those seen as most critical. Many products do not need incentives, like electronics or office equipment, but they serve to sensitize the market.

39. Promoting Home Performance with Energy Star still has a long way to go.

Establishing service provider networks and other necessary infrastructure is the challenge, not recognition of the brand. Selling the package is the challenge, but with a few savvy contractors it could really take off. It would probably take 1 to 2 years to get a good pilot for each IOU, but the infrastructure should be established before moving to a statewide effort.

40. The penetration rates of equipment branded Energy Star are the best source of information for the potential penetration of currently non-branded products, but it depends a lot on the technology and the market.

Examples of Energy Star branded product penetration rates at the national level include: clothes washers, which have achieved about 22 percent market penetration since 1997 (8 years); and dehumidifiers are at 60 percent in three years. These penetration rates change of course based on the specs and the federal standards. Penetration rates depend on the product, and their replacement cycle. Generally speaking, the electronics industry typically does not need utility intervention because they are such an innovative industry on their own.

41. Retailers, manufacturers, distributors, and the Energy Star Program are the key players in moving Energy Star branded equipment.

Retailers obviously are the ones that sell the products to consumers, and are there to finalize the sale, for that reason they are probably the most important market actor. Manufacturers provide the products that meet the specifications. Distributors get these products to the retailers, and Energy Star establishes the specifications and does a lot of advertising.

42. For the Energy Star whole performance approach, the rating service providers, trade associations, and trainers.

Rating service providers provide the key information to the customers; associations like the Building Performance Institute can provide trainers and promote best practices. Energy Star establishes home system performance standards and protocols and does a lot of advertising. In this situation the most important player is the contractor as he or she is the one that will be making the final sale.

43. Consumers are expecting that products will have all of the features and qualities they want and a compromise in that quality would have a negative impact on the brand.

People do not want to compromise anything, even to “do the right thing”. These products have to be comparable in look, feel, and performance to non-branded products. Neither programs nor manufacturers want to deal with negative reactions to the brand that are associated with poor quality. Right now customers view Energy Star favorably (30 percent of households have purchased an Energy Star product and are happy with it.)

44. Service providers want to ensure that customers can afford the equipment, otherwise financing becomes an issue, and are satisfied with the operational price. If

they're offering a whole home comfort package they need to make sure the customer is planning to stay put.

Customers have to be able to understand the fixed price of the equipment and the operational price. The service provider should facilitate this understanding if they want to make the sale. If the equipment costs are too overwhelming, finance issues will have to factor in which could jeopardize the close of the sale. Home equity loans are popular these days to address some of these issues.

The sale of a whole home comfort package will depend on how long the resident plans to stay. If they're planning to move shortly they may be more concerned with square footage or other aesthetic remodeling to increase the value of the home. But if they plan to stay, and more people are, they will decide based on their budget and available financing. Pilot programs can help flesh out the details of customer needs.

Branding, Nonresidential

45. The barriers of consumer confidence, awareness, and the visibility of energy efficient equipment options or a strong market presence, or the lack of knowledge about energy efficient choices and the relevance of those choices were confirmed as barriers, but not the most critical ones, and not potentially addressed through branding initiatives.

Among these barriers, the lack of awareness and lack of visibility of energy efficient equipment may be the most important ones for the nonresidential markets. Some of the most significant barriers to improving energy efficiency cannot be addressed by branding initiatives. Just branding equipment, for example, misses the point of improving systems and building performance, which are more critical issues. That is why the Energy Star nonresidential program focuses on rating buildings, not just equipment.

46. Split incentives, managerial awareness of energy related choices, lack of whole building/system performance are some of the other important barriers to improving efficiency, not just branding.

Split incentives are a very important barrier, which also relates to consumer awareness of the potential benefits. There is a general lack of understanding of the significance of energy choices and overall energy issues do not carry much weight with management. This is not to say that branding is not important.

47. Addressing barriers of building performance are more significant to getting energy efficiency improvements into the market than product labeling in the nonresidential sector.

The issues of whole building performance are more significant to overall improvements in energy efficiency than product labeling on the nonresidential side. However, there is some market penetration for nonresidential products that have been branded. For example, in the commercial food service sector (sprayer heads are one item); trade shows are starting to highlight the Energy Star label.

48. Energy crises bring awareness to the issue but information needs to be accessible on an ongoing basis. There are specific opportunities like tenant turnover and remodeling that allows for intervention, but equipment breakdown is not as important. Interventions themselves can also create trigger events.

Energy crises bring these issues to the fore, and everyone wants to do something about it, the same is true for high energy prices. Branding may not do much to address this issue as does having information available on an ongoing basis. At certain specific events like tenant turnover or remodeling, individuals may be prepared to make changes. An education event can be a trigger event in and of itself. Equipment breakdowns are less important in the nonresidential sector because building managers are typically monitoring things closely.

49. No new brands should be introduced into the market.

There are already well recognized brands in the market, and adding to those would create substantial confusion. Energy Star has been around since 1990-92 and is at 64 percent awareness. Creating a new brand is very expensive. It is better to work through existing channels to get more equipment included in the brand, if that would be the reason for creating a new brand. Limiting branding to equipment that can deliver energy savings on its own is the strategy that is place at EPA right now, and they do that to protect the brand. The reason many products have not yet gotten the label is because they are not ready for “prime time”. New brands, or even higher efficiency standards within these brands, would not necessarily increase penetration of these technologies into the market.

50. New initiatives should focus on building loyalty and market share for existing brands.

Branding beyond Energy Star is very difficult and can be confusing to consumers. Any initiative should take caution not to interfere with the existing CEE (Consortium for Energy Efficiency) Tiers. If there is a need to differentiate energy saving products that are under the Energy Star label, differential incentives could be provided based on the energy savings to customers, but this is challenging. Building on loyalty through existing programs like Flex Your Power is a good idea. Promoting it through LEED may be more difficult given where they’re at with performance guarantees. Using the Energy Star Tier Two ratings would provide an opportunity for differentiation between the higher efficiency Energy Star products.

51. The whole building approach for the nonresidential sector will probably be more fruitful than equipment branding.

There may be particular products that can successfully be promoted under the Energy Star label for the nonresidential sector, but the largest opportunity for improved energy efficiency in that sector is through improving the efficiency of building systems. There are still huge opportunities in Home Performance with Energy Star and in the commercial food service sector. Types of equipment that still may show potential are heat pump water heaters, ice machines, and pre-rinse spray valves.

52. Developing a new brand would take a tremendous amount of effort, focusing on specific sectors will make it easier, but will depend on the sector.

Creating a competing brand would take a huge, likely ineffective amount of effort. Co-branding with Energy Star would take less effort and would likely be more effective. Such an approach is in play in New York where NYSERDA's Energy Smart / Energy Star program is in operation. Targeting the effort by sector would be most effective for the whole building approach, this way the needs of that specific sector can be met. Convincing a few top companies in any one sector may be a good starting point. It may take one to three years to get such a program off the ground, and three to five to see results. The financial resources required for such an effort would cost tens of millions. Energy Star currently uses fifteen million annually just in product initiatives, a totally new brand would cost significantly more. Penetration rates would depend on the program design and how the market responds to the brand.

53. There may be opportunities for bundling energy and water savings into a brand.

In areas where water resources are an issue, this could add value to the energy savings label.

54. The key market actors and stakeholders in branding initiatives are the manufacturers, followed by those in the distribution chain.

When manufacturers adopt a brand, they pull it into their marketing, their packaging, and their overall labeling. Without their participation, the equipment would never be built to Energy Star specifications. The distributors play a key role in getting the brand out to the customer at the point of sale and have a vested interest in seeing that product move off the shelves. Other players include end use suppliers and trade associations. They can provide more information as a marketing vehicle, and national associations are more oriented to this type of effort than local chapters.

55. Customers association of the brand with "doing the right thing" is an important sentiment to tap into. Grabbing the attention of management with this message is still a challenge.

The perception that going with the Energy Star label is "the right thing to do" is the key to marketing a brand. Unfortunately management firms are not particularly concerned with energy issues; it is not part of their corporate culture.

56. Branded products also need to deliver on performance at a level comparable or better than existing equipment.

Consumers need to have confidence they are not giving anything up to "do the right thing." Products need to look, feel and perform like other products. Pre-rinse spray valves for example are a little different from traditional spray valves so there has to be a brief training effort incorporated into the program. Bundling equipment and features, like the Energy Star Kitchen, is one way to sell a better whole system.

57. The reactions of customers to the initiative will depend on the program design adopted. A co-branding option will be well received; a new brand will be confusing.

Reaction to a whole system approach will depend on the role of energy in the organization.

Energy Star has seen positive results and associating with this brand and building it up will likely have positive payoffs. If energy plays a significant role in the organization, or the CEO can be convinced that it does, participation will be forthcoming. This will depend to a large extent on the mission of the organization and their existing energy costs.

58. Branding initiatives should be synergistic with benchmarking, rebate and incentive programs, but programs should be kept simple.

No one program will address all of the barriers faced by energy efficiency programs. The more these programs can work together toward the common goal the better for customers.

Certification programs, Residential

59. Customers typically do not lack confidence in their contractors but indeed have too much confidence in them, because in many cases they are not properly trained in energy efficiency services.

Builders have a lot of clout with customers because the customer is typically not very aware of his or her systems and defers to the expert. Some are very interested in first hand information and others are comfortable with referrals. It is true however that there is a lack of training of contractors in providing energy efficiency services, but customers do not know that. Contractors usually focus on their specific equipment and not at the impacts of that equipment on the whole home performance. Customers do not think about whole house performance either.

60. The real barrier to getting more efficiency upgrades is the lack of qualified contractors, and third party verification or certification.

Qualified contractors need the support of a third party verification or certification to distinguish them from other service providers.

61. Point of sale is a frequently proposed trigger event, but presents challenges; remodeling events may be more effective; another is housing improvements after a natural disaster.

The energy efficient mortgage has been a hotly pursued strategy for a while, but with tight housing markets, like those of California, it does not seem realistic because the market moves so quickly. Without the pressure, it would be an ideal time to intervene, especially if coupled with financing options.

A contractor savvy in selling his energy efficient services could also take advantage of this opportunity. Someone wanting to get new windows should be made aware of the related issues, if energy savings and home comfort is their objective. Unfortunately the value of objective information is fairly small.

Since housing markets are so tight, people are doing more remodeling and looking at ways to expand living space in their existing homes. This is another opportunity to take a holistic look at the home's systems, overall comfort, health and safety.

Finally natural disasters like floods, hurricanes, or brush fires are times when home improvements are obligatory. Making efficiency upgrades may help minimize damage in the future, and may only present a minimal incremental cost to the homeowner.

62. A voluntary certification program should be of individual contractors who are trained across disciplines in the operation of the whole system. Quality control and verification should also be in the program plan.

It is important to decide who would implement the initiative, and would be responsible for the certification. Third party implementers typically have an easier time implementing programs than the state, which tends to get political. Certification needs to mean something, and holding individuals accountable for work seems the most logical, at a corporate level there is no real assurance. These certified individuals need to have an understanding of how systems work together and the implications of their failing to work together. Quality control and verification, while it can get costly quickly, is also important to follow up on the certified contractors and make sure that their certification means a proper installation.

63. This initiative would help to address the barrier of market distinction for qualified contractors but the demand for these contractors would depend on whether people recognize the value of these services.

64. This type of program would take significant effort, over about five years.

The program would have to be laid out in stages. There could be results in the first couple years, and then take three to five years to add more depth to the program.

65. A certification program should try to not focus on one single technology. Whole house systems are difficult, but are more appropriate for time of sale interventions.

Focusing on certain measures may miss key opportunities when there is a change over event like the sale of a home. Home Performance with Energy Star is trying to take the whole house approach. It is important to tie health and safety issues into the overall sale of the program, and these too are best addressed through whole house strategies. One example would be a program focused on indoor air quality. The initiative should not be limited by energy efficiency.

66. The impacts of a certification program would be difficult to measure.

It is hard to distinguish the effects of training from certification. The value is in the two together. Certification means that the training has been done, and it is something that can be valued by customers, if the training leads to action on the part of the trainee. Certification should have the effect of "raising the bar" in the market.

67. The key market actors in a certification program are the trade associations that would be targeted in the training.

Lighting, HVAC professional associations, insulation contractors association, California Building Performance Association, and the code officials are the key trade associations. Providers of peripheral services like home inspectors may provide a more direct connection to customers. Their support would be helpful. They too could be the focus of a certification effort if the program wants to focus on the information side of the equation, not the technical installation.

68. Customer perceptions that affect energy efficiency programs include fear that sealing a home makes it unhealthy, or they care about their personal impact on the environment, economic drivers, and home durability.

There is a perception in the market that sealing up a home can lead to moisture problems or other indoor air quality problems. On the other hand, there is an increasing market share that is interested in minimizing their personal impact on the environment. An initiative that can incorporate sustainability including health, safety, green building products, and energy efficiency could really have impacts. This too builds on the holistic perspective.

Demonstrating the success of this approach with some strong contractors at the beginning of the initiative is important.

Some individuals are strictly looking at the economics of the energy savings potential, but not many people are focusing on this perspective.

Consumers are also very concerned that their homes are well maintained because given tight housing markets they are more likely to stay in their homes, and want them to last.

69. Legislation addressing this issue has to be carefully crafted so it does not do more harm than good.

For example, if this type of energy efficiency initiative was rolled into a broader legislative commitment to combat global warming it could lend momentum and clout to the effort.

If specific legislation could be drafted to address contractor liability that may have an impact. Holding contractors responsible for improper installation would really get their attention.

Tax incentives, which should be very carefully thought out, could be used to stimulate the market. If the infrastructure to provide the services is not in place, this can have a negative impact on the stability of the market and the program goals over the long term. Taking time to let this develop is probably a better approach.

Certification programs, Nonresidential

70. Generally speaking a lack of consumer confidence in the skills and abilities of contractors to provide energy efficiency services is not a barrier, but it depends on the end use or technology that is being discussed.

If the system or technology has been in the market for a while, there is probably a confident and able service industry. For example, for air conditioning services there

is plenty of confidence in the market. New technologies or “fledgling industries” may face some uncertainty on the part of customers. Currently commissioning, where the whole system is performing properly, does lack qualified professionals.

71. While California already has certified home energy raters, providing more assistance to nonresidential contractors may help improve the quality of services and consumer confidence, but there are already a number of certification programs in place.

Some improvements could be made in the training and certification of commissioning agents, which has already been discussed in California. Given the existing certification programs for LEED, licensed professionals, and CEM certification, it may be more important to build on these existing certifications that add more to the list.

72. Creating a new certification program would not reduce the barrier of consumer confidence in the provision of these services, but may be able to generate some energy savings.

A program that did address the barriers of funding, enforceability, legal liability, endorsement, and sponsorship or representation (i.e. who is the individual being certified for? Would the state, the utility, the Energy Commission, the CPUC or be represented by this certified individual?) May be able to generate some energy savings.

73. Implementing a successful certification program would take some extra effort, and a program could be developed in 6 to 12 months, and may cost around $20 million including all program training, development, and for all market segments.

74. A competency requirement for building commissioners would be easier at the agent level than at a sub-system level.

A building commissioner would be responsible for handling the integration of all of the systems, control systems, lighting controls, etc. They could address the major failures that commonly arise with economizers, direct digital controls not being properly calibrated, and mixing boxes for air distribution systems and photo controls for daylighting systems.

75. Penetration rates for technologies installed would not necessarily increase, but there would be greater confidence in achieving energy savings.

The real objective is to make sure systems are installed properly and are operating properly. Since there are losses right now because of poor installation or integration, a certification program could improve confidence that the equipment is working properly and achieving energy savings.

76. The most important actors for a certification program would be the utilities, and existing industries that provide control or operation and maintenance services.

The utilities are important actors because they have strong networks with customers; they are trusted and can provide non-biased information to customers because they are not trying to promote a particular product. Industries providing control and operation and maintenance services could lend some intellectual capital to develop

such a program, as long as the effort does not become focused on one technology or one brand.

77. A program would have to control for ”upselling”, or the perception of such, by certified contractors.

If a person takes their car in for an oil change and they are told they need new plugs, a new muffler and their brakes are shot; they may be disappointed because all they wanted was an oil change to begin with. Certified commissioners would have to be careful in their approach to avoid this.

78. Customers will usually be taking action as a result of price signals, but may do it for other reasons.

Energy savings and cost reductions should be driven by a response to price signals. People in lease arrangements will not likely be responding because they are not responding to a price signal. Some firms will see value in getting an Energy Star sticker on their door to advertise they are “doing the right thing” to the public.

79. Programs should include some education element, and should be sensitive to specific market segment needs including ethnic and language issues.

Since there will be a certain level of misunderstanding, given variable awareness levels of energy decision makers within businesses, the programs will have to be explained. The unique issues of language, ethnicity and other market segments need to be handled independently.

80. Legislation is not the best approach to developing certification programs. It is better to allow utilities find creative ways to reach the agreed upon energy savings goals.

Commissioning, Tune-ups and O&M, Nonresidential

81. The barriers of equipment neglect, un-optimized building systems, and lack of awareness of the inefficiencies of equipment leading to improper equipment maintenance were affirmed as important barriers especially for small firms, but several more were also cited.

System integration is one additional barrier that is often overlooked which can hinder performance, as well as insufficient documentation of how the systems are supposed to work. Building operators have inadequate feedback on energy use, because they do not get the energy bills. Operations are often taken for granted. This general lack of awareness is the most important barrier.

Large building owners may have people that are charged with monitoring the building systems but smaller buildings do not, especially 2 to 4 story buildings and smaller. These smaller building owners and operators rarely have enough time to address these issues.

The level of sophistication of knowledge among building operators is lacking, even though systems continue to grow more complex. Learning to manage a building is still treated as a trade but it needs to be professionalized because of the

sophistication of the systems. Proper education about energy issues needs to be made available to small building owners, through BOMA and other organizations that already offer education.

Leasing arrangements make it difficult to make buildings more efficient. The issue of split incentives is a general barrier, which is also true for building commissioning.

There is a lack of case study information for specific markets. Public building examples do not hold water with private business owners. Building owners are focused more on managing risk not maximizing profit. They need strong demonstrations and case studies of their business peers, not building types, to motivate action.

There is a lack of whole building systems professionals to provide these services.

82. Commissioning, tune-up and O&M has to be incorporated into the pre-design or preliminary design discussions for new buildings, and the change in ownership or lease for existing buildings.

For new buildings it is most important to discuss issues of commissioning, tune-ups and operation and maintenance at the point of design. A building owner or operator should be guaranteed three things: 1. Proper documentation of systems operation, 2. Training for the building operators, and 3. A system to get information on building performance and energy costs to operators.

For existing buildings when there is a change of ownership, lease arrangement, remodeling event, end of life measures, or at any time a building owner is going to think about capital investments and changes.

83. Several recommendations were offered to overcome the identified barriers, including better peer based case studies; and a stronger infrastructure for providing whole system services.

Case studies and demonstrations that target specific peer groups would be helpful in promoting best practices in building commissioning, tune-up and O&M. Case studies have to be relevant to their business. There needs to be more people to provide commissioning services, and training efforts to address that need.

84. Commissioning, tune-up and O&M needs to be well defined, targeted to specific markets, with clear objectives and then supported through existing utility or other programs.

Incentives for this type of project can only be provided after the terms are clearly defined and participants and program implementers understand the objective. Utilities can initially create demand in the market by providing incentives, and then market forces for risk management can be highlighted through peer demonstrations. Clear deliverables need to be able to come out of the process to make it tangible. One example may be bonuses for energy savings to the service providers.

Programs that could integrate these strategies are Savings by Design, the seminars and training of the LEED program, and the energy centers like PEC should be offering these services. Do not create another bureaucracy to address this issue, but use private venues and existing programs to promote these ideas in the market.

Target these efforts to the building owners most in need of services, specifically small buildings two to four stories or shorter.

Potential participants should be carefully screened to see if they're ready to participate, and their buildings are good candidates for the markets that are to be attracted.

85. It is important to remember that the market is not necessarily broken.

Business owners and operators may not be aware that their buildings are inefficient, but that may be because the existing market does not require them to recognize it. These inefficiencies are being absorbed by the broader economy right now, and changing that will only provide marginal benefits.

86. Overcoming the infrastructure barrier of whole system service providers would take a significant level of effort over time, and take significant financial resources.

High level commissioning services are scarce in today's market. If great demand is created with out first addressing the supplier issue, it could throw the whole market out of balance. These service providers may emerge independently, or through training of existing contractors to provide these types of systems.

Preliminary efforts could be launched in the 2006 program offerings of the state, but the infrastructure issue would have to be addressed first. It may be better to take the time, maybe six years, to develop a program and get it into the market the right way with the right people with the right skills and coordination.

This type of program may take between five and ten million dollars, but it depends on whether it is focused on retro-commissioning or new construction. Funding would cycle with the program, demanding greater resources as the program ramps up with incentives, and fewer when the program sees the effects of the concept being internalized.

87. The implications for this effort could be significant but it is difficult to estimate.

Given that current penetration is so low, the effect of a program could be to double, triple or quadruple the penetration. The effort needs to be cautious of growing too quickly and throwing the supply and demand of such services out of balance. Energy prices may affect the interest in this type of program.

88. There are many important stakeholders including service providers, consumer groups, designers, BOMA, facility management, real-estate organizations and brokers, and tenants. While all players are important, the designers, building owners and managers are particularly important.

Each of these stakeholders has a role in the efficiency of the building. Designers, building owners and managers are typically involved in the design discussions. Their input is valuable as well as their buy-in to the idea of a more efficient building. Broadening the group that participates in this discussion to include BOMA and real estate agents may have a positive influence as well on overall market acceptance.

89. Building owners do not usually believe that their buildings are exceptionally inefficient, and it is not their primary concern.

Building owners often feel that they already bought efficiency when their systems were established, and hearing otherwise can be a shock. Monitoring operations of the systems have been squeezed out of the market because people think they're paying for these services when they buy the equipment, but they're not. Businesses are generally more focused on risk management, not profit maximization, and the risks faced by energy inefficiency are typically a low priority to the overall success of the business.

90. Consumer reactions are shaped by their perceptions of energy costs, now and in the future, but relating other costs to energy may make the program more appealing.

Customers are not primarily concerned with operating their building, but instead running whatever their business is. Energy has to be couched as a financial issue, and leveraged with peer interest. Near term energy costs have the greatest influence on these decisions. The higher the perceived costs the easier the sell. Energy costs are overshadowed by other costs like employee costs, so selling programs on the issue of productivity can help significantly. If energy costs were included in the capitalization of the building, management would be more apt to pay attention to the issue.

91. Engaging potential participants in the assessment process, collaborating with the private sector, and providing clear evidence of the benefits will help to overcome negative reactions to a program.

A program directly implemented by the state will likely have a cold reception from the market. A multi-faceted approach that reaches out to the private sector and involves these market actors (building operators, etc.) in the planning process, with clear evidence of the potential benefits, will go a long way to thawing relations before the program enters the market and make it more successful in the long run.

92. Policy shifts may be premature, and would best be reserved until such time as we understand this market better. They may, however, be acceptable if they can assure stability in program offerings.

Legislation has a tendency to solidify approaches, which is dangerous to do before the market is fully understood. Taking the time to understand the market is very important. Stability in existing programs that are working, however, would be welcome.

Demand Response, Residential

93. There was partial agreement, and partial disagreement that California policies are limiting demand response, that fixed rate structures are inhibiting demand response rates, customers are not understanding the benefits of demand response rates, or that they are unwilling to take on the risk of demand response rates.

One respondent noted that demand response rate structures might not be a prerequisite for a demand response initiative; price response programs can co-exist

with fixed rate structures. The other felt that the fixed rate structure does significantly hinder demand response, and that a demand response rate should be the default rate for the state. Residential customers and small businesses may face the barrier of understanding, but there is some evidence that they do not understand their current bills and demand response programs can improve their understanding of their bills.

94. There are several additional barriers to demand response including understandable bills, supply side buy-in, education, and prescriptive action for customers, risk aversion, and lack of dynamic rates.

Residential customers do not get clear bills and typically do not make sophisticated energy decisions. They cannot be expected to respond to price signals if they do not understand their rate structure to begin with. Professionals in the supply side part of energy use do not take demand response into consideration as it is not recognized as a resource. They need to have confidence in the reliability of demand response action because of their need to be conservative in their estimates and their overall risk aversion. The potential benefits of demand response need to be conveyed to the public, and firms need to have specific actions to create demand savings once they recognize the need to do something.

95. Demand rates should be the default rate structure and consequently there is no trigger event.

Energy efficiency is already a part of the customer service, and demand response should be too. There is always going to be volatility in the market, but in order to be prepared to respond in the next crisis, the demand response rate has to be in effect. It takes longer to get such a policy in place than the volatility event will last.

96. The best time to move customers to demand response rates is not clear.

Switching customers to a demand response rate will depend on their perceptions of security in the energy market. An energy crisis presents the opportunities of awareness of the issue, but there is also more fear of instability in prices, changing may not go over well. When there are more stable prices, people may be more open to try a change, but they will be less aware that there is a serious demand issue at hand.

97. Demand response programs should encourage the use of critical peaking rate structures or real time pricing.

With a critical peaking rate structure, utilities can use this critical rate to trigger a response from customers in addition to the on-peak/off-peak rates. While it is true that it costs more to deliver energy at certain peak times, residential customers do not have time or interest to constantly monitor energy markets. Whatever approach is adopted, it should be consistent.

98. Energy efficiency and demand response have to be addressed together.

There is a false separation of energy efficiency and demand response as two issues in the policy arena. Demand response is the short term action, while energy efficiency is a longer term response. Customers cannot be expected to change

equipment just to address demand response. The infrastructure must be designed to address both issues simultaneously.

99. California should encourage demand response programs, establish cost effective demand response rates, and provide consumers with information on the benefits and revenue impacts of demand response programs.

This is a fine idea, but its success will depend significantly on how it is done.

100. Consumers are not responding to demand response because rates only address energy efficiency.

Any strategy that is recommended should consider the consumer's perspective and the fact that they are not being asked to respond.

101. In addition to demand response rates, demand control also needs to be incorporated into building and appliance codes.

The codes would have to incorporate the building type and appliance, and those specs are too detailed to cover in this interview.

102. Implementing a demand response program may take three to five years, around $20 million, and may have significant penetration in the market; all of these factors would be dependant on the approach adopted.

It would take some time to address all of the issues with implementing such a program. It could probably be done in three years on the short end, and five years on the longer end. The cost would mostly be incurred by the utilities if it were a rate structure transition. A very rough estimate of the cost of a state wide demand response program, not default rates, would be around $20 million. If a default rate was adopted by the state, there would be 100 percent penetration, because everyone would be on a demand response rate, but maybe only 50 to 70 percent of customers would actually change their load structures. A targeted voluntary program may be able to achieve 33 percent penetration.

103. There are several important players, including government and other market players.

The CPUC and the Energy Commission obviously have an important role, since they are the ones establishing the policies in collaboration with the utilities and would be the ones to implement the rate structures. The California Independent System Operator, which is responsible for systems load, has the authority to recognize demand side savings and to manage the load accordingly. Dispatch operators, and resource planners also need to be involved in the discussion of how to recognize the value of demand response in load management. Technology vendors are trying to get demand response technologies into the market. Customers will create the market pull and ultimately be the ones using the services. Consumer groups will need to play a role in informing ratepayers of how a change in the rate structure will affect them. The legislature can also play a leadership role in demonstrating the need for a change.

104. Consumers are concerned about the impacts they may be able to have on overall demand; that the rate change may have a negative effect on their bills; and need to be provided with clear information to overcome these perceptions.

Customers need to know that their actions will make a difference, because they do. One argument against demand response rates is often that customers will not understand their bill. Research shows that they do not understand the bills they have now, and a demand rate structure may actually improve their understanding of what they are paying for and what they are getting. It will likely lower cost on average despite the common fear that it would raise cost. Education has to concentrate on dispelling this myth. Having a 6 month to a year transition period where customers get a shadow bill that shows what they pay now and what they would pay on a demand response rate would be very effective. It gives customers a chance to think about the real impacts and prepare for their response.

105. Legislation needs to focus on removing caps on high rates; establish policies that integrate energy efficiency and demand response.

One interviewee had no suggestions for legislative change. The other felt that the AB-1X rates that cap high rates should be removed, because it keeps customers from saving money through demand response rates. The legislature needs to recognize the equal importance of energy efficiency and demand response in integrated rates, building and appliance codes, and public goods funding.

Demand Response, Nonresidential

106. There was partial agreement and partial disagreement that California policies are limiting demand response, that fixed rate structures inhibit demand response rates, customers are not understanding the benefits of demand response rates, or that they are unwilling to take on the risk of demand response rates.

One respondent noted that demand response rate structures might not be a prerequisite for a demand response initiative; price response programs can co-exist with fixed rate structures. The other felt that the fixed rate structure does hinder demand response. Residential customers and small businesses may face the barrier of understanding more so than large commercial and industrial customers, but it may be one that is easily addressed through education. Customers do feel some risk in taking on a demand response rate, but business customers are most averse to the risk of losing anything in the way of comfort and affect on their products or services, not the price risks.

107. There are several additional barriers to demand response including understandable bills, supply side buy-in, education, and prescriptive action for customers, risk aversion, and lack of dynamic rates.

Small commercial customers especially do not get clear bills; this is less of a concern for medium and large customers. Professionals in the supply side part of energy use do not take demand response into consideration as it is not recognized as a resource. They need to have confidence in the reliability of demand response action because of their need to be conservative in their estimates and their overall

risk aversion. The potential benefits of demand response need to be conveyed to the public, and firms need to have specific actions to create demand savings once they recognize the need to do something.

108. Additional barriers include the disincentive created by the Standard Performance Contract incentives, the existing incentive program, and awareness of technologies.

Managing cooling load has run up against problems with the Standard Performance Contract program because of the incentives for high efficiency chillers. Large incentives for these chillers neglect the benefits of integrating thermal storage, and drive participants toward having more chillers not addressing the opportunities for demand response. The incentive programs through the public benefits charge specifically do not allow for demand response. Demand response technology has come a long way since the 80s and 90s, but myths about poor performance persist.

109. Trigger events for addressing demand response strategies are clearly defined for certain technologies, like thermal storage, by changeover in equipment, renovation / expansion, limits to capacity, and new construction.

When firms are ready to replace a chiller or older cooling systems, thermal storage can be introduced as an alternative to more energy consumption. This is also true when a building is expanding its capacity and may have a greater cooling load demand. In some cases a building may face limits to the amount of power that can come into the building through existing power lines. New construction is the most effective time to introduce demand management strategies.

110. The best time to move customers to demand response rates is not clear.

Switching customers to a demand response rate will depend on their perceptions of security in the energy market. An energy crisis presents the opportunities of awareness of the issue, but there is also more fear of instability in prices, changing may not go over well. When there are more stable prices, people may be more open to try a change, but they will be less aware that there is a serious demand issue at hand.

111. Demand response programs should encourage the use of critical peaking rate structures or real time pricing.

With a critical peaking rate structure, utilities can use this to trigger a response from customers. For large customers real time rates can also work because they have the ability to monitor the market on an ongoing basis and make sophisticated decisions. Demand charges also better reflect the real cost of delivering energy at certain times. Since it costs the utility more to get it to you at those times, you should have to pay for it. Time dependent valuation being used by the Energy Commission is encouraging this thought process. Short-term structures must include incentives, but long-term efforts must include rate structure changes.

112. Demand control also needs to be incorporated into building and appliance codes.

The load factor of the building needs to be something energy managers think about. Energy savings is only half of the picture. This could be done by setting limits on maximum power that can be used for different uses, for example lighting can only take 1kW. This method is being put into practice in Europe.

113. Implementation needs to be consistent.

Whatever plan is adopted it must be consistent and done over several years to reduce confusion, make for more effective evaluation of the approach, and improve overall effectiveness. Constantly changing the approach can be detrimental to progress over the long term.

114. Programs and incentives need to be modified to incorporate load control and demand response.

There should be some incentives in California for reducing load based on the kW/ton or measures for reducing peak demand. The Standard Performance Contract program for example has no demand response incentives only energy savings incentives, because of the public goods charge, which does not allow demand response incentives.

115. When implementing demand response programs or demand response rates customers are going to be interested in not only how much they are benefiting but the benefits to the utility as well.

If the utilities are making a strong profit on these programs but the customers gains are marginal, customers will be less inclined to participate, or may demand a greater incentive. If the savings are equitably distributed, everything is OK. If the customer is the one coming out with the greater portion of savings, they may be willing to pay more for making the upgrades themselves. It may however be difficult to get much disclosure from the utilities on their actual benefits from demand response activities.

116. California should encourage demand response programs, establish cost effective demand response rates, and provide consumers with information on the benefits and revenue impacts of demand response programs.

This is a fine idea, but its success will depend significantly on how it is done.

117. An effective demand response program could happen fairly quickly with substantial results, but should be very well thought out.

Strong demand response programs may be able to shift 100 MW from on-peak to off-peak in a few years or more. It, of course, depends on what the demand response program is, and how consumers accept it. It is unclear how much money it would take, maybe around $20 million or $300 per kW to $475 per kW as an incentive. A targeted program that addresses needs of different sectors could achieve 33 percent penetration or more for the largest commercial industrial sectors.

118. There are several important players, including government and other market players.

The CPUC and the Energy Commission obviously have an important role, since they are the ones establishing the policies, in collaboration with the utilities. They can

also play a marketing role in getting the story out. The CA ISO, which is responsible for systems load have the authority to recognize demand side savings and to manage the load accordingly. Dispatch operators and resource planners also need to be involved in the discussion of how to recognize the value of demand response in load management. Utilities will also have an important role in communicating options with customers, and exerting their influence on decision making. Technology vendors are trying to get demand response technologies into the market. Customers will create the market pull and ultimately be the ones using the services.

119. Consumers are concerned about the impacts they may be able to have on overall demand. They need to see individual benefits as well.

Customers need to know that their actions will make a difference; otherwise they will be apathetic to the whole idea. To motivate them they really need to see that there are benefits for them, that it will not cost more to be on a demand response rate, and they may even save money. They need to be convinced that they are not giving anything up in terms of comfort or product quality either. Once they are participating, bills should reflect the actual benefits to the participant in a clear and tangible way. When the dollars are there, behaviors change. Consumer's social benefits can also be highlighted. Siting of power plants is a huge issue and demand response should be marketed as a program that can minimize the NIMBY effect.

120. One interviewee did not recommend legislating demand management programs, but the other felt that legislation could be used to move demand response programs closer to energy efficiency programs in the state.

One interviewee felt that California was already pursuing a lot of effective program activities and worried about conflicting legislation or policies. The other recommended legislation that could allow load management to be considered with energy efficiency. There is an inaccurate assumption in today's programs that energy savings will lead to demand savings.

Demonstration and Case Studies, Nonresidential

121. Operators and Facilities managers are aware of energy efficient equipment and products, they understand how these products can be used to their benefit, and what kind of benefits can be achieved. They have case studies and demonstrations to draw information from.

It may be that there are people out there that do not have this broad understanding, but operators and facilities managers are well aware of these issues and opportunities. The preventions and measures have been around for over 30 years and people working in the field should know about them.

122. The most significant barriers to implementing energy efficiency improvements are financial, not a lack of case studies and demonstrations.

When rebates were available to large owners, they were participating in programs; the benefits can be demonstrated to tenants at the end of the year when you're handling escalation clauses (i.e. explaining any changes in their rent). Small owners face a real barrier of not having resources to do retro-fit work.

123. Control companies, and Energy Star programs are very valuable sources of information. Building owners are frequently seeking out energy information to inform their business decision process.

There are ample informational resources, if a firm is interested. Control companies are very willing to show how their systems maintain and control buildings. EPA's Energy Star benchmarking program also is a good resource for comparing building performance. Most building owners have an energy audit done before they purchase any property. They will typically compare that building's performance to the rest of their portfolio of buildings on a per square foot basis. Knowledge about the opportunities for efficiency improvements is most useful right after the audit is completed, because then they're ready to act.

124. Building owners rely on professional energy experts to provide information and examples of technologies that can save them energy, and also have their own case studies to build on.

Energy experts will be the ones implementing the changes, and they have numerous examples to demonstrate the effectiveness of their processes. Owners have to be cautious of these sources because they may exaggerate the savings. It is best to get at least three estimates before moving forward with a contractor. Large building owners will keep record of their own successful projects, as well as general data on all buildings, to serve as or develop case studies and demonstrations for other buildings in the portfolio to emulate. Utilities could also bring out case studies. BOMA (Building Operators and Managers Association) and other energy specific organizations also house a wealth of information.

125. Operators may fear that bringing in experts, or presenting energy saving examples to their superiors for fear that they will look like they do not know what they are doing.

There is no lack of information or case studies, it is a matter of bringing this information into the decision making process. If an operator is intimidated, it will obviously hinder the action process.

126. Building operators will be most aware of energy issues in June when rates go up for time of year; when they have budget to do things; or if the building is out of sequence with the portfolio.

Every year, around June, energy management issues come to the attention of operators as prices rise to address summer demand. Otherwise these issues may surface when a building manager has the budget to work on this issue or if a red flag goes up on a building that is out of sync with the portfolio. Building energy use is compiled each month and if one shows a significantly higher per square foot energy usage number, they find out why and take measures to correct it, or make the responsible parties pay for the overage.

127. Rebate programs, support for distributed generation, occupancy sensors, and retrofitted lighting are all more important than developing more demonstrations and case studies.

The state should focus its efforts on rebate programs, which would help everyone. Significant savings potential exists for distributed generation options like thermal storage and outside air. Mandatory occupancy sensors and more lighting retrofits would also generate significant savings.

128. The most important stakeholders are large owners and institutional building owners.

Large and institutional building owners own most of the commercial property in California. If these big companies, like Douglass Emits, Heinz, and EOP could demonstrate, the smaller building owners may be motivated to take action.

129. Energy savings are beneficial to both the building owner and the tenant.

The building owner will usually make the upgrade and prorate the cost over the lifetime of the measure. The tenant participates in that cost because they also get the benefits of the savings. This arrangement motivates the building owner and operator to commit to achieving the energy saving because they are laying out the money, and the tenant knows it. All of this is disclosed to the tenant in the escalation process where they see what the paybacks will be. Giving them all of the information and including them in the process will lead to a satisfactory upgrade event for all parties involved.

130. No new legislation is required because Title 24 can be used to make sure measures are included in buildings.

Energy Efficient Commercial Leasing

131. One of the largest barriers to implementing energy efficiency improvements in commercial leased property is presented by split incentives.

Neither the lessee nor the building owner recoups the whole benefit of the efficiency upgrade because of their contractual situation. This reduces the incentive for building owners or occupiers to improve efficiency.

132. Property management decision makers and tenants are not knowledgeable about how leases allocate costs for energy.

Tenants are typically the least knowledgeable of how energy costs are allocated. Three typical lease scenarios are common. The Gross Lease is where the owner pays the energy costs and other costs. In a Net Lease the tenant pays the costs including energy. A variety of lease arrangements fall in between these two types of leases. For example the landlord may pay a certain amount of the energy cost and the tenant pays the remainder.

133. Financing or capitalizing energy efficiency investments can also present a barrier to more improvements.

Awareness or understanding on the part of the lender is a typical reason for this difficulty. Appraisers, as a primary source of information to lenders, are also not very knowledgeable on this issue. They do not typically understand operating costs and

how it relates to the value of the building. It is also difficult to demonstrate that energy efficiency has improved the value of the building.

134. Decision makers do not write effective leasing agreements to begin with.

The market is full of poorly written confusing leases and the lawyers writing them are not aware of building dynamics and operating costs because they are not involved with any ongoing operations of the building, the landlord or the tenant.

135. There is an unfounded fear among landlords that improving properties may increase their property taxes.

While this fear persists, it is basically unfounded because the appraised value of the building is rarely affected by the energy efficiency improvements that are made.

136. The promotional benefits of being labeled an Energy Star or LEED building get diluted in multi-tenant situations.

When an owner occupies a building there is greater incentive to tout his or her own efficiency, but when the tenant does not have ownership that benefit loses some of its appeal.

137. It is most likely that the impetus for improving the building will come from the building owner, not the tenant, because they are the ones interested in building management issues. Promoting favorable “energy efficiency” lease terms should target building owners first.

Tenants are primarily concerned with their day to day operations and building management is not their business. In most situations the lease terms that will lead to more improvements in energy efficiency will be those favorable to building owners. Owners can be reached at trade association events, or other marketing venues.

138. The conclusion of the lease is the most important trigger event.

At the conclusion of the lease the building owner will either renew the lease or get a new tenant, at which point two other influential parties enter the equation. Real estate agents play an important role in the leasing process. Many prospective tenants will ask for their advice on the leasing terms and if they are standard, the real estate agent will say so and recommend acceptance. As influential players in this process, real estate agents are an important group to make aware of lease terms that may facilitate energy efficiency improvements. Appraisers can also be influential in the lending process. Both of these groups may be educated in the preferred leasing tools through their continuing education process. When a building owner is interested in offering a lease that could allow for efficiency improvements, the real estate agent and appraiser can recognize the terms as standard. If a tenant is looking for a building that would allow for energy efficiency improvements, the real estate agent will at least know the terms to look for.

139. Improving commercial leasing terms to facilitate energy efficiency improvements should focus on the existing tools in the commercial leasing market, not create new ones.

The program effort needs to meet the market where it is at, embracing market terminology and the understanding of standard practices. Branding is not worth a whole lot of effort, time would be better spent focusing on using existing lease terms and practices that people are already familiar with like the BOMA (Building Operators and Managers Association) model lease. Promoting a model lease and getting it incorporated into a standard lease template could accelerate the shift to this type of lease. Simple additions like an annual or bi-annual benchmarking could be written into a lease. The fixed base lease is widely used with an energy expense clause, which is a good lease feature with good incentives for both the landlord and the tenant. Another is the tenant cost recovery clause where a building owner can recover the cost of the improvements from the savings the tenant gets but with no affect on the tenants rent.

140. A program should employ market push and market pull tactics.

Push marketing would try to get building owners, property managers, appraisers and real estate agents on board at trade events, or leverage existing Energy Star or other networks to raise awareness about lease terms. These market actors will in turn communicate with tenants. Pull marketing would focus on tenants, trying to get them to demand lease terms that are favorable to energy efficiency. Carefully designed web sites could be an important tool to pull the market demand.

141. Audits could be subsidized to encourage awareness of the opportunities in a building.

This would create momentum in the industry, and could be a very cost effective use of resources. In New York, for example, half of the energy audit is paid by the program and the other half is paid if the owner makes the recommended improvements.

142. Any program that is launched needs to make a long term commitment to the market.

People are turned off by programs that come and go. Potential participants need to know that the incentive they are planning for will be there in the next few months if they ca not finalize the decision right now. The more programs change, the more people will spend time trying to game the system. Programs should be simple and constant. Results would likely be seen in about a year and would grow exponentially.

143. The program should be complemented with a strong operation and maintenance effort including training.

144. There should be on-balance sheet and off-balance sheet options for financing.

Building owners or lessees need either option to finance improvements, but it is most important for building owners. Whoever is financing the improvement will worry about how it looks on their balance sheet because it can affect their ability to get a loan.

145. Programs should be realistic in terms of how much paperwork can be done, and the time demands of the professionals you are dealing with.

Building owners and real estate agents have plenty of other things to do and they make plenty of money. Programs therefore have to be designed to meet them where they are.

146. Program funding would depend on the desired effects but can be started at a relatively reasonable cost, with substantial effects.

The initial education and trade association networking could start with as little as a $100,000. Program spending will likely be directly proportional to program impacts. The program could start with prototypes, focus groups and continuing education seminars. Once the program was moving it might be that more than half of building owners would change their leases.

147. Any enthusiasm among building owners to “be green” should be tapped to move the initiative forward; advantages of worker productivity or other benefits are also powerful.

Business owners often have a desire to tell their employees they are “doing the right thing”. While they are not particularly concerned about energy savings or even rental costs because it is such a small part of their overall benefits, tenants can be encouraged by gains in productivity that may result or improvements in the work environment.

148. Legislative recommendations included benchmarking and tracking of commercial property similar to the MLS for single-family homes.

With an industry wide base of commercial leasing properties, tracking would facilitate access to finding energy efficient spaces for tenants that were interested in them. It would also help the financing process, because building values could be more easily tracked and correlated to energy efficiency improvements, giving appraisers needed information to value properties appropriately.

149. Other recommended legislation included a law which would not allow property owners to challenging property assessments based on energy efficiency.

Property taxes should not be linked to the energy efficiency improvements, but the appraised value should be recognized. Buildings owners should never be encouraged to not improve the efficiency of their building to avoid increases in property taxes.

Interagency Coordination

150. Currently there is no credit given to programs that work together.

151. Consumers are provided with several resources to find programs to meet their needs.

The California energy efficiency web site provides a lot of information, the state web site has links to efficiency programs, people get referred at the retail level and there are radio and TV ads. There are ample referral services out there.

152. There may well be a multi-organizational desire to help other programs or program providers.

153. There are cross-program efforts in California.

The CPUC has helped to administer cross program efforts since 2002. The structure is set up but the functionality may be lacking, since it was not high on their priority list. There are a lot of interagency coordination activities happening, but most barriers have surfaced in the past 5 to 6 years.

154. The new collaboration paradigm will have an effect on many of these perceived interagency coordination barriers.

The 2006 paradigm for collaboration says that utilities will implement programs, the Energy Commission will return to a focus on PIER work and codes and standards. The CPUC will go back to regulating. These changes will eliminate many of the barriers mentioned. It will also give benefit and credits for working together with one area and service territory because they will be implementing and administering programs regionally.

155. One of the largest barriers to coordination has been the existing policy for program implementation.

A competitive and contentious environment was created as utilities and implementers were vying for the same limited funds from the state. There was no incentive to work together after having worked together for years.

156. The short timeframe for program approval and the discontinuity of Energy Commission codes and standards cycle is also a barrier to successful program implementation.

Program budgets are only approved for one year, and there is a 6 to 8 month approval cycle, which means programs have a lot of spending uncertainty. Programs start and stop, which is confusing to potential customers. The Energy Commission's codes and standards cycle overlaps with the three-year program cycle. For example, the next codes and standards will come out in 2008, at the tail end of our 2006-2008 programs. This effectively chops the program into one two-year program and one one-year program, requiring a redesign for the last year. Coordinating the timing of program transition with building codes and standards would be very helpful.

157. Cross program coordination strategies should remain informal, but with established common goals with incentives for collaboration.

There must be an incentive to reach common goals and everyone should have a stake in it, instead of the disincentive of competition for public funds. One of the primary incentives for programs is getting credit for energy savings. With multiple program implementers, even though collaboration may generate better services, the current system will only give credit to one organization, so they may end up doing it by themselves and leaving out the other organization's program elements, which were needed for a comprehensive approach. Without specific recommendations on how to structure a collaboration effort, issues like these need to be addressed.

The move away from competition for program funds is a good one. The new agreement for 2006 says that utilities will administer all of the funds, bidding out the

implementation contracts, and allowing the utilities to get to the formal goal the best way they can.

158. Statewide coordination should not necessarily be the objective of a coordination effort.

Most individuals are eligible for only one program, not multiple programs; cross coordination is not going to help that person much. Coordination with regional organizations like local governments and community organizations would be more helpful to get information out to customers. More program opportunities are available to customers on a local or regional level through their service provider.

Coordination should not lead people to the assumption that the needs of customers are the same. People live in different climates, for example, and coordination should never be done just for coordination's sake, which is what often happens for statewide programs.

In some cases cross-state coordination makes more sense, for example an air conditioning program that is coordinated regionally with Arizona, Nevada and some other arid regions makes more sense because the air conditioners have the same specs and weather patterns are similar.

159. It would be useful to formally identify where collaboration would make sense.

Gathering the various administrators to come to a formal agreement about where collaboration would make sense would be helpful, as long as they also recognize that there are many situations in which it does not make sense.

160. Cross program coordination would not have substantial benefits for customers and could be very expensive.

Very few customers would likely be able to take advantage of information about other programs in the state, and building the brand that people would think to contact to get this information would be very expensive. It is really not recommended.

161. The interested stakeholders in coordination efforts are the utilities, local governments, contractors, builders, retailers, manufacturers, community based organizations, the Energy Commission and CPUC.

The interests and support or opposition to the coordination effort would depend on how the collaboration is structured. No matter what the collaboration looked like, program implementers and regulators would have to be at the table.

162. Customer behaviors or belief that may influence interagency coordination is primarily the belief that getting information from more than one source makes that information more credible.

If customers are hearing a coordinated message from their local government and their utility, they are more likely to be convinced that it is accurate. Building on this belief, programs should focus on coordination with local governments and community organizations to raise awareness of program opportunities. Any program effort should take consumer reactions into consideration, since the whole objective is

to influence consumer behavior and that cannot be accomplished without addressing their needs.

163. Legislation is not appropriate to address interagency coordination; it creates dissention, frustration and confusion in the interpretation. The new CPUC guidelines are more appropriate and will effectively address many coordination barriers.

Purchasing Standards and Programs

164. The first cost of energy efficient equipment options is too high for many governmental and non-profit organizations.

One interviewee strongly agreed that this is a barrier. The other interviewee was less certain that this was a barrier, noting that energy efficient equipment is not always more expensive, and in a bid condition this is not always a barrier. It would depend on the criteria for the purchase decision being used. If first cost is the primary focus then small changes in cost will present obstacles. But most agencies are looking at life cycle costs, or more holistic pictures of the cost of products within their overall operations, not just the first cost.

165. Several other barriers to investing in energy efficiency equipment were noted, and included: supply, education, risk aversion, existing purchasing guidelines, and connecting with the proper decision makers.

Supply can be a barrier for new and innovative technologies before they are fully integrated into the market. There needs to be an adequate supply to meet competitive bidding requirements, and there must be enough volume to bid in sufficient quantities.
The education barrier is multi-faceted. First of all it may be a product that the purchaser is not familiar with. They may not have enough information about its energy efficiency specifications if it is not reported in the catalogue. In a bidding situation, the purchasing agent needs to know what criteria to look for. In general, people do not understand all of the benefits of energy efficiency. With public demand, government procurement agencies will have to respond, as will manufacturers providing goods and services.

There is some tenancy to avoid new products in general because of uncertainty about performance, or familiarity with the product.

Existing purchasing guidelines are also restricting, and the structure is already established for acquiring products.

Sometimes reaching the person responsible for making a decision on what to buy can be difficult. The state's procurement experts should give local governments advice on what should be purchased. Manuals or other guidelines would be helpful.

166. The key times to intervene in purchasing decisions may depend on the technology; crisis events present opportunities, coordinating efforts with Strategic Sourcing, existing contract recurring schedules, and negotiation of joint purchasing efforts are important.

When there is a large-scale event, like after an earthquake, which requires significant purchasing, this is an opportunity to replace with high efficiency equipment. Efforts could be coordinated with Strategic Sourcing to consolidate purchasing power to get more purchasing into fewer numbers of contracts, get the best bid, the best equipment, and the best contract. Focus on contractors that meet the criteria for environmental standards.

Thousands of contracts expire all the time, coordinating the bidding process with these events will open opportunities to get more efficient, environmentally friendly equipment. We already have a contract that allows joint purchasing efforts for local governments and non-profits and we're looking at some multi-state purchasing agreements.

167. Procurement programs for energy efficiency should be incorporated into existing procurement practices.

One person in the procurement process should be charged with the education of other procurement staff on what to look for in energy efficient equipment, in negotiating contracts and writing specifications. A support sales force should get these ideas out to local governments and non-profits. Education should be the focus of the initiative.

168. Procurement guidelines could be developed and used on a voluntary basis by any institution and could be formally adopted by state agencies.

One project currently underway will be developed based on research of other procurement programs across the nation. Three basic categories of guidelines would be developed for appliances, building materials, and design practices. The guidelines would be developed through a committee of stakeholders, including product suppliers and agencies that would be doing the purchasing, where current procurement practices would be reviewed. Once the guidelines were developed, the top executives of large institutions and government agencies would be encouraged to adopt them as standard practice. At the state level as well, the guidelines should be adopted as standard practice through policy or legislation.

169. The state should use its purchasing power and volume based pricing advantages to purchase energy efficient equipment for government buildings and non-profits. The state should provide purchasing specs and allow wider use of state purchasing contractors.

This will get a better price and a better product from the manufacturer, if they have a sales commitment. Producers will be more willing to get into these markets if there is some security in the demand from the state. It can be very helpful for upstream partnership programs.

In this situation, local governments would need to be responsible for their decisions on the requirements, but guidelines from the state would be helpful. They will not appreciate being told what to do, but they will need information to make their choice.

The key is to make sure the program is voluntary and as accessible as possible so it will be widely used. The Governor has already made steps in this direction, at least by recognizing its importance. There is also Environmentally Preferable Purchasing

programs in about 30 departments in the state, which is another venue to get this started.

170. This type of program could be developed in a couple of years, requiring staff dedicated to environmentally preferable purchasing, and a budget of $150 to $500 thousand per year.

One program that is already in play has a timeline of two years to develop and implement the effort. Once the procedures are established it could be implemented into contracts as they expire.

The program that has started in California has budgeted $270,000 for two years to get the plan up and running. Illinois did it for $500,000 per year in the 70s and 80s.

171. It is difficult to estimate the number of local government and non-profit agencies that would take advantage of this type of procurement opportunity.

There would probably be a number of local governments that would participate to get lower prices through volume discounts. If the effort was well promoted and coupled with education, and the price advantage was significant, there would be a lot of organizations that would participate. Big cities would be the first to line up. Smaller cities, school districts, and CHIPS will come when they see the price advantage. The Collaborative for High Performance Schools would want to follow the guidelines and would help in school funding.

172. The market actors and stakeholders in a procurement effort could include the private sector in addition to government and non-profit organizations.

Collaboration with large companies that have a demonstrated commitment to environmental purchasing (like Kiser Medical and Home Depot) would be important players to involve in the effort to maximize the benefits.

Trade associations like BOMA (Building Operator and Maintenance Association), the Facilities Managers associations, and manufacturing associations can also play a major role. The Department of General Services, the Energy Commission, the Office of the State Architect, Superintendent of Schools, non-profits, higher education, corrections; are all entities that should be involved.

People that are involved in the policy formulation role in their organizations can have a lot of clout in the overall development of the procedures and guidelines. [The interviewees provided names of specific individuals, which are recorded in the interview documentation].

173. Potential participants will be concerned about changing established practices, and any prospect of a mandatory program that will limit their choices and freedom to make decisions. They also do not want to introduce cumbersome administrative tasks into their daily activities.

There are many imbedded institutional practices and approaches for purchasing, and people have a natural resistance to change. A program should be voluntary, with a strong education element to bring people on board. They may mistrust the implementing organizations, and strong education can help in overcoming this

barrier. Programs also need to be user friendly so they attract the largest number of participants.

174. Legislation or an executive order could get this type of program off the ground for state agencies, specifically those that fall under the authority of the Governor.

Starting at the top could demonstrate the usefulness of this approach and its value to the public. It does not have to be limited to energy efficiency, but can include environmentally friendly materials, water conservation, etc. Taking the Environmentally Preferable Purchasing approach is better because it is a whole package approach.

Local governmental and non-profits and businesses could come on board on a voluntary basis as the program continues to grow.

Residential equipment Tune-ups and O&M services

175. The barriers of post installation equipment neglect, and lack of awareness were confirmed to be true, but several other barriers were noted.

In many cases the equipment is improperly installed in the first place, but customers do not realize that because they are more concerned about whether the unit is doing its job, not how well it is doing its job. It is from this limited perspective that they are providing the quality assurance and quality control of the installation. Contractors have no incentive to do better because they still are paid for the services, and can get in and out of more jobs more quickly by focusing on speed not quality. No one else is providing the quality control or quality assurance, but it is needed to allow contractors who want to do the right thing to be distinguished in the market, and rewarded by customers who are looking for quality services.

176. The sale of a home, installation of new equipment, or a service call are opportunities for integrating whole system evaluation as an added value service.

At these trigger events, the customer has initiated the contact, and providing these add on services to equipment repair and replacement could be shown to provide more value to the standard services. It may not be an easy sell, controlling for perceptions of bait and switch would be important.

177. Time of year considerations must be integrated into any successful program.

The seasonal demand for services generates a trigger event that can be important to take advantage of or at least not ignore. For example, promoting air conditioning services in September will not coincide with peak demand for these services. On the contrary, trying to launch a program in the spring when service calls are high on air conditioning unit failures would not be successful because those providing the service do not have time to integrate programs. There must be adequate planning to maximize the advantages of these cycles and minimize the obstacles. Planning for the long term will help.

178. An initiative focusing on residential tune-ups and operation and maintenance should start with good market research, strong third party implementers, and have an education element.

The market cycles and conditions must be well understood in order to “prepare for the harvest”. Strong third party implementers will be an asset because they already have a market interest and experience. The program must generate market pull through, customer education on the differences between contractor’s services, the value of a long term cost assessment, and what makes for a quality contractor. Using a tiered approach and linking promotional efforts will also improve market penetration.

179. In-home system tune-up services and cost effective planned replacement was endorsed by this interviewee, as long as a quality control component is included.

Quality control must be included to make sure things are done right the first time, and continue to be done right. There needs to be strong follow-up.

180. The level of effort needed for an operation and maintenance program would depend on the desired penetration, but could be launched fairly quickly.

The level of effort required would depend on the market penetration that was desired, but the more important factors are that it is done effectively, is planned for the long term, and focuses on the markets needs, not asking the market to follow the government needs. It could be launched in 6 months to one year depending on the experience of the planners, and would likely cost tens to hundreds of millions to implement. Over 15 years, with a really strong program, 30 to 40 percent of the market could be influenced.

181. The program should be fielded through third party implementers, with utility endorsement.

Third party implementers are most experienced with the market, and are consequently best suited to implement these programs. They can handle the design, management, tracking, modification, and ensure quality contractors are providing services. Utility endorsement is also important because they are the foremost trusted source of information for customers. They can be very helpful in providing the necessary networking and informational support, but they need to be protected from association with bad contractors through strong quality control program elements. A second approach to reaching customers could be through contractors marketing efforts, or the real estate industry. Getting the real estate industry involved would probably have to be mandatory. Contractors will be involved by providing the services in the field. Information program providers can assist by providing clear, concise, and specific information and messages. Training and education providers can support the effort by training with hands on efforts that incorporate experience and certification.

182. Changes in customer perceptions should be monitored throughout program implementation.

The public misperceptions about equipment and contractors needs to be monitored to see if the program is having impacts. Customers want good information about their systems; they just are not getting it right now.

183. Policy recommendations may influence the penetration of tune-up and operation and maintenance practices include a mandatory requirement when

property changes hands for a minimum efficiency standard, adequate funding, minimal bureaucracy, long term commitment, and third party administration.

Like the Title–24 standards, property changing hands could be required to meet minimal performance requirements. Any initiative must have adequate funding, but that is simple and committed to the long term. Third party implementers are best suited to fulfill this role.

Technical Training Grants

184. The key barriers to market penetration of energy efficient contracting practices are in part the technical training of contractors, but more importantly the business training of contractors.

Contractors may in some cases be in need of greater technical training in energy efficiency, particularly in the area of rating their own homes, before a rater comes to visit. The greater deficiency is in applying a successful business model to promote and sell high efficiency homes and services. The contracting industry is a tough one, many are simply trying to stay afloat, and charging more for services that are not appropriately understood by the public puts them at a disadvantage in a market tradition of rewarding the lowest bid. The barriers are not a lack of raters, or other energy professionals.

185. Better training for contractors should be an ongoing effort and should meet them where they are at in the learning / experience process.

Contractors coming out of school are a key target, and could be reached through the education process, but existing contractors are also very important because they are continuously passing knowledge on to the next generation of contractors. Existing contractors are hard to reach, when their services are in demand they do not have time for training, and when their services are not in demand they do not have the resources to increase their training. Conferences have been successful methods to garner interest and follow up support for contractors without the intense concentration on one subject that is usually the case for training. Ongoing mentoring may be another opportunity once some role models are established.

186. Training should be holistic and linked to other program strategies.

Participants should be exposed to all components of the building, so they can leave the training with a better understanding of the systems approach to building. They need to be aware of how components of the shell interact with the distribution systems and other inter-relationships. Contractors should be cross-trained in other disciplines so they have an appreciation for how those systems work. To maximize the impact of such a program, it should be tied to other efforts like certification.

187. Training grants for community colleges may be helpful, but it presents limited options.

Community colleges may have strong inroads to new contractors, but it does not present many opportunities for existing contractors, who have significant influence in the market in training new contractors. These educational institutions may have

exceptional classroom skills, but they're not reaching existing contractors is problematic. There are existing training programs that serve as effective models that are not technical school based.

188. Business training and developing marketing and hands on informational tools for the field are a better use of resources than developing training materials.

Training materials are often very expensive, and the training manuals are quickly discarded. Practical tools like video tapes, visual graphics (especially for non-English speakers), and laminated graphs and charts will likely have much wider circulation after the training occurs, and have a greater impact. Creativity is the key.

189. This type of program could be deployed statewide in 2 to 3 years.

Since there are already effective models for doing this program, scaling it up to the statewide level would mostly require the addition of trainers. Bear in mind while there may be attendance at events even in the first and second years, it will take time to see the effects in the market. In current programs, in a class of 30 people per year maybe half will do something with their training and a third will use it as a primary marketing tool.

190. Trade associations are the most important actors in a successful program.

These organizations currently have the skill set to provide the necessary training, and implement the programs. They also have clout within the industry and can support and endorse best practices. Utilities and cities can also endorse and support such programs. Educational institutions can be influential to new contractors entering the market, and other service providers can also hold sway. Getting economic development associations on board may also give a program momentum.

191. Contractors need to be ready to look at their practices critically, be motivated to get new information, and see value in getting trained before they will consider participation.

When contractors are willing to look at their past practices and recognize their lack of expertise, they may be motivated to learn something new or get more information. They will value training as a tool to move their business forward, or at least not move backward. The fear of being left behind in an ever changing market may be a strong motivation. Contractors should try to anticipate changes, like code changes, and adapt. Typically they are very reactive, not proactive in their approach to these changes, whereas architects, raters, and inspectors are more proactive. Not all contractors need to be ready to participate, programs need to carefully select those that already have good business practices and an interest to develop a group of contractors that can distinguish themselves in the market.

192. Legislation and policy changes can provide encouragement for best practices, additional skills, demonstrated expertise, and cohesion with a broader state agenda.

Builders could be eligible for an alternative tax if they are utilizing a systems approach in their building strategy. This would encourage them to pursue this best practice and recognize those that do. Contractors should be trained like raters so when the raters come, they can have confidence that they will pass; this should be

enforced by a regulatory body. Contractors with certain certifications should be eligible for insurance rate deductions; this would be a strong motivation to learn and implement these practices. Continuing education requirements for licensing will get more contractors into training. The programs can gain momentum if they are infused with a broader state agenda like combating global warming.

Third Party Verification

193. While there may be a lack of confidence in the expected energy savings and the proper installation of measures, it is not the primary barrier to greater efficiency.

California has had state sponsored energy efficiency programs since 1976, and our consumption has remained fairly flat since then, while the national consumption has climbed. People have been doing energy efficiency for many years, when you get their attention they are willing to do it.

194. The primary barriers are the high first cost of items, proper installation, understanding the whole house from a system perspective, consumer priority, and contractor knowledge.

Systems are not going to be changed out or upgraded to high efficiency systems if they are working because a new one is very expensive. Proper installation is a problem, but the bigger problem is that people are not understanding home energy efficiency from a systems perspective. Everything connected to new equipment must be properly sized, sealed, and updated so the whole system is operating efficiently. Contractors are trained to a large extent by their peers or working partners. Proper sizing is one of the common problems, but customers never call back because they do not know what to expect, no one is attempting to sell customers a whole process or a total system package.

Customers are not as motivated by potential energy savings as they are by the benefits of health and comfort. They also are not concentrating on efficiency because their primary concern when something breaks in their home is how to get it fixed right away. If they have heard of a rebate they may go for it, if the process is simple.

195. Resale of property and major remodeling projects that require a permit are prime opportunities for third party verification.

If third party verification was mandatory, they would find out about the requirement during the permitting process, and if it was voluntary they could look for the information on their own. These are the most convenient opportunities to target.

196. Third party verification could be incorporated into existing programs like the home energy rating system.

The home energy rating system could benefit from an add-on program that included the verification of installation or quality of installation in the process. Creating several layers of programs gets complicated; it is best to build on what is already out there.

197. A mandatory program could be modeled after California's smog certification program for automobiles.

If you want to drive in California you have to have a smog certificate for your car. Likewise, if you are interested in building in California you could be required to have a rating to get a permit. The burden would be on the seller or remodeler to make the improvements before the permit is granted. A homeowner that discovers they have to make $2500 in upgrades would have to do that on their own and the cost would come out of the purchase price of the home. It may be that if they make the upgrade, the house would be rated ”silver” or something like that, and it would add to the value of the home. This is in contrast to the energy efficiency mortgage that is criticized for interfering in the sales process. Making the homeowner do the improvements avoids the financial stuff, and is all very straight forward.

This would not address the issue of system performance or installation, but there would be more efficiency being pursued, and energy savings would be achieved.

198. Establishing a third party verification service would not succeed in boosting consumer confidence, but it may increase the performance of installations.

A third party verification service does not address the issue of consumer confidence, and would only increase the performance of installations if it is linked to other penalties and training for contractors.

199. The best way to boost consumer confidence is to get the local utility company and the state to endorse a program or individual.

When a customer sees that the state and local utility are involved in the process, this is all the information they need to trust the validity of the effort. Customers are accustomed to utility involvement, and they look for the state’s stamp to verify that it is OK.

200. A strong third party verification program would be very expensive and require a large workforce to address a secondary issue.

Mandatory or voluntary, the resources and expense of training, updating standards, and keeping people informed would be significant. The issue of customer confidence is not the most important one to address. Right now there are not even enough building inspectors, raters or other trained people to do third party verification. Developing this infrastructure would be difficult and there would be strong opposition to it.

If resources were made available it could be done in 3 to 5 years, taking many millions of dollars.

201. A third party verification program should address remodeling, add-ons to homes, resale, HVAC replacement and window replacements.

Windows in particular present a large opportunity, because there are lots of windows being done right now. If installing windows could lead into a whole house system inspection and verification, this would be a huge opportunity.

202. The key actors in improving efficiency in California are the CPUC the Energy Commission and the utility companies, in addition to contractors, the real estate industry, financial industry, trade associations, building inspectors, etc.

Their respective roles were well summarized in a recently reached agreement for the 2006 program cycle. Utilities will implement and manage the program funding. The Energy Commission will concentrate on codes and standards and provide overarching vision and oversight. The CPUC are the regulators and will also contribute to the overarching vision, and handle any state enforcement issues.

Other parties like contractors, the real estate industry, financial industry, trade associations, building inspectors, remodeling associations, and evaluators, are all important groups to have at the table. They provide useful input about what types of programs work and devise plans for what could be effective in the future. Raters would be excited about this type of program, real estate associations would not like it and see it as an additional burden.

203. Consumer reactions will depend on whether the initiative is voluntary or mandatory. If voluntary, they will have to believe in the cause, and if mandatory they will complain but still do it.

Those participating in a voluntary program will not resent the process and will be confident in their choice to “do the right thing” for whatever reason. A mandatory program will generate some resentment, but if it is made quick and easy to comply and the benefits were clear, the resentment may fade over time. If these programs, either version, can be sold on the issues of health and safety they will be more likely to be seen as a real benefit.

204. Any effort should take the time to gauge consumer attitudes through the use of focus groups.

Focus groups should be done up and down the state, providing customers with potential models and then give them the option to change different components of the model until they came up with something they were satisfied with. The end goal is to make a program that is attractive, convenient and beneficial.

205. Legislation or policy recommendations should be linked to things happening already.

New things are fine as long as they are tacked onto existing programs. The exception would be if there was a mandatory rating certification. That would require new legislation.

Upstream Partnership Programs

206. Upstream partnership is a tool for engaging market actors who are upstream from the customers; any program using this tool must be tailored to the market it wants to influence.

There are multiple factors that play into the desire of manufacturers to get a product into the market and acquire market share. Partnership is not just going to mean incentives, but a comprehensive knowledge of the market before getting involved, and a careful ear to the needs of the stakeholders. The appropriate approach may depend on where the prospective product is in its lifetime, if it is a new product, incentives may help; if there is a need for a major redesign to get more efficiency,

design support may be more beneficial. This all needs to be pursued in the program design phase, so stakeholders can have relative confidence in a program plan once it hits the market. Remember, the whole market will not be interested in working with the program but carefully choosing among those that are interested can have significant pay off as those unwilling to participate initially are pulled into the market. Upstream partners will have to ultimately choose if participation and the offer presented to them will be in their best interest.

207. When working with upstream actors, a regional or national focus will be more apt to draw their attention.

Manufacturers will be drawn by acquiring market share. They do not operate their businesses with respect to California only markets, except in some very isolated cases. A regional or even national perspective is needed to draw their attention. To accomplish this, coalitions with like minded programs trying to improve the efficiency of technology in the market need to be forged. For example, California should try to work with programs in the Northwest toward their similar goals. California, considering its size, has a lot to offer these alliances but should not expect to be able to accomplish much on its own.

208. Several technologies and products show potential for upstream partnership efforts including: lighting fixtures, room air conditioning, windows, manufactured homes, economizers, set top boxes, computer power supplies, and even incandescent lighting.

While the approaches to engage upstream partners may differ for each of these types of technologies, they were identified as having significant remaining potential for the state.

Innovations in lighting technology are being made but are having a hard time making it to the market. Few of the Lighting for Tomorrow contest winners are getting into the hands of manufacturers. Facilitating the advancement of product lines in this way may be more helpful for manufacturers than being provided an incentive. The product lines for room air conditioners need to be made more efficient but in this case too, design support may be more helpful than a direct incentive. For windows, which already have very efficient designs, getting the high efficiency lines adopted as the standard in big box stores like Home Depot would have national implications and is an example of a good opportunity to use a major manufacturer incentive. Manufactured homes have a large potential in California. Small commercial economizers are a big market in California but the manufacturers could use assistance in improving the reliability, controls and overall designs of these products. Increasing the penetration and use of low power mode on set top boxes (cable box for example), mainstreaming the use of low powered internal computer power supplies, and improving incandescent lighting technology were also cited as having potential in California through upstream partnerships.

209. Guaranteed purchase orders may also be a strong tool in the upstream market intervention strategies.

Programs should take advantage of competition within state buildings. These could be venues to highlight equipment, making it the “right choice”, presents an opportunity to help more products make their way into the market. These opportunities can be very attractive to manufacturers and they do not require an extra monetary incentive.

210. The existing institutional environment for attributing credit for savings is a barrier to more market transformation based programs.

There needs to be a way to credit multiple programs or sponsors, be they utilities or whomever, for the energy savings achieved. The current situation is too limiting.

211. The key trigger events for dealing with upstream market actors will depend on the technology and the specific market.

The most important things for programs to focus on include: when do manufacturers redesign to meet their other market demands? When do retailers place most of their orders? Are there other major issues, for example removal of lead that will be a higher priority in this design cycle? What can be done in between these major cycles? When partners are open to considering design changes and new products, will they depend on these factors among others? Program implementers will have to do their ”homework” and have open conversations with stakeholders to plan accordingly.

212. Traditional market assessment needs to be the first step in a successful program that includes an upstream partnership campaign; it should not, however, only look at upstream partners and should be able to have a sustained market presence.

The market assessment should identify who needs to be partnered with, what they need, when they need to do it, bring together multiple tools, team with people to build clout, and be ready to talk about influencing the market in a certain time or period. In addition, the program needs to look at the overall goal; that upstream partnership, particularly an incentive, will result in lower consumer prices. It needs to give manufacturers plenty of advance notice, and keep them involved in the process. Finally, any program has to be able to demonstrate to their partners in the field that they will be around to see them through this transition; intermittency will significantly hinder the program’s credibility in the market.

Whole Building Diagnostic Testing

213. There is a lack of a systems approach in providing building information, and a lack of awareness of the synergistic benefits and effects of energy choices, which hinder proper decision making; as well as a lack of contractors that can provide whole building diagnostic testing.

In addition to these already identified barriers, there is a lack of software to pull all of the building information together in a useful way. It is being developed but is not yet ready. The design aspects of the building and the infrastructure to provide information are also not well developed, which affects the provision of building

information. If the state were to put together a strong education program, many of these barriers could be overcome.

214. Opportunities to effect change in this market include a change in tenancy, any major renovation, or the financing of a real estate transaction.

These are times when building owners may be thinking about how their systems work.

215. A program to encourage whole building diagnostic testing should have utility involvement, including incentives.

Utilities would be most likely to administer the programs, hiring contractors to do the actual work and use in-house expertise. The recommended measures that came out of a testing would have to be linked to an existing program and the utilities are in the best position to make those recommendations and referrals. The utilities could also play a role in financing.

216. California should consider increasing the penetration and availability of whole building analysis to achieve energy savings through a systems approach.

The systems approach is the best method as long as it is not too expensive. It is important to remember that systems approaches are not that well understood. If the definition is not clear, problems could arise. It is a nice idea, but difficult to implement until there is a better understanding of what a systems approach is.

217. Contractors will not likely to be able to provide diagnostic services in addition to their traditional services, in the short run.

Contractors do not have the training and education to provide both types of services at this time, but eventually it may be possible. Right now systems integration is a very young industry, it is rare to find anyone that can provide these types of services. It may turn out, as the market develops, that some providing systems integration services will be derived from contractor generalists and others will have developed independently. If there is need in the market someone will fill the role. Contractors should start to get trained in whole systems approaches.

218. Getting a diagnostic testing initiative would take a fair amount of effort over the long-term to see results and would require significant resources.

To get a program launched would take significantly more effort than is being expended currently on California's energy efficiency programs. It is a long term issue that would need a commitment of 10 to 15 years to get it implemented and see results, because industries are very slow to change. For example the switch to electronic ballasts took nearly ten years. These types of programs cannot be done "on the cheap". The audit would probably cot $0.10 per square foot, and implementation about $10 / square foot. State funding would only have to cover a portion of that cost. The rest should be funded through the public goods charge and the participant contribution. If the penetration was spread over ten to twenty years, it would be about five percent per year with the most in the middle of the program cycle.

219. The utilities, building owners, contractors, and systems integrators are all actors and stakeholders in whole building diagnostic testing.

The building owners at the executive level are critical to have on board because they have the clout in the business. If they are convinced something is in their best interest, they'll put the necessary pressure downstream to get the results they expect. "Systems Integrators" are the people that are analyzing and improving the systems, or just one piece of that equation.

220. Customers are concerned about compromising comfort when installing energy efficiency improvements.

This will be very dependent on the measures that are being discussed, but in general it is important to try to avoid disruptions and maintain or improve the comfort level with the upgrade. Causing discomfort, either during the installation phase or the operations of the actual measure itself will have negative effects on the whole industry. These measures should be screened out of the program. This should not be an issue when performing the diagnostic test alone.

Whole House Diagnostic Testing

221. There is a lack of a systems approach to providing building information, and a lack of awareness of the synergistic benefits and effects from equipment. There are also few contractors willing to provide diagnostic testing because of limited capacity or adequate compensation.

These were recognized as the key barriers, but there is also a lack of general public awareness of the benefits of testing and retrofitting. Customers anticipate performance problems because they do not know things can be done about it, and they do not understand the relationship between the costs and performance, indoor air quality, moisture detection, etc. Customers are not actively demanding these services because they are not seeing much of them yet. The lack of customer awareness is the largest barrier.

222. Demand for these services will be stimulated through public education.

As the public becomes aware of these opportunities, they will demand these services. Technicians are not getting out and pushing these services, and they really can not until the public is educated. Marketing these services is very expensive for them to do on their own. It is also difficult to get contractors to participate in programs when the public is not actively demanding the services. The quality of service provided and the communication with customers will be a strong determinant in the continued demand for these services.

223. New home construction, sale of a rental unit or owner occupied home, major renovations, and in some cases equipment replacements all present times at which a program may successfully intervene in the decision process.

For new construction, every home should have a diagnostic test. New homes often do not work well, and this is the time at which things can be done at a very reasonable cost to capture the potential. Rental units should be required to be

brought up to a certain efficiency standard at time of sale. This has been used in Vermont with success. Data is provided to the buyer, well enough in advance so they can incorporate this information into their decision on which homes to make an offer. Owner occupied homes could have the same process, but perhaps not making it mandatory. At major renovations significant energy savings can be captured. Mechanical equipment replacement is a difficult event to capture in residential markets, because it is usually an urgent situation, and there is no time for an inspection.

224. A successful program prescription is to have a strong public education program coupled with contractor training at little or no cost.

Since lack of consumer awareness is the key barrier to greater use of whole house diagnostic testing, the first step is to educate customers on the benefits. Start with the non-energy benefits of air quality, health, mold problems, building degradation, comfort, added home value and then move into the energy savings and environmental benefits. Demonstrate that the upgrades are actually free because of the value of the energy savings. Training for contractors should be ample and available at little or no cost. It should be accessible to where they live and work, less than a two-hour drive. The training needs to be very good because it is a new skill for contractors.

225. Contractors should be trained to provide whole system services, and bundle the service with more profitable work.

Contractors should be able to provide a seamless service to the customer as the one identifying the problems, explaining the benefits of fixing the problems, and then doing the actual work. While good testing may be expensive, the work that is generated through that testing should cover those costs and still make a profit. Decoupling these services would just mean that one party loses on the testing and the other gets to reap the benefits of the upgrades, it is better to have these interests combined. Building this industry will take time. Years ago, home inspections did not exist; now they are regularly in demand.

226. This program would be a market transformation effort that would require a concentrated push to get things started, and then staged in key areas as the program grows.

The market needs to be moved enough in the initial stages to get contractors to provide the service and to generate public demand. This is the time when value has to be demonstrated to the contractors. Focusing on geographical regions makes sense to get started and then spread the program out. Training should be very well thought out, and strongly linked to marketing. It will take considerable time, but there should be some visible benefits after two or three years. It would not be unrealistic to expect a program like this to cost around two-hundred dollars per home. The program should drive to a point in time where home buyers would not even consider buying a home without this kind of information; it may happen in ten years.

227. Demonstrations can be a powerful marketing tool, especially if popular figures are involved.

If results are demonstrated by high powered figures like the Governor of California, or well-known home improvement celebrities like Steve Thomas from This Old House, you can draw public interest. It is good publicity for someone like the Governor of California and it promotes the program.

228. Contractors are the key market actor without their support the effort will fail.

Programs must be designed to meet their needs, while they push the market forward. Contractors need strong support to get these services going. Real estate agents, bankers, insurance companies, property inspectors, property managers, and code officials should also be sensitized to the value of improving energy efficiency in a home.

229. Concentrate on selling customers problem solving not energy savings.

Almost everybody is interested in improving the quality of his or her home, but not everyone is interested in saving energy. They may experience skepticism as to whether the problem can be fixed, but they will likely be pleasantly surprised that by solving a performance problem, the energy savings come for free. Demonstrations are the best way to get this information to customers, and show them the diagnostic tools in action. Show the leaks, and problems.

230. Legislation with mandatory diagnostic testing may not be the best approach. Instead legislation should focus on supporting market transformation efforts through training and marketing.

Expert Panel Discussions

A series of panel discussions were conducted with a carefully selected population of market actors and experts. Panel topics and participants were developed in cooperation with the Energy Commission project manager, and focused on intervention strategies identified by the project team as having significant potential for meeting the goals of the AB 549 project. Expert panels were held on the following topic areas:

- Home Energy Evaluation Strategies and Techniques
- Information to All Homeowners
- Residential Time of Sale Trigger Events
- Low-Income Multifamily Housing Strategies
- Nonresidential Training and Certification
- Technical Issues of Benchmarking
- Use of Benchmarking

Each panels covered the following general discussion topics:

- General discussion about this overall intervention strategy. Does it make sense? Will it work in California? What about this do you like? What do you dislike? Should it be developed? Why or why not?

- If this intervention strategy were to be developed or expanded (if now partially developed) how would it need to be implemented? What structural characteristics would need to be incorporated into the initiative? Over what timeframe would this need to be developed? Over what timeframe would it need to be offered and pushed to get established in the market or to create enough demand to make it successful?
- What do you think would be the level of demand for this type of intervention if it was done well and we used some of the strategies we have discussed? What types of market segments would benefit most and why? Which market segments would benefit least and why?
- What do you see as the key barriers that would have to be overcome to successfully implement this intervention? And what would you suggest be done to help overcome these implementation barriers?
- What techniques would you use to market and promote this initiative? How would you incorporate it into or coordinate it with other programs services now offered?
- Who are the key market actors and stakeholders that would support this initiative and serve as development allies? Who are the key market actors and stakeholders that would resist this initiative in California and why would they resist? What can be done to overcome this resistance and how effective would this effort be?
- If this initiative was successfully designed and launched statewide, what do you think would be the level of interest and participation from the target market(s)?
- In your opinion, what would be an appropriate annual budget for this initiative to cover the upfront planning and development efforts and also the annual implementation costs? What is the budget range that would be needed for this initiative?

The selected participants were recruited, and the panel discussions were held by teleconference to minimize costs and inconvenience to the panel participants. The panel discussions were guided by a topic protocol and were facilitated by staff from RLW Analytics so that the sessions stayed on subject and provided needed perspectives. A sample interview guide is shown in Appendix B.

Panel Attendees

Home Evaluation Expert Panel, February 9, 2005

Jay Luboff, formerly of California Public Utilities Commission, was targeted as having extensive knowledge of the public policy surrounding inspectors and raters and related strategies.

Tom Conlon, of GeoPraxis, was targeted as having extensive knowledge of a program where home inspectors were trained to collect information on home energy efficiency.

Charles Segerstrom, director of the PG&E Stockton Training Center, was targeting as having extensive knowledge in all the residential areas and training for nonresidential market actors. Charles attended the Home Evaluation, Information to All Homeowners, Multifamily and Low-Income, Residential Time of Sale, and Nonresidential Training and Certification panels.

Information to All Homeowners Expert Panel, February 22, 2005

Charles Segerstrom, director of the PG&E Stockton Training Center, was targeting as having extensive knowledge in all the residential areas and training for nonresidential market actors. Charles attended the Home Evaluation, Information to All Homeowners, Multifamily and Low-Income, Residential Time of Sale, and Nonresidential Training and Certification panels.

Wally McGuire, director of Flex Your Power, was targeted as having extensive knowledge of marketing campaigns and distribution of energy efficiency information to the public.

Lynn Fryer Stein, of Primen/EPRI Solutions, was targeted for her involvement in developing online tools for customers regarding energy efficiency.

Mark Martinez, program manager for Southern California Edison, was targeted as having extensive knowledge of IOU information systems and billing strategies.

Mike Messenger, of Energy Commission, was targeted as having extensive knowledge of providing more useful information to homeowners.

Harvey Michaels, of Nexus Energy Software, was targeted as having extensive knowledge of online audits and developing online tools for household benchmarking.

Bob Knight, president of Bevilacqua-Knight Inc. (BKI), was targeted as having extensive knowledge of third party program management and use of information systems.

Residential Time of Sale Expert Panel, February 23, 2005

Charles Segerstrom, director of the PG&E Stockton Training Center, was targeting as having extensive knowledge in all the residential areas and training for nonresidential market actors. Charles attended the Home Evaluation, Information to All Homeowners, Multifamily and Low-Income, Residential Time of Sale, and Nonresidential Training and Certification panels.

Neal DeSnoo, Energy Officer for the City of Berkeley, was targeted as having extensive knowledge of some of the most aggressive local energy ordinances in the state of California.

Mike Hodgson, California Building Industry Association, was targeted as having extensive knowledge of the home building industry.

Wayne Waite, Regional Energy Director for Housing and Urban Development, was targeted as having extensive knowledge of federal energy efficient loan requirements.

Stanley Wieg, of California Association of Realtors, was targeted to represent the real estate industry which has the most influence on home sales.

Paul Jacobs, Appraiser Trainer for Enterprise for Economic Excellence, was targeted to represent the appraisal industry which has control over attributing monetary value to energy efficiency improvements in homes.

Roy Newman and Buzz Howard, loan trainers for Mortgage Training Services, were targeted to represent the lending and underwriting communities. They also possess extensive knowledge of Energy Efficient Mortgage products.

Multifamily and Low-Income Expert Panel, February 23, 2005

Charles Segerstrom, director of the PG&E Stockton Training Center, was targeting as having extensive knowledge in all the residential areas and training for nonresidential market actors. Charles attended the Home Evaluation, Information to All Homeowners, Multifamily and Low-Income, Residential Time of Sale, and Nonresidential Training and Certification panels.

Nehemiah Stone, program manager for H-M-G Affordable Comfort Program, was targeted as having extensive knowledge of several multifamily and low income programs as well as the interaction between state agencies, IOU's, and third party programs.

Wayne Waite, Regional Energy Director for Housing and Urban Development, was targeted to represent government agencies on the national and state level. HUD is the largest and most powerful agency at the national level that operates in the low-income arena.

Doug Shoemaker, Non-Profit Housing Association of Northern California (NPH), was targeted to represent the multifamily and low –income non-profit organizations, developers, and asset managers.

Bill Pavao, Deputy Director of Community Affairs for California Housing and Community Development, was targeted to represent the state housing development agency.

Linn Warren, Director of Multifamily Programs for California Housing Finance Authority, was targeted to represent the state housing finance agency.

Nonresidential Training and Certification Expert Panel, February 24, 2005

Charles Segerstrom, director of the PG&E Stockton Training Center, was targeting as having extensive knowledge in all the residential areas and training for nonresidential market actors. Charles attended the Home Evaluation, Information to All Homeowners, Multifamily and Low-Income, Residential Time of Sale, and Nonresidential Training and Certification panels.

Rex Boynton, president of North American Technical Excellence (NATE), was targeted to represent the largest and most successful program for testing and certifying air conditioning contractors.

Kara Castenada, executive director of California Air Conditioning Contractors Association (ACCA), was targeted to represent the contracting community.

Phil Haves, scientist at Lawrence Berkeley National Laboratory (LBNL), was targeted for his involvement with a current National Science Foundation (NSF) project to develop training software for aspiring building operators who attend Oakland area community colleges. The software is similar to a 'flight simulator' for buildings.

Roger Ebbage, instructor at Lane Community College, was targeted for his work as a vocational educator.

Technical Issues of Benchmarking Expert Panel, March 2, 2005

Gene Rodrigues, director of Energy Efficiency for Southern California Edison, was targeted as having extensive knowledge of IOU benchmarking and targeting efforts and to represent IOU's involvement in any statewide effort.

Mary Ann Piette, scientist at Lawrence Berkeley National Laboratory (LBNL), was targeted as having extensive knowledge on benchmark tool development and for involvement in the Public Interest Energy Research (PIER) benchmarking effort.

Martha Brooks, Energy Commission, was targeted as having extensive knowledge of current benchmarking efforts.

Darryl Mills, Energy Commission, was targeted as having extensive knowledge of current benchmarking efforts.

Al Garcia, Energy Commission, was targeted as having extensive knowledge of current benchmarking efforts.

Use of Benchmarking Expert Panel, March 8, 2005

David Goldstein, of Natural Resources Defense Council, was targeted as having extensive knowledge of current benchmarking efforts.

Barry Abramson, of Servidyne, was targeted to represent third party auditors and benchmarking tool developers.

Bob Accomando, of Arden Realty, was targeted to represent tenant occupied commercial buildings and for the particular benchmarking and auditing practices performed within their buildings.

Shelly Levin Billik, vice president of Environmental Initiatives for Warner Brothers, was targeted to represent owner occupied commercial buildings.

Al Garcia, Energy Commission, was targeted as having extensive knowledge of current benchmarking efforts.

Key Findings from Expert Panel Discussions

Home Evaluation Expert Panel

This panel examined the role of home energy evaluation in the residential single-family home sales process. We discussed a three-tier process, where greater levels of detail are brought into the process according to the desires of the homebuyer and the efficiency opportunities present in the home. The first step in the process involves expanding the current home inspection process to include an energy component. Homes with significant energy savings opportunities where the homebuyer would like to finance these opportunities through an energy-improvement mortgage or energy efficient financing option are referred to a home energy rater. Homebuyers desiring more comprehensive analysis of their home, including diagnostic testing that can measure energy losses and identify health, safety, indoor air quality and comfort issues would be referred to a home improvement contractor providing these services.

1. Current market operation: The market currently supports home inspectors and currently supports contractors who actually do installations, and in some cases, perhaps, some diagnostic testing, but there is very little sustainable market support for the home energy rating with detailed analysis, outside of new construction.

2. Proposed role of home inspectors: Inspectors are capable of performing initial ”triage” energy evaluations and are generally accepted by the real estate community. Visual indicators and age of equipment could be the trigger for further diagnostics. The home inspector enters the time of sale transaction later in the process than the real estate agent and lender. Those actors feel there does not need to be a separation between the home energy rating and the initial energy audit. The mortgage lender would prefer to see those two activities merged in because they simply get the screening and the rating information earlier in the process. There would be demand for energy inspections from consumers and real estate agents who wish to differentiate themselves from others especially as interest rates go up and there is increased competition in the market.

3. Increased market actor awareness of energy efficiency: Home inspectors, lenders, appraisers, and especially realtors are key market actors. The appraiser is the field representative of the lender and the lender in essence works for the realtor. Education is required to mitigate negative perception of ratings and energy efficient mortgages by realtors. The implementation should be voluntary and encourage real estate agents and inspectors to go to training and demonstrate that it can work. Once there is a ground swell of positive case studies it would then move into a second phase which would be regulation mandating ratings at a time of sale. A well presented business model is necessary to get real estate participation and coordination with trade associations is critical.

4. Initial implementation strategy: The implementation strategy could begin with some sort of a pilot effort. The first step in the pilot would focus on realtor-targeted training to increase the awareness level in the targeted population. The training would need to focus on convincing market actors that the efforts will not slow down

or in any way affect the success of a transaction and could build competitive advantage. In addition, there may be some benefit in coordinating the effort with some sort of a direct install effort to take advantage of the on-site nature of the assessment. The second pilot program (already underway in the bay area) is to overhaul the Residential Energy Conservation Ordinances (RECO) in a way that complements an awareness campaign. Positive case studies could come out of these two pilots that will likely set the stage for the longer-term vision. The third component of the pilot would be working with the secondary mortgage market to integrate service demand from the lending community for this type of initiative.

5. Long term implementation strategy: The long term regulatory implementation strategy could follow the recent Green Building Initiative (GBI). The governor could create a task force and invite people to join in order to add high-level visibility and support. The Energy Commission could lay out a clear set of operational guidelines to support the development of the home evaluation initiative. This effort will require a leader to create subgroups and subcommittees to consider design or operational options. The governor could consider an executive order that affects the Department of Real Estate in regard to realtor education requirements and the California Housing Finance Authority in regard to promoting energy efficient mortgages and financing. These organizations process a large volume of loans each year, constituting a secondary market in which the Governor's office has some level of influence. The banks over which the state has some influence, that are in some way involved with financing mortgages should be brought in as allies to help move the initiative in the market.

Information to All Homeowners Expert Panel

This panel examined interventions that broadly provide information that will motivate improvements in energy efficiency to all residential households into the general residential housing market, with the objective of providing information. The overall concept is to manage the population of residential buildings as a "fleet" of constantly improving efficiency. The potential elements of an overall strategy include: 1) Targeting market interventions at buildings that have the greatest potential for energy savings. 2) Focusing attention on providing strong feedback information on customer energy bills that will allow customers to compare their recent energy use to other like customers (e.g., size of house, neighborhood) and to their previous usage patterns 3) Home energy audits that would be provided online in an effective format that would provide immediate information at the customer's first "hit" on the site, but also would allow the customer to delve deeper to further explore their energy use patterns and options for saving energy. 4) Customers would receive marketing materials such as through bill stuffers and Flex-Your-Power media campaigns.

1. Current market operation: Information programs are now viewed as overhead and no energy savings are applied to them such that they are seen as low performers. These programs have not been effectively evaluated to get at the impacts of these services. Utilities are invested in their bill processing approaches with millions of dollars in investments and would have to outsource billing to get innovative billing and information to customers. The utilities may not be in the

position to provide these services without large investments in interactive systems. Utilities have very low levels of on-line billing, but they push on-line billing because it saves the utility money. It is more efficient and more profitable for the utilities since they gain the float dollars using e-payments.

2. Targeting strategies: The data from approximately 2 million home energy audits performed in the past could be mined and used more effectively. This data could be used by aggregating it at the census or block level to get a good targeting picture. The audit data often has vintage data for appliances and the older homes that have older systems are a good place to start; 40 year old homes often have 40 year old systems in them that are great targets. Change of utility service is a trigger point that could be used to target programs and services. Questions could be asked of customers when they are setting up an account about the home and the age of the equipment. The information gathered during the sign-up process could then be used to target programs. The inspectors and realtors often know the sales points of the home and an old piece of equipment is not used as a sales point. That old unit can be identified as a targeting point that the customer can share with the utility when new accounts are set up.

3. Elements of an online audit: 1) Bill disaggregation, i.e. energy cost by appliance or by end-use 2) Benchmarks 3) Disclosure of options for efficiency measures and other rates where available. It takes about a dozen questions to get enough information for a baseline calculation in the audit. Not all customers require very specific calculations, but there needs to be a short fast approach and a different approach for the detailed analysis for those who want it. The real value is the screening value to get people who are eligible for programs and then they can sign up for a program electronically. For example, a homeowner with an old air conditioner can click and enroll in the HVAC tune-up program or click and sign up for the rebate program for high efficiency AC units. On-line audit programs are a leader to get an on-site inspection where more detailed measures can be identified. This is a cheap, effective, screening process that allows contact with people who need these services. The online-audit could be used as a utility screening tool internally and a service to the customer externally. In Massachusetts the web and phone based audits are used as screening for on-site services so that the online-audits will provide leads to the on-site efforts to identify where a house visit can be cost effective.

4. Bill formatting: There may be a need for research on bill formation allowing people to configure their bills to focus on things like energy efficiency potential or climate change issues. There is a need to limit distributing customer contact information to everyone so that customers are not contacted by several marketing people selling new equipment or insulation, etc. The utilities could help notify customers and then invite them to respond or to take actions. When utilities send information to customers they often have an opt-out option from utility mailings, but the opt-out rate is only a couple of percent. There could be programs that do weather normalized analysis at the individual customer level and provide customers with detailed information on what they are consuming compared to what they can be consuming ideally.

5. Marketing campaigns: Look at the campaign and not at the individual components. Flex your power educates children and green school programs focus on children as do other programs and they may be at risk if the impacts cannot be proven. These programs are valuable, but very hard to evaluate except by anecdotal evidence. We ca not rely on any one or two or three things, you have to do what you can to raise awareness and make sure the ease of response if there. Make it very easy in many ways to get people into these services. It is hard to get people to go look at this, but we need to keep trying and making it simple to do so.

6. Long term strategy: Need to think of things in terms of web communities in the future. And look at this as more than just an audit approach, or a screening approach, but look at it from a more diversified web communities approach to dealing with the business needs as well as the energy efficiency needs. The web may be a key in future programs, we need to open the door to consumers in anyway we can if we are to meet the energy goals of the state. E-mail and web are becoming the standard approach for offering and providing services. We used to never use the web, now we use the web every time we need some information. It is becoming the standard very quickly.

Residential Time of Sale Expert Panel

This panel examined opportunities around the residential time of sale event for bringing together efficiency opportunity information, efficiency program participation information and financing options in a way that removes barriers to efficiency improvements without impeding the real estate sales transaction process. The panel discussed a coordinated suite of market interventions which include the following: 1) Home Inspections that routinely include energy inspections. 2) At the request of the buyer, a home energy rating can be performed if the energy inspection indicates the potential for cost effective energy efficient upgrades to the current features. The home energy rating provides the information required to obtain an energy improvement mortgage (EIM). 3) Disclosure of the available efficiency programs applicable to the property should be disclosed to the homebuyer (AB 1574 required home inspectors to provide this type of information). 4) Information on demand response program options and rates will be presented when a new electric service account is opened. 5) Training on energy efficiency features and the value of an efficient home should be provided to realtors and appraisers participating in the residential sales transaction process.

1. Current market operation: The newer, higher priced homes tend to have all the energy efficient technologies in them, whereas the entry level homes which are more likely to fall to foreclosure have the least number of energy efficient components. Home inspections, termite, and structural inspections impact the listing and marketing of any property and affect the sale, timing, and price. Typically the selling broker orders the home inspections and they request it as part of their offer. A home inspection is ordered prior to the appraisal because it gives the buyer a list of things to negotiate on the price and then typically they go to their lender after that. Loan officers can be fairly influential at point of sale as they are normally involved right up front in the pre approval process and once the loan application begins there

is increased interaction. Jumbo lenders that are making loans above the Fanny Mae and Freddie Mac limits need to be included in any initiative and they would do EIMs working along with Fanny Mae guidelines. Most of the guidelines from FHA, VA, Fanny Mae, and Freddie Mac put the decision making power with the underwriter and they must use whatever information they can from professionals. This information could be in regards to energy efficiency if it shows the cost effectiveness, is the cost of the extra monthly payment going to be out run by the savings in energy. Appraisers, realtors, and lenders licensed through the Department of Real Estate (DRE) are required to take continuing education every 4 years.

2. Home inspection and energy rating: A home energy rating at the time of home inspection without diagnostic testing is favorable to market actors. In the original design of HERS, stability over time was sacred. It is an opportunity with phase 2 of California regulations for the state to set its own reference based on title 24 and for California to enact stability over time as a way to address that particular issue.

3. Proposed informational approach: In other states they are now requiring some kind of rating that is recorded and passes along any time a house is re-sold. When a house is sold it could be rated and the rating could be recorded with title. This provides information to the actual potential purchaser and arms them if they would like to make a house more energy efficient in the future because they are aware of the current status. The information approach includes a requirement that homes get rated. A required rating is more favorable to market actors than a requirement to install measures at time of sale. A properly regulated rating provider or neutral entity, such as an IOU, could maintain the rating database and provide information to appraisers and lenders. Rating information could be automatically downloaded into the real estate multi-listing service (MLS).

4. Market actors' utilization of information: The realtor or the seller would have to disclose mandatory energy efficiency ratings because that would become a material fact in the transaction. Also, the realtors would build that information into their marketing package. The retrofitted home would have a market advantage over the non-retrofitted home and the lower scoring home would then be vulnerable to price competition, which would be reflected in the market pricing. Energy ratings would undoubtedly be disclosed and it would be a point of negotiation. Appraisers in general would accept that sort of information and incorporate it into the appraisal process, particularly if it were recognized by realtors.

5. Market the benefits of the EIM to consumers and lenders: In California, there is an affordability factor and borrowers that cannot afford high payments are looking for creative financing, such as interest only loans and adjustable rate mortgage to create an initial low monthly payment. The selling point is that the EIM will reduce your utility bill and factor right in with the affordability factor. Any lender looking at a home project looks to the expenses and if they are lower because of energy efficiency then it is more likely that there will not be a default on loan. Lenders are driven much more by the secondary market than they are by the front end kinds of inquiries in the transaction. If Fanny Mae or one of the Equities require that some significant portion of a lender's portfolio include EIM or will increase your yield a little

bit on the EIM, then that would drive a tremendous amount of activity that we can never reach from the escrow side of it.

Low Income Multifamily Expert Panel

The following acronyms apply to the Low Income Multifamily expert panel discussion:

Cal HFA	California Housing and Finance Association
HUD	Housing and Urban Development
CTCAC	California Tax Credit Allocation Committee
CDLAC	California Debt Limit Allocation Committee
HCD	California Housing and Community Development
AHMA	Affordable Housing Management Association
QAP	Qualified Allocation Plan

This panel examined a series of intervention strategies intended to improve the energy efficiency and affordability of existing multifamily and low income housing in California. The interventions attempt to work with existing policies, procedures and business practices to the maximum extent possible. The following elements are envisioned for a coordinated strategy for multifamily and low-income housing: 1) Subsidized housing tax regulatory process is key lever. Requirements for improving energy efficiency as a condition of participation in these programs may be appropriate. 2) Property rehabilitation is key trigger event. 3) Whole building diagnostic testing. 4) Gap financing products are available for financing housing rehabilitation and other improvements required for program participation. These products can potentially be adapted to finance energy efficiency improvements. 5) Subsidized housing units that participate in federal and state housing programs are generally inspected on an annual basis. These inspections provide an opportunity to identify energy efficiency upgrades and provide referrals to existing energy efficiency programs. 6) Tie HVAC diagnostics into annual inspection process. 7) Property managers are in a position to make many day-to-day decisions that affect energy efficiency of the properties they manage. Education and training programs targeted at property managers may help improve the efficiency of their properties.

1. Current Market Operation: Typically a multifamily housing developer is applying to HCD, CTCAC, Cal HFA, probably a local funding source, a private bank, and possibly other sources for millions of dollars. Resources for affordable housing developers include the tax exempt bonds of which Cal HFA is one of the main providers, the CTCAC, and the multifamily housing program which HCD administers. Nearly every type of affordable housing goes through one of those agencies if not multiple ones. In almost all cases developers use both the tax-exempt bonds from CDLAC and the tax credit areas financings to preserve the project. In affordable housing projects, tax credits are probably involved in close to 80 percent. Property managers are often the people that are aware if machinery is being kept up and operated at the way for its ideal energy efficiency. Many of the nonprofits have an

asset manager making capital improvements and investments decisions in the property. AHMA, which is primarily section 8 projects and is made up largely of for-profits, is a very large and well-organized trade association made up primarily of asset managers. The major trade associations for the nonprofits are: NPH the Northern California trade association with 600 members, the Southern California trade association with 600 members, San Diego Housing Federation, the Southern California Association for Nonprofit Housing, and the California Coalition for Rural Housing. Not all members are developers, but all of these organizations relate to only three or four state housing agencies.

2. Targets: A) Target ”preservation projects", preservation of the housing as affordable, in California. Many of these projects go through Cal HFA is one of the main agencies that to receive tax exempt bond financing, as part of the refinancing of these projects when they are using a contract with HUD for section 8, or some other HUD based financing. The California housing partnership program, the state associated nonprofit, does work on restructuring preservation projects. The proposed process would identify the list of preservation projects that are most likely to be experiencing major recapitalization, not minor recapitalization, as part of a buyout of an original investor. B) Target state agencies as arbiters of energy efficiency information. The state housing agencies could be facilitators to get funneled information to developers in a reasonably clear fashion. The agencies could also facilitate education for developers in this area. For the most part non-profits are looking to the state housing agencies for information and not either the Energy Commission or an IOU.

3. Energy ratings: Programs could make money available for the HERS rater and for energy consultants as well. HERS costs roughly $75 per unit and for the larger projects the unit cost goes down but does not diminish. There could be a cap at $6,000 per project for the HERS rater, and $5,000 per project for the energy consultant. The effort could fill out all the forms for a developer, arrange for the HERS rater, arrange to get them an energy consultant, and even advise them on equipment choices. Therefore it adds very little, proportionally almost nothing, to the project manager’s time. HERS rating costs could be at least partially, if not wholly subsidized initially, until there are enough people understanding the value of the HERS rater. A logical thing to do could be to have a HERS rater’s costs be something that is included with money that is already coming down from the state. Cal HFA has a predevelopment loan program, which includes preconstruction and sometimes even pre-acquisition kinds of expenditures, that could include HERS as an eligible cost in that program. Another option could be to make the cost a reimbursement for successful projects; when a loan is closed with Cal HFA it is folded in without requiring a separate application for predevelopment. There is a need to make HERS rating a simple, over-the-counter product: a developer could send in a request and a HERS rater comes to their site.

4. Long term strategy: There could be a hard linkage between the Cal HFA, CDLAC, and CTCAC funds and available funds for energy upgrades that sponsors would avail themselves to. It would need to be a fairly straightforward and easy process to access those funds as part of their normal application for the other

funding sources. A cost effective approach could be to make information systems available to the property managers and train them on how to use the system. They could get real-time information on how their properties operate, where the biggest energy users are, and how the energy use of one property compares to another property. If those that are managing these properties have these systems that are based on quality data, and that tells them how their properties are working, they will see the market reason in energy efficiency. It could be a requirement that properties get a HERS rating to be eligible for funding of energy efficient improvements. Developers and managers would be willing to have some new requirements provided that they were tapped into a cost-effective and centralized strategy. These are rehab projects in the $5 to $10 million range with an average of $25,000 per unit. If at the point of refinance they were required to get a HERS rating for that refinancing they may find that if they borrowed another $120,000 for the project to make energy efficiency upgrades, then, not only would the project be more valuable, but then they would get a better interest rate.

Training and Certification Expert Panel

This panel examined the role of training and skills certification of particular market actors associated with some of the intervention strategies contemplated for the AB 549 project. The targeted market actors are HVAC service technicians and mechanical contractors, building operators, property managers. One of the strategies under consideration in this project is to provide grants to training organizations and community colleges to address energy efficiency issues within traditional training programs or provide specialized training in energy efficiency issues.

1. Current market operation: There is a significant skilled labor shortage in our industry. There are between 15,000 & 20,000 openings every year, that is anticipated growth in the employment base in the HVACR industry. Contractors are racing around trying to handle installations and do service work who are not committed at this point and they see no direct reason to stop what they're doing and get their guys certified. Vocational school graduates that are armed with enough knowledge, the ACCA manual as an example, to go out and build on that knowledge in the field are then told 'you better set all those training manuals aside because we have got to make some money here and here is how you can do that.' If the marketplace reinforces behaviors that are contrary to what is happening in schools, if the quality installation does not become the norm, if the contractors who practice it are not differentiated from others, then it does not create the right environment for properly trained people to practice their skills. Many people repairing and replacing HVAC equipment every day, working under their grandfather's contractor's license. The level of scrutiny and certification has not been raised on this group to where it could be. Just because somebody has 20 years experience turning a wrench does not mean they are doing things the right way. An industry that on an average has a 2 percent profit margin. AC contracting is quite seasonal and one of the programmatic aspects is trying to build planned maintenance type of programs for the shoulder months of activity as a way to try to sell quality installation work.

2. Issues affecting contractor certification: There is anxiety in taking an exam as the typical NATE certified technician is a little bit younger than the journeyman technician you see in the field. There are some fears associated with that which is why they are strongly encouraged to go through some test preparation, some kind of review courses. Controls contractors particularly, they were having great difficulty finding suitably trained, qualified, educated people to hire for their businesses. California Department of General Services held a Controls Procurement workshop that was focused on how to procure controls and get controls into buildings that actually work and do what you expect them to do, yet the need for training and the issues around training kept coming up all the time."

3. Vocational education programs Due to a property tax limitation measure where dollars stopped coming into the public service organizations, like community colleges, Lane Community College in Eugene, OR no longer has a degree for HVAC service technicians. A good HVAC lab takes a lot of floor space, it takes a lot of equipment, it takes a lot of support, a lot of dollar support and colleges do not always get that dollar support through state and tuition reimbursement. If you compare the cost of a math class or English class to the cost of doing HVAC service technician program and the dollars are absolutely night and day". "California Community College system with 108 campuses, 20 of them that have what could be called active HVAC vocational education programs, of those, there were really only about half of a dozen that had any viability at all. Department of Labor, the Department of Education, when they release this statistical data the demand for skilled labor is going through the ceiling and yet the enrollment in what we now call applied technology programs, is dropping precipitously. The state of vocational education and training in the California community college system is dismal and I know that the Governor has begun to address this Community colleges have turned their back on vocational education so significantly that they think their role is to prepare kids for 4 year degrees, well 4 year degrees do not always land nice middle class jobs like the HVAC world can With all professional technical programs, Industry has to come to the table. Union participation in community college programs is high; unions can mean very big dollars. Well, Industry could do that as well."

4. Field verification of installations could be required Make field verification of proper installation of HVAC systems a requirement. Continuing education credit units are not a bad idea. Texas was just able to win that battle If there is not such a rule that the need such continuing education, they would not do it. Realtors have much more stringent continuing education requirements than contractors do. The diagnostic testing programs that provide some sort of a paper trail or in a defensible process, need to gain stature and recognition whether it is refrigerant charge, etc. Some form of diagnostic testing and documentation, such as a number of different versions that are in the market place may be needed."

5. Near term strategies to increase number of certified technicians In 90 days, NATE is launching an HVAC energy analyst credential that will be the first senior certification, which means the candidate has to hold a NATE certification. That will be focused on things like load calculation, proper duct sizing, ceiling ventilation, and proper charging. NATE seeks to increase the awareness of an opportunity for

making all kinds of buildings, residential and non residential more efficient. PG&E regularly offer a training class for technicians as a way to prepare for the NATE exam and follow up that preparatory session with an on line computer based certification offering. The utility is about to roll out an incentive program for the first 500 people who participate to have the majority of their core and specialty test costs covered upon successful completion. Essentially it is a $100 incentive that covers about 2/3 of the cost of the core and specialty exam. Manufacturers have now built into their preferred dealer programs a requirement that the top dealers, contractors must have their technicians made certified. Carrier announced as of January 1, 2004 for any of their dealers to be what thy call a factory authorized dealer program, their elite program, they had to have 50 percent of their technicians NATE certified."

6. Long term strategies to increase certifications "an organization similar to the California Commissioning Collaborative, which might meet every 3 months, might be hosted by the utility money and be a way to promote communication in the area of education and training. Bring together the community college people, there is limited communication there, utility folks doing training, and then contractors and building owners and other stake holders in the industry. Contractors and owners may require some general business training to help them facilitate and be better business men, so they do not have to make unethical decisions day to day."

Technical Issues of Benchmarking Expert Panel

This panel examined the role of commercial building energy consumption benchmarking as a means to motivate improvements in energy efficiency. Benchmarking involves placing comparative energy consumption information into the nonresidential market in a way that building owners and operators can easily see how their buildings perform relative to historic consumption patterns as well as to other similar buildings in similar weather and use markets. Benchmarking is viewed as the initial step in a comprehensive efficiency upgrade program. Follow-on steps include retro-commissioning of building HVAC systems and controls and retrofit of inefficient systems with more efficient technology. Benchmarking is a key element of the Governor's Green Building Initiative. This panel examined several technical issues associated with the development and deployment of commercial building benchmarking systems.

1) The benchmarking tool would be designed to have multiple levels of increasing detail so that both the simplest benchmarking and potentially more meaningful comparisons could be done (drilling down) and a tool that provides more meaningful metrics may be important. 2) An issue with benchmarking buildings, in terms of a total energy consumption metric, is separating efficient operation and energy efficiency features. 3) Ideally, a benchmarking tool would motivate further investigation into what may be cost effective for the individual building. That further investigation could be either retro-commissioning focused on identifying and correcting operational problems or an energy audit focused on identifying cost effective capital improvements to the building's energy efficiency features. 4) In conjunction with benchmarking, the user of the benchmarking tool should be provided with effective marketing information to encourage further investigation and

action to achieve energy efficiency in the building. 5) The benchmarking tool should be designed to encourage repeated uses of the tool to track the progress of improvement in the energy efficiency of the building.

1. Current market operation: Existing commercial building benchmarking systems include the EPA Energy Star benchmarking system and the LBNL CalArch California Building Energy Reference Tool. Both of these systems use a web interface and compare the energy consumption data of one's building to a database of building consumption data for a large number of other existing buildings. The EPA tool uses the federal Commercial Building Energy Consumption Survey (CBECS) data, while the current CalArch tool uses data from the Commercial Building End Use Survey (CEUS) that is specific to California buildings. The CEUS data was first collected in the early 1990's and is updated periodically – a current survey is now in the process of being conducted with building data being available for use by CalArch in late 2005. Development of the CalArch tool was funded by the Energy Commission's PIER program.

2. Layered approach with a simple tool as a first step: LBNL's white paper on building energy benchmarking suggests a layered approach that allows the knowledgeable user to view more detailed, specific information in a benchmarking first step, while also containing the level of effort required by the average user. It would also provide a point in the right direction for what the average user should do next. Simple benchmarking is the starting point for customers and can get people into the system and the approach. In general this is an awareness creation tool and an entry for people beginning to explore what energy efficiency opportunities are available in their building. In general, the more technically complex the tool is made to increase accuracy the less the participation will be from the average user. At least initially, it would be best that a majority of the market get exposed to this whole concept as a starting point to move on. Targeting specific types of buildings as audiences for benchmarking tools could be another possible layer."

3. Periodic benchmarking: LBNL is working to normalize weather data to an average year, so that when comparing energy use from year to year, it is done in a weather-normalized way. Periodic benchmarking could also be viewed as "base lining", comparing a benchmark score to some baseline year to determine if energy use is going up or down. One of the advantages of benchmarking on a periodic basis, particularly if the information is on a utility bill, is that the customer, every month, could get feedback on the energy impact of changes in equipment or operation practices. In addition this type of benchmarking could spur the user on to the next set of activities, including audits, retro-commissioning, and retrofits.

4. Actionable information: Users could receive information on: where they rate relative to their peer group, whatever that peer group might be, and some sort of energy consumption or cost intensity index on a square footage basis. Essentially going to the next level past benchmarking is really feeding into the existing program, as much as possible. The marketing message that accompanies benchmarking is an important feature that could influence the participation and response rate. Benchmarking information should be structured in such a way that it harnesses all of the potential program areas that customers can participate in. It could present the

programs in the best light possible and let the customer decide using some sort of easy follow-on mechanisms, such as web sites or telephone numbers, to take the next action step.

5. Leads to audits and retro-commissioning: There is currently a push to standardize retro commissioning and commissioning as a measure that produces energy savings. These are savings that could be garnered from either operating a building in an efficient fashion or ceasing an action that defeats already installed energy efficient hardware. A potential strategy builds on the benchmarking tool that is currently under development for the European Union for Kyoto CO2 tracking that presents two paths simultaneously. These action paths are A) presenting the low cost, no cost recommendations for particular building systems based on the kinds of retro commissioning areas that people typically look at in that type of building. B) It similarly presents retrofit options for particular building systems and building types. The tool would not attempt to choose the retro-commissioning or retrofit measures but could provide cost effectiveness information.

6. Long term strategy: Integrating benchmarking with existing tools: Customers who use Energy Manager, the Bill Manager suite of tools, or an IOU specific tool are customers who choose to keep track of their energy consumption and demonstrate an interest in knowing enough so that they can take some action to help manage their bill. The home energy saver, which is a national web-based energy analysis tool, tracks their users and asks them questions all the time; though this is a voluntary option and not viewed by all customers. It would be a complicated set of requirements for the utility bill to start normalizing for weather and other factors in each customer's individual bill. However hooking it up to tools like Energy Manager, Bill Manager could quite easily be done. A national tool, such as Home Energy Saver, has much less opportunity than a California-based tool, to link people to audit, retro-commissioning, retrofit, or other programs. The collaboration between utilities and other state programs could lead to much higher levels of activity for California. Customers are continually presented with information from utilities about either efficiency, demand response, or various options to help them manage the energy bill.

Use of Benchmarking Expert Panel

This panel examined the role of commercial building energy consumption benchmarking as a means to motivate improvements in energy efficiency. Benchmarking involves placing comparative energy consumption information into the nonresidential market in a way that building owners and operators can easily see how their buildings perform relative to historic consumption patterns as well as to other similar buildings in similar weather and use markets. Benchmarking is viewed as the initial step in a comprehensive efficiency upgrade program. Follow-on steps include retro-commissioning of building HVAC systems and controls and retrofit of inefficient systems with more efficient technology. The overall elements of the benchmarking intervention are as follows: 1) Building financing and refinancing as key trigger events at which benchmarking should occur. 2) Expectation that the utilities would take action to insure that all buildings are benchmarked. 3) It is

critically important to motivate further investigation into what may be cost effective for the individual building. That further investigation could be either retro-commissioning focused on identifying and correcting operational problems or an energy audit focused on identifying cost effective capital improvements to the building's energy efficiency features. 4) In conjunction with benchmarking, the user of the benchmarking tool should be provided with effective marketing information to encourage further investigation and action to achieve energy efficiency in the building.

1. Current market operation: For commercial office buildings, when a financing episode occurs, generally there is some kind of due diligence effort required. Due diligence studies are not required to investigate the energy use of a building as an industry standard. The purchaser of a property usually defines the due diligence requirements. The lenders require a report on the structural integrity of the building, whether ADA is conformed, and the environmental conditions at the building. There are no regulatory requirements for due diligence. For smaller size commercial buildings without a large owner, the due diligence study is very probably less likely to be done. There is a business niche for companies that actually do due diligence reports, a lot of engineering firms do it and some firms specialize in it. That market is very competitive and the due diligence report is part of the transaction costs. Even though the benchmarking is not challenging, the standard due diligence effort is not looking at that now. There is no simple to use benchmarking tool available to aid the due diligence effort.

2. Simple effective benchmarking tool: It is difficult to balance between complexity of the benchmarking tool and the value of what you get out of it. The Energy Star tool does not accurately describe the level of performance of a basic efficient building that is operated inefficiently, i.e. it might still score well on the Energy Star scale. The goal is to try to distinguish between a building that scores well because it is not heavily used versus a building that scores well because it is efficient. An enhancement to Energy Star could include further information on the potential for improvements and whether that improvement is a retrofit of hardware or a change of operations or both. The tool could also include consumption per square foot or some other factor as a benchmarking mechanism. A per square-foot guideline would probably be much more helpful and would be specific to the building type and the type of end-use. The Energy Commission or the utilities could try and set criteria for when two dollars in energy consumption per square foot is good and when is it bad. The semantics, the language that is used to talk about energy efficiency in general is important and that should be a constant priority. The benchmarking tool could be packaged and distributed in such a way such that it identifies the audience and attempts to speak to them.

3. Due-diligence requirement by lenders: Even for very large buildings the energy portion of a due-diligence report is very probably not done unless it is being done by someone that has an energy interest. They would not be reporting on the energy consumption of the building. A seller could provide a history of operating expenses, such as maintenance costs and utilities. The lending community probably

would not view an additional requirement as a barrier. Energy is not seen as an issue that is going to affect tremendously the value of the property at this point.

4. Marketing: The EPA benchmarking tool has the marketing benefit of being recognizable, which is probably why about a quarter of the buildings in California are Energy Star. A California specific benchmarking tool could be somehow associated with Energy Star, which would be especially important for organizations that have buildings in California and in other states as well. Energy Star has already been incorporated with LEED for existing buildings as well. There is a lot of value in teaming with brands such as Energy Star and Flex Your Power. To look at benchmarking as a slightly different, slightly easier to use consumer algorithm could require integrating the tool with the utility web site. The tool could also be tied to facility and trade publications, in print and on-line, such as BOMA, Building Management Magazine, and ASHRAE Journal. Tenants could receive benchmark information in newsletters or on building owners' websites. EPA-Energy Star and Flex your Power could be used for brand recognition and for their already developed web site information rather than creating a whole new site, as well as tying into the existing logo and name identification.

5. Leads to retro-commissioning and audits: One option could be some sort of an audit or "HERS rating" for commercial buildings. That would look at the technology and the efficiency measures in the building and create some basis for comparing the ideal utility bill versus the actual utility bill. This could help in motivating people to do retro commissioning. The idea could be to set up some sort of system where the owner has easy access to information about how the building should perform versus how the building is really performing. The challenge for any tool set up to have building owners or operators input building information themselves is it has to be very easy to use and has to tie into the next step, such as a retro commissioning or retrofit program. There is currently a review of the HVAC systems, as to the condition of the equipment, in building financing transactions. This process could include inspecting everything that is driving the energy of the building, as part of the due-diligence effort. A large company may do it in-house with a combination of professional engineers (PE) and building operators. For a third party it could be a combination of PE's and junior engineers. A simple walk through audit of a building including: a simple review of the mechanical system, the lighting, the hours of operation, and might be able to explain the benchmark results without undergoing a full commissioning of the building, because the commissioning process itself can be expensive. Retro-commissioning could produce significant savings in the building without spending a lot of money if there is a team internally. Most buildings do not have those resources and it is not a quick process to come in, from the outside to do that. For large buildings an option could be to train building operators to do that retro-commissioning. For smaller buildings an option could be to have a simple audit to determine if full scale retro-commissioning would be cost-effective or link the customer to a retro-commissioning program. The Energy Commission was tasked by the executive order to develop a commissioning guideline.

Residential Key Findings:

The residential single family, multifamily, and affordable housing market hold a significant opportunity for energy savings. Any single family housing market intervention strategy that applies to a time-of-sale trigger event should be coordinated with the real estate industry to achieve success. Likewise, any multifamily or affordable housing market intervention strategy that applies to a rehabilitation trigger event should be coordinated through the state housing agencies to achieve success. The remainder of the housing stock that does not apply to these trigger events should be managed as a ”fleet” of ever improving efficient housing.

The intervention strategy to best improve efficiency while working with current public goods programs would be an energy rating requirement. The rating process would initially be a rating without diagnostics, where default values are used for non-observable characteristics of a home. The rating could be a RESNET and/or lender approved model for financing purposes. An IOU or rating provider could be the depository for rating information. For single family homes at time of sale, this rating would be performed by the home inspector. For multifamily and affordable housing at time of rehabilitation or recapitalization this rating would be performed by a HERS rater whose cost would be rolled into subsidies, tax credits, or financing from the state. Homes that are not subject to these trigger events would be encouraged to go through an on-line audit process that would screen for cost effective opportunities to go further into on-site audits or whole house diagnostics. I addition, the required ratings from single family and multifamily/affordable trigger events could lead to more detailed diagnostic testing.

The goal of the intervention strategy is to effectively identify and target sites with the greatest opportunity for public goods programs to be cost effective. The strategy does not seek to replace, but to supplement current IOU and third-party programs. In addition, this approach will provide valuable information to develop household benchmarking and improve third party verification of energy saving measures.

APPENDIX D: BEHAVIORAL SCIENCE RESEARCH

The technical solutions available to improve energy efficiency of buildings have been studied extensively in the past. Available literature includes studies of common practice and emerging technologies, their performance characteristics and their energy savings potentials. To complement this knowledge about available technology, we also need to identify knowledge (and knowledge gaps) related to human energy users. This is because the role of human behavior is crucial in shaping energy flows.

For example, human choices (of building and technology characteristics), as well as human actions (management, control, use and abuse of buildings and technologies), produce both high efficiency and low efficiency outcomes. Present energy use is determined by past choices and actions. Any alterations in future use will depend both on hardware innovations and new choices and actions taken by human energy users.

The AB549 relevant social science literature can be classified in terms of how it focuses ("where" it focuses) on the energy use behavior problem. In general, the literature can be placed in the following categories of research focus:

- Psychological states: what attitudes impact their behavior?
- Choice: how are choices made?
- Information delivery: how does information impact the behavior?
- Concrete behavior of persons and groups: action that could consume and save energy (e.g., studies of patterns and causes of consumption, studies of conservation and efficiency choice).
- Demand: How do suppliers and consumers create demand together? How do market systems work? (e.g., actor-network studies)
- Peak load and demand response: effects of rates and electricity system emergency warnings (mostly residential)
- Nonresidential/business/government decision-making and action

In the following, all of these topic areas were considered. In some cases the existence of relevant references and literature is identified. In others, key insights from work in those areas most useful to the AB549 process are provided. Important review articles have been helpful in sorting out key findings and identifying significant studies (e.g., Stern and Aronson 1983, Coltrane et al. 1986, Katzev 1987, Rosa et al. 1988, Stern 1992, Lutzenhiser 1993, Shove et al. 1998, Wilhite et al. 2001, Lutzenhiser et al. 2001).

Individual Level: Importance of Consciousness & Knowledge

- Energy flows are largely invisible. They are difficult to detect and operate outside of view, produced and distributed at a distance and purposely hidden from everyday notice. As a result, energy is taken-for-granted, overlooked, and ignored. Energy operates outside of normal consciousness (Kempton 1982, Lutzenhiser 2002, Shove 2000).
- At the individual level, consciousness or awareness that energy might even be a problem is an important first step. Awareness of energy problems and conservation or efficiency possibilities is quite limited under normal circumstances (crises are exceptions). There have been periodic rising and declining levels of awareness of and interest in energy and energy problems over the past several decades. The most recent review of polling data is now fairly dated (Farhar et al. 1980; Farhar 1993).
- Even when awareness levels are elevated, there is a variability in belief in the importance of energy, energy problems, and even energy crises (Farhar 1991; Lutzenhiser et al. 2003)
- Personalization or ownership of energy problems (personal responsibility), as well as a sense of efficacy (ability to affect change as a result of individual action) also varies across the population. Persons have to believe that they can actually make a change that will make a difference somewhere (either in their lives or for the benefit of others). This is also variable from time to time, place to place, and within different social groups (e.g., lifecycle stages). (Gecas 1989, Peters and Feldman 2001, Woods 2004, Geller 2002)
- Concern is a pre-condition for action (Lutzenhiser 2002). Motivation to act is strongest when individuals are aware that there is a problem, if they feel some ownership of the problem [i.e., if a person judges himself or herself personally responsible for the positive or negative outcome of the problem (Stern, Dietz, and Black 1986)], and if they have a sense of efficacy (i.e., belief that their efforts will make a difference). Individuals have varying degrees of concern — they may be aware that there is a problem but do not feel responsible for the problem or they may not believe that changes in their behavior will make a difference. Understanding these variations in concern can bring insights into why individuals choose different courses of action (or non-action).
- Although concern is a necessary condition of action, it is not sufficient to bring about behavioral change. The ability or capacity to act is also an important pre-condition for conservation. (Lutzenhiser 2002)
- Knowledge—regarding what one might do about energy problems (or opportunities) and how to go about doing it—is an important capacity dimension. Capacity to act depends on the individual's knowledge of technologies, energy prices, program options, and links of energy use to their own behavior. It has been easy for energy analysts to believe that persons (consumers, organizational

managers) are well informed and possess appropriate technical expertise. In economic analysis, “perfect information” is ordinarily assumed. However, the consumer’s level of knowledge about energy efficiency technologies and opportunities is generally limited.

- Low levels of understanding of something generated at a distance, hidden in walls and buried in technical systems also means a generally limited technical capacity to analyze problems and compare solutions. Even persons with highly rationalistic styles can get it wrong (Kempton and Layne 1988).
- People are not completely confused, though. The literature on folk models points out cognitive systems (ways of thinking about energy) that can be fairly coherent, even if often at odds with engineering and policy models. The way energy analysts and efficiency program designers think and talk about energy can be quite different from how consumers think and assess their choices. And although their models may work according to unexpected logics, they can also produce predictions that are quite similar to those of experts (Kempton 1982).
- A classic example of folk models has to do with how persons think about thermostat operation. An argument is made in the literature that a significant number of people think of it as a valve. That the farther you turn it to the right, the more intense the response will be—i.e., the hotter or cooler the air will come out (Kempton 1986). Although incorrect, under a variety of circumstances, the model ”works” quite well (Lutzenhiser 1992).
- Anecdotal evidence indicates that this can also be true in the commercial sector, where managers may think about how buildings use energy by referring to their mental models of how their houses work (their folk models of the house) (Jacobs 2004). Another anecdote involves the furnace technician who counseled the homeowner against a high efficiency furnace because”…anytime you mix water [condensate from the flue gasses generated by high efficiency furnaces] and metal and fire, you’ve got a problem.”(Lutzenhiser 2004).
- There is little opportunity for most consumers (or private sector decision-makers) to really develop personal technical competence related to energy efficiency. This is also true of a host of other environmentally significant competencies (e.g., related to other forms of routine consumption and pollution) (Geller 2002). One purchases a furnace perhaps every ten to fifteen years, and more likely buys one with a new or remodeled house. What is more, that sort of competence actually is not needed. In modern societies, we can rely upon access to technical expertise.
- However, frequently that expertise is either not readily available or individuals have a hard time trusting it (e.g., because they have not purchased a furnace for fifteen years). Lack of experience, and low comfort and trust levels with technical experts, can vary socially—e.g., along gender and age lines, with women and both older and younger persons feeling (and actually being) more susceptible to being taken advantage of in the sales process (Lutzenhiser 2002c).

- Utility programs and government-sponsored programs can provide more credible and trusted technical information and advice than seems to be available solely from the private sector. However, an individual's awareness of programs, benefits and assistance also seems quite limited (and also likely varies across social groups). Even during the California energy crisis, when considerable public information was readily available, awareness of rebates and incentives and program participation levels were quite low (Lutzenhiser et al. 2003).

Role(s) of Information at the Individual Level

- In part, the capacity to act clearly depends on the quality of information disseminated (e.g., the message is clear and the message comes from a trusted source, etc.). According to Stern (1992), the quality of information presented is more important than the quantity. Social psychologists and marketers know that messages are more effective if they are specific, vivid and personalized (Stern 1992). However, the sources of information are also important. Individuals are more likely to take action if the information comes from trusted sources (e.g., researchers have found that information from community organizations or the county are often more trusted than from companies (Stern et al.1986; Stern 1992 and Lutzenhiser 1993).
- Providing energy feedback (e.g., from meters or bills) is an important part of the assessment process since it can increase the individual's self-efficacy. In other words, feedback can help individuals assess how the changes made a difference. Since lay-people often systematically miscalculate energy use, they also may misjudge the degree to which their efforts have reduced energy use or energy costs. If an individual is not able to assess the outcome of his/her effort accurately, there is the risk that he/she will discontinue current efforts or fail to make new efforts in the future (Farhar and Fitzpatrick 1989; Lord 1996; Payne 2000).
- Information delivery systems are also important. A wide variety of delivery vehicles are routinely used in energy efficiency programs. These may include bill "stuffers", brochures, web sites, flyers, educational events, direct outreach (e.g., to non-English-speaking population), energy education through schools, and public service announcements. There is little or no information in the social science literature on the effectiveness of these means, singly or in combination, during routine or crisis conditions, for which groups, for which messages, for which technologies or program offerings.
- There are studies in the literature that have looked at the effects of energy efficiency rates, appliance labels, and other information. The findings include that standard labels may be only minimally effective, with evidence that careful attention to the design of labels can significantly increase their impact on consumer choice (Egan 2000, CLASP 2004, Dethman et al. 2000).
- Branding (e.g., the Energy Star brand) and certification (e.g., third-party assurance of technology and energy services performance) are almost certainly

effective in securing higher levels of consumer confidence. Warrantees and guarantees also are important, given the low levels of knowledge about the particular products (furnaces, air conditioners, appliances) that are the targets of efficiency efforts. However, there is virtually no social science literature that tells us how, when and where these work, and how well.

- The California Flex Your Power campaign was likely the largest short-term social marketing effort ever undertaken. It arguably was successful in raising awareness, teaching conservation behaviors (and reinforcing known behaviors), encouraging altruistic responses from consumers and businesses alike, and linking persons with resources. Some of these effects were evidenced by consumer self-reports (Lutzenhiser et al. 2003). But the nature of the effort has yet to be fully documented. It is not clear how much of a "campaign" character a large-scale efficiency program targeted at existing buildings might require. The evidence from the social marketing literature suggests that campaigns can be effective and may be necessary under some circumstances (Stern and Dietz 2002, MacKenzie-Mohr 1999, Bender et al. 2002).
- Even after a well-run information campaign, knowledge about programs or products can vary greatly between individuals or groups. Insufficient or incomplete knowledge about, for example, where to learn about programs or how to take advantage of various programs can make conservation programs less effective than anticipated. In addition, people systematically misjudge energy use (e.g., overestimating visible energy use such as lights and appliances and underestimating less visible energy use such as water heating and furnaces) and they may not accurately recognize incentive structures that could save significant energy or money (Kempton 1987; Kempton et al. 1985; Lutzenhiser et al. 2002 and Stern 1992).
- Comprehension of information will determine the ways in which individuals assess the various conservation options available to them. Individuals assess both financial and non-financial considerations (Stern 1992)—the range of "on-energy benefits" (NEBs) with which energy efficiency planners are increasingly familiar (more about NEBs below).

Decision-making Styles and Processes

- A person's ability to evaluate or assess various program options as part of the decision-making process not only depends on adequate information and knowledge, but also on the cognitive styles and objective conditions (social, technical, and structural) faced by individuals or groups. Individuals will assess the perceived costs and benefits of participating in a program or purchasing a new appliance using both financial and non-financial considerations (Stern 1992, emphasis added). In fact, research suggests that financial incentives motivate investment by those who have made the initial commitment (e.g., have requested an energy audit) but financial incentives do little to get households to contact the program in the first place (Stern 1992). Similarly, not all technological investments will be assessed in the same way (e.g., the purchase of a front-

loading washer may seem a less viable option if one expects to relocate in a few years, since the machine might not be appropriate in a new location).

- A fair amount of research has been done related to how choices are weighed and actually made by persons (both consumers and organizational actors). It is clear that people have different kinds of metrics. For example, they may choose home improvement options that are more visible or larger (e.g., in the absence of another rule, bigger may be better). Homeowners may prefer to invest in solar, not because it's more cost-effective and efficiency, but because they can see it and other people see it. When they see it they say, "I did something here." "I did the right thing—for myself and for the environment" (Wilk and Wilhite 1984).
- Although persons may often use a dollar metric to measure energy and savings (Kempton 1982), the need for an economically rational tradeoff between energy costs and sticker price (i.e., optimal over the short or long run) may not be considered. In addition to program implementers' long experience with this in the energy case, the new field of behavioral economics is developing a significant literature about how financial choices appear to consumers and how real world, sub-optimal choices really are made (DiClemente 2003; Bender et al. 2004).
- Incomplete information and transaction costs are well known factors that lead persons to "bounded rationality" and "satisficing" — "good enough" decision-making "rules of thumb." In addition, persons are frequently presented with "choice sets" of attributes and constraints that make optimizing decision-making at best difficult, and too often impossible (Blumstein et al. 2001).
- There is a small literature on decision heuristics that considers how energy information from bills, prices, and future costs are processed by consumers and organizational decision-makers (MMI 2003; Lord 1996; Payne 2000).
- Although rebates and tax credits are commonly used energy efficiency program tools, there is little work in the social sciences that would help us understand when they are necessary, how large they need to be to trigger an action, or whether they function as much as an additional indicator of utility and government confidence (that this is a "smart thing to do") as they do as financial incentives.
- The energy efficiency policy and program evaluation work on non-energy benefits (Hall and Roth 2003) stresses the non-energy attributes of energy efficiency choice. Some of these can be striking (Heerwagen 2000, Heschong et al. 2002; Heschong et al. 2004). There is a complementary body of social science work that stresses that most energy choices are actually not energy choices at all, but ones in which energy is either an incidental or completely unconsidered aspect in the decision-making process (Shove et al. 1998; Wilhite et al. 2000; Lutzenhiser et al. 2001).

Applying Individual-Level Findings to Interventions

- Social-psychological literature can inform energy program development, focus group research and is useful for program assessment. In addition, this research

can contribute through understanding the effects of various individual beliefs, uneven knowledge of the issues, and varying comprehension of information on energy-related behavior. Furthermore, the application of social-psychological research can improve information dissemination and comprehension. Finally, assessment of how individuals make sense of financial and non-financial costs and benefits can inform program outcomes.

- Tax Credit Example: The application of social-psychological research to the analysis of potential AB549 interventions such as tax credits suggest that the intervention can only be successful if people are aware of the existence of those credits and know what to do to receive them. Hirst et al. (1986) found that less than a quarter of U.S. households claimed conservation credits when they were widely available in the mid-1980s. Similarly, Dillman et al. (1983) found that higher-income households were more likely to take advantage of tax credits than lower-income households.
- Home Energy Rating System (HERS) Example: Stern (1992) lists four conditions that increase the likelihood of success of a HERS program:
  - The program sponsor advertises it well.
  - The program offers builders marketing assistance and advertising money.
  - The program is considered credible with local consumers.
  - There is cooperation with the builders association.

  The effect of these conditions are twofold — they not only increase builders' confidence that changes to their routines will sell more homes, but they also increase consumers' confidence that they will benefit from buying a highly rated home (Stern 1992).

- The application of key social-psychological research (e.g., concern, information, knowledge and assessment) may increase greatly the likelihood that these types of programs are successful and should be considered during program planning.
- Even though only two examples of intervention priorities are listed here, social-psychological research and other social research can be applied in similar ways to other potential trigger events and intervention strategies to inform energy program development. Since social habits, preferences, status considerations and behavior patterns also affect how energy is used and influence what types of programs will be considered, lifestyle research may begin to addresses some of these issues. For example, understanding how lifestyle can affect behavior can shed light on why some programs (e.g., purchasing front-loading washers) may be less successful than expected.

Group Level: Collective Behavior and the Segmented Character of Consumption and Conservation

- Policy directed only at energy-efficiency technology (without considering variations in energy use, status distinctions, or lifestyle difference) do not result always in expected savings because they often assume that all people use technologies and consume energy in ways very similar to one another. In addition, there is often an assumption that the primary incentive for people to change behavior or adopt efficient technologies comes from financial cost-benefit calculations about their energy choices (Lutzenhiser 1993; Lutzenhiser and Gossard 2000; Stern 1986; Wilhite et al. 2000).
- However, these underlying assumptions cannot fully explain energy use patterns because household consumers – with very similar housing sizes and energy using features and equipment – have energy consumption rates that vary as much as three to one (Lutzenhiser 1992; Lutzenhiser 1993; Schipper et al. 1989; Shove et al. 1998; Socolow 1978a; Socolow 1978b; Sonderegger 1978). Furthermore, economic considerations are not necessarily the primary (or only) considerations for conservation — other motivations may be non-financial including pollution reduction or socioeconomic status displays (Stern 1992; Lutzenhiser et al. 2002).
- From a policy perspective, emphasis on financial considerations alone without consideration for how people use energy in their homes, why they participate in some programs but not others, and why they may choose one appliance over another can lead to unexpected results.
- Routine behavior consists of long-standing habits, routines, patterns of action, conscious choices, and resulting in differences in energy use and energy savings. Energy use is built into everyday life.

Households (Not Individuals) Consume Energy

- Individual decision-making does not fully explain energy use in the home. There are other intervening variables (e.g., social) that affect energy use. Therefore, models that only examine attitudes and individual decision-making are limited, especially as a policy approach (Lutzenhiser et. al 2002).
- Actually, most household consumption and all consumption in firms and organizations is done by groups of people together. They are governed by collective processes and choices.
- Energy consumption may be better understood through everyday routine habits and practices (such as comfort, cleanliness, and convenience) than negotiated by household members within a greater social context of the expectations about what makes a ”good home” (Shove and Warde 1997; Wilhite and Wilk 1987, Erickson 1997, Hackett and Lutzenhiser 1991). In other words, rather than being individual choices, energy use patterns are routine, everyday household practices are both habitual and social (social habits) (Lutzenhiser 1993).

- People are caught up in complexes of behavior that also includes their buildings, their equipment, one another, their work, and their lifestyles. They have certain kinds of patterns of occupancy and travel and energy flows that follow from those. They also hold beliefs about how they should live, the practices and habits that they enforce on one another (e.g., how many parties you should throw, how many people live in your house).
- An important aspect of these social routines, norms and expectations involves status display (e.g., what you have, what you have to have, and how big it has to be). Because everyone can not (and does not want to) practice conspicuous consumption at the same levels, the resulting patterns of behavior, technology use and consumption are highly variable across the population.

Energy Use is Highly Differentiated and Socially Segmented

- Given the discussion above, it should not be surprising that the assumption of an ”average” consumer is not supported by social science energy research. Homes with similar or identical physical characteristics (such as square footage, room configurations, and appliances) vary in their energy use to an extent that can only be explained by differences in occupant behavior (Socolow 1978a; Socolow 1978b; Sonderegger 1978).
- Sonderegger (1978) found that roughly 54 percent of the variance in energy use could be explained by obvious physical features, while the remaining 46 percent of the variance could not be explained. He concluded that “unpredictable behavior patterns of the occupants introduce a large source of uncertainty” in determining energy use (Sonderegger 1978).
- More recent research has shown that households with similar technological configurations and housing sizes vary in energy consumption as much as three to one (Hackett and Lutzenhiser 1991; Lutzenhiser 1992; Lutzenhiser 1993; Schipper et al. 1989; Shove et al. 1998).
- A number of energy researchers have used lifestyle and cultural distinctions as a way to better understand and explain variations in energy use (Erickson 1997; Gossard 2004; Lutzenhiser 1988, 1992, 1997; Lutzenhiser and Gossard 2000; Schipper et al. 1989; Uusitalo 1983).
- Research has shown that income, education, family size, number of people living in the home, number of hours that a home is occupied, size and type of dwelling, and stage of lifecycle (i.e., young singles, young families, families with teenagers, empty-nesters, and retired households all have various consumption rates that tend to increase and peak during the ”middle-years” as people accumulate more material possessions) are important indicators of household energy consumption (Newmand and Day 1975; Gladhart et al. 1986; Lutzenhiser 1988; Schipper et al. 1989; Zuiches et al. 1987).

- Comparisons among lifestyle groups demonstrate differences in aggregate energy consumption and that the factors that drive consumption (i.e., social, housing, technological) also vary (Lutzenhiser and Gossard 2000).
- Gram-Hanssen (2003) found that households with similar socio-economic status had very different energy use patterns that were more fully explained by the number of appliances in the home and how appliance were used in the home than by whether the appliances were energy efficient.
- Recognizing the segmented character of consumption (and conservation potentials) the Electric Power Research Institute (EPRI) offered a psychographic segmentation scheme in the 1980s to its member utilities that featured both elements of social stratification (high to low class or income) and personality (EPRI 1990).
- It is widely recognized in stratification studies in sociology, anthropology and political science that ”birds of a feather flock together”, suggesting that residential location should also be expressed in patterns of consumption. Given findings of quite different levels of consumption in similar structures, it remains to be seen whether the ”birds of a feather” principle results in high consumption locales vs. low consumption locales.
- The segmentation of consumption (and conservation/efficiency potential) also means that targeting for programs, incentives, services, and social marketing ventures becomes very important.

Conservation Behavior and Efficiency Investment are also Segmented

- Dillman et al. (1983) found that, when faced with a conservation imperative, low-income households lowered energy consumption among all end uses, while higher income households maintained energy consumption and/or took advantage of tax credits and incentive programs. Similarly, they found that higher income groups were more able and willing to invest in efficient equipment and housing (also see Lutzenhiser et al. 2002 for a review).
- Social expectations and cultural understandings influence acceptable and the types of material goods that meet the expectations a particular lifestyle (e.g., the size or type of house one should have, the style of car one should drive, and the like). For example, status considerations can influence equipment purchases (Hackett and Lutzenhiser 1990).
- Similarly, equipment such as solar panels may be considered distasteful by the social group in which one is a member because of an accepted or implicit understanding that the panels do not meet aesthetic expectations (e.g., they may be considered unattractive to passers-by or they may not fit in with the aesthetics of the neighborhood). Conversely, in another social circle solar panels may be a symbol of concern for the common good (e.g., those with solar panels care about clean air and future generations) (Gossard 2004).

- There is a significant literature on social attitudes and conservation behavior. The simple answer is that the two are not very closely related. Well-measured attitudes should predict behavior but they rarely do. So however it is that persons actually choose to act is only loosely coupled to what they say they're thinking about doing (Lutzenhiser 1993).
- There has been a call for models that go beyond attitudes in trying to understand conservation response. The California crisis surveys revealed that consumers were motivated by a combination of cost-consciousness, efficiency-consciousness (avoid waste), environmental values, and altruistic interest in "doing our part" for the common good. At this point in time, Californians have been at least somewhat sensitized to energy as an issue, and have shown that they can take action (Lutzenhiser et al. 2003).
- Another area of concern has to do with comfort and a person's willingness to compromise comfort in pursuing efficiency. This is a complicated question and while the physiological and engineering comfort research is large, there are serious questions about the accuracy of that literature, as well as social science research that suggests that comfort standards may be more flexible or elastic than had been imagined. The implications for policy are in the area of non-compressor cooling, remote load control and demand response technologies that increase temperature levels during hot periods, and ventilative cooling (see Hungerford 2004).
- Strategies pursued by a significant minority of Californians during the crisis involved either using less air conditioning or turning their air conditioners off, regardless of the temperature (Lutzenhiser et al. 2003).
- There is a small but interesting literature on thermostat control and management. Most people do not set their thermostats and let them run. Also, persons who use automatic temperature setbacks do not simply choose a single setback and stick with it. Perhaps a third of the people use the thermostat the way that engineers and efficiency program planners think they do. One-third or more of probably use it strictly as a manual off/on switch. Also, the literature is unclear about which is the better energy conservation strategy. Even though programmable thermostats are sold as energy-saving devices, there is evidence that suggests that those people did not do any better with that strategy than people who were using the manual strategy (Nevias, 1991and Lutzenhiser 1992b).
- There is also evidence that persons differ in their willingness to control the building shell through strategic opening and closing of doors and windows. Some are completely unwilling to do this for more natural cooling because of pollution and because of security and crime concerns. On the other hand, others do it almost religiously. It is deeply built into everyday strategies that they use for cooling. Even in some parts of California that are quite hot, some part of the population does not use compressor cooling at all. In short, there is more variation than might be imagined in cooling behavior in California (Hall et al. 1994).

Implications for Interventions

- The effect of real time pricing could vary substantially between groups. For example, it may conflict with social considerations such as keeping the home acceptably warm, cool, and lit. (Wilhite and Wilk 1987). This may be especially true for higher-income households who may be better able to afford changing prices.
- Tax credits or appliance rebates (generally on higher-end appliances) may be used more often by higher-income households (such as found by Dillman et al. 1983).
- Newer, more energy-efficient homes may not have the aesthetic appeal for some groups (e.g., do not have "charming" features of older homes).
- Time of sale or lease requirements for modifications before the sale may motivate sellers to invest minimally. Similarly, improvements may not fit with status expectations or aesthetic tastes of buyers, in which case they could swap out equipment or alter the improvements.
- Another program consideration is how different groups in society take advantage of various programs. Some programs (such as energy bill assistance or home weatherization) are targeted to low-income families while others (such as energy-efficient appliance rebates) are set at nominal levels even for high-end (and highly expensive) equipment that is out of reach for most consumers. In this respect, there is a large "middle" group who cannot take advantage of rebate programs on equipment that could conceivably lower their energy consumption (Gossard 2004).
- Although not always explicitly articulated, lifestyle is often implicit in many energy policies. For example, California's Flex Your Power marketing campaign was designed to reach specific societal segments of the population such as Hispanics, Blacks, and Asians (Bender et al. 2002). Yet due to an implicit assumption that these ethnic groups are similar in other ways (e.g., they share within-group values), it may be implicitly believed that all members of a particular group will respond similarly to the same media message, when in fact they may not.
- Programs may be better informed by understanding how energy use, technological adoption, and program participation vary by lifestyle (e.g., low-income, rural, white male vs. an urban, corporate, upper-middle class, black woman vs. a middle-class, Hispanic family of five living in the suburbs), while also understanding the various constraints that people in different lifestyle groups may face in terms of time, access to technologies, and varying social expectations (Gossard 2004).

Energy Efficiency and Organizations

Defining the Problem: Why Don't Organizations Make Rational Energy Efficiency Decisions?

- In general, the data [covering 1000s of lighting investments by 1,400 participating firms] reinforce the view that there is a large potential for profitable energy-saving investments that is not being realized because of impediments that are internal to private and public-sector organizations (DeCanio 1998)
- From a sample primarily from three Energy Commission programs: Public Sector Loan and Grants, Cool Roofs, and Innovative Peak Loads, in-depth interviews revealed that not all firms and public sector organizations interviewed took conservation actions, and that the nature of actions taken and their potential effectiveness varied, even across organizations that appeared to be relatively similar in important ways (Lutzenhiser et al. 2002)
- New data from one of the US Environmental Protection Agency's voluntary pollution-prevention program show that both the level and variation in returns to lighting upgrade investments cannot be explained by standard economic models. Substantial gains in energy efficiency can be achieved without sacrificing profitability. Both economic and organizational factors account for some of the variation in observed returns to these investments, but the results suggest a need for improved and more comprehensive theories of the investment behavior of firms and other organizations (DeCanio 1998)
- The development of electricity consumption within the period 1986-1996 was empirically studied in a Swiss nation-wide survey of office buildings. Energy conservation measures were found to be more frequently implemented in buildings with professional energy managers or where energy was monitored by a director. However, only one seventh of the accumulated effects of all the consumption decreasing events were caused by explicit conservation measures. In contrast, almost four-fifths of the decreasing effect was caused by events where energy savings were not an issue (e.g., centralization of computer suites). In this case, a model of purposive action fails to explain energy consequences (Weber 2000).
- An organizational model indicates the need to move from policy models derived strictly from economics to those which treat institutional issues as central (Cebon 1992)
- If integrated, the engineering and economic and behavioral perspectives can help to speed the market penetration of energy conservation (Shama, 1983)

Importance of Organizational Awareness, Knowledge, and Information

- Lack of knowledge, know-how and technical skills in many final energy sectors: private households, small and medium-sized companies and small public administrations do not have enough knowledge about possibilities for electricity saving or enough technical skills. Small and medium-sized companies do not employ their own experts for energy management, especially if their production is not energy intensive. The owner or the managers are completely occupied with day-to-day business. Lack of information and knowledge is not found only among energy consumers, but also among architects, consulting engineers and installers (Jochem and Gruber 1990)
- Poor information on energy rates (none of the people asked knew what they were billed), on appliance energy use, and no feedback on natural gas consumption was reported to be an important influence on energy-using behavior in small commercial buildings (under 10,000 square feet) (Komor and Katzev 1988)
- Among 500 companies interviewed energy saving measures were not realized in part because ”information about the right measures is missing” (Gruber and Brand 1991)
- Organizations vary considerably in their sophistication and ability to identify and implement effective conservation and/or efficiency strategies. Organizational responses to the 2001 California energy crisis depended upon their particular circumstances and their ability to act within the limited time frame of the crisis. For example, the presence of technology such as an energy management system made it easier for some organizations to take action to control or limit their energy use; organizations drew upon their past experience and institutional knowledge base to identify how their organization should respond to the 2001 energy situation; and both public and private organizations tended to use peers and trade allies as sources of information and models for action (Lutzenhiser et al. 2002)
- Public opinion during the 2001 California energy crisis influenced some organizations to take visible conservation actions such as reducing lighting levels (Lutzenhiser et al. 2002).
- The information gathering and analysis capacity of the people formally responsible for energy conservation within an organization such as a university must exceed the information gathering and analysis requirements implicit in a given solution (Cebon 1992)
- These people must exercise sufficient power, through coercion or incentives, over the people whose cooperation or support is necessary for successful implementation of a given technology, to overcome any objections to implementation of that strategy (Cebon 1992)

- Early adopters have more information – information plays a role in risk reduction: An empirical investigation of the adoption of technological innovations by100 small- and medium-sized home building firms across the country shows that home builders who are more apt to adopt non-diffused technological innovations tap into more sources of information about new products from portions of their organizational environments than do non-adopters. The data also indicate that the characteristics of the individuals who are relatively early adopters of high uncertainty innovations differ from those more apt to be relatively early adopters of low uncertainty innovations. The empirical findings support the general hypothesis that uncertainty reduction plays a key role in the adoption of technological innovations in residential construction. (Toole 1998)
- General vs. internal feedback information on efficiency goals: The differential effects of two forms of feedback on energy consumption behavior were examined in two units of a metallurgical company. In one unit, employees received information about energy conservation, had to set goals and received feedback on their own conservation behavior. The same procedure was followed with employees in a second unit, but they also received information about the performance of the first unit. In accordance with predictions from social identity theory and social comparison theory, the results clearly showed that employees in the comparative feedback condition saved more energy than employees who only received information about their own performance, even half a year after the intervention. A remarkable finding was that behavioral change took place with hardly any changes in attitudes or intentions. (Siero et al. 1996)
- Can information itself (without cash subsidies) increase investment in new technologies? A model of retrofit investment in high-efficiency lighting technologies suggests that information programs appear to make a significant contribution to the diffusion of high-efficiency lighting in commercial office buildings. There is also evidence that the programs are more effective in encouraging retrofits by those who have already invested in advanced lighting technologies than by first-time purchasers. (Morgenstern and Al-Jurf 1999)
- A 4-week long information-intervention experiment, over two winters, promoted efficient heating behaviors in individual offices in a large office building. Short- and long-term effects were assessed for each 4-week period. The study found that improvements were observed in each intervention period, with some behavior maintained 1 year later. Changes suggest program capacity to correct relapses in earlier pro-environmental behavior. (Staats et al. 2000)

Significant Macro-Organizational and Market/Network Factors

- Failures of complete maximization are to be expected. It was Herbert Simon's view that firms operate under conditions of 'bounded rationality' and that "satisficing" rather than maximizing is descriptive of how firms actually operate in uncertain environments. (DeCanio 1993)

- Limited access to capital and historically or socially formed investment decision patterns: difficulties in raising funds for energy efficiency investments are often obstacles for similar groups of energy consumers in varying locations. (Jochem and Gruber 1990)
- Among 500 companies interviewed energy saving measures were not realized in part because the money was “needed for more important investments.”(Gruber and Brand 1991)
- Disparity of profitability expectations between electricity producers and users: The disparity in the rate of return expectations between electricity consumers and utilities leads to a bias in favor of supply investments. (Jochem and Gruber 1990)
- Organizational networks play an important role in shaping and constraining innovation. Barriers to innovation in residential construction include business cycles and industry activity, industry structure and organization, competition and risk aversion, information, technical frames and industry culture. (Lutzenhiser 1994)
- Only 14 percent of the total consumption decreasing effect (in a large Swiss study) was due to genuine conservation measures, while 79 percent was caused by events where energy conservation was not considered. By far the most energy-relevant events, 77 percent were decided without respect to their impact on energy consumption. That is, the majority of events affecting energy consumption were decided without reference to any consideration of energy. Hence, the decrease in consumption was an unintended side effect, mostly due to technical efficiency gains related to central computing, telephone switchboard and lighting equipment. Energy related events intended for a different purpose than energy conservation, but decided with energy efficiency in mind can be a true alternative to energy conservation measures (i.e., actions specifically taken to conserve energy) (Weber 2000).
- Innovations exhibiting relative advantage and having value to the consumers are adopted quickly…To facilitate faster adoption, one must establish better, more reliable consumer information as to what the innovation of conservation energy is all about, where to obtain it, how to use its various components in combination, how it fits present energy practices and what are its relative advantages. (Shama1983)
- Among 500 companies interviewed energy saving measures were not realized in part because “the companies want to wait for new technical solutions.”(Gruber and Brand 1991)
- An examination of retailer purchasing decisions in closed markets reveals that in “the long-term retailers prefer to move away from concentrated sourcing. It is proposed that this preference for balanced sourcing stems from a desire to avoid excessive dependence and opportunistic behavior on the part of wholesalers, among others. We also find that wholesaler's superior role performance has a strong positive association with retailer's purchasing intentions. The notion of dependence-offsetting actions, in addition to other rationales advanced for

diversifying purchases is evoked to help explain balanced sourcing."(Chatterjee et al. 1995)

- A focus on the role of organizational networks in shaping and constraining innovation. A study of residential cooling purchase decisions revealed that producer networks routinely limit technology transfer in a variety of ways. (Lutzenhiser, 1994)
- With current changes in the manufacturer-distributor marketing channels, industrial distributors are carrying an increasing percentage of industrial goods. As a result of mergers and acquisitions, they are larger and more powerful. Product line exclusivity is less prevalent. These factors constrain the ability of product line manufacturers to exercise power over their distributors. However, despite this environment, manufacturers still require commitment from their distributors in order to carry out a coordinated marketing program. In a study of high-tech distributors, to develop distributor commitment, behavioral determinants (such as trust, dependence, communications, power, idiosyncratic investments, and continuity) were included along with marketing determinants (product salability and ease of sale). The results demonstrated the importance of marketing variables in distributor commitment and that separations between marketing and behavioral variables tend to be artificial. (Goodman and Dion 2001)
- Marketing channels - Interdependency, contracting, and relational behavior: the dependency structure between wholesale-distributors and their major suppliers is posited to influence the type of contract used. In turn, dependency structure and type of contract is hypothesized to influence wholesale-distributor performance. This process occurs both directly and indirectly through some intermediate constructs, such as long-term orientation, relationship length, and relational behavior. (Lusch and Brown 1996)

The Dynamics of Action within Organizations

- The broader non-energy literature on organizational decision-making stresses the "non-rational" as well as the systematic/structured elements of modern complex organizations. The organization—whether large or small—is seen as an arena of competing claims, conflict and struggle for resources. In this context, it is not difficult to understand how and why the most rational and cost-effective energy efficiency choices may be made on non-energy grounds. (Perrow 1986, Scott 2002, Lutzenhiser et al. 2001, Kunkle et al. 2000; Janda et al. 2002; McBride et al. 2002).
- Even when organizations have significant internal expertise in energy efficiency, the technical nature of that knowledge, as well as the relatively low status of facilities planning, maintenance and procurement operations (in most organizations), limit the effective deployment of that expertise (Lutzenhiser et al. 2001, Kunkle et al. 2000).

- Separation of responsibilities for energy expenditures and conservation actions: for example the case of split incentives, where the owner of a building or electrical equipment is not always identical with the user or the party paying the utility costs. (Jochem and Gruber 1990)
- No perceived control of energy use and therefore little energy cost influence over energy-using behavior by small commercial buildings owners/managers observed. (Komor and Katzev 1988)
- A diffusion of responsibility (with none of the parties concerned primarily about energy use) was found to influence energy-using behavior among small commercial businesses in a shopping center. (Komor and Katzev 1988)
- Companies across 8 different industries in West Germany were not exploiting available energy conservation options because of the particular production and management characteristics of each industry. (Gruber and Brand 1991)
- Among 500 companies interviewed energy saving measures were not realized in part because management reported that "new production plants were already energy efficient."(Gruber and Brand 1991)
- Firms do not behave like individuals. The behavior of the firm is the outcome of the interplay of the motivations of the individuals comprising it, the rules and conventions governing their interaction, and the environment within which the firm operates. This barrier to energy efficient investment is offered as one account for some of the deviation from the standard economic presumption of cost minimization or profit maximization in US firms. (DeCanio 1993)
- The profitability performance of the firm is influenced as much by its structure, governance, and organization as by its adherence to any set of mechanically applicable procedures for maximization of profit with a given technology. (DeCanio 1993)
- Office building industry goes through boom and bust cycles. All four building markets investigated experienced a boom phase of the cycle in the last several years, reflecting strong regional economies. Buildings are investments. They represent tangible assets that provide predictable income streams to conservative investors. This fact fundamentally structures and constrains the building development process. (Lutzenhiser et al. 2001)
- At some point, economists' unwillingness to acknowledge evidence of shortcomings in corporate decision processes becomes itself a barrier to progress. Those who study the actual workings of firms know that corporate cultures exhibit a rich diversity of forms and show large variations in performance. (DeCanio 1998)
- Small organizations with little energy consumption, organizations served by municipal utilities, and organizations with fixed price contracts with third party suppliers were affected very little by higher energy prices. (Lutzenhiser et al. 2002)

Complexities of Organizational Decision Making

- Differences in structure and events in the institutional environment can explain almost all differences in decision making…Allocation of responsibilities, which reflected prior choices of centralized versus decentralized structures, dramatically affected the universities' decision making capacities…Decentralized organizations are less efficient because they must reproduce their decision making apparatus for each subunit (faculty). (Cebon 1992)
- In order to overcome the institutional obstacles related to new technology design, found in 2 universities by Cebon, an organizational model of energy conservation decision-making is suggested. In Cebon's view, "Interventions which fail to use one of these four options will fail."

  1 Select technologies that fit existing organizations: try to direct the particular technologies to organizations they match well. That is, the policy analyst would attempt to map the characteristics of various technologies to organizational practices.

  2 Reconfigure technologies to fit existing organizations.

  3 Select organizations likely to be receptive to target technologies. The sooner opinion leaders adopt the technology, the faster it will diffuse.

  4 Modify organizations so they can select the technology: appropriate policy measures to modify organizations depend on three things. First, where in the organization do the changes need to be made? Second, what is the desired duration and rate of the change? Third, who is the change agent? (Cebon 1992)
- Statistical or selection bias in estimating investment returns. If the estimated returns to most types of prospective investment projects are biased systematically upward, then management may impose a hurdle rate greater than the firm's cost of capital to ensure that the returns actually realized on projects undertaken are high enough to be profitable. (DeCanio 1993)
- Given what we have learned about building markets and the nature of building industry interests, it is clear that increasing the energy efficiency of buildings is of little value to the building industry. In terms of the parameters important to the building industry, buildings are energy efficient. There is really no value to the building industry in making buildings more energy efficient—it is risky. (Lutzenhiser et al. 2001)
- The importance of energy efficiency fluctuates – for example, September 11th and an economic downturn pushed energy out of the limelight shortly after the 2000-2001 energy crisis. (Lutzenhiser et al. 2002)
- Why the mainstream theory of economic behavior fails: the majority of energy consumption choices are embedded in decisions related to technical infrastructure, which are strongly determined by the existing infrastructure, social consumption standards and individual consumption patterns. In Western societies, energy is just a marginal factor and is usually treated as less important

than other marginal factors, such as safety, convenience and comfort (Weber 2000).

- An industrial firm's energy efficiency decision making model posits seven stages, which range from no energy savings decision making to energy efficiency program implementation to steady state energy efficiency decision making. It is hypothesized that government energy-efficiency programs, such as the Industrial Assessment Center (IAC) Program funded by the US Department of Energy (DOE), can accelerate the speed industrial firms move through the model's seven stages. Data were collected about firms' stages in the model before and after receiving one of the three IAC benefits: a direct energy assessment; the employ of a student alumnus of the IAC Program; or use of energy efficiency information from an IAC website. It was found that each IAC benefit is associated with a significant positive change in firms' energy efficiency decision making within a relatively short period of time. (Tonn and Martin 2000)
- Decision-support may play a key roll: Investment decisions are an important part of meeting the future energy efficiency demands from industries across sectors (e.g. to address global competition or commitment to the Kyoto Protocol). From a managerial perspective, the need to improve decision support may be essential to facilitate and improve investment decisions concerning energy efficiency. In-depth interviews with energy intensive companies and non-energy-intensive companies from different sectors in Sweden identified the need for improvement of working methods in order to support the decision-making process. Here, external players seem to be playing an increasingly important role. Access to correct information, better follow-up activities, and transparent, understandable calculations are also considered to be important. (Sandberg and Söderström 2003)
- Change may not be an improvement. Using comparative case data from two universities, Cebon (1992) developed an organizational model of energy conservation decision-making. Unlike an economic model, the importance of power and incentive distribution and information acquisition and analysis are highlighted, showing how energy conservation behavior changes through organizational decentralization, but does not necessarily improve it. Critical dimensions in new technology design are discussed and a model/tool for analyzing policy is suggested. Policy options modeled indicate the need to move from policy models derived strictly from economics to those that treat institutional issues as central. (Cebon 1992)
- An assessment of the capacity of the innovation attributes proposed in Rogers' diffusion theory (Rogers, 1995) to predict the intention to adopt energy conservation interventions provides a first test of some refinements to Rogers' theory. Results indicate that perceived compatibility is a general and important predictor of the intention to adopt energy conservation interventions. For two of the four energy conservation interventions, intervention was first of all judged on its advantage. If the perceived advantage was minor, a potential adopter often decided to reject an innovation solely on the basis of this assessment. If the

perceived advantage was high, the evaluation process usually continued; perceived compatibility then became the second evaluation criterion. The theoretical and practical implications of these findings are discussed. (Vollink et. al 2002)

- Organizational decision-making practices may lead firms to inappropriate levels of investment in energy efficiency. Modern approaches to organizational decision-making, such as the “garbage can” model, where organizational decisions are made under ambiguous criteria in an environment of organized anarchy, describe the realities of organizational decision-making, in contrast to the simple unitary rational actor model's predictions, and clarify an evaluation of an energy audit program for organizations. (Goiten 1989)
- New data from one of the US Environmental Protection Agency’s voluntary pollution prevention program show that both the level and variation in returns to lighting upgrade investments cannot be explained by standard economic models. Substantial gains in energy efficiency can be achieved without sacrificing profitability. Both economic and organizational factors account for some of the variation in observed returns to these investments, but the results suggest a need for improved and more comprehensive theories of the investment behavior of firms and other organizations. (DeCanio 1998)

Concern for Risk and Effects of Price

- Specific limitations such as the lack of confidence in new conservation services and products, or specific legal and administrative regulations that inhibit efficiency technology adoption were noted by Jochem and Gruber (1990).
- Small commercial buildings owners/managers were influenced by the belief that conservation entails reduced comfort. (Komor and Katzev 1988)
- Among 500 companies interviewed energy saving measures were not realized in part because “the right personnel are not available.”(Gruber and Brand 1991)
- Asymmetric information and divergent incentives. One frequently cited factor causing under investment in energy saving technologies is the alleged shortsightedness of management. For example, managerial compensation is often tied to recent performance…this sort of job turnover may lead managers to prefer projects with short payback periods even if those projects are inferior, in some global profit maximizing sense, to others of longer duration… Managers will be deterred from initiating risky projects if the personal consequences of failure seem to be much larger than the payoff to success, and if managers are risk averse. (DeCanio 1993)
- The nature of building development constrains innovation. The building industry strives to reduce risk and produce reliable economic returns by using standard approaches and models that have worked well in the past. (Lutzenhiser et al. 2001)

- Rising energy prices impacted organizations in different ways. Many organizations were concerned about the threat of blackouts. (Lutzenhiser et al. 2002)
- Any meaningful and fast penetration (of energy conservation products) would not be achieved without price reduction (Shama1983)
- Consequences of energy use may not be realized in the costs of energy due to inappropriate electricity tariffs with fixed standing charges and energy charges that do not reflect the varying cost of the load curve. (Jochem and Gruber 1990)
- The fact that energy costs are small as a percentage of gross income (between .5 percent and 1.5 percent) influenced energy-using behavior in small commercial buildings. (Komor and Katzev 1988)
- Among 500 companies interviewed energy saving measures were not realized in part because "the development of energy costs in the future is uncertain."(Gruber and Brand 1991)

Implications for Interventions

- Findings related to overcoming barriers to market penetration of energy conservation include: developing energy conservation systems, targeting energy conservation systems, informing and motivating the consumer, considering marginal social cost pricing, offering financial incentives, ensuring appropriate distribution, discouraging energy-inefficient practices, and using flexible mandates. (Shama, 1983)
- Systematic education and training in which several professional groups are trained simultaneously to alleviate the obstacles to improving electricity efficiency is required to remove information barriers during the design process. (Jochem and Gruber 1990)
- To move toward greater increases in energy efficiency in commercial buildings a change process must occur at three levels:
    - Making energy efficiency relevant to the commercial buildings market (e.g., green and sustainable buildings, creating quality work environments)
    - Encouraging demand and institutionalization of energy efficiency in the marketplace (e.g., working in progressive markets, working on build-to-suit projects).
    - Standardization within the development/design process (e.g., LEED) (Lutzenhiser et al. 2001)
- Traditional energy efficiency programs designed for the residential sector, such as audits and special rates, may not be appropriate in the small commercial sector (Komor and Katzev 1988)

- Programs should focus on organizational concern, conditions, and capacity rather than market barriers. They suggest the need for moving from a short-term crisis approach to a long-term policy approach. For example, they advocate developing relationships with organizations, creating more certainty in the marketplace, rewarding good practices, and doing a better job of outreach, recognition, networking, and education (Lutzenhiser et al. 2002)
- Programs specific to the small commercial sector should recognize and exploit non-financial determinants of behavior, target decision makers (e.g., equipment contractors), intervene at the time of retrofits and remodels, and improve user information (Komor and Katzev 1988)
- Appraisal practices required by the secondary mortgage market do not recognize cooling design innovations, such as natural ventilation and ground-coupling. The federal government is a key actor in these markets, and can play a positive role by removing barriers to innovation in the secondary mortgage market. (Lutzenhiser 1994)

The Role of Government

- Government should act as a clearinghouse for information on energy technologies, a neutral purveyor of objective information, thereby reducing perceived risks to firms. (DeCanio 1993)
- Government should provide management consulting, such as with agricultural experiment stations. DeCanio writes that it is not difficult to visualize a network of industrial experiment stations, demonstrating (among other things) energy efficient technologies. (DeCanio 1993)
- Government should also serve as a rallying point. (DeCanio 1993)
- Building codes and regulations provide a level playing field in the new commercial buildings market. (Lutzenhiser et al. 2001)
- Energy labeling has effects upon and benefits for organizations as well as for household consumers. (Jochem and Gruber 1990)
- General information should be given to the top management in industry and in the public sector to motivate them to initiate the attempt to reduce energy costs. (Jochem and Gruber 1990) Information might also come from other sources such as utilities.

Demand Response

- One of the results of the California energy crisis of 2001 has been increased policy attention to possibilities for reducing peak loads—particularly at times when the system is operating near capacity and the marginal cost of electricity generation or purchase is very high. Borenstein et al. (2002) argue that ”the demand side of the industry should play a more active role, receiving economic incentives to help balance supply and demand.”

- Reductions in peak demand can lead to decreases in the costs of generating electricity, improvements in system reliability, and reduced emissions (Weare 2003).
- The desired "demand response" can result from either direct load control (e.g., air conditioner remote cycling by the utility) or user control, with the latter usually induced by real-time pricing (passing peak energy costs through to consumers), time-of-use pricing (charging different prices during set peak and off-peak time blocks), and/or critical peak pricing (higher prices charged during unusually high peak load periods.
- While most demand response policies have been discussed (and some implemented) for large commercial, industrial or institutional energy users, there is also growing interest in encouraging demand responsiveness (i.e., peak-shaving, load-shifting, and overall reductions in demand) by residential energy users. In fact, much of the empirical research done to date found in the literature focuses on the residential sector (e.g., time-of-use pricing experiments).
- However, Braithwait (2002) suggests that "two main factors have weighed against the benefits of TOU [time-of-use] pricing for residential customers: (1) TOU prices do not accurately reflect the variability of wholesale power costs and (2) residential customers use a relatively small amount of electricity. The combination of these two factors must be traded off with the costs of installing meters, metering, and billing."
- "Toward Utility Reform Network"(TURN) argues that "most small customers will not benefit from TOU pricing, because they do not have enough load to shift to pay for the meters"(TURN 2003).
- It also is not clear that most consumers would favor higher peak utility rates, even if they stood to benefit from them. For example, mistakes can be made (forgetting to adjust an air conditioner thermostat), and the consequences could be costly. For this reason, most residential peak rate proposals acknowledge a need for "enabling" technologies such as programmable thermostats and information supplied by the utility (via emails, web sites, pagers, telephone calls) about current and projected prices. (Goldman et al., 2002).
- The literature on residential electricity demand response reveals that relatively little social science work has been done in this area (there is a larger body of work by economists concerned with calculating price elasticities under various time-sensitive price regimes, but it pays little attention to behavioral response or consumer understandings).
- A cursory examination of public opinion polling data from California suggests that questions related to "dynamic pricing" (e.g. time-of-use, critical peak pricing) have rarely been asked. However, a 2001 Field Poll solicited opinions about four proposals related to demand management strategies. These included: increased peak hour prices, time-of-use pricing, setting a household quota, and pre-planned periodic blackouts. The only proposal that received majority approval was to ask all consumers for a 10 percent reduction in their consumption, with

penalties for those who fail to achieve this goal (Field Institute 2001). Support for TOU pricing was 48 percent, down from 59 percent two decades earlier (Field Institute 1980).

- In the summer of 2001, studies of the state's Flex Your Power conservation advertising campaign (Bender et al., 2002) and of residential consumers' behavioral responses to the energy crisis (Lutzenhiser et al., 2002, 2003) found strong evidence of voluntary reductions in energy use that resulted from a combination of consumer actions, that included turning off lights, turning air conditioners off or adjusting thermostats upward, shifting loads to off-peak periods, installing energy-efficient appliances, and using fewer appliances. These results suggested that residential consumers, on the whole, were better able to alter their patterns of energy use than previously had been thought. Some of their actions were explicitly focused on peak demand reduction (e.g., washing and drying at night), while others (using less air conditioning, shutting off pumps and spas, using appliances less) undoubtedly had peak benefits even though they were most likely intended to reduce overall energy use.
- The social science literature reports time-of-use experiments as early as the1970s (Black 1978, Heberlein et al., 1982). In fact, Black (1978) reports that President Jimmy Carter wanted time-of-use rates to be adopted nation-wide Participants in experiments tended to report favorable evaluations.
- In terms of actual reductions in peak demand from dynamic pricing, Faruqui and Eakins (2000) review of a number of experiments within different customer classes over the past twenty years found a fair amount of variation, but with overall load reductions being very common in the samples.
- In California, several utilities have made residential time-of-use electric rates available for some time, although few customers have adopted them. A review of residential dynamic pricing developments in other states shows a mixed picture (interviews and web research conducted by Lutzenhiser and Sawyer (2003)). In some places new programs are being considered or introduced, while in others support for dynamic pricing has waned and programs have been discontinued. For example, Gulf Power shifted from TOU to a critical peak pricing approach. Georgia Power reported having only twenty-five residential customers registered for its TOU program in 2003. Illinois Power, which has offered residential TOU rates since the early 1980s, reported 2,150 (0.4 percent) of its residential customers were participating. Portland General Electric has recently initiated a TOU program as part of Oregon's utility restructuring. However, the utility is careful to caution customers on its website that "if you cannot significantly shift your usage, you may not save money and may pay more than on the Basic Service rate."
- Puget Sound Energy's (PSE) residential TOU program provides an instructive example of how customer opinion can change. During the 2001-2002 period, PSE conducted an ambitious residential dynamic pricing program that was widely praised (Tamaki, 2001; Pollom, 2002) and was well-received by approximately 300,000 customers, whose electricity use during peak periods was 5 percent less

than customers on the conventional rate (Green, 2002). However, at the end of the energy crisis, a rate with small differences between peak and off-peak periods (6.4 cents/kWh at peak times and 5 cents/kWh during economy hours), and a monthly $1 fee (Brown, 2002), ensured that 90 percent of customers on the rate saw increases in the second year of the program (Lewis, 2002). It was subsequently abandoned. From the PSE program experience, Faruqui and George (2002) conclude that ”finally, and most importantly, any program should make a majority of the customers better off, or it should not be offered.”

- An Energy Commission-funded experiment that recruited 70+ Sacramento Municipal Utility District (SMUD) high-use households to a time-of-use rate with significantly higher critical peak prices (“called” during energy shortage and/or high price periods) showed overall energy savings and general satisfaction with the rate. Some participants did not reduce their consumption levels and a number of problems with the enabling technology (“smart” thermostats) were reported. (Wood et al. 2004)
- An experiment conducted using members of a Chicago voluntary energy-savings coop organization in which time-of-use rates were applied ”during a relatively cool summer with unusually low peak energy prices, showed a strong response to high price notifications and overall demonstrated the ability to adjust consumption in response to price.” More than half of the participants showed significant response to price notifications, and most of the rest showed some response. Participants overall were satisfied with the program, found it easy to understand and to participate in, and were pleased with the bill savings they experienced (Summit Blue 2004). The special nature of the participant population suggests that the results cannot be generalized to larger populations with any confidence.
- The California State-wide Pricing Pilot (SPP) randomly assigned (with opt-out) about 1700 residential and small commercial customers to a variety of treatment groups to which information and time-sensitive rates were applied. Overall reductions in energy use (over the levels predicted by past bills) were observed across the sub-samples and elasticities of demand were calculated. Variations in the magnitude of response were observed, however, across customer segments, depending on income, home ownership, equipment stocks, and house size. (Charles Rivers Associates 2004)
- A survey of SPP participants showed fairly high levels of satisfaction with the rates and reports of behavior change from many participants (MMI 2004). Low response rates do not allow generalization to the population as a whole. The SPP participants, although initially randomly-assigned to the experiment, were able to opt out of the program and many did so. The resulting program-selection bias, coupled with survey-selection bias, does not allow generalization to a larger population with any confidence.
- The literature indicates a need to fit program rates, technologies and behavioral expectations to customer needs and circumstances. However, from the existing literature and limited program experience, we know relatively little about

consumer perceptions or responses. It is clear that program success (in terms of reduced peak loads) depends upon poorly understood behavioral responses, often with complex and costly technologies involved. It remains for experiments such as the Energy Commission/SMUD and SPP to begin to document consumer response patterns, load impacts and benefits, and possible distributional effects within different parts of the residential sector.

Analysis of Consumer Survey Data

In January 2005, Lutzenhiser Associates conducted a review of California public opinion surveys in support of the Assembly Bill (AB) 549 research project. Surveys completed during the previous five years were investigated. The goal was to collect information on the extent of Californians' interests in and commitments to energy efficiency and conservation, as well as their views of various energy policy approaches and programs.

The original AB549 study design anticipated conducting consumer surveys. However, time and resource constraints precluded that approach. It was hoped that adequate information could instead be found in already-collected survey results. In our review of existing consumer surveys, we were, in fact, able to locate fairly consistent information about energy attitudes, opinions, and conservation behaviors reported by California residential consumers—both before and after the 2000-2001 energy crisis (the period when interest and concern would be expected to be at their highest levels).

These findings are presented in the following sections. The first (the balance of this introductory section) presents a discussion of some important broad public opinion trends. In the remaining sections we consider more specifically opinions about the energy crisis; Californians' energy conservation-related attitudes and behaviors; their views of various energy policy alternatives; and implications for the AB549 process.

Background: Energy and Environmental Problems

In recent years, Californians and other Americans have expressed high levels of concern about a range of problems affecting the social, cultural and political fabric. For example, long-standing concerns have included education, poverty, employment, health, and development (economic, urban, and transportation). Also, beginning in the late 1970s and early 1980s, issues related to technology and the environment began to appear on the list of public concerns and have stayed there (Dunlap and Scarce 1991). These newer issues have included problems related to: energy shortages, sources of energy, conservation and renewable energy technologies, water supplies and safety, air quality and pollution, solid waste and recycling, and most recently traffic congestion, sprawl and planning issues. Parts of the social infrastructure that had been taken for granted prior to the 1980s have increasingly become "problematized—with the most recent in California being electricity supplies, as a result of the 2000-2001 energy crisis (Lutzenhiser et al. 2003).

Dunlap and Scarce, in their 1991 review of two decades of U.S. public opinion polls, found that both the numbers of environment and technology problems, and their perceived threats to human well-being, had grown throughout the period. What's more, while environmental problems rarely top persons' volunteered lists of "most important problems" (e.g. often falling below concerns about crime or education), the polls that Dunlap and Scarce reviewed (as well as more recent California polls summarized below) show a strong unwillingness to sacrifice the environment in order to solve other problems (e.g., to bolster the economy, increase energy supplies, preserve jobs, and the like). This suggests that consumers are aware of, and interested in addressing long-term interests (such as environmental sustainability), while at the same time attending to more immediate problems (the ones that rise and fall in the polls such as the energy crisis, budget deficits, and election outcomes).

Energy has periodically been the primary focus of opinion polls, and is somewhat more frequently included in studies of general environmental problems. In addition to the Dunlap and Scarce (1991) review cited above, Farhar has reviewed and summarized public opinion about energy in particular, most recently in Farhar (1994). Unfortunately, we have not been able to identify any more recent reviews of either environmental polls or polling specifically related to energy, particularly for the state of California.

We were able to identify fifteen different public opinion polls or social surveys of residential consumers that contain energy-relevant items and were conducted within the state of California between 2000 and 2004. These are listed in Table 15 below and referenced throughout the following discussions.

Table 15. Consumer Surveys with Information on Energy-Related Attitudes, Opinions and Behaviors: California 2000-2004.

Sponsor/Polling Org.	Title of Survey	Reporting Date
Los Angeles Times / Roper Center	"Current Energy Crises"	Jan 4, 2001
Field Institute	"California Electricity Crisis"	Jan 19, 2001
Los Angeles Times / Roper Center	"Continuing Energy Crises in CA"	Feb 14, 2001
Field Institute	"Residents' Reaction to the California Energy Crisis"	May 22, 2001
Los Angeles Times / Roper Center	"Continuing Energy Crises"	June 23, 2001
Public Policy Institute of California	"PPIC Statewide Survey: Californians and their Government"(4th in the series)	July 19, 2001
Energy Commission / Washington State University	"Conservation Behavior: Crisis Period"	Oct/Nov 2001
The Energy Foundation	"California Statewide Energy Issues"	Feb 1, 2002
Public Policy Institute of California	"Special Survey on Californians and the Environment"(3rd in series of 8)	May/June 2002
Public Policy Institute of California	"PPIC Statewide Survey: Californians and their Government"(10th in the series)	Aug 14-21, 2002
Energy Commission / Washington State University	"Conservation Behavior: Post-Crisis Period"	Jan/Feb 2003
Public Policy Institute of California	"Special Survey on Californians and the Environment"(5h in series of 8)	June 4, 2003
Public Policy Institute of California	"Special Survey on Californians and the Environment"(6th in series of 8)	Oct/Nov 2003
Public Policy Institute of California	"Special Survey on Californians and the Environment"(7th in series of 8)	June/July 2004
Public Policy Institute of California	"PPIC Statewide Survey: Californians and their Government"(17th in the series)	Aug 4-11, 2004

The Electricity Crisis and its Impact on Environmental Attitudes

Several of the issues polled by the Public Policy Institute of California (PPIC) illustrate the rise and fall in relative importance of energy vs. other short and long-term problems. The PPIC conducts a variety of statewide and special issue surveys, some of which have been planned in series with identical questions that enable comparison of responses through time.

Crisis Polling

Energy was a key topic of interest in a "*PPIC Statewide Survey: Californians and their Government"* (C&G) survey fielded on July 19, 2001. A summary of this C&G survey, the fourth in a new series that continued through the 2002 election cycle, can be found in the press release entitled "Californians Galvanized by Energy Crisis" (PPIC 2001) [3].

[3] A brief history of the PPIC from their website: "In 1993, William R. Hewlett, Roger Heyns, and Arjay Miller worked together to conceive and implement the idea of a public policy research institution

In the summer of 2001, an unprecedented majority (56 percent of all respondents) identified a single issue—"electricity prices, deregulation"—as being the most important problem facing California. This response represented a sharp increase from the 25 percent level of concern about electricity reported earlier in the crisis (in the January 2001 survey). PPCI further reported that, prior to 2001 electricity had *never* been mentioned as an important issue on a PPIC statewide survey.

Just before the March 2002 primary election (and nearly a year after the 2001 crisis summer), the top three issues of importance to likely California voters were: education, the economy and electricity. By the August 2002 C&G survey, Californians remained most interested in the same 3-E's (education (17 percent), the economy (13 percent), and electricity (11 percent)). However, by the August 2004 C&G survey, energy and electricity concerns were not mentioned in response to "Which one issue would you most like to hear the presidential candidates talk about between now and the November 2nd election?" Top issues at that time included "the economy, jobs, unemployment" (26 percent – up from 13 percent in 2002) and the "Iraq situation, war in Iraq" (21 percent). Education was mentioned by 5 percent (a big drop from 17 percent in 2002). When asked the follow-up question, "Is there another issue that you want to hear about almost as much?" the economy and the Iraq situation again topped the list, with education mentioned by 8 percent and "energy, oil prices, gasoline prices" falling to the bottom of that list with 2 percent of responses. The energy crisis had faded and electricity systems concerns had been replaced by other issues.

However, the presence of strong underlying pro-environmental values continued in evidence both during the crisis and during the period of unsettled markets that followed. The PPIC polls showed high levels of agreement with the statement "California should protect the environment even with increased gas and power prices" in both 2001 (68 percent) and 2002 (65 percent).

According to the PPIC statewide report in 2001:

> "The electricity crisis and its economic consequences have not shaken Californians' strong desire to maintain the quality of their environment. Sixty-eight percent [68 percent] of state residents – compared to 57 percent of Americans – agree with the statement that we must protect the environment, even if it means higher prices for gasoline and electricity. Despite efforts by the Bush administration to increase public support for their energy plan, the majority of Californians (54 percent) would prefer to have U.S. energy policy focus on conservation and regulation, rather than the development of new supply. Californians are less likely than the nation as a whole (37 percent to 44 percent) to say that expanding exploration, mining, and drilling, and new power plant construction should be the most important U.S. energy priority.

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dedicated solely to the issues and events that affect the people of California. Based on their discussions, Roger Heyns wrote a concept paper spelling out the basic principles upon which the institute would be founded, and William R. Hewlett endowed the institute with an initial gift of $70 million. The purpose of the endowment was to ensure the institute's independence and objectivity. Together, the founders established and launched the Public Policy Institute of California in July 1994. David W. Lyon was selected to serve as the institute's founding president."

Indeed, few Californians believe that higher gasoline prices and electricity shortages in recent months are a good reason to allow new exploration in federally protected areas. Seventy-one percent of state residents – compared to 56 percent of the nation as a whole – would prefer to see the federal government consider other solutions to the crisis."[4]

Current Views

There is evidence for continuing value for environment quality several years later in the July 2004 C&E survey from responses to an "environment versus economy question", to which 55 percent responded that environmental protection should be given priority even at the risk of curbing economic growth. In a commentary published in the Sacramento Bee on August 1, 2004, Mark Baldassare, research director for the Public Policy Institute of California reported polling results showing that Californians "now rank environmental protection over economic growth."[5]

Supporting factors (excerpted directly from the article) include:

- ·Californians are increasingly concerned about smog and higher gasoline costs.
- ·Air pollution ranks as the most important environmental issue (followed by pollution in general, and water pollution – for a combined total of 48 percent of responses to an open ended question).
- ·Most believe that air pollution has become a serious threat to their personal and family's health (59 percent broken down as 20 percent reporting a "very serious" and 39 percent a "somewhat serious" threat).
- ·A majority (76 percent) reported that global warming is a reality that requires immediate policy action.
- ·Most Californians think that their state government, rather than the federal government, will best reflect their own environmental aspirations.

These 2004 responses are highly consistent with the trends reported thirteen years earlier by Dunlap and Scarce (1991):

- Public concern for environmental quality was high.
- Growing majorities saw these problems as an increasing threat.
- Increasing majorities supported governmental action.
- Majorities sided with environmental protection over economic growth.
- Individuals indicated a willingness to pay the increase in cost.

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4 July 2001. PPIC Statewide Survey: Californians and Their Government. Mark Baldassare, Senior Fellow and Survey Director.

5 "Green Grow The State's Voters; It's Not About Money: Eco-Protection Ranks Ahead Of Economic Growth As An Issue" Mark Baldassare's commentary published by the Sacramento Bee, August 1, 2004 and also online at http://www.ppic.org/main/commentary.asp?i=507

But *who* should work on these problems? The PPIC 2004 survey responses suggest that Californians continue to believe in *shared responsibility* for solutions. The conclusions here are excerpted from the ”Green Grow the State’s Voters” article (with percentages added from July 2004 survey results):

- Californians look to the state to promote cleaner air and greater fuel efficiency (56 percent think that the increase in gas prices is a permanent change).
- Yet today they appear willing to pay higher sticker prices for their cars (and to increase their taxes for pro-environmental purposes e.g., 47 percent said they would seriously consider the purchase or lease a hybrid fuel or electric vehicle even if it cost more, and 16 percent would seriously consider it if the vehicle did not cost more).
- There is a widely held belief (56 percent) that the federal government is not doing enough in the environmental arena.
- Two in three Californians favor the governor's call for higher vehicle license fees for new cars to pay for state programs to put cleaner engines in dirty diesel buses and trucks.
- The majority of voters (57 percent) like the governor's futuristic idea of having California leading the way in the development of hydrogen fuel cell technology through the construction of a ”hydrogen highway", with 200 fueling stations by 2010.
- They support the goal of having a solid share of new homes in California at least partially run on solar power starting in 2006 (82 percent thought it was a ”good idea”).
- The governor's idea that states in the Western United States increase their energy efficiency by 20 percent by 2020 is also highly popular (79 percent in favor); in light of the fact that many Californians prefer energy conservation to offshore oil drilling.
- More than eight in 10 Californians support state legislation that requires all automakers to reduce greenhouse gases for new cars sold in the state.
- Two in three residents support a proposal to allow solo hybrid vehicles to use car pool lanes as a way of promoting fuel-efficient automobiles.
- And nine in 10 Californians want a law that requires all trucks that deliver goods in California to meet federal air pollution standards.

Energy-Related Attitudes and Opinions

The Energy Foundation, the Los Angeles Times/ Roper Center, The Field Institute, and the Public Policy Institute of California all conducted public opinion polls to specifically gather information regarding attitudes and opinions during the energy crisis of 2001. More than a dozen of these surveys were reviewed and topics relevant to conservation, energy efficiency and the environment are summarized. In addition, Dr. Loren Lutzenhiser collected crisis and post-crises attitude and behavior

data for the Energy Commission in two survey waves in 2001 and 2002 (Lutzenhiser 2003). The results of those surveys (identified as ”Energy Commission/WSU” below) provide detailed information about California consumers’ views of energy problems and energy issues.

Because the energy crisis occasioned all of these studies, their questioning tended to focus on crisis-related issues. This means that some of their findings might only apply to a similar electricity supply crisis (e.g., opinions about whether the state should purchase the transmission system). Those crisis-specific findings are not considered here. However, questions related to behavioral conservation actions, efficiency investments, program fairness, and policy preferences have more general applicability in both crisis and non-crisis conditions. Those results have been extracted for the present analysis and are reported here.

Crisis Conservation Behavior

During the crisis, both state-sponsored and utility-specific programs presented consumer information and created program opportunities for households to conserve. The February and June 2001 LA Times/Roper surveys asked a variety of questions related to conservation programs (e.g., 20/20 program awareness and appliance replacement), as well as questions about how household energy bills were and were not affected by rate increases. [6]

A very large majority of respondents (53 percent ”strongly approve” plus 23 percent ”somewhat approve”) supported *proposed* legislation to encourage conservation by providing $75M in rebates to encourage trade-in of old appliances for more energy efficient models (LA Times/ Roper February 2001).

A year later, a number of questions in an Energy Foundation poll specifically addressed state-instituted energy conservation programs (e.g., rebates for conservers, incentives to buy more energy efficient appliances, etc.). Several of the questions were posed in relation to the economy and/or the environment. For example, 73 percent reported that the ongoing conservation programs either ”somewhat help” (53 percent) or ”greatly help” (20 percent) the economy. In combination, responses to related questions showed fairly strong support for continuing, and even increasing, then-current conservation efforts. A few examples include:

[6] In 2001, the 20/20 Program provided 20 percent rebates on energy costs during summer months to customers of investor owned utilities who reduced their usage 20percent or more.

Did efficiency & conservation programs help prevent against even larger increases in energy bills?

The Energy Foundation 2002	
Yes-Great Deal	13 %
Yes-Somewhat	28 %
Yes-A Little	13 %
No	39 %

Should California (increase/decrease/keep same) the conservation and efficiency programs?

The Energy Foundation 2002	
Increase Programs	50 %
Decrease Programs	9 %
Keep the Same	37 %
Don't know/NA	5 %

If California continues conservation and efficiency programs, will it (increase/decrease) the state's energy security?

The Energy Foundation 2002	
Greatly Increase	16 %
Somewhat Increase	50 %
Somewhat Decrease	14 %
Greatly Decrease	4 %
Don't Know/NA	17 %

In the June 2001 LA Times/Roper poll, 51 percent of households reported *actually trying to cut back* in order to qualify for the 20/20 program. Of these, 37 percent said they successfully qualified for the program, while14 percent were unsuccessful (an additional 14 percent said that the program did not apply to them, 22 percent did not try to qualify, and 4 percent were unaware of the 20/20 program).

The combination of the three LA Times/Roper Center polls also gave considerable attention to conservation as a method of better managing California's energy system. Several additional questions on conservation were added to subsequent polls as Summer 2001 approached and more time elapsed under the state's policy initiative to concentrate on conservation efforts for controlling the supply crisis. Some of the broader questions found in three L.A Times polls included:

Have you conserved? How? (Respondents could list up to 6 conservation actions.)

LA Times/Roper Center 2001	Jan	Feb	June
No	23 %	11 %	9 %
Lights Off	62 %	74 %	66 %
Less HVAC	33 %	49 %	41 %
Insulate	6 %	10 %	5 %
Repl. Appliance w/ E-Effic. model	11 %	19 %	13 %
Use Elec. Equipment less	28 %	40 %	38 %

The June 2001 poll also found that 28 % of respondents said that they used less electricity during peak hours (a dramatic increase from the 0 percent and 2 percent reported in the January and February polls, respectively).

To explore motivations to conserve, those that reported conserving were further asked:

Did you cut back more to conserve in a time of shortages, or to save money?

LA Times/Roper Center 2001	Jan	Feb	June
Conserve because of shortage	15 %	20 %	24 %
Save money	27 %	24 %	25 %
Both	34 %	44 %	41 %

The Energy Commission/WSU surveys (conducted in 2001 and 2002) asked a series of very detailed questions about conservation actions taken by households in response to the crisis. Respondents were able to report their actions in their own words and these were classified into 70+ action types, which were subsequently collapsed into 11 categories. These included a number of ”hardware” (efficiency investments) and ”behavioral” actions. The results are presented in Figure 8 below. A high proportion (75 percent) of the population reported taking some kind of action to conserve.

Among those who reported conservation actions in the Energy Commission/WSU survey, the largest proportion said that they were motivated by an interest in preventing system black-outs, with large majorities also reporting other altruistic

motives, as well as self-interest in keeping bills down (Lutzenhiser, et al. 2002). Figure 7 presents the range of motivations reported.

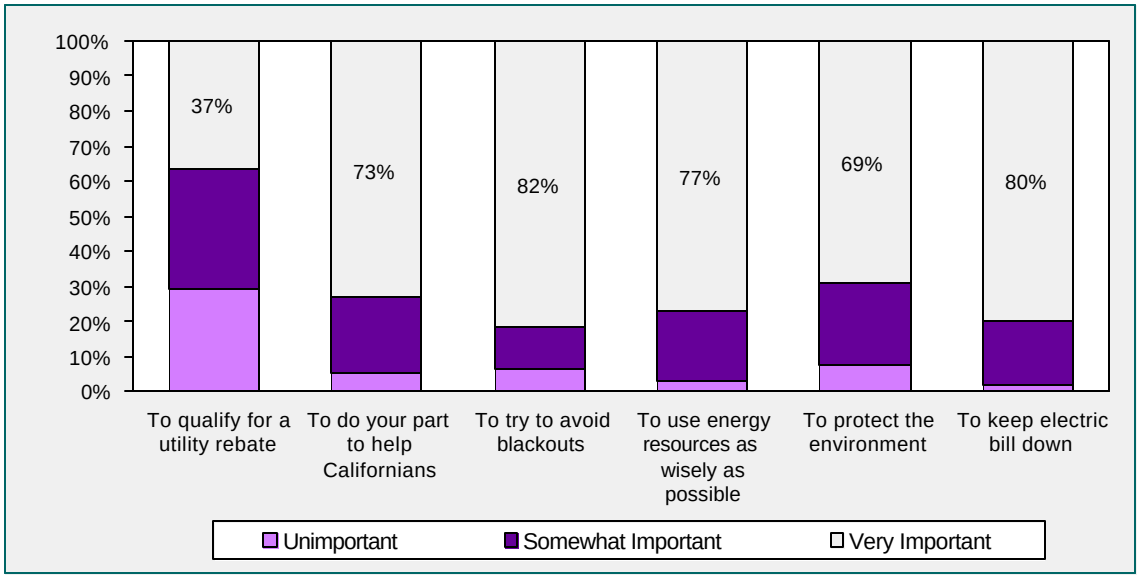

Figure 7. Motivations for Conservation Behaviors 2001

Behavior Change and Energy Efficiency Investment

While the actions reported in the Energy Commission/WSU surveys are similar to those reported in the Times/Roper polls, additional details in the former describe the wider variety of conservation actions taken. The Energy Commission/WSU surveys also offer evidence that conservation and energy efficiency actions were continuing a year after the crisis. As noted in Figure 8, both ”hardware” and ”behavioral” changes were reported. The latter ranged from turning lights off in unoccupied rooms to using hot water more sparingly, shifting laundry and dishwashing to off-peak hours, using air conditioning more sparingly, and even not using air conditioning (despite hot summer temperatures). While some of these responses may only be expected during crisis conditions, others seem to have been part of older habit sets that were reactivated by the crisis (and that might be reactivated in the future). It is also important to note that the behavioral changes reported offer evidence of some of the inherent ”flexibility” or ”elasticity” of energy needs, energy demands, and even comfort standards—flexibility that had not been envisioned prior to the crisis by energy efficiency planners and policy makers.

A number of longer-lasting hardware improvements to appliance stocks and buildings were also reported by consumers. Not surprisingly, there were fewer of these actions than behavioral changes. However, they offer some insights into household willingness to make investments in higher-efficiency equipment when a need and opportunity is presented. While the long-term persistence of behavioral shifts (and their effects) may be problematic, the hardware improvements can be

expected to be longer-lived (with appropriate caveats about expanded consumption in other areas, "snap-back", etc.) [7] .

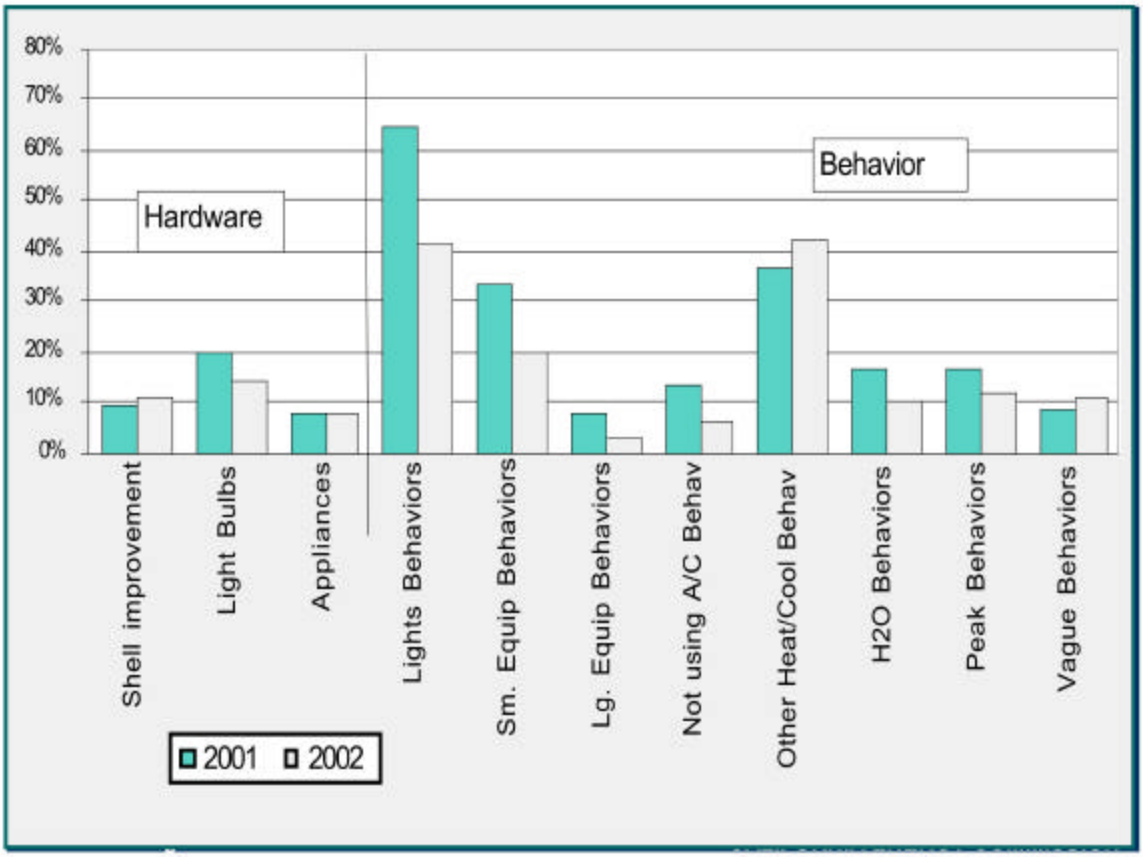

Figure 8. Conservation Behaviors and Efficiency Investments Reported by California Households in 2001 and 2002

Efficiency improvement did not stop with the passing of the crisis. When considering the potential for future efficiency investments (such as appliance replacement or building shell improvements), a significant proportion of consumers surveyed believed that their major appliances and HVAC systems were candidates for replacement. The following percentages of Energy Commission/WSU respondents reported:

[7] Snap-back is the erosion of efficiency gains as a result of altered comfort standards or usage patterns.

"…having an appliance that was old enough to replace."

Energy Commission/WSU Study (2001) -"old enough to replace"	
Refrigerator *	22 %
Central AC	19 %
Furnace	12 %
Clothes Dryer *	10 %
Clothes Washer *	7 %
Window AC	6 %
Dishwasher	5 %

Energy Commission/WSU 2001 survey respondents who were re-surveyed in 2002 were also asked which appliances that they had *actually* replaced over the past year. It is interesting to note that the most frequently replaced items (asterisked above) were refrigerators, washers and dryers. Central air conditioning and furnaces, although "old enough" to be replacement candidates, were very rarely replaced. Also, when making their choice of replacement appliance, 3/4 of the purchasers reported that they were "taking energy into account" in their purchase decision.

When it comes to shell improvements, there is also a significant stock of buildings whose owners perceive them to be candidates for improvement. When Energy Commission/WSU respondents were asked how energy efficient their house was, they reported the following:

Energy Commission/WSU (2001)	
Home is very efficient	27 %
About average	50 %
Not very efficient	23 %

It is not the case that the lowest income households with the poorest housing were those most likely to report their homes as inefficient. When income is considered, these assessments are quite similar across income groups.

Inconvenience and Suffering (and Making Things Better)

It is clear that persons can and did save energy, both as a result of making behavioral changes and efficiency investments. They also strongly supported state efforts to promote and facilitate conservation. And they also see further efficiency improvements as possible. However, were their actions inconvenient? Painful? Difficult to imagine being repeated except under unusual circumstances?

The Field Institute surveys in January and May 2001 shed some light on consumers' views of their conservation experiences. In the January 2001 poll, respondents were asked, "How much your household can conserve without major inconvenience?" The results showed some surprisingly large estimates (e.g., 42 percent estimated"20 percent or more").

Field Poll 2001	January
0 %	6 %
1-9 %	11 %
10-19 %	30 %
20-24 %	13 %
25-39 %	16 %
40+ %	13 %
Don't Know	11 %

The median estimate was a 15 percent cutback. The poll further reported that the majority of the public thought that only voluntary efforts (not government mandates) were needed to achieve an overall 10 percent cutback in electricity use.

The May 2001 Field Institute survey posed a follow-up question regarding"*…how much you have cut back on electricity usage since the state of the energy crisis?"* A large percentage (although smaller than the January estimates) reported 20+ percent savings rates. Overall, a vast majority (80 percent) of households reported cutting back to some degree on electricity usage.

Field Poll 2001	May
0 %	15 %
5 %	17 %
10 %	25 %
15 %	14 %
20+ %	24 %

Energy Commission/WSU survey asked respondents about their experiences *after* having taken conservation action—e.g., "Do you think the things you've done to reduce your energy use have decreased the quality of your life, made you somewhat less comfortable, had no serious effect or possibly improved the quality of your life?" The results were surprising, with a large majority reporting either "no serious effect" (55 percent) or "possibly improved quality of life" (22 percent). All of the responses are presented in Figure 9 below.

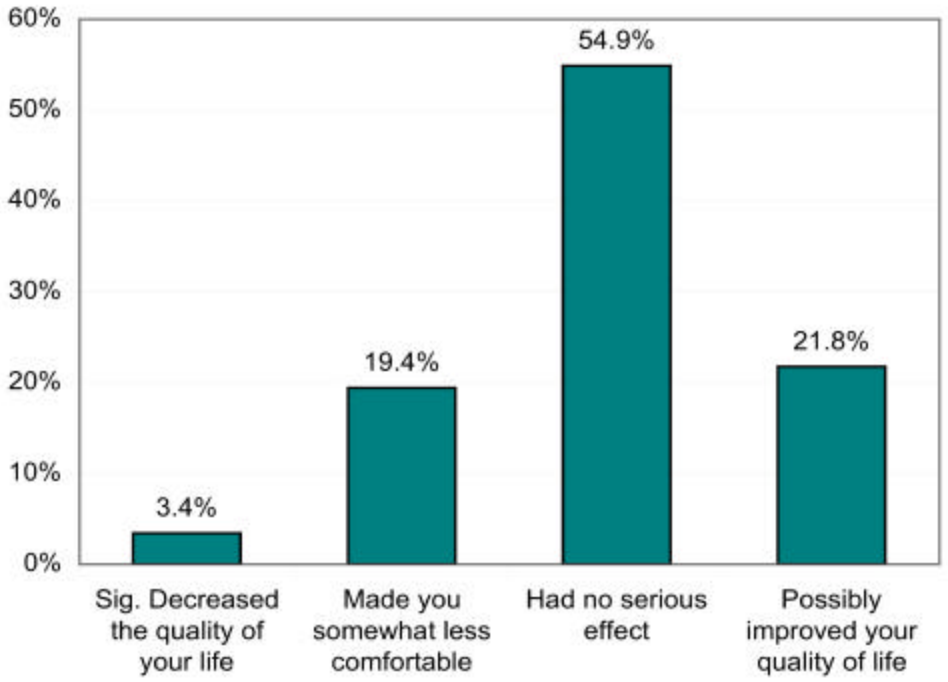

Figure 9. Quality of Life Impacts

A year later, in the 2002 Energy Commission/WSU follow-up survey, among those who conserved, 60 percent *disagreed* with the statement "my conservation efforts involved real sacrifices."

During non-crisis periods, various governmental and non-governmental programs are concerned with and act to address equity issues. Although everyone suffers during a crisis, a larger burden was perceived to fall on the low-income population (although protections from rate increases for the lowest usage tiers should have shielded many of the lowest income from the price effects of the crisis). The 2002 Energy Foundation survey reported the following responses to the question:

"Who has suffered the most from the energy crisis?"

The Energy Foundation	Feb
General Consumer	29 %
Low Income	31 %
Business (General)	15 %
Small Business	19 %

The June 2001 Times/Roper poll reported that 43 percent of respondents said the current rates were ”not a financial problem”, for them, while 27 percent said they were a ”big problem” and 29 percent a ”small problem.” Interestingly, at this time very few residential consumers would have experienced any rate hikes (and ultimately many/most households were protected from price increases, which tended to be focused on the highest usage customers).

Prospects for the Future

Californians seemed to be thoughtful and sober about longer-term energy and environmental problems and prospects. The 2001 and 2002 Energy Commission/WSU surveys asked consumers about whether energy problems can be solved without lifestyle changes or if ”real changes” would be required in the long term. A surprising large majority indicated that real changes were needed (see Figure 10).

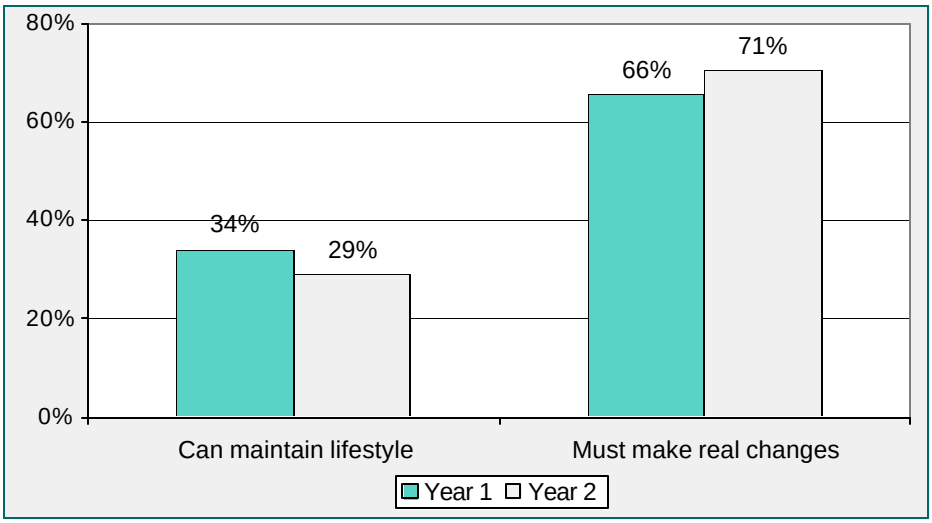

Figure 10. Lifestyle Changes Need to Solve Energy Problems?

A similar question asked in the June 2002 PPIC survey found that 53 percent believed that major lifestyle changes would be needed to solve today’s *environmental* problems, while 44 percent said that few or no changes are needed, and 3 percent did not know (June 2002, PPIC C&E survey).

Figure 11 shows the range of responses to another series of forward-looking questions about energy and environmental problems asked in the 2002 Energy Commission/WSU survey. Large majorities indicate belief in serious future problems in several key areas, including: energy supply, prices, pollution, toxics, and environmental impacts. Although these are very high proportions, they are not at all out of line with the general thrust of other California and U.S. public opinion studies.

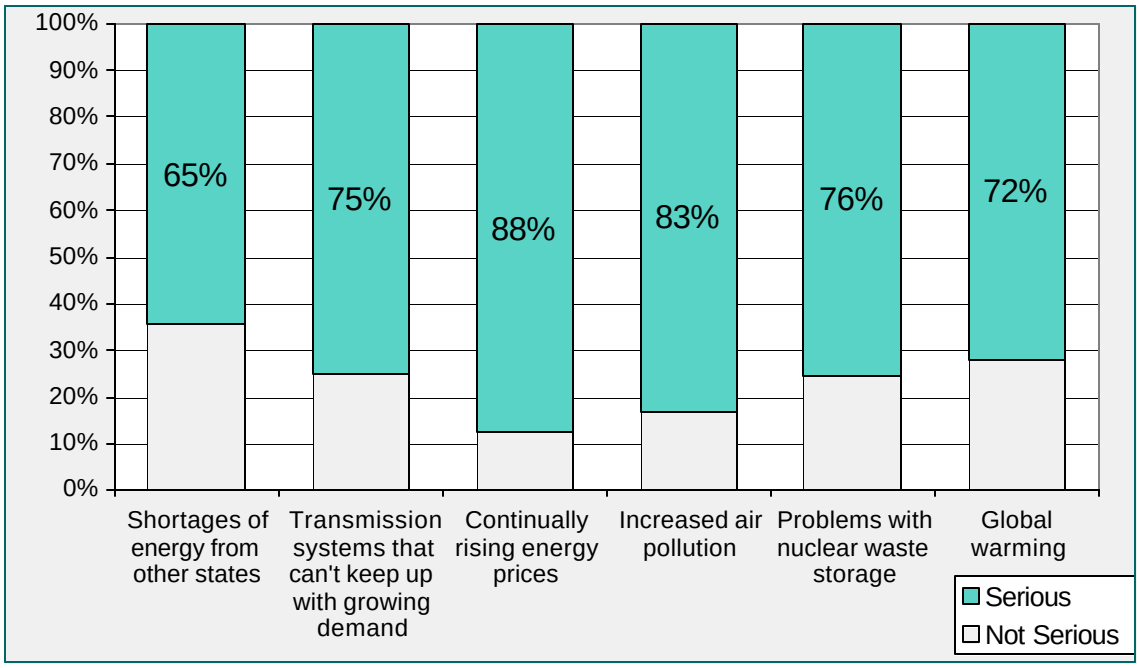

Figure 11. Perceived Seriousness of Future Energy and Environmental Problems

Policy Support

The perceived seriousness of these problems is also expressed in a variety of policy preferences expressed by Californians in the surveys reviewed. A strong and consistent theme is environmental protection and support for environmentally-conscious policies, in many cases despite possible economic and system reliability consequences.

For example, the Energy Commission/WSU surveys found extremely high proportions (from 87 percent to 97 percent) in favor of energy conservation, efficiency, and development of renewable energy sources (see Figure 12).

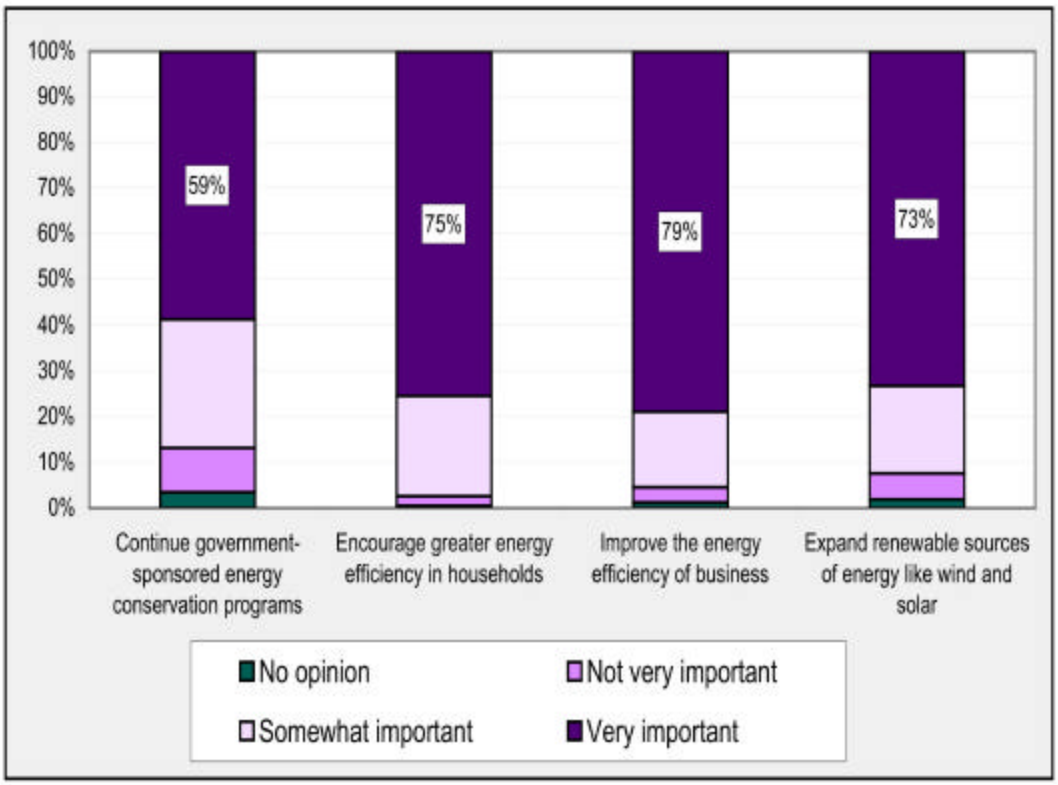

Figure 12. The Importance of Energy Efficiency and Renewable Resources

Similar results were reported in 2002 and 2004 PPIC surveys. The Energy Foundation's 2002 polling also showed very large majorities (e.g., 84 percent) in favor of alternative energy sources, as well as increased efficiency standards—even imposed on the hugely popular SUV (64 percent favoring new gas mileage requirements).

Double the use of alternative energy sources by 2010?

The Energy Foundation 2002	
Strongly Favor	60 %
Somewhat Favor	24 %
Somewhat Opposed	7 %
Strongly Opposed	5 %

Increase gas mileage requirements for SUVs?

The Energy Foundation 2002	
Strongly Favor	47 %
Somewhat Favor	17 %
Somewhat Opposed	12 %
Strongly Opposed	17 %

In order to reach a proposed goal of *doubling* renewable energy supplies, 71 percent of the Energy Foundation respondents reported a willingness to pay (along with all other energy consumers) an additional $1.50 per month; 50 percent were willing to pay an additional $3 per month. [8]

Energy Foundation survey questions concerning activities implemented to solve the 2000-2001 California energy crisis revealed that Californians tended to disagree with state policies to relax pollution standards and accelerate the building of fossil fuel generation. For example, 70 percent of respondents believed that developing alternative or renewable energy sources was more important in terms of California's energy policy (vs. 22 percent supporting fossil fuel generation). A very large majority (71 percent) held the belief that then-current policy emphasized building more traditional sources of generation versus (their preferred) alternative sources.

In addition, 82 percent "somewhat" or "strongly" favored a policy that requires activation of the cleanest available energy supplies before *tapping* other fuel sources (rather than the use of all potential generating facilities regardless of pollution created). And 43 percent opposed continuing the temporary set-aside of air quality standards for any additional amount of time in order to encourage the rapid development of energy plants (4 percent supported continuing the set aside for 6 months, 12 percent for an additional year, while 34 percent thought the set aside should be no more than absolutely necessary, and 6 percent did not know).

The February and June 2001 LA Times/Roper Center surveys asked several questions concerning what energy sources the state energy policy should focus on for greater stability and lower bills. In February 65 percent opposed (54 percent "strongly opposed" and 11 percent "somewhat opposed") the easing of federal environmental regulations to allow for pollution limits to be exceeded in order to increase the output of electricity. Even in the middle of the energy crisis, there was further evidence that environmental values did not erode in questions regarding the lifting of the moratorium on drilling for oil off the California coast. A large majority (64 percent) disapproved lifting the moratorium, while 31 percent approved.

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[8] In response to: "In order to achieve the goal of doubling renewable energy supplies in California by the year 2010, would you be willing to pay—along with all other energy customers—an additional 1 dollar and 50 cents per month? (Question repeated at $3 level). Presumably the additional money would be paid via utility bills to support state programs related to renewable energy supplies.

Further evidence of widespread support for a general pro-environment stance is found in the June 2002 PPIC survey responses to two alternating questions: (1) ”Protection of the environment should be given priority, even at the risk of limiting the amount of energy supplies—such as oil, gas, and coal—which the U.S. produces” and (2) ”Development of U.S. energy supplies—such as oil, gas, and coal—should be given priority, even if the environment suffers to some extent.” In response, 65 percent choose protection of the environment, 29 percent development of U.S. energy supplies, and 6 percent did not know or did not answer.

In that same survey, 85 percent favored doubling the state’s utilization of alternative forms of energy. These reports of environmental concern are consistent with power supply questions polled in the PPIC’s 2001 survey—where 54 percent supported an energy policy concentrating on conservation and regulation, and 39 percent approved of building new electricity generation plants.

The preferred power sources for new electric power plant in California (if built) in 2001 were: hydro-power (42 percent), natural gas power (25 percent), nuclear power (17 percent), and coal power (2 percent).[9] “However, looking beyond the more conventional choices, there is strong support for increasing renewable sources of energy. Two in three Californians say they would favor developing more solar and wind power, even if it meant higher electricity prices”(PPIC press release July 2001).

Strong support for *non-nuclear* energy alternatives was also found in the 2001 LA Times/Roper poll, along with willingness to see *non-nuclear* plants sited in home communities, and continuing opposition to new nuclear power plants.

Support for new non-nuclear power plant development?

LA Times/Roper Center 2001	Feb	June
Strong Favor	65 %	62 %
Favor	18 %	25 %
Opposed	5 %	4 %
Strong Opposed	7 %	5 %
Not Sure	5 %	3 %

Non-nuclear plant built in your community?

LA Times/Roper Center 2001	Feb	June
Willing	62 %	60 %
Not Willing	15 %	18 %
Depends	5 %	5 %
Not Sure	2 %	4 %

[9] 3% reported “other” and 11% “did not know”.

New nuclear power plant development?

LA Times/Roper Center 2001	Feb	June
Strong Favor	19 %	24 %
Favor	14 %	19 %
Opposed	13 %	11 %
Strong opposed	47 %	35 %
Not Sure	7 %	10 %

In addition, 62 percent of respondents reported that they thought that California depends ”too little” on alternative sources such as solar and wind generators.

Finally, the January 2001 Field/California poll sought opinions regarding four proposals related to demand/supply-side management strategies. *Recall that these opinions were solicited during the energy crisis and reflect reactions to conditions and uncertainties of that period*. At the same time, these findings shed some light on views of such policies in non-crisis conditions—e.g., when they might be viewed even less favorably. Of the policy options presented to respondents, the only proposal that received majority approval was to ”ask all consumers for a 10 percent reduction in their consumption amounts and penalize those consumers that fail to achieve this goal.” Opinions on a ”time-of use” pricing strategy were nearly evenly split (48 percent approving, 50 percent opposing). ”Rolling blackouts” (78 percent opposed) and ”setting a household quota for electricity usage” (68 percent opposed) were widely unacceptable.

Conclusions

From our review of the public opinion polling and social surveying literature, particularly focusing on work done in California from 2000 through 2004, we identify the following conclusions of relevance to the AB549 process:

- A number of polls and surveys were conducted in California during and after the 2000-2001 energy crisis that included a wide range of energy-relevant questions posed to California residential consumers. There is substantial agreement in their findings.
- Despite crises and uncertainties about energy, Californians continue to hold the pro-environmental, pro-conservation and pro-renewable energy views consistently reported by pollsters across the U.S. over the past three decades.
- Citizen/consumers favor a strong role for government in addressing energy and environmental problems.
- There are high levels of approval for state and utility-sponsored energy conservation and efficiency policies and programs. Significant funding levels have been seen as justified and persons are somewhat willing to pay from their own resources to achieve conservation goals.
- There is a sense of the importance of a shared responsibility for solving energy problems. Government, business and consumers all need to take responsibility.

- Persons were willing to conserve during the crisis and there is substantial evidence that they did so.
- They were motivated by altruistic considerations more than financial ones (altruistic motives were frequently reported, and actual price impacts were minimal across much of the population).
- Efficiency (hardware) investments as well as behavioral changes were undertaken during the crisis.
- Persons also see opportunities for further efficiency improvements in appliances and buildings.
- They were not generally inconvenienced or made to suffer by their conservation actions. Some actually reported an improvement in their quality of life.
- Californians also perceive equity impacts that need to be addressed in policy and programs.
- Persons believe that real changes are needed in the future to solve energy and environmental problems, and they are aware of a wide range of those problems and express considerable concern about their seriousness.
- They very strongly support continued energy conservation and renewable energy programs.
- They very strongly oppose environmental degradation as a cost of increasing energy supplies, and they strongly oppose certain energy sources (e.g., nuclear and coal), while strongly favoring others (hydro, solar, and other renewables).
- The PPIC's Mark Baldassare sums up the most recent California public opinion in this area as"…many are calling for environmental actions that serve multiple purposes—cleaning dirty air, improving fuel efficiency and developing alternative energy sources."(Sacramento Bee 2004).
- AB549 planners and legislators can have confidence that Californians are likely to support programs to reduce wasteful energy use in existing buildings, particularly when those programs are perceived to be fair, reasonable and effective.

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APPENDIX E: ADDITIONAL MARKET SEGMENTATION STRATEGIES

This section contains an analysis of the Residential Appliance Saturation Survey (RASS) to obtain additional information for developing interventions and estimating the energy and demand savings potential of these interventions. The goals of this analysis were to:

- Identify patterns of segmentation of California consumer markets,
- Identify sub-groups of consumers who are better able and/or more likely than others to undertake conservation/efficiency actions.
- Better understand of the sizes and characteristics of specific sub-groups of hard-to-reach consumers.

This section is organized in four major subsections. Following this introduction, data and methods used for segmentation analysis are discussed. The next section summarizes key segmentation issues for a range of residential technologies—from refrigerators, clothes washers and other appliances, to air conditioners, lighting, pools, and shell upgrade potentials (e.g., windows and insulation). The last section examines technological and behavioral differences in hard-to-reach segments, specifically non-English speakers (primary language) and low-income households. Detailed tables of social segmentation for all of the technologies, building characteristics, and behaviors considered are included at the end of the section.

Data and Methods

The RASS Data Set

Data on residential sector energy use and efficiency choice are not widely available, and when they can be obtained they are often incomplete. . For example, they may include information on hardware but not occupants, or information on consumers' attitudes but little on their behavior or technologies. Fortunately, several of the major utilities within the state of California, coordinated by the Energy Commission, have recently completed a survey of California residential consumers' appliance holdings and dwelling characteristics. Billing information has also been added to the survey results, and estimates have been made of electricity consumption at the end-use level (e.g., average annual energy use for refrigerators, water heaters, pool pumps, etc.). This "Residential Appliance Saturation Survey" (RASS) provides information to support utility and state forecasting and planning efforts. The RASS is fairly current (the data were collected in 2003) and it contains fairly high quality information on a range of technical as well as social variables. [10] The following (from the RASS documentation) provides some useful background information on the data collection and post-survey processing.

[10] See the Energy Commission RASS website at: http://www.energy.ca.gov/appliances/rass/

"For the first time in California, the large Investor Owned Utilities (IOUs) pooled resources and performed a RASS and Unit Energy Consumption (UEC) Study as a team. The project was administered by the Energy Commission and sponsored by Pacific Gas and Electric (PG&E), San Diego Gas and Electric (SDG&E), Southern California Edison (SCE), Southern California Gas Company (SoCal Gas), and Los Angeles Department of Water and Power (LADWP). KEMA-XENERGY was the prime consultant. Itron provided data cleaning and performed the Conditional Demand Analysis. RoperASW fielded the non-response follow-up.

The RASS effort has resulted in a research product that provides both statewide and utility-specific results. The study was designed to allow comparison of results across utility service territories, climate zones and other variables of interest (i.e. dwelling type, dwelling vintage, and income). The study includes results for 21,920 residential customers that are weighted to the population represented by the sponsoring utilities. The saturation results capture both individual and master metered dwellings. This rich set of customer data includes information on all appliances, equipment, and general usage habits. The study also includes a detailed conditional demand analysis (CDA) [our note] that calculates unit energy consumption (UEC) values for all individually metered customers.

The study was initiated in late 2002 and the sampling plans and survey implementation occurred throughout 2003. The results from the RASS study were used to develop a CDA model. This analytical method uses a combination of customer energy use with the responses from the customer survey to model end uses and develop unit energy consumption results for those end uses. (KEMA-XENERGY 2005)

Data Access and Limitations of the Analysis

Unfortunately, the RASS data could not be obtained in a form that was easy to analyze. We would have preferred to use a file containing the basic household level data to examine the relationships among relevant social and technical variables. This would allow us to construct a detailed and nuanced picture of how appliance holdings and dwelling characteristics are socially segmented in California. However, unresolved issues related to data ownership and public access meant that we could not obtain the data set, even for the purposes of the AB549 study.

Instead, we were forced to access the data through a fairly cumbersome and time-consuming process that involved a web browser-based data access arrangement. [11]

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[11] The KEMA-XENERGY website maintains the RASS database, which is publicly available via a query process. As the site states: *"The RASS Reports banner allows users to perform interactive queries on the database as well as to access specific UEC results. Please register as a first time user or sign in to obtain access to the results pages.* Database location: http://websafe.kemainc.com/RASSWEB/DesktopDefault.aspx

As a result, we were limited to fairly simply queries, a small range of social variables (which could not practically be combined), and a ”copy and paste” strategy for saving tabulations (downloadable reports are not supported). Because we had very limited time and resources available, we focused only on the most obvious and important social segmentation variables (e.g., income, home ownership/renter status, and ethnicity), and on technologies that use the largest amounts of electricity (e.g., refrigerators, air conditioners, pools, etc.).

Distributions of Basic Variables

Unit energy consumption (UEC) estimates, along with appliance ”saturations” (i.e., proportions of the population reporting ownership of each piece of hardware) are reported in Table 16 for different housing types (single family detached, apartments, mobile homes, etc.). These values are based on the sample data (21,920 cases) and the numbers of sample households are reported for each building type on the table.

Table 16. Saturations–RASS 2004

	Single Family		Town Home		2-4 Unit Apt		5+ Unit Apt		Mobile Home	
	UEC	Sat.	UEC	Sat.	UEC	Sat.	UEC	Sat.	UEC	Sat.
All Household	7,105	13,82 homes	4,469	1,780 homes	3,877	1,608 homes	3,807	3,377 homes	5,662	563 homes
Conv. Elec. heat	1,494	0.04	724	0.06	584	0.15	658	0.23	1,150	0.1
HP Elec. heat	1,077	0.01	392	0.01	315	0.02	335	0.05	1,031	0.03
Aux Elec. heat	296	0.28	114	0.21	85	0.19	74	0.13	298	0.31
Furnace Fan	162	0.68	73	0.54	65	0.32	51	0.26	118	0.58
Central Air	1,423	0.46	713	0.41	1,019	0.28	749	0.32	1,143	0.39
Room Air	227	0.15	148	0.14	120	0.16	105	0.22	227	0.34
Evap Cooling	688	0.05	595	0.02	374	0.02	403	0.02	537	0.27
Water Heat	3,079	0.05	1,723	0.04	1,657	0.09	1,567	0.1	3,258	0.17
Solar Water Heater	1,708	0	407	0	.	0	32	0	.	0
Dryer	713	0.34	591	0.32	429	0.17	548	0.17	549	0.42
Clothes Washer	127	0.95	63	0.76	62	0.37	14	0.26	11	0.86
Dish Washer	84	0.7	63	0.61	66	0.38	59	0.48	47	0.55
First Refrigerator	824	1	769	1	722	1	721	1	809	1
Second Refrigerator	1,245	0.25	739	0.11	700	0.06	586	0.04	1,143	0.13
Freezer	937	0.24	877	0.09	964	0.07	908	0.04	951	0.3
Pool Pump	2,671	0.14	.	0	.	0	.	0	.	0
Spa	467	0.13	270	0.03	.	0	.	0	180	0.03
Outdoor Lighting	284	0.67	173	0.56	228	0.32	206	0.25	232	0.56
Range/Oven	301	0.41	240	0.44	191	0.41	207	0.49	208	0.27
TV	519	0.96	465	0.92	439	0.92	436	0.96	457	0.93
Spa Electric Heat	1,719	0.07	694	0.02	.	0	.	0	3,550	0.02
Microwave	140	0.97	125	0.92	125	0.91	122	0.92	113	0.96
Home Office	148	0.2	158	0.19	145	0.17	144	0.15	121	0.13
PC	578	0.75	591	0.68	521	0.54	532	0.59	458	0.45
Water Bed	840	0.02	748	0.02	732	0	757	0.01	773	0.03
Well Pump	862	0.05	842	0.01	911	0.01	816	0.01	724	0.18
Miscellaneous	2,147	1,532	1,339	1,257	1,462					

Please note that all of the other tables in this report present weighted *population estimates*—the default output of queries generated on the KEMA-XENERGY interactive web database. Also note that these are not state-level estimates (although they are likely to be close), since they represent a weighting of cases to

the populations only of the *sponsoring utilities*. A number of smaller public and coop utilities are not included in from those estimates.

Also note that the *total number* of cases varies across tables in this report. This is because ”refusal”, “no response”, and ”don’t know” categories (which are different for different variables) are generally excluded from our analysis for ease of interpretation.

Table 17 reports the distribution of cases across the 13 Energy Commission climate zones sampled in the RASS study. The largest population clusters are, of course, in the Bay Area and Southern California.

Table 17 RASS Case Distribution.

Energy Commission Climate zone	Count	
CZ 1 Arcata	272,949	3 %
CZ 2 Santa Rosa	340,998	3 %
CZ 3 Oakland	816,480	8 %
CZ 4 Sunnyvale	1,592,666	15 %
CZ 5 Santa Maria	1,227,998	12 %
CZ 7 San Diego	193,170	2 %
CZ 8 El Toro	1,567,414	15 %
CZ 9 Pasadena	1,233,479	12 %
CZ 10 Riverside	1,017,247	10 %
CZ 11 Red Bluff	624,270	6 %
CZ 12 Sacramento	270,932	3 %
CZ 13 Fresno	1,190,204	12 %
Totals	10,347,808	100 %

Four Energy Commission climate zones are not included in the RASS survey: CZ6-Los Angeles, CZ14-China Lake, CZ15-El Centro, and CZ16: Mount Shasta

Table 18 shows population-weighted estimates of the sizes of consumer segments defined by dwelling type. The single family detached type represents about 57 percent of all units, with 39 percent in multi-unit buildings and 5 percent being mobile homes.

Table 18. Building Type

	Total	
SINGLE FAMILY DETACHED	5,417,201	57 %
TOWNHOUSE, DUPLEX, OR ROW HOUSE	731,198	8 %
APARTMENT OR CONDO (2-4 UNITS)	965,513	10 %
APARTMENT OR CONDO (5+ UNITS)	2,034,775	21 %
MOBILE HOME	445,110	5 %
Totals	9,593,797	100 %

Table 19 focuses on annual household income as a second key segmentation dimension. The income distribution is quite broad—with nearly a third (27 percent) having fairly low incomes (<$25K/yr) and a similar percentage (28 percent) having incomes above $75K/yr.

Table 19. Annual Income

	Count	
LESS THAN $25K	2,373,149	27 %
$25-35K	1,199,789	14 %
$35-50K	1,193,071	13 %
$50-75K	1,598,756	18 %
$75-100K	927,183	10 %
OVER $100K	1,562,470	18 %
Totals	8,854,421	100 %

Table 20 shows home ownership (a third key dimension) to be the dominant pattern, with renters representing only about 38 percent of the population.

Table 20. Own or Rent Home

	Count	
OWN	5,861,028	61 %
RENT	3,664,862	38 %
NO RESPONSE	67,907	1 %
Totals	9,593,797	100 %

Table 21 reports primary language spoken at home. English is by far the most common, at 81 percent. However, 29 percent of all households do not speak English at home (by far the largest share of that group speaks Spanish).

Table 21. Primary Language Spoken in Home

	Count	
ENGLISH	8,221,569	81 %
SPANISH	1,351,971	13 %
ASIAN	412,969	4 %
OTHER	156,568	2 %
Totals	10,143,077	100 %

Table 22 shows that the vast majority of respondents are living in their year-round residences. About 2 percent of the cases were dwellings occupied only part of the year. These cases were excluded the analyses in this report.

Table 22. Residency

	Count	
FULL YEAR RESIDENT	10,147,482	98 %
PARTIAL YEAR RESIDENT	200,326	2 %
Total	10,347,808	100 %

Relationships among Segmentation Variables

Some important insights into the structure of consumer segmentation can be gained from examining the relationships among key social segmentation variables. Table 2–8 through 2–13 present two and three-way cross-tabulations of ownership, income, building type, and building size data. They reveal some important patterns among segmentation variables that are likely to influence appliance saturations. But these could not be directly examined with the techniques that we were required to use in our analysis. [12]

Table 23 shows the relationship between home ownership/renter status and dwelling type. The vast majority (79 percent) of owner-occupied units are single-family detached houses. Renters, on the other hand, were much more likely (77 percent of the time) to live in multi-unit structures. These two variables are very highly correlated in the California case.

Table 23. Building Type by Own or Rent Home

	Own		Rent		Total	
SINGLE FAMILY DETACHED	4,631,631	79 %	847,652	23 %	5,479,283	58 %
TOWNHOUSE, DUPLEX, ROW HOUSE	327,271	6 %	323,522	9 %	650,793	7 %
APARTMENT OR CONDO (2-4 UNITS)	187,070	3 %	727,519	20 %	914,589	10 %
APARTMENT OR CONDO (5+ UNITS)	291,935	5 %	1,675,407	46 %	1,967,341	21 %
MOBILE HOME	371,924	6 %	43,297	1 %	415,221	4 %
OTHER	51,197	1 %	47,466	1 %	98,663	1 %
Totals	5,861,028	100 %	3,664,863	100 %	9,525,890	100 %

Table 24 considers the relationship between income and ownership status. Not surprisingly, 59 percent in the lowest income group are renters, while 66 percent in the middle income group are homeowners, as are a very large proportion (85 percent) of the highest income group.

[12] Once again, this was due to limited time and resources, as well as the limitations of the KEMA/XENERGY web database.

In many cases, a larger number of original RASS categories have been collapsed in order to display a manageable amount of information. This is true in the case of income, where 6 RASS categories have been merged into 3 categories for analysis. While we do not claim that <$35K is necessarily a ”low” income, it can be—and for many couples and families it is low enough to make elective purchase of energy-saving equipment or building upgrades unimaginable. On the other hand, incomes above $75K/yr probably do allow for a fairly wide range of voluntary purchases, while incomes in the middle ($35K-75K) range can support home improvements and new appliance purchases fairly easily, particularly with credit.

Table 24. Own or Rent Home by Income Ranges

	< $35K		$35-75K		$75K+		Total	
OWN	1,460,394	41 %	1,814,217	66 %	2,096,738	85 %	5,371,349	61 %
RENT	2,064,798	59 %	952,943	34 %	369,065	14 %	3,386,806	39 %
Totals	3,525,192	100 %	2,767,160	100 %	2,465,803	100 %	8,758,155	100 %

Table 25 examines the relationship between income and building type, and Table 26 and Table 27 drill deeper, by looking at that relationship within the home owner and renter segments. They show that lower income households are more likely to live in multi-family dwellings, and particularly within the renter category, where less than 454K (23 percent within that income group) live in detached structures. The highest income group is much more likely to live in single-family buildings, and among higher income homeowners, that proportion reaches 85 percent.

Table 25. Building Type by Income

	< $35K		$35-75K		$75K+		Total	
SINGLE FAM DETACHED	1,513,581	42 %	1,697,619	61 %	1,894,641	76 %	5,105,842	58 %
TOWN, DUPLEX, ROW	247,569	7 %	197,767	7 %	218,982	9 %	664,319	8 %
APT OR CONDO (2-4)	535,169	15 %	222,248	8 %	110,247	4 %	867,665	10 %
APT OR CONDO (5+)	989,259	28 %	601,142	22 %	243,508	10 %	1,833,909	21 %
MOBILE HOME	287,360	8 %	73,051	3 %	22,275	1 %	382,686	4 %
Totals	3,572,938	100 %	2,791,827	100 %	2,489,653	100 %	8,854,421	100 %

Table 26. Building Type by Income Range (Own)

	< $35K		$35-75K		$75K+		Total	
SINGLE FAM DETACHED	927,686	70 %	1,326,029	81 %	1,601,694	85 %	3,855,409	80 %
TOWN, DUPLEX, ROW	46,607	4 %	90,171	6 %	128,110	7 %	264,887	5 %
APT OR CONDO (2-4)	56,270	4 %	54,220	3 %	55,721	3 %	166,210	3 %
APT OR CONDO (5+)	57,623	4 %	105,404	6 %	85,841	5 %	248,868	5 %
MOBILE HOME	230,008	17 %	61,580	4 %	20,725	1 %	312,312	6 %
Totals	1,318,194	100 %	1,637,404	100 %	1,892,091	100 %	4,847,686	100 %

Table 27. Building Type by Income (Rent)

	< $35K		$35-75K		$75K+		Total	
SINGLE FAM DETACHED	454,029	23 %	211,247	23 %	108,732	31 %	774,008	24 %
TOWN, DUPLEX, ROW	168,806	9 %	71,977	8 %	55,139	16 %	295,922	9 %
APT OR CONDO (2-4)	450,051	23 %	157,396	17 %	41,335	12 %	648,783	20 %
APT OR CONDO (5+)	868,583	44 %	473,936	52 %	142,660	41 %	1,485,180	46 %
MOBILE HOME	32,420	2 %	4,604	1 %	190	0 %	37,215	1 %
Totals	1,973,889	100 %	919,160	100 %	348,056	100 %	3,241,108	100 %

Table 28 shows the relationship between building size and owner/renter status. Table 29 then adds consideration of income within the owner and renter segments. About 65 percent of renters live in units of 1000 square feet *or less*. We can also see that owners are much more likely to live in dwellings that have at least 1250 square feet (74 percent). However, there is also a strong income effect. Within the owner category, 66 percent of the lowest income group lives in buildings with 1500 square feet or less. That proportion drops to 47 percent in the middle income group, and in the highest income group of home owners 74 percent live in dwellings of 1500 square feet *and larger*. Among renters, there is a less pronounced income effect with households at all income levels living in smaller (e.g., <1500 sq ft) units—although there is some increase in size with increase in income (e.g., with 95 percent, 92 percent and 71 percent for each of the income groups, low to high, living in units smaller than 1500 sq ft).

Table 28. Square Feet of Living Space

	Own		Rent		Total	
750 SQFT or LESS	167,353	3 %	1,072,639	34 %	1,239,991	13 %
751-1000 SQFT	450,678	8 %	985,957	31 %	1,436,635	16 %
1001-1250 SQFT	866,670	15 %	515,713	16 %	1,382,383	15 %
1251-1500 SQFT	1,093,341	18 %	301,520	10 %	1,394,862	15 %
1501-2000 SQFT	1,636,606	27 %	183,471	6 %	1,820,078	20 %
2001-2500 SQFT	904,267	15 %	86,361	3 %	990,629	11 %
2501-3000 SQFT	494,177	8 %	24,340	1 %	518,517	6 %
3001-5001+ SQFT	383,666	6 %	17,755	1 %	401,422	4 %
	5,996,758	100 %	3,187,756	100 %	9,184,517	100 %

Table 29. Square Feet of Living Space (Own)

	< $35K		$35-75K		$75K+		Total	
750 SQFT or LESS	101,411	8 %	40,805	2 %	11,253	0.5 %	153,469	3 %
751-1000 SQFT	192,175	15 %	118,025	7 %	71,916	3.5 %	382,116	8 %
1001-1250 SQFT	255,386	20 %	296,888	17 %	193,831	9.5 %	746,105	15 %
1251-1500 SQFT	283,784	23 %	372,672	21 %	264,128	12.9 %	920,584	18 %
1501-2000 SQFT	280,306	22 %	534,051	31 %	555,779	27.1 %	1,370,136	27 %
2001-2500 SQFT	76,948	6 %	253,379	15 %	410,805	20.1 %	741,132	15 %
2501-3000 SQFT	41,650	3 %	101,636	6 %	270,346	13.2 %	413,632	8 %
3001-5001+ SQFT	20,835	2 %	23,540	1 %	270,379	13.2 %	314,754	6 %
Totals	1,252,495	100 %	1,740,996	100 %	2,048,437	100 %	5,041,928	100 %
% <=1,500 SF		66 %		48 %		26 %		
Group N as % of Total	25 %		35 %		41 %			

Table 30. Square Feet of Living Space (Rent)

	< $35K		$35-75K		$75K+		Total	
750 SQFT or LESS	733,908	43 %	207,914	25 %	51,065	14 %	992,887	34 %
751-1000 SQFT	503,488	30 %	302,260	36 %	84,773	24 %	890,521	31 %
1001-1250 SQFT	234,529	14 %	171,484	20 %	53,364	15 %	459,377	16 %
1251-1500 SQFT	112,789	7 %	94,689	11 %	58,564	16.6 %	266,042	9 %
1501-2000 SQFT	73,622	4 %	45,854	5 %	53,813	15 %	173,289	6 %
2001-2500 SQFT	24,032	1 %	18,742	2 %	25,620	7 %	68,394	2 %
2501-3000 SQFT	1,455	0 %	6,824	1 %	15,643	4 %	23,922	1 %
3001-5001+ SQFT	6,059	0 %	709	0 %	10,986	3 %	17,754	1 %
Totals	1,689,882	100 %	848,476	100 %	353,828	100 %	2,892,186	100 %
% <=1,500 SQFT		94 %		91 %		70 %		
Group N as % of Total	58 %		29 %		12 %			

While the more detailed segmentation analyses we would have preferred could not be conducted for this project, these tables show that multivariate segment definition would allow precise targeting—focused at the quite different conditions and needs of different consumer subgroups. However, the end-use segmentation below, while generally confined to bivariate analyses, offers sufficient information to at least limit the over-estimation of market and policy potentials.

Targeting Potentials: Social Segmentation of Appliances & Shell Elements

Why Segmentation?

Again, we want to segment the population because there are known differences between residential consumer households that make some more likely than others to adopt energy efficiency improvements. Some may not have the resources to make significant purchases. Others may not have the opportunity. Under most circumstances, higher income households and homeowners are probably the most

reasonable targets—if and when they are in need of efficiency upgrades (some already have newer homes and better equipment). On the other hand, lower income households and renters can do little about central air conditioning (except possibly some maintenance) and many end uses such as ceiling insulation. They may, however, be able to buy new refrigerators and washing machines.

An important task for the AB549 team is, then, to identify realistic opportunities for improved efficiency (less waste) in existing buildings, as well as significant barriers to change. A strategy to do that is to "whittle" down optimistic estimates of what is technically feasible (and even cost-effective) to what is reasonable—an estimate that is cognizant of consumers' real-world conditions and constraints.

That is what the segmentation analysis is all about. Its goal is to use the best available data (e.g., RASS) to come up with sober estimates of who are the most likely candidates for efficiency upgrade—based on the age and condition of their appliances and buildings, as well as their ownership prerogatives and their financial resources. RASS provides imperfect measures of all of these. However, RASS does provide useful information about where efficiency gains may be unlikely with conventional incentives (e.g., cases where income, ownership, building and equipment characteristics are not favorable).

In this section we review the results of our segmentation analysis for a series of selected appliances, shell elements, lighting, pools, and spas. For each possible upgrade we identify target groups and special considerations that differ from technology to technology, e.g., equipment characteristics, replacement rates, ages of discarded units, operations and maintenance, and other behavioral issues. We do not present detailed tables for results in the body of this discussion. These can be found in Appendix 1.

To improve the usability of the appendix tables, in many cases we have highlighted consumer segments that are the most likely target groups for potential energy efficiency and resource conservation interventions. Also, in the appendix tables (and unlike those presented to this point in the report that have used column percentages); cell percentages are calculated as proportions of table grand totals (and labeled" percent of GT"). These percentages offer a ready grasp of the relative size of each cell in the table—i.e., the relative targeting potential of that category. It should also be noted that in the KEMA-XENERGY/RASS interactive saturation output, data cells that are based on 25 or fewer observations are displayed in red and marked with an asterisk. In our appendix tables (most of which have been condensed from the raw output), rows that contain data based on any small cells across the row are flagged with an asterisk at the end of the row label. Caution should be used in making inferences about the population based on the information in these small cells.

Demand Response (DR) Potentials

The first efficiency opportunity we considered was demand response. The RASS data set contains very little information that might be used to assess potentials for demand reduction. There is information on air conditioner and pool pump usage that might be considered in the design of residential DR programs—e.g., in emergency

load-shedding or routine cycling). This information is discussed in some detail later in this section.

The best data related to consumer behavior and DR are found in questions about use of electrical appliances ”during peak times” (Table 1.1–1 and 1.1–2 in the appendix document). Among *home owners*, 49 percent reported that they used appliances during the peak ”frequently” (40 percent for renters). Another 31 percent of owners and 27 percent of renters said that they did that ”occasionally” — leaving 20 percent of owners and 33 percent of renters reporting ”rarely or never.” All income groups are likely targets among owners, and among renters those with the lowest incomes are most numerous. However, it is important to realize that poorer quality housing may require renters and lower income *homeowners* to use air conditioning during peaks, regardless of requests and prices. Also, work schedules may allow some to avoid peak energy use, while others’ schedules may mean that they cannot avoid it.

Refrigerators

Table 46 through Table 51 in Appendix G report information on refrigerator characteristics and social segmentation. The data in those tables show that:

- Refrigerators are almost completely saturated in the population regardless of own/rent status or income range.
- Multiple refrigerators (2 or more per household) are more likely to be found at higher income levels in owner occupied units.
- *Older refrigerators* are the most likely to be discarded, with 75 percent of the units discarded in the previous year being 8 years or older (with a rate of discard almost equal across the 3 income ranges).
- About 41 percent of 1st refrigerators among owners, and 37 percent among renters, are 8+ years old.
- Among first refrigerators, renters in the less than $35K income group are more likely to have newer refrigerators than owners in that income group (37 percent versus 14 percent respectively).
- Second refrigerators (slightly over 1.3 M estimated, mostly among owners) may be more likely candidates for discard, with 51 percent among owners (and 35 percent among a small number of renters) being 8+ years old.
- If we assume that the two higher income groups are the most likely targets for replacement at conventional incentive/subsidy levels (shaded cells in tables):
    - Among owners, this likely replacement target amounts to 1.96M units that are 8+ years old (31 percent of this group’s 6.425M 1st and 2nd refrigerators).
    - Among renters, this likely replacement target amounts to 500K units that are 8+ years old (15 percent of this group’s 3.3M 1st and 2nd refrigerators).
- With significantly enhanced incentives, an additional 780K refrigerators (1st and 2nd units combined) in lower-income owner-occupied dwellings and 750K units

in renter households might also be targeted for replacement with higher-efficiency units.

- Since some newer units are sometimes replaced (less than 8 years old), a less conservative analysis might estimate replacement targets to be slightly higher.
- Behavior: There are few opportunities for marketing information to impact refrigerator use (via behavior change) in ways that would significantly reduce energy consumption. Refrigerator operations and maintenance (O&M)—(e.g., temperature settings and coil cleaning)—can improve performance. However, the RASS survey did not collect behavioral data related to refrigerator O&M.

Freezers

Table 52 through Table–55 report information on freezer characteristics and social segmentation. The data in those tables show that:

- The saturation rate of stand-alone freezers in the state population is approximately 17.5 percent (owners and renters combined), with 24 percent saturation in single-family units.
- Among owners, freezers are evenly distributed across the 3 income groups (7 to 8 percent in each), while among renters those in the <$35K category are more likely to own freezers.
- Multiple freezers are very uncommon (with owners more likely to have more than one stand alone freezer).
- Older freezers are the most likely to be discarded, with 81 percent of the units discarded in the previous year being 11+ years or older. Although based on small sample sizes, the data suggest that the rate of discard was uneven across income ranges with the $35-75K group responsible for just over half of all of the units discarded.
- About 36 percent of 1st freezers among owners (427K), and 28 percent among renters (50K), are 11+ years old.
- Second freezers (approximately 47K, almost entirely owners) may be more likely candidates for discard with 57 percent of those units among owners being 11+ years old.
- Again, if the higher income groups (shaded cells in tables) are plausibly the most likely targets for replacement policies (e.g., using conventional modest incentives):
    - Among owners, this likely replacement target amounts to 858.6K units that are 11+ years old (68 percent of 1.26M 1st and 2nd freezers in this group).
    - Among renters, this likely replacement target amounts to 80K units that are 11+ years old (34 percent of this group's 234.5K 1st and 2nd freezers).
- With significantly enhanced incentives, additional 400K units in lower-income owner-occupied dwellings and 154K units in renter households might also be targeted for replacement with smaller or higher-efficiency units.

- Behavior: There are few opportunities for marketing information to impact freezer use (e.g., via behaviors or settings) in ways that reduce energy consumption. Freezer operations and maintenance (O&M) — (e.g., defrosting, temperature settings, and coil cleaning) — can improve performance. However, the RASS survey did not collect behavioral data related to freezer O&M.

Clothes Washers

Table 56 through Table 62 report information on clothes washer characteristics and social segmentation. We include clothes washers in the analysis because of their contributions to hot water use. Unlike refrigerators, saturation levels between owners and renters are uneven — highly saturated among owners (97 percent), but saturated at somewhat less than half that rate (46 percent) among renters.

- The saturation rate of clothes washers' ranges from a high of 94 percent in single-family dwellings, 80 percent in mobile homes, and 70 percent in town homes, to a low of 26 percent in 5+ unit and 37 percent in 2-4 unit apartments.
- Individual clothes washers are unevenly distributed across the 3 income groups:
  - Among owners, the higher income groups more likely to have in-home washers.
  - Among renters, the lowest income group is most likely to have in-home washers.
  - Discards: Overall, 57 percent of washer discards were 11years or older. However this overall rate differs between owners and renters. 60 percent of discards by owners (219K units) were units in the 11+ group, but only 46 percent of renter discards (31.6K) were in the 11+ years group.
  - About 26 percent of clothes washers among owners, and 18 percent among renters, are 9 years or older.
  - Among owners, only 9 percent (489K of 4.6M) of clothes washers are front-loading models, with most owned by those in the $75K+ income range. Among renters, 8 percent are front loaders (100K of 1.2M washers).
  - Again, if the higher income groups (shaded cells in tables) are the most likely targets for replacement:
    - Among owners, this likely replacement target amounts to less than 955K units (865K if adjusted downward for 9 percent front loaders among owners) that are 9+ years old. This target represents only 19 percent of this group's 5M units.
    - Among renters, this likely replacement target amounts to less than 145K units (133K if adjusted downward for 8 percent top loaders among renters) that are 9+ years old. This target represents only 12 percent of this group's 1.2M units.
  - With significantly enhanced incentives, approximately 340K units in lower-income owner-occupied dwellings and 108K units in renter households might also be targeted for replacement with front loaders that use less water per load.

- Behavior: There are opportunities to impact washer use (e.g., via behavior, settings and equipment selection) in ways that can reduce energy consumption, —specifically, information regarding front loaders at point of sale (currently 8-9 percent saturated) of units and laundry tips for using less hot water (currently 45 percent wash in hot water between 1-5+ times per week).

Air Conditioners

Central AC

We see in Table 17 above (RASS sample), that central air conditioners are saturated in the 40 percent range (46 percent single family units, 41 percent townhouses, and 39 percent mobile homes) and are less common in multifamily units (28 percent in 2-4 unit apartments and 32 percent in 5+ unit apartments).

The following table provides a rough idea of current air conditioner seasonal energy efficiency rating (SEER) values based on the age and condition of the unit. [13] The currently ENERGYSTAR® standard for central air conditioners is SEER 13. Units with SEER rating in the 19-range are on the market.

Table 31. Approximate AC SEER Ratings

Age and Condition	SEER
20 years old - Not well maintained	6
20 years old - Well maintained	6.5
10-20 years old - Not well maintained	7
10-20 years old - Well maintained	8
5-10 years old - Not well maintained	7.5
5-10 years old - Well maintained	8.5
Less than 5 years old	9
Base AC units put in today	10
High Efficiency Unit	14

Table 65 through Table 75 report additional information on air conditioner characteristics and social segmentation. The data in those tables show that:

- There are almost 2.5M central air systems in owner occupied homes and 811K in rented homes.
- Multiple central air conditioners are more likely to be found at the highest income level in owner-occupied homes (174K homes in the $75K+ range out of a total of 220K homes with 2 or more air conditioners).

[13] This table is published by E-Star™ (a Colorado non-profit organization committed to advancing energy efficiency in housing) on line byhttp://www.e-star.com/ecalcs/table_ac.html.

- Older central air conditioners were the most likely to be discarded in the past year (79 percent, or 73.6K, were 11 years or older—32 percent in the 11-20 yrs old class and 47 percent in the 21+ group).
- There is some evidence that the higher income groups ($75K+ households) are more likely to discard somewhat newer units.
- In terms of ages of existing central air conditioners, about 52 percent among owners and 59 percent among renters, are 9 or more years old. [Among renters, 785K units central units in California are estimated (tables for central air conditions in rented units have not been included).]
- Since older ACs are more often replaced among higher income groups, and since higher income households have the vast majority of central units, the likely potential target for replacement at conventional incentive/subsidy levels is 1.1M 9+ years old units in existing owner occupied housing in the top two income groups.
- Because ACs are high energy users (an estimated 1,423 UEC in single-family detached units and 1,143 UEC in mobile homes, on average), it may be worthwhile to invest significant incentives to secure replacements among the 320K central AC owners in the <$35K income group.
- Behavior: There are many opportunities for information to impact air conditioner use (e.g., manual control, filter replacement/cleaning, settings, and advanced time-sensitive controls) in ways that reduce energy consumption. Looking at some of the most basic O&M behaviors, the RASS survey collected data related to *central* air conditioner maintenance and found that:
    - 72 percent of owners *had not* performed air conditioner maintenance in the past 12 months
    - 76 percent of renters *had not* performed air conditioner maintenance in the past 12 months

Room AC

- Over 18 percent of the population is estimated to have about 1.9M room air conditioners (of these, 255K residences have more than one). Room air conditioners are fairly evenly distributed between owners (55 percent) and renters (45 percent), with slightly more units in owned homes (1M) than in rentals (879K). However the saturation varies considerably across type of building:
    - 14 - 15 percent saturation in town homes and single family residences, 16-22 percent in 2-4 unit and 5+ unit apartments, and 34 percent saturated in mobile homes (approx. 136K units).
    - 46 percent of first room AC units are 9 years or older with a greater proportion found in the <$35K income group compared to higher income groups.
    - Among homes with room ACs, 56 percent or 840K are estimated to use them in the evening (6 pm – 9 pm) ”sometimes” or ”always”. This behavior is fairly evenly split across owners (400K or 48 percent) and renters (440K or 52 percent)

- Given the relatively low cost of room air conditioners, all income groups with older room ACs might be considered likely targets for replacement (shaded cells in tables). If this is true, then the target group size is about 457K. Models with easily changeable filters and controls such as digital readouts for the thermostat setting, and a built-in timer make it possible to make energy savings adjustments.
- Behavior: There are many opportunities for information to impact air conditioner use (e.g., manual control, filter replacement, and settings) in ways that reduce energy consumption. RASS survey data did not obtain behavioral data specific to room air conditioner maintenance.

Shell – Lighting

Table 76 through Table 87 report information on lighting characteristics and social segmentation. Unlike other end uses, it is assumed that all income ranges are viable targets for increasing saturation levels of CFLs and lighting controls. The summarized RASS data [14] in those tables show that:

- · 75 percent or 6.4M homes (owned and rented, out of an estimated 8.5M) are a likely target for increased interior CFL saturation since:
  - 43 percent of owned and 59 percent of rented homes have no CFLs – a combined total of over 4M homes.
  - 27 percent of owned and 25 percent of rented homes have no CFLs – an addition of 2.2M homes.
- A number of miscellaneous efficiency-enhancing products related to interior lighting control are not in common use. However estimating their contribution to household electric conservation is likely to be difficult:
  - Interior timers: 81 percent or over 4M owned homes do not use them.
  - Interior motion detectors: 81 percent or over 4M owned homes do not use them.
  - Interior dimmers: 51 percent or over 2.6M owned homes do not use them.
- Over 5M homes have *exterior* incandescent lighting. The potential replacement target for CFLs is huge, since 82 percent (4.1M) owner occupied homes estimated *do not have any* exterior CFLs and the RASS investigators note that an another 14 percent only have 1-2 exterior CFLs.

[14] "It was not possible to disentangle indoor lighting usage from the other loads covered by miscellaneous usage. However, we believe that a good estimate of indoor lighting usage is approximately sixty percent of the residence type's miscellaneous usage. Given this assumption, indoor lighting usage would range from 754 kWh in 5+ unit apartment residences to 1288 kWh in single family homes." (KEMA-XENERGY, et. al. 2004, p. 10). The ENERGY COMMISSION does not rely solely on RASS for lighting estimates; most of their forecast model numbers come from Market Share Tracking and New Construction.

- A number of miscellaneous products related to *exterior* lighting and lighting control are not commonly used but, if adopted, could contribute toward conservation:
  - Exterior metal halides (for landscape and yard lighting): 94 percent or over 4.7M owned homes do not use them.
  - Exterior timers: 82 percent or about 4.2M owned homes do not use them.
  - Exterior light sensors: 80 percent or over 3.9M owned homes do not use them.
  - Exterior motion detectors: 64 percent or about 3.2M owned homes do not use them.

Shell – Remodeled in past year

Table 88 through Table 95 report information related to the social segmentation of remodeling. We include this information since it tells us something about the relative frequency of remodeling as a ”target" event. In the RASS study, ”old” homes are defined as those built prior to 1997 and ”new” homes are those build 1997 – 2003. These data show that:

- Old homes make up 92 percent of the estimated owner-occupied housing stock (almost 5.6M of nearly 6.1M). Only 13.7K new homes were remodeled in the same period (less than 1 percent of the total estimate of 467K).
- 911K old owner-occupied homes were estimated to have been remodeled (in some way) within the past year. That is approximately 16 percent of the 5.6M pre-1997 owner occupied homes.
- If each income group remodeled at the same rate, we’d expect to find one third of the remodels in each income group – that is not the case. Eighty three percent of the remodeled older homes are owned by those in the top two income groups (and over half of these are in the highest income group).

Shell – Insulation

Table 96 through Table 104 report information on shell characteristics related to insulation and social segmentation. The data in those tables, broken down by own/rent and building type, or income show that:

- 13 percent of the owner-occupied housing stock consists of single-family homes without attic insulation (688K of out of over 4.4M single-family units estimated). Almost one fifth (1M out of more than 5M) of owner occupied homes of all building types are estimated to have no ceiling insulation.
- There are 771K single-family owner occupied homes with only 0-3 inches of attic insulation, plus an additional 225M under-insulated units among town houses, apartments, mobile and other homes – this under-insulated group represents 27 percent of the owner-occupied housing stock that reports insulation.

- If we assume that homes with 0-3”of insulation in the two higher income groups are the most likely targets for adding insulation at conventional incentive/subsidy levels:
  - The target potential across all owned building types is approximately 673K owned homes with 0-3”of insulation (after approximately 278K owned homes in the <$35K group are excluded). [15]
  - Single-family owner homes without any insulation in the two higher income groups are the largest subgroup with an estimated 398K homes.
  - Owner town houses in the two higher income groups represent a small subgroup with an estimated 36.5K units without any insulation.
- 17 percent or 909K owner occupied homes are single-family homes without wall insulation. A total of 1.1M (21 percent of 5.4M) owned homes of all types do not have wall insulation.
  - Taking income into account, RASS data suggests that 520K (or 68 percent of 767K) owned single-family homes without wall insulation fall into the two higher income groups ($35K and upward).
- While not considered likely targets here, some tables on the shell characteristics of rented homes are included in the table section.

Shell – Windows

Table 105 through Table 108 report information on shell characteristics related to windows and social segmentation. The data in those tables, broken down by own/rent and building type show that:

- 46 percent of owned homes have all single pane windows (vs. 43 percent with all double pane, and 11 percent mixed).
  - Single-family homes with single pane windows account for 33 percent of owner occupied homes—almost 1.9M homes.
  - Each of the other owner occupied home types with single panes account for 1-5 percent of the total (RASS estimated) owner occupied housing stock—778K units across town homes, duplexes, row, apartments, and mobile homes.
- 61 percent of owner occupied homes have metal frame windows (3.5M of over 5.7M estimated).
  - The vast majority (73 percent of the homes with metal framed windows) are single-family detached units (almost 2.6M)
  - The remaining 27 percent are spread fairly evenly across the other house types (ranging from 140K – 307K each)
- Window replacements are expensive and income is a likely market factor for consideration:

[15] Note that weighted RASS query totals vary when cross-tab breaks, such as income, are added to a query.

- If the target is limited to owned homes with single pane windows in the top income group, this potential target group amounts to 562K homes. If the target potential includes homes in the $45-75K range, the total is 1.1M homes.
- If the target is limited to owned homes with metal frame windows in the top income group, the potential target amounts to 816K homes. If we include homes in the $45-75K range as well, the potential is estimated at 1.6M homes.

- With significantly enhanced incentives, approximately 503K units with single pane windows in lower-income owner-occupied dwellings and 539K units with metal frame windows in owner households might also be targeted for replacement with more energy efficient windows.

Swimming Pools

Table 109 through Table 118 report information on swimming pool characteristics and social segmentation. We see that the vast majority of pools are located in the owner occupied housing segment (780K or 97 percent of the total estimated). Table 32 reports that pool pumps are 14 percent saturated in the single-family detached sector (owners and renters combined, with the majority owned) and have a UEC of 2,671 (second only to the annual electricity use of an electric hot water heater at 3,079 UEC).

The following guideline for pool filtration is provided by the California Swimming Pool Industry Energy Conservation Task Force (and posted on the PG&E website) [16] :

"Reduce filter operating times to no less than 4 to 5 hours per day during the summer and 2 to 3 hours per day during the winter period. *This will reduce annual electrical consumption by 40 to 50 percent. Normal and heavier swimming use may require as much as eight or more hours of filtration per day."*

[16] This information is available in many places online, including the Pacific Gas and Electric site: http://www.pge.com/res/rebates/pumps_motors/pool_tips/

Table 32. Monthly Energy Consumption (Kilowatt Hours) of Various Size Swimming Pool Pumps [15]

Pumping Hrs per Day	1/2 HP	3/4 HP	1 HP	1-1/2 HP	2 HP
2	38	52	64	98	126
4	76	104	128	196	252
6	114	156	192	294	378
8	152	208	256	392	504
10	190	260	320	490	630
12	228	312	384	588	756
14	266	364	448	686	882
16	304	416	512	784	1,008
18	342	468	576	882	1,134

Other summary data from KEMA-XENERGY/RASS queries show that for single-family owner-occupied homes:

- Electricity reductions from pool heating is not a likely target:
  - 59 percent of these pools are not heated and 13 percent are heated with solar, while:
- 23 percent are heated with natural or bottled gas (21 percent and 2 percent respectively).
- 6 percent are heated with electricity or a heat pump (5 percent and 1 percent respectively).
  - In addition, 86 percent (491K) of pools in single-family owned homes are either not heated or heated only once a month in the summer (and even fewer are heated in the winter)
- Approximately 52K pool pumps were discarded in the past 12-month period (and 74.5K were added). Almost all discards came from households in the top two income categories. RASS did not collect information on the age of existing pool pumps.
- Pool pumps, pool covers, and timers are likely potential targets across all income groups due to their relative-low cost and short payback period. [17]
  - The potential target for savings related to pool pumping (filtration) is two-fold: first by reducing pump run time to the minimum effective period, and second through replacement of lower volume pumps with pumps that produce more flow at equivalent horsepower resulting in even shorter filtration periods and lower operating costs.

[17] "Replacing the pool pump was the most cost-effective measure, with a simple payback of 3 years. The original 1-horsepower pump for the 15,000-gallon pool was oversized. This is standard industry practice, according to Parker. Replacing the pump with a 3/4-horsepower unit saved approximately 1,200 kWh per year and offered an appealing return on investment of approximately 30%. After the third year that translates into $100 per year of untaxed profit. The homeowner noticed no difference in the performance of the pool cleaning system after the insulation." (Home Energy Magazine, 1998).

- In terms of reducing pump run periods, the likely targets for pool timers are 235K pools (39 percent of 600K) in single-family owner-occupied homes that do not currently have timers.
- For reduced summer run time, the targeting potential includes 252K pools filtered for over 5 hrs per day (87K of these are filtered 8-21+hrs per day).
- For reduced winter run times, the target potential is 107K pools filtered for over 5 hrs per day (21K of these are filtered 8-21+hrs per day.)
- The potential target for pool covers is large since only 26 percent of the 600K pools estimated are currently covered.

Spas and Hot Tubs

Table 119 through Table 126 report information on spa and hot tub characteristics and social segmentation. Table 16 reveals that the vast majority of spas are in the single-family sector. They are 13 percent saturated in that sector. Spa pumps have a UEC of 467 while electric spa heaters have an additional UEC of 1,719 (electric spa heaters are 7 percent saturated in the single-family sector). Our summary of RASS data is limited to single-family, owner occupied homes:

- Most owner-occupied single-family detached homes do not have spas or hot tubs (84 percent or 3.2M)
- Since about two thirds of those with a spa or hot tub (406K) are private units found in the $75K+ income group (with most of the remaining third in the $35-75K group) information and/or modest conventional incentive levels may be all that is needed to encourage adoption of conservation and efficiency measures.
- Since three times the electric energy consumed is used to heat a spa rather than to filter, the best targets for conservation and efficiency measures are the 306K units with an electric heater. However, the potential target is much smaller than the total, since 43 percent of spa/hot tubs in single-family owner homes are ”never” heated or are only heated ”0-2 times per month.” Only 167K (across all fuel types) are set to maintain a specific temperature.
- Spa covers might be encouraged, however only 35 percent are not covered currently and those may be units that are not heated.

The ”Hard to Reach” Market Segments

In general, our appendix tables have reported 3 income categories, collapsed from the 6 available in the RASS data. For our basic segmentation analyses, we merged the lowest two RASS income groups (<$25K and $25K-35K) and the resulting lower income category (annual income <$35K) was often excluded as a primary target for appliance replacement and shell improvement interventions (although it was included in some lighting replacement and behavior change estimates).

In the analysis reported in this section, we focus more narrowly on the *very lowest* income group—those households with annual incomes of less than $25K/year. Because the lowest income segments are the least likely to be able to afford new appliance purchases and building upgrades, they are considered ”hard to reach” by

most conventional incentive and information-based intervention programs. Overall, this group represents about 2.4M households or 27 percent of the population—a fairly large group.

For a household of one person (about 30 percent of this group), this income level (average wage of about $12/hr) might or might not be considered very ”low income” — depending on cost of living, age, medical conditions, etc. Also, recall that this is a *range* of incomes, which seems in the RASS data to be approximately normally distributed between about $5k and $25k/year. [18] For two-person households (27 percent of the lowest income segment), incomes anywhere in this range represent a much tighter budget. Families of three, four and more (another 43 percent) in this group find themselves at or below the official poverty level, and therefore eligible for a variety of public social welfare benefits. In all of these cases, it is reasonable to consider this group ”hard to reach” via conventional energy efficiency initiatives, and, in fact, a number of special energy assistance programs have traditionally been targeted to the lowest income segment (and to sub-segments, such as the elderly poor).

Another consumer segment considered ”hard to reach” consists of households whose primary language spoken at home is not English. Some of this group are also low income (47 percent, in fact) and, as a result, are doubly hard to reach. However, regardless of income, households in this category may be difficult for program implementers to recruit through conventional English-language appeals, consumer information and incentive offers. So our analysis also focused more narrowly on these households (nearly 2M RASS households and about 19 percent of the total population). We examined their appliance holdings and dwelling characteristics separately from the English-speaking majority in order to provide a realistic assessment of how much of a cultural outreach problem might exist for different hardware and behavioral intervention targets.

The Lowest Income Households

In our analysis of the RASS data on low-income hard-to-reach households (see details in Appendix G, Table 127 through Table 132); we focused only on those end-uses, technologies and behaviors that are the most realistic targets for efficiency improvement, given the limited financial resources and dwelling ownership rates in those households. Our analysis found that:

- 841K (16 percent) of 5.3M RASS *owner-occupied* dwellings are owned by households with annual incomes under $25K per year. About 1.4K (43 percent) of 3.3M RASS *renter households* report incomes under $25K per year. As noted above, this income segment represents about 27 percent of the population.
- Among low-income homeowners, 42 percent (351K) frequently use electric appliances during peak times of day. This is somewhat lower than the 49 percent estimate of peak appliance users among all homeowners, and is relevant both for

[18] It is possible to generate a RASS report of income by other demographics (but not appliances) that includes $0-10k, $10k-20k, and $20k-25k intervals.

identifying demand-response (DR) opportunities and considering DR equity issues.

- Among low-income renters, 38 percent (554K) frequently use electric appliances during the peak. This is close to the 40 percent rate for renters across all income levels. DR opportunities and challenges are similar for this sub-segment—although possibly poorer quality housing and other conditions may require greater on-peak usage (e.g., for cooling) that might be considered optional in other groups.
- Among households with <$25K annual incomes:
  - 49 percent of refrigerators in owner-occupied dwellings are 8+ years old (408K) — somewhat higher than the 41 percent across all owner income groups. These might be seen as a reasonable replacement target.
  - 38 percent of refrigerators in renter-occupied dwellings are 8+ years old (521K) — about the same as the percentage across all renter income groups (37 percent). Replacement targeting, with some additional considerations, might be possible in this sub-segment as well.
- Across all income groups, only 5 percent of homeowners are estimated to wash 5+ loads of clothes in hot water per week (229K)—the most likely group to target for washer replacement and/or behavior change. The total number of homeowners in the <$25K income group reporting doing laundry in hot water 5 times or more per week is only a very small number—estimated at 21K households (<1 percent of all homeowners).
- Among renters, about half of the total high hot water laundry users (5+ loads/wk) are found in the <$25K group. However, once again their actual numbers are small (29K or 2 percent of all renters).
- Central air conditioner (AC) maintenance, which can significantly improve efficiency, is low across all owner income groups (only about 28 percent of all homeowners with central AC). However, a slightly higher percentage in the lowest income group (31 percent) reports performing AC maintenance. We estimate the educational opportunity for improved low-income homeowner central AC maintenance to be 226K households.
- Recall that central AC maintenance is low across all renter income groups (24 percent overall), and renters in the lowest income group are only slightly better at performing maintenance (84K or 26 percent). We estimate the educational opportunity for low-income renter central AC maintenance to be 239K households. We should note that there are some additional constraints for this group (in addition to out-of-pocket costs) such as non-ownership of the equipment.
- Among all homeowners at all income levels, 19 percent of room ACs reported are 9-13 years old and 32 percent are older than 13 years. These are the most likely targets for room AC replacement. In the lowest income group, the percentage of 9-13 year old units is comparable to the overall average. However, a higher percentage (38 percent) of this group, have units that are 13+ years old.

We estimate a replacement target for these two categories of older units in this segment to be 100k units.

- Among all renters, 17 percent of room ACs are 9-13 years old and 29 percent are 13+ years old. The percentages of units in these categories are similar for the <$25K income group (18 percent and 28 percent respectively). We estimate a replacement target for these two categories of older units in this segment to be 170k units.
- A much higher percentage (42 percent) of the dwellings owned by those in the <$25K group are under-insulated (in the 0-3”range for attic insulation) compared to 28 percent of all owner-occupied homes. However this potential target group represents a relatively small proportion (18 percent) of all under-insulated homes—169K of 952K overall.

Non-English Speaking Households

In our analysis of non-English speaking hard-to-reach households using the RASS data (see details in the appendix document, Table 133 through Table 156); [19] we focused on a somewhat wider variety of end-uses, technologies and behaviors than in the low-income analysis. Although (as noted above) a large percentage of non-English speaking households are also low income, the majority has sufficient resources to undertake a wider range of efficiency options. Figure 1 shows the relative sizes of home ownership and renter groups, at various income levels, for English and non-English speaking households.

[19] Note that these tables return to the column percentage convention, because of small cell sizes and the need to compare distributions across language groups.

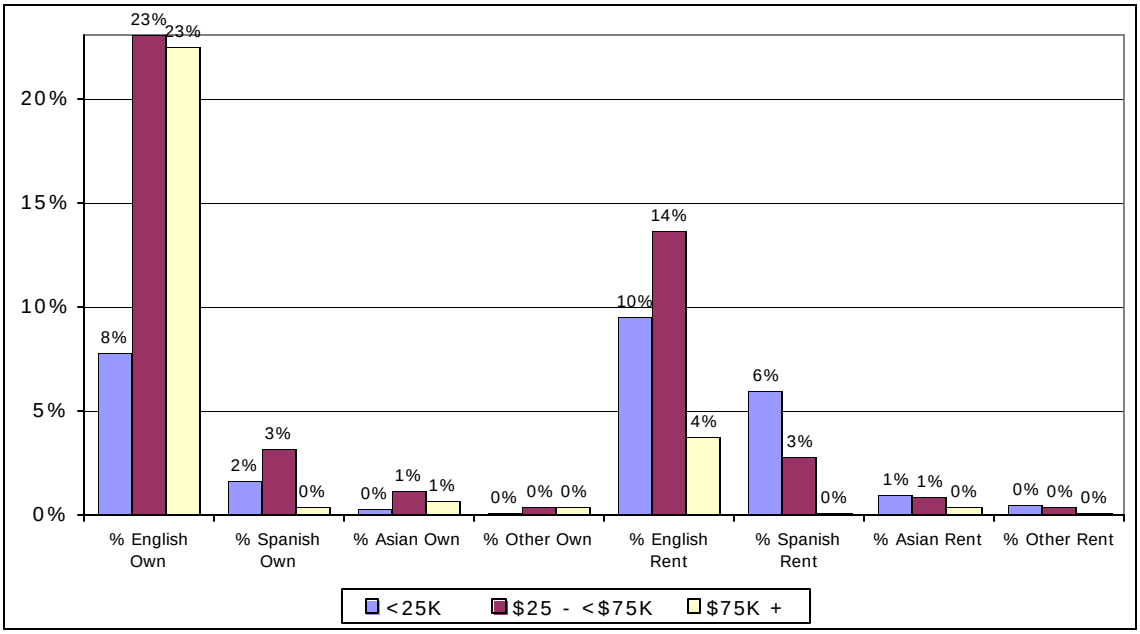

Figure 13. Home Ownership, Primary Language Spoken, and Annual Income – Percentage of Grand Total (8,693,993)

The "hard to reach" nature of *low-income non-English speaking* households involves a combination of limited access to information and limited financial means. The need may be greater in this segment as well, since these households may have poorer housing conditions and less efficient technologies overall. The problem is different with *higher income non-English speaking* households, where multi-lingual family members may well have access to information in English. The language problem for efficiency planners is also somewhat different among Spanish-speaking target audiences versus non-English/non-Spanish speakers (e.g., those speaking Asian and Eastern European languages). The Spanish language media are extensive in California, while the reach of non-Spanish/non-English communications channels is often more localized.

Because of limited time, resources and data access via the RASS web interface, we were not able to perform separate analyses for low-income vs. higher income groups within the various non-English language segments. This would have been desirable, given the separate and joint effects of culture and income on efficiency choice. The analysis that differentiates those effects remains for another day. However, the analyses we were able to perform reveal the following:

- About 700K (13 percent) of 5.3M RASS residential housing units are owned by households where English is not spoken at home.
- Peak energy use in these households is likely to be somewhat lower than in English-speaking households. About 34 percent of Spanish-speaking, 26 percent of Asian language speaking, and 36 percent of "others" report that they used electrical appliances "rarely or never" during peak hours—compared to only 23

percent of English-speaking households. On the other side of the coin, about 38 percent of non-English speaking groups report ”frequent” appliance usage during peaks, compared to 46 percent of English-speakers.

- About 250k non-English speaking (NES) *homeowners* have first refrigerators 8 years old and older. This group also has about 35K 8+ year old *second* refrigerators. Among NES *renters*, about 350K have 8+ year-old first refrigerators. However, these all tend to be lower rates of possession of old refrigerators than in the English speaking segment. We estimate a total of about 685K refrigerators that are potential replacement targets in the NES segment.
- NES segments (particularly Spanish and Asian language groups) also tend to have much lower rates of freezer ownership than English speaking households (8 percent for Spanish, 13 percent for Asian, vs. 26 percent for English). Overall, there are a relatively small number (about 25K) of older freezers (11+ years old) in the NES segment.
- NES and English-speaking (ES) households report about the same rates of *clothes washer* ownership in owner-occupied housing. Among renters, however, the NES rates are much lower (16-31 percent vs. 43 percent in NES households). The *age* of clothes washers in NES households is somewhat *newer*, with 14-22 percent NES vs. 29 percent ES reporting washers 9-30 years old.
- It is interesting to note that 56 percent of all households in the population report ”none” to questions about number of hot water washes per week. However, that proportion drops to 43 percent in Spanish-speaking households and increases to 65 percent in Asian language households. There may be significant differences in meanings and cultural practices related to hot use that should be understood when communicating to different cultural groups about energy conservation.
- The rates of *central* air conditioner ownership are similar across all language groups for both homeowners and renters. However, there seem to be some interesting differences in the ages (and likely efficiencies) of *room* air conditioners. Asian homeowners seem more likely (62 percent vs. 47 percent overall) to have older room AC units (13-31 years old). Also, Spanish-speaking renters reported having more ”older” units—(57 percent) compared to the average (52 percent).
- There are also lower rates of AC maintenance among NES compared to ES households. Only about 14-18 percent of NES owners (vs. 30 percent ES owners), and 11-20 percent of NES renters (vs. 24 percent among ES renters), reported air conditioner maintenance having been done in the previous year.
- Very low percentages of NES households (4-8 percent) report having swimming pools compared to ES households (18 percent).
- The distributions are similar for hot tubs and spas. Only 5-6 percent of NES households vs. 18 percent of ES households report having hot tubs or spas.
- A higher proportion of NES owner-occupied households have low insulation levels (0-3 inches of attic insulation)—e.g., 32 percent among Spanish and 42 percent among Asian households—compared to 26 percent among ES owner-

occupied homes. However, the number of under-insulated NES homes is a relatively small (128K) compared to the total number of such homes (almost 1.1M).

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APPENDIX F: ENERGY ANALYSIS ASSUMPTIONS

The electricity, natural gas and peak demand savings potential of the interventions considered in the project are calculated from a combination of the technical potential of a particular technology to save energy and the role of the intervention in improving the adoption of the technology. The technical potential calculations consider the building type, existing building stock, the energy savings potential of a set of technologies targeted under the intervention, the saturation of equipment types in the general population and the frequency with which the target population comes in contact with a particular intervention. The adoption model considers the ability of the intervention to address barriers that influence the technology adoption process.

The technical potential calculations follow the model used by Xenergy (2002) for a series of potential studies conducted for existing residential and commercial buildings. Technical potential is defined as the energy savings resulting from complete penetration of all measures in applications where they are deemed technically feasible from an engineering perspective. The overall technical adoption model is shown in Equation F-1 below:

Equation F-1

$$Technical\ \ potential = Building\ \ stock \times EUI \times F_{savings} \times F_{applicability} \times F_{feasibility} \times F_{not\,complete}$$

Where:

Technical potential	= technical savings potential in GWh, MW or Mtherm
Building stock	= existing building stock by building type. These data are generally expressed in terms of number of homes for residential buildings or building floor area for commercial buildings
EUI	= energy use intensity for the building type and end-use affected by the efficient technology, defined with units consistent with the building stock data (e.g. kWh/SF or therm/home)
$F_{savings}$	= savings factor, which is the end-use savings fraction associated with the efficient technology
$F_{applicability}$	= applicability factor which is the fraction of the floor space that applies to the efficient technology by building type. For example, the applicability factor for an efficient air conditioner

would be equal to the fraction of the floor space that is served by air conditioning

$F_{feasibility}$ = feasibility factor, which is the fraction of the floor space where it is technically feasible to convert from standard to efficient technology

$F_{incomplete}$ = incomplete factor, which is the fraction of the floor space that has not been converted to the efficient technology

Data on existing building stock floor area, end-use intensity, savings factor, applicability factor, feasibility factor, and the incomplete factor were gleaned primarily from the Xenergy Statewide Energy Efficiency Potential Studies for residential and commercial buildings. These data were supplemented with additional data collected during the research conducted for the AB 549 project.

Residential Sector Measures

A brief description of the measures considered for the residential analysis is as follows:

Central Air Conditioner Upgrade: Central air conditioners may be of the unitary variety (all components housed in a factory-built assembly) or be a split system (an outdoor condenser section and an indoor evaporator section connected by refrigerant lines and with the compressor at either the outdoor or indoor location). Efficient air conditioner measures involve the upgrade of a standard efficiency unit to a higher efficiency unit.

TXV: Thermostatic expansion valves (TXV) optimize refrigerant flow over a wide range of load conditions. The TXV helps regulate the refrigerant to match the load conditions inside the home, thereby reducing compressor use. The air conditioners then operate about 10-20 percent more efficiently. TXVs also reduce the effect of improper refrigerant charge on unit efficiency.

High Efficiency Room Air Conditioner: Window (or wall) mounted room air conditioners are designed to cool individual rooms or spaces. The efficient room air conditioner measure involves the upgrade of a standard efficiency unit to a higher efficiency unit.

Heat Pump: Heat pumps consist of a refrigeration system using a direct expansion cycle to provide both heating and cooling. Heat pumps may be of the unitary variety (all components housed in a factory-built assembly) or be a split system (an outdoor condenser section and an indoor evaporator section connected by refrigerant lines and with the compressor at either the outdoor or indoor location). Efficiency heat pump measures involve the upgrade of a standard efficiency unit to a higher efficiency unit. Both heating and cooling efficiency are affected.

Condensing Furnace 92 AFUE: Condensing furnaces have annual fuel use efficiencies (AFUEs) of 90 percent or higher, compared to standard efficiency furnaces with AFUEs of around 78. For this measure, it is assumed that a standard-efficiency central furnace is replaced with a condensing furnace.

Programmable Thermostat: A clock thermostat reduces the heating set point or increases the cooling set point during programmed periods during the day or week. This method of control is used, most often, to reduce heating and cooling energy use during unoccupied periods. Clock thermostats for heating and cooling units are available in one-day, seven-day, and 365-day programmable versions, with a battery backup in case of power failure.

Ceiling Fans: Humans can remain comfortable in a warm humid environment if sufficient air movement is provided. For this measure, propeller style fans are hung from the ceiling to provide air motion directly to occupants. Energy savings can occur when occupant comfort is maintained at higher room air temperatures due to the rapid air motion provided by the fans.

Whole House Fans: Whole house fans keep a home cool during the cooling months instead of running the air conditioner. These fans typically consume about one-third the energy of a central air conditioner. These fans pull cool night air from the outside, move air through the house, and/or remove hot air through the attic.

Attic Venting: Attic venting reduces heat gain in the summer and prevents condensation (humidity) in the winter. This measure involves a motor-driven, thermostat-controlled fan.

HVAC Diagnostic Testing and Repair: This measure involves diagnostic and repair services for existing central air conditioners to improve their efficiency. Inspection and services of AC systems involves checking the refrigerant level, cleaning the coils, cleaning the blower, and cleaning or replacing filters. Additionally, furnace adjustments increase efficiency by insuring that the furnace fan stays on as long as there is heat in the exchanger. Fan off control is adjusted to maximize efficiency. Additional adjustment of the thermostat anticipator, which controls gas burn time, can increase furnace cycling efficiency.

Duct Repair: An ideal duct system would be free of leaks, especially when the ducts are outside the conditioned space. Leakage in unsealed ducts varies considerably with the fabricating machinery used, the methods for assembly, installation workmanship, and age of the ductwork. Current duct sealing methods include use of computer-controlled aerosol and duct pressurization tests to verify sealing effectiveness.

Duct Insulation: Insulation material inhibits the loss of heat or cool through the system ductwork. Several types of duct insulation are available, including flexible duct, pre-insulated flexible duct, duct board, duct wrap, tacked or glued rigid insulation, and water proof hard shell materials for exterior ducts. Duct insulation for existing construction involves wrapping un-insulated ducts with an R-4 insulating material.

Ceiling and Floor Insulation: Thermal insulation can conserve energy by reducing heat loss or gain through the ceiling or floor of a structure. An important characteristic of insulating materials is the thermal resistivity or R-value. Typical insulating materials include: loose-fill (blown) cellulose; loose-fill (blown) fiberglass; batts of fiberglass; and rigid polystyrene. Typical ceiling insulation upgrades for

existing structures consist of adding R-19 insulation to an un-insulated home or increasing insulation from R-19 to R-38 for homes with some existing insulation.

Floor Insulation: Floor insulation involves adding R-19 insulation to raised floors built over unconditioned ventilated crawls spaces in existing homes. Homes constructed with cement slab foundations do not apply.

Wall Insulation: For existing construction, this measure involves adding R-11 insulation to un-insulated walls. This is usually accomplished by drilling holes into the building's siding and blowing in insulation material.

Infiltration Reduction: Infiltration reduction measures include weather-stripping and caulking. These measures reduce energy consumption by improving the tightness of the building shell thereby limiting heat gain and loss. Professional installation of these measures generally includes use of a blower door to verify leakage rates.

Cool Roofs: The color and material of a building structure surface will determine the amount of solar radiation absorbed by that surface. By utilizing the appropriate, lighter-colored building materials (and lower solar absorption), the roof will absorb less solar radiation and consequently reduce the cooling load.

Double Pane Clear Windows to Double Pane, Med Low-E Coating: The energy performance of a window is determined by the type of glass, the number of panes, the use of tints, the thickness of, and the gas type used in the gap between panes (for multi-pane windows). Low-E coatings improve the energy performance of a window by reducing heat losses and solar heat gains.

Window Film: This measure involves application of a dark-colored film to the existing windows of a home. The film lowers the amount of solar heat gain into a building, and thus decreasing the cooling load.

Sunscreen: This measure is a dark colored screen that is attached to the outside of a window. Similar to window film, this measure lowers the solar heat gains through a window.

Compact Fluorescent Lighting (CFLs): Compact fluorescent lamps are designed to replace standard incandescent lamps. They are approximately four times more efficient than incandescent light sources.

Energy Star Efficiency Refrigerator: ENERGY STAR® refrigerators exceed the stringent new July 1, 2001 minimum federal standards for refrigerator energy consumption by at least 10 percent.

Refrigerator Early Replacement: Early replacement of an older refrigerator (10 years old or more) with a new standard-efficiency refrigerator can save significant energy due to Federal standards on new refrigerator energy consumption.

High Efficiency Freezer: Stand-alone freezers include either upright or chest models. Efficient freezers exceed standard efficiencies by 10 percent or more.

Energy Star and High Efficiency Clothes Washer: A standard clothes washer uses various temperatures, water levels, and cycle durations to wash clothes depending on the clothing type and size of the laundry load. A high-efficiency

vertical-axis clothes washer eliminates the warm rinse option and uses a spray technology to rinse clothes. Such machines also use a spin cycle that eliminates more water from the clothes than conventional clothes washers and are generally driven by more efficient motors. A horizontal axis clothes washer can be top loading or front loading, and uses significantly less water (hot and cold) than the standard vertical axis machines.

Energy Star Dishwasher: ENERGY STAR labeled dishwashers save by using both improved technology for the primary wash cycle, and by using less hot water to clean. They include more effective washing action, energy efficient motors and other advanced technology such as sensors that determine the length of the wash cycle and the temperature of the water necessary to clean the dishes.

High Efficiency Clothes Dryer (gas and electric): A standard clothes dryer uses various temperatures and drying durations to dry clothes depending on the clothing type and size of the laundry load. The cycles are generally controlled by a timer. An energy efficient clothes dryer uses a moisture-sensing device to terminate the drying cycle rather than using a timer. In addition, an energy efficient motor is used for spinning the dryer tub.

High Efficiency Water Heater (electric or gas): The electric water heater measure involves substitution of a standard efficiency water heater (with an energy factor, EF, of 0.88) with a high efficiency water heater (EF of 0.93). For gas, a 0.60 EF water is replaced with a high efficiency, 0.63 EF, water heater. Energy factors are a measure of water heater efficiency that combines recovery efficiency with standby losses.

Heat Pump Water Heater: Air-to-water heat pump water heaters use a refrigeration cycle to extract heat from the air surrounding the water heater and transfer this heat to the water. When mounted indoors, heat pump water heaters provide space cooling and dehumidification along with water heating. Residential heat pump water heaters replace base electric units with the same tank capacities.

Solar Water Heater: Solar water heaters use solar energy to preheat water supplied to a conventional domestic hot water heating system. The energy savings for the system depend on solar radiation, air temperatures, water temperatures at the site, and the hot water use pattern. Most systems are designed to meet approximately 70 percent of the annual hot water needs of the home.

High Efficiency Boiler: Boilers provide hot water for some multifamily dwellings. This measure involves installation of a high efficiency gas boiler (95 percent efficiency) instead of a standard 82 percent efficient boiler.

Boiler Controls: Controllers optimize the performance of a boiler by learning the daily demand pattern of domestic hot water and adjusting the water supply accordingly. The controllers usually have the ability to automatically lower water temperatures during low use periods.

Low Flow Showerhead: Many households are still equipped with showerheads using 3+ gallons per minute. Low flow showerheads can significantly reduce water heating energy for a nominal cost. Typical low flow shower heads use 1.0-2.5 gallons per minute compared to conventional flow rate of 3.5-6.0 gallons per minute.

The reduction in shower water use can substantially lower water heating energy use since showering accounts for about one-fourth of total domestic hot water energy use.

Pipe Wrap: Pipe wrap is insulation material inhibits the transfer of heat through the hot water piping. In residential applications, usually the first five feet of pipe closest to the domestic water heater are insulated.

Faucet Aerators: Water faucet aerators are threaded screens that attach to existing faucets. They reduce the volume of water coming out of faucets while introducing air into the water stream. A standard non-conserving faucet aerator has a typical flow rate of 3-5 gallons per minute. A water-saving aerator can reduce the flow to 1-2 gallons per minute.

Water Heater Blanket: Adding water heater blankets to the hot water storage tank can reduce standby heat loss. This measure is especially effective when installed on older, less-insulated tanks.

High Efficiency Pool Pump and Motor: This measure involves the replacement of a standard-efficiency motor and low volume pump with a smaller high-efficiency motor and a new high-volume pump.

Nonresidential Sector Measures

A brief description of the measures considered for the nonresidential analysis is as follows:

T-8 Lamps with Electronic Ballast: T-8 lamps are a smaller diameter fluorescent lamp than T-12 lamps. When paired with specially designed electronic ballasts, T-8 lamps provide more light output per unit of energy input, resulting in energy savings. Electronic ballasts replace the standard core and coil technology in magnetic ballasts with solid-state components that operate at higher frequencies, causing the fluorescent lamps to operate more efficiently with less flicker.

Reflectors: Optical reflectors are mirrored surfaces installed in fluorescent fixtures to direct light toward a specific area or work surface. By installing optical reflectors, four-lamp and three-lamp fluorescent fixtures can be reduced to two lamp fixtures and still provide sufficient lighting levels.

Occupancy Sensors: Occupancy sensors (infrared or ultrasonic motion detection devices) turn lights on upon entry of a person into a room, and then turn the lights off from ½ minute to 20 minutes after they have left.

Continuous Dimming: Dimming electronic ballasts can be incorporated into a daylighting strategy around the perimeter of office buildings or in areas under skylights. These systems use photocells sense lighting levels and reduce power consumption and light output when sufficient daylight is available.

Compact Fluorescent Lighting (CFLs): Compact fluorescent lamps are designed to replace standard incandescent lamps. They are approximately four times more efficient than incandescent lamps with equivalent light output.

Halogen PAR Flood Lights: Halogen PAR (parabolic aluminized reflector) lamps use an enclosed tungsten filament within a halogen-filled glass tube. A 90-watt halogen PAR lamp can replace a conventional 150-watt standard incandescent PAR lamp.

Metal Halide Lamps: Metal halide lamps are approximately four times more efficient than incandescent lamps. Metal halide (MH) lamps are a form of high intensity discharge (HID) lamp with good lighting efficiency and excellent color rendition.

High Pressure Sodium Lamps: Existing 400 watt mercury vapor (MV) lamps can be replaced by 250 watt high pressure sodium (HPS) lamps in many applications. Although the color of light from HPS lamps is somewhat yellow, these lamps can be used to save energy in applications where color rendition is not important.

Outdoor Lighting Controls (Photocells and Timeclocks): Photocells can be used to automatically control outdoor lighting systems by turning the systems on only at night. When lights do not need to be on all night, a photocell in series with a time clock provides maximum savings and eliminates the need for manual operation and seasonal time clock adjustments. Time clocks enable users to turn on and off outdoor lighting systems at specific times during the day or week.

Chiller Efficiency Upgrade: Centrifugal chillers are generally used in building with cooling requirements greater than 200 tons. Centrifugal chillers reject heat through a water cooled condenser or cooling tower. In general, efficiency levels for centrifugal chillers start at 0.80 kW/ton (for older units). This measure evaluates the energy savings from the installation of a high-efficiency chiller (0.51 kW per ton) versus a standard unit (0.58 kW per ton).

Energy Management System: The term Energy Management System (EMS) refers to a complete building control system which usually can include controls for both lighting and HVAC systems. The HVAC control system may include on\off scheduling and warm-up routines. The complete lighting and HVAC control systems are generally integrated into personal computer with control system software.

EMS optimization: Energy management systems are frequently underused and have hundreds of minor inefficiencies throughout the system. Optimization of the existing system frequently results in substantial savings to the measures controlled by the EMS (e.g. lighting, HVAC) by minimizing waste.

VSD – Cooling Circulation Pumps: Variable speed drives installed on chilled water pumps can reduce energy use by varying the pump speed according to the building's demand for cooling. There is also a reduction in piping losses associated with this measure, which can have a major impact on the heating loads and energy use for a building.

DX Packaged System Efficiency Upgrade: DX packaged air conditioning systems provide cooling for much of the commercial floor space in California. This measure involves installation of a high-efficiency packaged AC unit versus a standard unit.

Evaporative Pre-cooler: Evaporative pre-coolers are used to evaporatively cool outdoor ventilation air ahead of the conventional air conditioning system, thereby reducing the need for mechanical cooling.

Programmable Thermostat: Setback programmable thermostats are appropriate controls for HVAC equipment that serve spaces with regular occupied and unoccupied periods, resulting in periods of time when heating and cooling setpoints can be adjusted outside the normal comfort range to save energy during unoccupied periods.

Window Film: This measure involves application of a reflective film to an existing window. Reflective window film is an effective way to reduce solar energy gains, thus reducing mechanical cooling energy consumption.

Cool Roof: The color and material of a building structure surface will determine the amount of solar radiation absorbed by that surface. By using an appropriate reflective material to coat the roof, the roof will absorb less solar radiation and consequently reduce the cooling load.

Tune up/Advanced Diagnostics: This measure evaluates the energy savings from an air conditioner tune-up that includes cleaning the condenser and evaporator coils and establishing proper refrigerant charge. Efficiency improvement of 15 percent to 40 percent is expected. The measure also includes fresh air economizer controls providing demand control ventilation and consisting of a logic module, enthalpy sensor(s), and CO2 sensors in appropriate applications.

Motor Efficiency Upgrade: Premium-efficiency motors operate at higher efficiency with fewer losses than standard efficiency motors. These motors are generally more reliable, resulting in reduced downtime and replacement costs.

VSD on Motor Installation: Energy usage in HVAC systems can be reduced by installing electronic variable frequency drives (VFDs) on ventilation fans. VFDs are a far more efficient method of regulating fan output than conventional systems using inlet vanes or dampers. Energy required to operate a fan motor can be reduced as much as 85 percent during reduced load conditions by installing a VFD.

Motor Efficiency Upgrade for Refrigeration System Fans and Compressors: In addition to saving energy, premium-efficiency motors are more reliable, resulting in reduced downtime and replacement costs.

Evaporator Fan Controller for Medium Temperature Walk-Ins: In response to the temperature setpoint being satisfied in a medium temperature walk-in cooler, evaporator fans are cycled to maintain minimum necessary air flow, which prevents ice build-up on the evaporator coils. In conventional systems, fans run constantly regardless of walk-in cooler air temperature.

Strip Curtains: Installing strip curtains on doorways to walk-in boxes and refrigerated warehouses can produce energy savings due to decreased infiltration of outside air into the refrigerated space. Although refrigerated spaces have doors, these doors are often left open, for example during product delivery and store stocking activities.

Night Covers: Installing film or blanket type night covers on display cases can significantly reduce the infiltration of warm ambient air into the refrigerated space. This reduction in display case loads in turn reduces the compressor and condenser energy. The target market for this measure is small, independently owned grocery

stores and other stores that are typically closed at night and restock their shelves during the day. The target cases are vertical displays, with a single- or double-air curtain, and tub (coffin) type cases.

Humidistat Controls: A humidistat control is a control device to turn refrigeration display case anti-sweat heaters off when ambient relative humidity is low enough that condensation (sweating) will not occur. Savings result from reducing the operating hours of the anti-sweat heaters, which without a humidistat control generally run continuously.

Demand Defrost Controls: Defrost of evaporator coils in freezer displays is normally completed on a timed basis, but this is wasteful, as the time interval is designed to remove ice around the coil under worst case humidity levels. Demand defrost sensor and control systems are designed to defrost the coil only when needed.

Floating Head Pressure Controls: Floating head pressure controls allow a refrigeration system to operate at a lower condensing temperature, where compressor operation is most efficient. Energy savings can be realized if the refrigeration system head pressure is allowed to float during periods of low ambient temperature, when the condensing temperature can be dramatically reduced.

Variable Speed Compressor Retrofit: A variable speed compressor is a screw or reciprocating compressor whose output modulated by a frequency inverter. When low load conditions exist, the power to the compressor motor is decreased.

Retrofit Glass Door on Medium Temperature Displays: Like the freezer case doors that are now common practice in grocery stores, there are opportunities to install doors on existing medium temperature displays, resulting in display load reductions and thus energy savings.

Power Management Enabling: This measure can be applied to PCs, PC monitors, and copiers. For PCs and copiers, manual enabling of the power management features is the only viable solution. For monitors, manual enabling and group enabling via network software are options.

LCD Monitors: (Liquid crystal display) LCD monitors use less energy and provide better display quality than conventional cathode ray tube (CRT) monitors.

External Hardware Controls: Occupancy sensors have been used for years to conserve energy in office lighting applications. The application has expanded to include other office equipment as ”plug-load sensors” incorporate an occupancy sensor with a relay that is able to turn equipment that is plugged into it on or off. The plug-load sensors range from devices that control a single electrical outlet or piece of equipment, to devices that control multiple outlets and can work together with other sensors.

Printer Nighttime Shutdown: The simplest action to save printer energy is to shut the machine off at night. While this recommendation is particularly important for conventional printers without power management, it is important to turn off ENERGY STAR printers as well, as they can draw up to 30-45 watts when in low power mode.

Ceiling Insulation: Installing fiberglass or cellulose insulation material in floor, wall or roof cavities will reduce heat loss or gain across these surfaces. A typical upgrade for commercial buildings is increasing insulation levels on flat roofs from R-5 to R-24.

Double Pane Low Emissivity Windows: The energy performance of a window is determined by the type of glass, the number of panes, the use of tints, the thickness of, and the gas type used in the gap between panes (for multi-pane windows). Low-E coatings improve the energy performance of a window by reducing heat losses and solar heat gains.

Duct Insulation: Insulation material inhibits the loss of heat or cool through the HVAC system ductwork. Several types of duct insulation are available, including flexible duct, pre-insulated flexible duct, duct board, duct wrap, tacked or glued rigid insulation, and water proof hard shell materials for exterior ducts. Duct insulation for existing construction involves wrapping un-insulated ducts with an R-4 insulating material.

High-Efficiency Furnace/Boilers: High-efficiency condensing gas furnaces and boilers have annual fuel utilization efficiencies (AFUEs) of greater than 95 percent or more compared to base efficiencies in the 80 percent range.

Boiler Pipe Insulation: Insulating accessible steam or hot water supply pipes in the boiler room can save energy, depending on the temperature of the hot water or steam and the ambient temperature.

Boiler Tune-Up: A high-efficiency boiler tune-up performed by a properly trained technician can improve average combustion efficiency by 2 to 10 percent. To ensure that the boiler tune-up is a success, the tune-up technician generally uses an electronic flue-gas analyzer.

Heat Recovery: Air-to-Air Heat Exchangers: Air-to-air heat exchangers can be used to transfer heat between the intake ventilation air stream and the HVAC exhaust air stream. During periods when the outside air is colder than the inside air, the heat exchanger transfers heat from the exhaust air to the incoming air reducing heating energy use. When the outside air is warmer than the inside air, the heat exchanger transfers heat from the incoming air to the exhaust air, lowering the temperature of the incoming air, and reducing cooling energy use.

Gas Water Heater: Efficient Gas Water Heaters measure evaluates savings from replacing a standard natural gas storage-type water heater with a high efficiency storage-type water heater.

Instantaneous or Demand Hot Water Heater: Demand water heaters are available in propane (LP), natural gas, or electric models. Unlike ”conventional” tank water heaters, tankless or instantaneous water heaters heat water only as it is used, or on demand. Since there is no water storage, standby losses are virtually eliminated. Pipe losses are reduced when the water heaters are installed at the point of use.

DHW Circulation Pump Timeclock Retrofit: Installing a time clock on the circulation pump for the domestic hot water system can reduce demand during periods when the building is unoccupied. Since, systems must be protected from

damage from freeze in all California climates timeclocks may include an override setting if the temperature reaches below a pre-determined set point.

Tank Insulation: Commercial water heater insulation is available either by the blanket or by square foot of fiberglass insulation with protective facing. Typical insulation thickness is 2 to 4 inches, with R-values ranging from 5 to 14. Additional insulation can reduce standby losses and improve overall efficiency.

DHW Pipe Insulation: The first five feet of pipe closest to the domestic water heater should be insulated. Current Title 24 Energy Standards require insulation only on the portion of DHW piping through which water is recirculated. Some energy savings are possible by insulating non-recirculating branch piping, depending on the frequency of hot water use through this piping.

Low Flow Shower Heads: Standard non conserving shower heads have a flow rate of 3.5 to 6 gallons per minute (gpm at 80 psi). Typical water saving shower heads use 1 to 2.4 gpm and are designed to provide a good quality shower with less water. Water saving shower heads are available in a variety of styles to produce acceptable shower quality.

Faucet Aerators: Standard non conserving faucet aerators have a flow rate of 3-5 gpm (at 40 to 60 psi). Water saving faucet aerators for bathroom applications have flow rates of 0.5-1.0 gpm and water saving faucet aerators for kitchen applications have average flow rates of 1.5-2.0 gpm. Water saving faucet aerators deliver water at a lower flow rate, but there is usually no perceptible reduction in service because the aerators are designed to entrain more air into the water, creating a foamier flow that tends to wet objects more thoroughly.

Active Solar DHW Systems: Solar water heaters preheat water supplied to a conventional domestic hot water heating system. In addition to system design and component quality, solar water heater performance depends on solar radiation, outdoor temperature, and daily water use.

Infrared Griddle: A griddle is a thick slab of flat steel heated from below by electric or gas burners. In an infrared (IR) griddle, standard burners are replaced with a porous ceramic plate burner that improves heat transfer to the griddle plate.

Convection Oven: Convection ovens use a small fan to circulate hot air within the oven cavity. In general, a convection oven will save 30 percent of the energy used by an oven.

Instantaneous Infrared Broiler/Conveyor Oven: The instantaneous infrared broiler uses the weight of the food plate to actuate the broiler flame instead of leaving the flame burning continuously. The broiler is designed to reach full operating temperatures quickly, eliminating preheat time.

Catalytic Infrared Fryer: Fryers cook foods by submerging them in hot animal or vegetable oils. The oil is heated by gas-burners with the flame traveling through several tubes that are submerged in the oil. Standard natural gas-fired fryers are about 50 percent efficient. Infrared fryers use internal fins or other heat-absorbing obstructions attached to the inside of the tubes. The fins or obstructions pick up more heat from the flame, improving efficiency to about 65 percent. Catalytic fryers

have woven wire or steel wool-like material inside the fire tubes. Catalytic infrared fryers are about 72 percent efficient and save about 30 percent of the energy used by standard gas-fired fryers.

Power Burner Range/Fryers: The power burner range is an improved atmospheric burner. The term ”power” means that a blower drives gas and air flow to the burner. Gas and air are mixed in a plenum and the mixture is regulated to achieve more efficient combustion. The thermal efficiency of the power burner is 63 percent compared to 42 percent for standard atmospheric burners found on conventional cook top ranges and conventional fryers.

Pool Heater: High efficiency pool heaters are now available with efficiencies of over 90 percent. These heaters used technologies similar to those of high efficiency boilers.

Pool Cover: Installing a pool cover is one of the most cost-effective ways to reduce energy use with a heated swimming pool. Pool covers typically save about 50 to 65 percent of the energy used to heat the pool if the cover is on 12 hours per day.

Solar Pool Heater: Unglazed solar pool heaters are effective in many California climates. These systems use low cost plastic collectors that drain back into the pool when not in use.

Measure unit energy savings were calculated for each measure along with an ”eligibility” factor which is simply the product of the applicability, feasibility and non-complete factors from the Xenergy study, supplemented by data from the RASS analysis described in Appendix E. For interventions that cover a series of measures, an adoption rate was estimated for each measure covered by the intervention. The measure adoption rate accounts for the fact that certain measures (for example, compact fluorescent lamps) are more likely to be adopted than replacement windows or new high-efficiency air conditioning systems within a particular intervention strategy.

Residential Time of Sale Energy Ratings

General assumptions used in the Residential Time of Sale Energy Ratings analysis are listed in Table 33 below:

Table 33. Residential Time of Sale Energy Rating General Assumptions

Characteristic	Value	Notes
Participants	218,187	Population of single family homes built prior to 1979 targeted, totaling 7,926,917 units. Fraction of units coming up for sale based on HMG report is .275. Analysis assumes 10 % of homebuyers request an energy inspection.
Incentive	$30/report	Recommendation from evaluation of GeoPraxis program (Mowris, 2004).
Estimated program cost	$1,751,862	Administration costs
Incentive cost	$6,545,595	
Total Program Cost	$8,297,457	
Energy Savings	76 GWh, 6.3 Mth	
Participant BCR	3.42	Assumes homebuyer pays for recommended improvements
TRC BCR	1.34	

The analysis assumes measures adopted by homebuyers in the same frequency as the GeoPraxis program. Unit energy savings, equipment saturations and costs are taken from the Xenergy Residential Potential Study. These assumptions are listed below:

Table 34. Residential Time of Sale Energy Rating Measure Assumptions

End use: Cooling

Fuel: Electricity

Base System: Split system Air Conditioner

Measure Description	Percent eligible	Average savings/home (kWh)	Measure Cost	Adoption ratio
Programmable Thermostat	13 %	76	$39	53 %
Basic HVAC Diagnostic Testing And Repair	13 %	187	$123	46 %
Duct Repair	18 %	110	$144	44 %
Double Pane Clear Windows to Double Pane, Med Low-E	23 %	339	$57	11 %
Ceiling R-19 to R-38 Insulation Blown in	18 %	51	$142	33 %
Wall 2x4 R-0 to Blow-In R-13 Insulation	13 %	143	$256	20 %
Infiltration Reduction	10 %	31	$100	73 %

End use: Cooling

Fuel: Electricity

Base System: Window Air Conditioner

Measure Description	Percent eligible	Average savings/home (kWh)	Measure Cost	Adoption ratio
HE Room Air Conditioner - SEER 10.3	9 %	74	$182	46 %
Programmable Thermostat (0.4)	5 %	25	$39	53 %
Basic HVAC Diagnostic Testing And Repair	5 %	60	$123	46 %
Double Pane Clear Windows to Double Pane, Med Low-E	9 %	111	$57	11 %
Ceiling R-19 to R-38 Insulation Blown in (.27)	5 %	16	$142	33 %
Wall 2x4 R-0 to Blow-In R-13 Insulation (0.14)	5 %	46	$256	20 %
Infiltration Reduction	4 %	10	$100	73 %

End use: Heating

Fuel: Electricity

Base System: Resistance Space Heating

Measure Description	Percent eligible	Average savings/home (kWh)	Measure Cost	Adoption ratio
Programmable Thermostat	4 %	255	$98	53 %
Ceiling R-19 to R-38 Insulation Blown-in	4 %	271	$543	33 %
Wall 2x4 R-0 to Blow-In R-13 Insulation	4 %	1,853	$1,844	20 %
Infiltration Reduction	3 %	153	$250	73 %

End use: Heating

Fuel: Gas

Base System: Gas Furnace

Measure Description	Percent eligible	Average savings/home (therm)	Measure Cost	Adoption ratio
Condensing Furnace, 92 AFUE	68 %	51	$679	44 %
Programmable Thermostat (.6)	15 %	20	$0	53 %

Measure Description	Percent eligible	Average savings/home (therm)	Measure Cost	Adoption ratio
Ceiling R-19 to R-38 Insulation Blown in (.73)	17 %	21	$0	33 %
Wall 2x4 R-0 to Blow-In R-13 Insulation (.86)	15 %	147	$0	20 %
Infiltration Reduction (.6)	12 %	12	$0	73 %
Duct Repair (0.68)	22 %	42	$0	44 %
Basic HVAC Diagnostic Testing And Repair	23 %	39	$0	46 %

End use: Lighting and Appliances
Fuel: Electricity

Measure Description	Percent eligible	Average savings/home (kWh)	Measure Cost	Adoption ratio
CFL, 0.5 hr/day	65 %	78	$101	63 %
CFL, 2.5 hr/day	65 %	694	$180	63 %
CFL, 6.0 hr/day	65 %	377	$41	63 %
Fluorescent Fixture 2L4'T8, 1EB	56 %	64	$108	39 %
HE Refrigerator - Energy Star	100 %	108	$100	31 %
HE Freezer	26 %	101	$50	31 %

End use: Water Heating
Fuel: Gas

Measure Description	Percent eligible	Average savings/home (therm)	Measure Cost	Adoption ratio
HE Water Heater (EF=0.63)	76 %	12	$74	19 %
Low Flow Showerhead	25 %	19	$0	83 %
Pipe Wrap	52 %	5	$0	64 %
Faucet Aerators	41 %	7	$0	80 %
Energy Star CW (EF=2.5)	82 %	31	$0	10 %
Energy Star DW (EF=0.58)	56 %	14	$0	25 %

End use: Water Heating
Fuel: Electricity

Measure Description	Percent eligible	Average savings/home (kWh)	Measure Cost	Adoption ratio
HE Water Heater (EF=0.93)	8 %	112	$50	19 %
Low Flow Showerhead	3 %	180	$26	17 %
Pipe Wrap	5 %	45	$5	64 %
Faucet Aerators	4 %	67	$11	80 %
Energy Star CW (EF=2.5)	9 %	607	$324	10 %
Energy Star DW (EF=0.58)	6 %	322	$204	25 %

Information to All Homeowners

General assumptions used in the Information to all Homeowners analysis are listed in Table 35 below:

Table 35. Information to All Homeowners General Assumptions

Characteristic	Value	Notes
Participants	150,000	33 % of homes targeted, 10 % of these elect to have the audit.
Estimated program cost	$1,751,862	Administration costs
Energy Savings	36.5 GWh	
Participant BCR	6.5	Assumes homebuyer pays for recommended improvements
TRC BCR	0.8	

The analysis assumes measures adopted by homebuyers in the same frequency as the Statewide Residential Audit program operated by the IOUs. Unit energy savings, equipment saturations and costs are taken from the Xenergy Residential Potential Study. These assumptions are listed below:

Table 36. Information to All Homeowners Measure Assumptions

Measure Description	Average savings/home (kWh)	Adoption ratio
Mail audit	171	0.7
Phone audit	257	0.15
In-home audit	611	0.15

Residential Equipment Tune-ups and O&M Services

This intervention examines mandatory tune-ups at time of sale and time of replacement. General assumptions used in the Residential Tune-up and O&M analysis are listed in the Table below:

Table 37. Residential Equipment Tune-ups and O&M General Assumptions

Characteristics	Value	Notes
Participants	1,497,588	Mandatory program involving TOS and replacement market. Single family homes built prior to 1978 targeted. 50 % compliance assumed
Estimated program cost	0	Mandatory - no program
Energy Savings	54.3 GWh, 0.2 Mth	
Participant BCR	4.78	
TRC BCR	3.63	

The analysis assumes refrigerant charge, airflow and duct leakage repairs. Energy and cost savings data from the Xenergy Residential Potential Study were used, as shown below:

Table 38. Residential Equipment Tune-ups and O&M Measure Assumptions

Measure Description	average savings/home	Cost
Basic HVAC Diagnostic Testing And Repair	244	$123
Duct Repair	229	$144

Low Income Multifamily Housing

General assumptions used in the Low Income Multifamily Housing analysis are listed in the Table below:

Table 39. Low Income Multifamily Housing General Assumptions

Characteristics	Value	Notes
Participants	308,371	56 % of multifamily residents are low income, 5 % of Multifamily housing units built before 1979 targeted (assuming major rehab every 20 years).
Estimated program cost		Carried by existing state agencies
Incentive cost	$58,016,398	100 % of incremental measure costs
Total Program Cost	$58,016,398	
Energy Savings	38.13 GWh, 5.3 MTh	
Participant BCR	3.43	Valid only if owners pay utility costs
TRC BCR	1.58	

The analysis assumes comprehensive upgrades to building shell, HVAC and appliances during rehabilitation. The measure savings and cost assumptions were taken from the Xenergy Residential Potential Study, and are summarized below:

Table 40. Low Income Multifamily Housing Measure Assumptions

End use: Cooling

Fuel: Electricity

Base System: Split system Air Conditioner

Measure Description	percent eligible	average savings/home (kWh, therm)	Cost per unit without incentive
10 to 14 SEER Split-System Air Conditioner	29.0 %	155.2	$1,082
Programmable Thermostat (0.4)	19.2 %	30.0	$39
Basic HVAC Diagnostic Testing And Repair	14.8 %	71.3	$123
Duct Repair (0.32)	21.3 %	40.2	$144
Double Pane Clear Windows to Double Pane, Med Low-E	26.6 %	73.8	$18
Ceiling R-0 to R-19 Insulation Blown-in (.29)	3.5 %	255.9	$125
Ceiling R-19 to R-38 Insulation Blown in (.27)	14.1 %	31.5	$114
Wall 2x4 R-0 to Blow-In R-13 Insulation (0.14)	17.7 %	11.5	$80
Infiltration Reduction (0.4)	11.8 %	12.0	$100

End use: Cooling

Fuel: Electricity

Base System: Window Air Conditioner

Measure Description	percent eligible	average savings/home (kWh, therm)	Cost per unit without incentive
HE Room Air Conditioner - SEER 10.3	16.1 %	60.3	$152
Programmable Thermostat (0.4)	11.6 %	20.1	$39
Double Pane Clear Windows to Double Pane, Med Low-E	16.1 %	49.6	$18
Ceiling R-0 to R-19 Insulation Blown-in (.29)	2.1 %	173.9	$125
Ceiling R-19 to R-38 Insulation Blown in (.27)	6.8 %	20.9	$114
Wall 2x4 R-0 to Blow-In R-13 Insulation (0.14)	10.7 %	8.6	$80
Infiltration Reduction	7.2 %	8.0	$100

End use: Heating

Fuel: Electricity

Base System: Resistance Space Heating

Measure Description	percent eligible	average savings/home (kWh, therm)	Cost per unit without incentive
Programmable Thermostat	11.2 %	122.5	$98
Ceiling R-0 to R-19 Insulation Blown-in	2.0 %	1405.6	$437
Ceiling R-19 to R-38 Insulation Blown-in	6.5 %	220.0	$437
Wall 2x4 R-0 to Blow-In R-13 Insulation	10.3 %	711.7	$580
Infiltration Reduction	6.9 %	73.5	$250

End use: Lighting and Appliances

Fuel: Electricity

Measure Description	percent eligible	average savings/home (kWh, therm)	Cost per unit without incentive
CFL, 0.5 hr/day	64.7 %	36.0	$47
CFL, 2.5 hr/day	64.7 %	322.5	$84
CFL, 6.0 hr/day	64.7 %	174.8	$19
RET 2L4'T8, 1EB	56.4 %	33.6	$60
HE Refrigerator - Energy Star	105.8 %	96.4	$100
HE Freezer	6.8 %	101.0	$50

End use: Water Heating

Fuel: Electricity

Measure Description	percent eligible	average savings/home (kWh, therm)	Cost per unit without incentive
HE Water Heater (EF=0.93)	14.4 %	90.7	$50
Low Flow Showerhead	4.4 %	145.2	$26
Pipe Wrap	9.2 %	36.3	$5
Faucet Aerators	7.3 %	54.4	$11
Water Heater Blanket	9.1 %	181.4	$14
Energy Star CW (EF=2.5)	12.3 %	511.7	$32
HE Clothes Dryer (EF=.52)	46.6 %	39.1	$15
Energy Star DW (EF=0.58)	9.1 %	239.9	$204

End use: Heating

Fuel: Gas

Base System: Gas Furnace

Measure Description	percent eligible	average savings/home (kWh, therm)	Cost per unit without incentive
Condensing Furnace, 92 AFUE	33.1 %	26.55	634
Programmable Thermostat (.6)	24.0 %	10.21153846	0
Ceiling R-0 to R-19 Insulation Blown-in (.71)	4.3 %	121.2369189	0
Ceiling R-19 to R-38 Insulation Blown in (.73)	14.0 %	19.32390533	0
Wall 2x4 R-0 to Blow-In R-13 Insulation (.86)	42.6 %	60.26934489	0
Infiltration Reduction (.6)	14.7 %	6.126923077	0
Duct Repair (0.68)	26.5 %	0	0
Duct Insulation (.6)	6.4 %	24.50769231	0

End use: Water Heating

Fuel: Gas

Base System: Apartment water heater

Measure Description	percent eligible	average savings/home (kWh, therm)	Cost per unit without incentive
HE Water Heater (EF=0.63)	69.2 %	10.39615385	74
Low Flow Showerhead	22.4 %	16.63384615	20
Pipe Wrap	47.2 %	4.158461538	0.54
Faucet Aerators	37.3 %	6.237692308	4.82

End use: Water Heating

Fuel: Gas

Base System: Central Boiler

Measure Description	percent eligible	average savings/home (kWh, therm)	Cost per unit without incentive
HE Boiler (EF=0.95)	2.1 %	29.10923077	7.08
Low Flow Showerhead	0.6 %	16.63384615	20
Faucet Aerators	1.0 %	6.237692308	4.82
Boiler Controls	2.0 %	31.18846154	3600
Energy Star CW (EF=2.5)	62.7 %	28.82384615	324
HE Clothes Dryer (EF=.52)	31.4 %	1.084615385	154
Energy Star DW (EF=0.58)	42.3 %	11.38	204

Retro-commissioning

General assumptions used in the Retro-commissioning analysis are listed in the Table below:

Table 41. Retro-commissioning General Assumptions

Characteristic	Value	Notes
Participants	99.9 MSF	Commercial buildings constructed prior to 1978 targeted at refinance event assumed to occur every 5 years. 10 % of these buildings elect to have retro commissioning done.
Estimated program cost	$9,990,258	Admin cost of $0.10/SF assumed based on PECI retrocommissioing program
Incentive cost	$23,976,620	37 % of CX cost ($0.24/SF)
Total Program Cost	$33,966,879	
Energy Savings	84.55 GWh, 16.85 MTh	
Participant BCR	4.95	
TRC BCR	2.87	

Average unit energy savings and retro commissioning costs from the 2004-2005 program submittals used in the analysis. These data are conservative relative to national average numbers from LBNL (Mills, et al., 2005), with 1.7 kWh/SF, 0.065 therm/SF, $0.27/SF cost.

Table 42. Retro-commissioning Measure Assumptions

Measure Description	Average savings/SF	Cost per SF without incentive
Retro commissioning	1.3 kWh/SF; 0.065 Th/SF	$0.68/SF

Energy Efficient Commercial Leasing

The analysis assumes a comprehensive lighting retrofit as part of the new lease or lease renewal process. General assumptions used in the Energy Efficient Commercial Leasing analysis are listed in the Table below:

Table 43. Commercial Leasing General Assumptions

Characteristic	Value	Notes
Participants	11.5 MSF	Commercial buildings constructed prior to 1978 targeted at lease renewal event assumed to occur every 5 years. 23 % of space is leased (HMG), and 50 % of this space is assumed to have a ”net” lease arrangement. An estimated 10 % of eligible floor space elects to have retrofit done.
Estimated program cost	$115,000	Program cost of $0.01/SF assumed
Incentive cost		Customers self-finance m easures or obtain referrals to other incentive programs
Total Program Cost	$115,000	
Energy Savings	8.64 GWh,	
Participant BCR	4.5	
TRC BCR	1.8	

Energy savings and costs for lighting upgrades taken from the Xenergy Commercial Building Potential Study.

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APPENDIX G: DETAILED SEGMENTATION TABLES

In the following tables, please note that a few variable labels (as well as a few headings) are asterisked or are displayed in red. In cases where the KEMA-XENERGY/RASS estimates were based on a small response rate (25 or fewer cases), results were displayed in red and asterisked in the cell to denote wide confidence intervals around the estimate. We have made every attempt to either note those cases in red or asterisk the rows where data were derived from one or more small cell. Where headings are asterisked, it is an indication that the column is comprised of data *mostly* based on small samples.

Energy Usage During Peak Hours

Table 44. Peak Time of Use of Electrical Appliances (Own)

Peak time use of electrical appliances (Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
FREQUENTLY	619,954	12%	937,898	18%	1,030,298	19%	2,588,150	49%
OCCASIONALLY	530,795	10%	556,370	10%	585,475	11%	1,672,640	31%
RARELY OR NEVER	286,055	5%	310,966	6%	471,948	9%	1,068,968	20%
Totals	1,436,804	27%	1,805,234	34%	2,087,721	39%	5,329,758	100%

Table 45. Peak Time of Use of Electrical Appliances (Rent)

Peak time use of electrical appliances (Rent)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
FREQUENTLY	765,566	23%	385,724	12%	174,564	5%	1,325,854	40%
OCCASIONALLY	524,489	16%	302,026	9%	80,832	2%	907,347	27%
RARELY OR NEVER	734,111	22%	258,886	8%	113,616	3%	1,106,612	33%
Totals	2,024,166	61%	946,636	28%	369,012	11%	3,339,813	100%

Refrigerators

Table 46. Number of Refrigerators

Number of refrigerators

		Own	% of GT	Rent	% of GT	Total	
	ZERO*	1,419	0%	1,722	0%	3,140	0%
< than 35K	ONE	1,242,144	14%	1,961,754	22%	3,203,898	37%
	TWO	197,262	2%	96,808	1%	294,070	3%
	THREE +*	19,485	0%	4,158	0%	23,643	0%
	NO RESPONSE*	84	0%	357	0%	442	0%
	Totals	1,460,394	17%	2,064,799	24%	3,525,193	40%
35 - LT 75K	ZERO*	1,169	0%			1,169	0%
	ONE	1,414,816	16%	882,760	10%	2,297,577	26%
	TWO	371,061	4%	64,143	1%	435,204	5%
	THREE +*	26,056	0%	0.00%	0%	32,096	0%
	NO RESPONSE*	1,115	0%			1,115	0%
	Totals	1,814,217	21%	946,903	11%	2,767,161	32%
75K +	ZERO*	741	0%	182	0%	923	0%
	ONE	1,429,556	16%	312,906	4%	1,742,461	20%
	TWO	603,781	7%	49,983	1%	653,764	7%
	THREE +*	61,843	1%	5,994	0%	67,837	1%
	NO RESPONSE*	817	0%			817	0%
	Totals	2,096,738	24%	369,065	4%	2,465,802	28%

GT = 8,758,156

Table 47. Percent of Sites with Old Refrigerator Discard and Age of Discarded Refrigerator

Old refrigerator discarded in the last 12 months

	Total	
NO	9,591,851	94%
YES	617,991	6%
Totals	10,209,842	100%

Age of discarded refrigerator

	Total	
< 2 YRS*	43,005	14%
2-7 YRS*	36,275	12%
8-10 YRS	65,179	21%
11-20 YRS	125,765	40%
21+ YRS*	42,764	14%
Totals	312,988	100%

Table 48. Age of First Refrigerator (Own)

Age of first refrigerator (Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
< 8 Yrs	739,589	14%	1,091,872	21%	1,280,249	24%	3,111,709	59%
8-10 Yrs	337,373	6%	361,692	7%	395,517	7%	1,094,581	21%
11+ Yrs	344,188	7%	332,550	6%	397,869	8%	1,074,607	20%
	1,421,150	27%	1,786,114	34%	2,073,635	39%	5,280,897	100%

Table 49. Age of First Refrigerator (Rent)

Age of first refrigerator (Rent)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
< 8 Yrs	1,184,400	37%	530,312	17%	251,811	8%	1,966,524	62%
8-10 Yrs	414,941	13%	191,766	6%	67,541	2%	674,249	21%
11+ Yrs	318,281	10%	163,673	5%	37,456	1%	519,409	16%
	1,917,622	61%	885,751	28%	356,808	11%	3,160,182	100%

Table 50. Age of Second Refrigerator (Own)

Age of second Refrigerator (Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
< 8 Yrs	56,183	5%	171,762	15%	334,865	29%	562,810	49%
8-10 Yrs	37,978	3%	76,939	7%	131,209	11%	246,125	22%
11+ Yrs	64,102	6%	103,460	9%	167,732	15%	335,294	29%
	158,263	14%	352,161	31%	633,806	55%	1,144,229	100%

Table 51. Age of Second Refrigerator (Rent)

Age of second refrigerator (Rent)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	%
< 8 Yrs	54,611	29%	28,186	15%	39,524	21%	122,320	65%
8-10 Yrs	7,556	4%	13,678	7%	11,200	6%	32,435	17%
11+ Yrs	14,331	8%	16,564	9%	3,187	2%	34,083	18%
	76,498	41%	58,428	31%	53,911	29%	188,838	100%

Freezers

Table 52. Number of Stand Alone Freezers (Own)

Number of stand alone freezers (Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
NONE	1,005,696	19%	1,351,027	26%	1,650,547	31%	4,007,271	76%
ONE FREEZER	377,878	7%	411,272	8%	410,325	8%	1,199,474	23%
TWO + FREEZERS*	24,101	0%	22,785	0%	14,192	0%	61,078	1%
Totals	1,407,675	27%	1,785,084	34%	2,075,064	39%	5,267,823	100%

Table 53. Number of Stand Alone Freezers (Rent)

Number of stand alone freezers (Rent)

	< $35K	%	$35-75K	%	$75K+	%	Total	
NONE	1,824,035	56%	887,957	27%	326,995	10%	3,038,987	93%
ONE FREEZER	148,546	5%	46,087	1%	33,097	1%	227,731	7%
TWO + FREEZERS*	5,608	0%	834	0%	379	0%	6,821	0%
Totals	1,978,189	60%	934,878	29%	360,471	11%	3,273,539	100%

Table–54 Old Freezer Discarded in Last 12 Months and Age of Discarded Freezer

Old freezer discarded in the last 12 months

	Total	
NO	10,167,898	99.6%
YES*	41,944	0.4%
Totals	10,209,842	100%

Age of discarded freezer

	Total	
< 10 YRS*	6,043	19%
11+ YRS*	25,254	81%
Totals	31,297	100%

Table–55 Style and Age of First Freezer

Style of first freezer

	Total	
UPRIGHT, FROST FREE	691,811	41%
UPRIGHT, MANUAL DEFROST	550,781	32%
CHEST, FROST FREE	207,320	12%
CHEST, MANUAL DEFROST	258,984	15%
Totals	1,708,896	100%

Age of first freezer

	Total	
< 10 YRS	1,066,522	65%
11+ YRS	585,409	35%
Totals	1,651,931	100%

Clothes Washers

Table 56. Laundry Equipment in Home (Own)

Laundry equipment in home (Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
YES	1,324,390	25%	1,731,657	33%	2,050,268	39%	5,106,314	97%
IN COMMON or DO NOT USE*	86,237	2%	56,018	1%	31,993	1%	174,248	3%
Totals	1,410,627	27%	1,787,675	34%	2,082,261	39%	5,280,562	100%

Table 57. Laundry Equipment in Home (Rent)

Laundry equipment in home (Rent)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
YES	676,555	24%	399,623	14%	230,981	8%	1,307,159	46%
IN COMMON or DO NOT USE*	980,198	35%	437,109	15%	115,623	4%	1,532,931	54%
Totals	1,656,753	58%	836,732	29%	346,604	12%	2,840,090	100%

Table 58. Age of Discarded Clothes Washer

Age of discarded clothes washer

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
1 - 10 YRS	52,226	12%	65,120	15%	72,643	16%	189,987	43%
11 + YRS	56,562	13%	81,490	18%	117,500	26%	255,551	57%
Totals	108,788	24%	146,610	33%	190,143	43%	445,538	100%

Table 59. Age of Clothes Washer (Own)

Clothes washer age (Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
< ONE YR	91,619	2%	144,712	3%	210,999	4%	447,332	9%
1-5 YRS	511,612	10%	787,244	16%	845,950	17%	2,144,806	42%
6-8 YRS	318,093	6%	377,972	7%	439,565	9%	1,135,631	22%
9 - 30+ YRS*	373,621	7%	409,394	8%	545,212	11%	1,328,226	26%
Totals	1,294,945	26%	1,719,322	34%	2,041,726	40%	5,055,995	100%

Table 60. Age of Clothes Washer (Rent)

Clothes washer age (Rent)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
< ONE YR*	60,446	5%	46,911	4%	17,922	1%	125,279	10%
1-5 YRS	316,667	26%	169,637	14%	106,236	9%	592,540	48%
6-8 YRS	143,283	12%	96,103	8%	48,608	4%	287,993	23%
9 - 30+ YRS*	117,816	10%	60,896	5%	44,550	4%	223,263	18%
Totals	638,212	52%	373,547	30%	217,316	18%	1,229,075	100%

Table 61. Type of Clothes Washer (Own)

Type of clothes washer (Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
TOP LOAD	1,233,418	24%	1,601,830	32%	1,764,787	35%	4,600,035	91%
FRONT LOAD	74,427	1%	125,161	2%	280,303	6%	479,891	9%
Totals	1,307,845	26%	1,726,991	34%	2,045,090	40%	5,079,926	100%

Table 62. Type of Clothes Washer (Rent)

Type of clothes washer (Rent)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
TOP LOAD	612,468	48%	346,392	27%	210,178	17%	1,169,037	92%
FRONT LOAD*	39,527	3%	39,974	3%	20,371	2%	99,873	8%
Totals	651,995	51%	386,366	30%	230,549	18%	1,268,910	100%

Table 63. Number of Hot Water Washes per Week (Own)

Number of hot water washes per week (Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
NONE	810,456	16%	901,561	18%	1,092,344	22%	2,804,361	55%
1-4 PER Wk	442,257	9%	729,468	14%	858,039	17%	2,029,764	40%
5+ PER Wk*	52,281	1%	89,093	2%	87,708	2%	229,082	5%
Totals	1,304,994	26%	1,720,122	34%	2,038,091	40%	5,063,207	100%

Table 64. Number of Hot Water Washes per Week (Rent)

Number of hot water washes per week (Rent)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
NONE	335,368	26%	184,897	15%	113,652	9%	633,917	50%
1-4 PER Wk	285,018	23%	194,114	15%	95,233	8%	574,365	45%
5+ PER Wk*	31,989	3%	8,138	1%	18,216	1%	58,343	5%
Totals	652,375	52%	387,149	31%	227,101	18%	1,266,625	100%

Air Conditioners

Table 65. Number of Central Air Conditioners (Own)

Number of central air conditioners (Ow

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
NONE	180,876	6%	130,132	5%	91,213	3%	402,222	14%
ONE CENTRAL AIR	471,971	16%	814,892	28%	953,226	33%	2,240,090	78%
TWO + CENTRAL AIR*	20,588	1%	25,523	1%	174,175	6%	220,286	8%
Totals	673,435	24%	970,547	34%	1,218,614	43%	2,862,598	100%

Table 66. Number of Central Air Conditioners (Rent)

Number of central air conditioners (Re

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
NONE	149,418	15%	32,424	3%	16,714	2%	198,556	19%
ONE CENTRAL AIR	422,868	41%	279,318	27%	106,253	10%	808,440	79%
TWO + CENTRAL AIR	8,668	1%	1,620	0%	2,747	0%	13,035	1%
Totals	580,954	57%	313,362	31%	125,714	12%	1,020,031	100%

Table 67. Age of Discarded Central Cooling (Own)

Age of discarded central cooling (Own)

	< $35K*	% of GT	$35-75K*	% of GT	$75K+	% of GT	Total	
1 - 10 YRS*	4,297	5%	9,425	10%	5,593	6%	19,315	21%
11-20 YRS*	6,492	7%	8,103	9%	14,922	16%	29,516	32%
21+ YRS*	9,526	10%	23,907	26%	10,630	11%	44,061	47%
Totals	20,315	22%	41,435	45%	31,145	34%	92,892	100%

Table 68. Age of Main Central Air Conditioner (Own)

Age of main central air conditioner (Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
< 4 Yrs	119,778	4%	207,813	8%	254,818	9%	582,409	22%
4-8 YRS	170,490	6%	228,170	8%	328,030	12%	726,690	27%
9-13 YRS	111,378	4%	183,286	7%	258,557	10%	553,221	21%
14+ YRS	206,440	8%	296,996	11%	322,814	12%	826,251	31%
	608,086	23%	916,265	34%	1,164,219	43%	2,688,571	100%

Table 69. Maintenance Performed on Air Conditioning System – Last 12 Months (Own)

Maintenance preformed on air conditioning system - last 12 months (Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
YES	173,006	7%	255,332	10%	305,458	12%	733,796	28%
NO	378,918	15%	651,427	25%	848,939	32%	1,879,284	72%
Totals	551,924	21%	906,759	35%	1,154,397	44%	2,613,080	100%

Table 70. Maintenance Performed on Air Conditioning System – Last 12 Months (Rent)

Maintenance preformed on air conditioning system - last 12 months (Rent)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
YES*	118,442	5%	51,171	2%	32,912	1%	202,525	24%
NO	342,631	13%	219,624	8%	82,572	3%	644,827	76%
Totals	461,073	18%	270,795	10%	115,484	4%	847,352	100%

Table 71. Have a Room Air Conditioner

Have a room air conditioner

	Own	% of GT	Rent	% of GT	Total	
HAVE ROOM AC	1,005,537	10%	879,269	9%	1,884,806	18%
DO NOT HAVE ROOM AC	5,426,073	53%	2,898,963	28%	8,325,036	82%
Totals	6,431,610	63%	3,778,232	37%	10,209,842	100%

Table 72. Age of Discarded Wall or Window Air Conditioner (Own)

Age of discarded wall or window air conditioner (Own)

	< $35K*	% of GT	$35-75K*	% of GT	$75K+	% of GT	Total	
1 - 10 YRS*	5,862	9%	12,910	19%	6,962	10%	25,734	37%
11-20 YRS*	4,705	7%	6,521	9%	6,167	9%	17,393	25%
21+ YRS*	11,063	16%	8,037	12%	6,677	10%	25,777	37%
Totals	21,630	31%	27,468	40%	19,806	29%	68,904	100%

Table 73. Age of Room Air Conditioner - 1st (Own)

Age of room air conditioner - 1st (Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
< 4 Yrs*	91,907	12%	72,091	9%	56,195	7%	220,193	28%
4-8 YRS	73,180	9%	85,773	11%	37,040	5%	195,994	25%
9-13 YRS	55,553	7%	44,174	6%	34,494	4%	134,221	17%
13 + YRS	86,315	11%	67,999	9%	68,525	9%	222,839	29%
	306,955	40%	270,037	35%	196,254	25%	773,247	100%

Table 74. Age of Room Air Conditioner - 1st (Rent)

Age of room air conditioner -1st (Rent)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
< 4 Yrs*	126,616	20%	50,490	8%	20,630	3%	197,736	32%
4-8 YRS*	65,398	10%	35,098	6%	9,767	2%	110,264	18%
9-13 YRS*	74,673	12%	34,801	6%	10,706	2%	120,180	19%
13 + YRS*	152,437	24%	43,585	7%	2,828	0%	198,850	32%
	419,124	67%	163,974	26%	43,931	7%	627,030	100%

It is estimated that there are an additional 243,087-*second* room air conditioners (Own/Rent combined) with 85,684 of those units (35.3 percent) nine or years older.

Table 75. Use of Room AC in Evening

Use of room AC in evening

	Own	% of GT	Rent	% of GT	Total	
NEVER / RARELY	352,046	23%	306,553	20%	658,599	44%
SOMETIMES-ALWAYS	400,312	27%	439,733	29%	840,044	56%
Totals	752,358	50%	746,286	50%	1,498,643	100%

Shell – Lighting

Table 76. Number of Interior CFL (Own)

Number of interior CFL (Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
None	685,772	13%	785,552	15%	790,347	15%	2,261,672	43%
1-2 products	356,629	7%	467,932	9%	573,354	11%	1,397,914	27%
3-5 products	211,370	4%	338,335	6%	406,361	8%	956,067	18%
6 + products	132,418	3%	195,634	4%	306,775	6%	634,829	12%
Totals	1,386,189	26%	1,787,453	34%	2,076,837	40%	5,250,482	100%

Table 77. Number of Interior CFL (Rent)

Number of Interior CFLs (Rent)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
None	1,221,163	37%	538,727	16%	184,016	6%	1,943,907	59%
1-2 products	477,884	15%	256,322	8%	98,619	3%	832,825	25%
3-5 products	208,857	6%	117,152	4%	46,798	1%	372,807	11%
6 + products*	72,433	2%	24,107	1%	33,899	1%	130,438	4%
Totals	1,980,337	60%	936,308	29%	363,332	11%	3,279,977	100%

Table 78. Number of Interior Timers (Own)

Number of interior timers (Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
None	1,208,809	23%	1,454,864	28%	1,596,721	30%	4,260,394	81%
1-2 products	156,104	3%	289,814	6%	389,562	7%	835,480	16%
3-5 products	14,868	0%	40,868	1%	78,339	1%	134,075	3%
6 + products*	6,409	0%	1,907	0%	12,216	0%	20,532	0%
Totals	1,386,190	26%	1,787,453	34%	2,076,838	40%	5,250,481	100%

Table 79. Number of Interior Motion Detectors (Own)

Number of interior motion detectors (Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
None	1,175,521	22%	1,437,075	27%	1,630,516	31%	4,243,112	81%
1-2 products	181,069	3%	295,632	6%	383,533	7%	860,233	16%
3-5 products	27,260	1%	52,015	1%	54,265	1%	133,540	3%
6 + products*	2,341	0%	2,731	0%	8,524	0%	13,596	0%
Totals	1,386,191	26%	1,787,453	34%	2,076,838	40%	5,250,481	100%

Table 80. Number of Interior Dimmers (Own)

Number of interior dimmers (Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
None	940,607	18%	970,490	18%	743,042	14%	2,654,139	51%
1-2 products	375,194	7%	589,564	11%	748,732	14%	1,713,490	33%
3-5 products	63,210	1%	164,299	3%	397,833	8%	625,342	12%
6 + products*	7,179	0%	63,102	1%	187,231	4%	257,511	5%
Totals	1,386,190	26%	1,787,455	34%	2,076,838	40%	5,250,482	100%

Table 81. Number of Exterior Incandescent (Own)

Number of exterior incandescent (Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
None	726,501	14%	762,674	15%	802,357	16%	2,291,532	45%
1-2 products	459,223	9%	631,834	13%	662,189	13%	1,753,247	35%
3-5 products	84,819	2%	280,036	6%	375,602	7%	740,457	15%
6+ products*	14,897	0%	52,717	1%	187,507	4%	255,121	5%
Totals	1,285,440	26%	1,727,261	34%	2,027,655	40%	5,040,357	100%

Table 82. Number of Exterior CFL (Own)

Number of exterior CFL (Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
None	1,118,652	22%	1,404,356	28%	1,611,929	32%	4,134,936	82%
1-2 products	145,239	3%	251,592	5%	286,042	6%	682,874	14%
3-5 products	18,980	0%	56,339	1%	92,719	2%	168,038	3%
6+ products*	2,570	0%	14,974	0%	36,965	1%	54,508	1%
Totals	1,285,441	26%	1,727,261	34%	2,027,655	40%	5,040,356	100%

Table 83. Number of Exterior Low Voltage Landscape (Own)

Number of exterior low volt landscape (Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
None	1,138,459	23%	1,472,481	29%	1,497,233	30%	4,108,173	82%
1-2 products	112,247	2%	182,034	4%	313,968	6%	608,249	12%
3-5 products*	23,768	0%	35,702	1%	80,168	2%	139,637	3%
6+ products*	10,968	0%	37,043	1%	136,287	3%	184,298	4%
Totals	1,285,442	26%	1,727,260	34%	2,027,656	40%	5,040,357	100%

Table 84. Number of Exterior Metal Halide (Own)

Number of exterior metal halide (Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
None	1,212,313	24%	1,601,115	32%	1,920,775	38%	4,734,202	94%
1-2 products	64,800	1%	108,438	2%	94,784	2%	268,022	5%
3-5 products*	7,516	0%	9,963	0%	8,571	0%	26,050	1%
6+ products*	812	0%	7,745	0%	3,526	0%	12,083	0%
Totals	1,285,441	26%	1,727,261	34%	2,027,656	40%	5,040,357	100%

Table 85. Number of Exterior Timers (Own)

Number of exterior timers (Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
None	1,190,154	24%	1,415,642	28%	1,503,522	30%	4,109,319	82%
1-2 products	91,197	2%	241,085	5%	345,377	7%	677,658	14%
3-5 products*	6,770	0%	17,659	0%	79,221	2%	103,650	2%
6+ products*	2,536	0%	15,404	0%	79,102	2%	97,042	2%
Totals	1,290,657	26%	1,689,790	34%	2,007,222	40%	4,987,669	100%

Table 86. Number of Exterior Light Sensors (Own)

Number of exterior light sensors (Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
None	1,077,371	21%	1,292,125	26%	1,600,087	32%	3,969,583	80%
1-2 products	195,382	4%	362,208	7%	332,457	7%	890,046	18%
3-5 products*	16,241	0%	25,113	0%	46,314	1%	87,667	2%
6+ products*	1,663	0%	10,345	0%	28,365	1%	40,373	1%
Totals	1,290,657	26%	1,689,791	34%	2,007,223	40%	4,987,669	100%

Table 87. Number of Exterior Motion Detectors (Own)

Number of exterior motion detectors (Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
None	878,968	17%	1,051,827	21%	1,247,729	25%	3,178,525	64%
1-2 products	384,473	8%	563,655	11%	640,333	13%	1,588,460	32%
3-5 products	26,649	1%	72,047	1%	99,889	2%	198,585	4%
6+ products*	567	0%	2,262	0%	19,271	0%	22,100	0%
Totals	1,290,657	26%	1,689,791	34%	2,007,222	40%	4,987,670	100%

Shell – Remodeled in past 12 months

Table 88. Home Has Been Remodeled (Own)

Home has been remodeled (Own)

	Old (Pre 1997)	% of GT	New (1997-2003)	% of GT	Total	
NO	4,659,702	77%	466,978	8%	5,126,680	85%
YES	910,910	15%	13,721	0%	924,632	15%
Totals	5,570,612	92%	480,699	8%	6,051,312	100%

Table 89. Rebuilt Most of the Home (Own)

Rebuilt most of the home (Own)

	Old (Pre 1997)	% of GT	New (1997-2003)	% of GT	Total	
NO	806,298	91%	9,635	1%	815,933	92%
YES	72,557	8%	940	0%	73,497	8%
Totals	878,855	99%	10,575	1%	889,430	100%

Table 90. Newer (1997-2003) Home Has Been Remodeled - Own

Newer (1997-2003) home has been remodeled - Own

	< $35K*	% of GT	$35-75K*	% of GT	$75K+*	% of GT	Total	
NO	46,197	11%	127,674	32%	217,878	54%	391,750	97%
YES*	470	0%	7,227	2%	5,629	1%	13,326	3%
Totals	46,667	12%	134,901	33%	223,507	55%	405,076	100%

(note small sample sizes in all income cagegories)

Table 91. Older (Pre-1997) Home Has Been Remodeled - Own

Older (pre-1997) home has been remodeled - Own

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
NO	1,169,617	25%	1,312,026	28%	1,393,416	30%	3,875,058	83%
YES	136,017	3%	272,794	6%	393,351	8%	802,161	17%
Totals	1,305,634	28%	1,584,820	34%	1,786,767	38%	4,677,219	100%

Table 92. Rebuilt Most of the Home – Pre-1997, Own

Rebuilt most of the home - Pre-1997, Own

	< $35K*	% of GT	$35-75K*	% of GT	$75K+	% of GT	Total	
NO	113,879	15%	244,229	32%	342,761	44%	700,871	91%
YES*	18,245	2%	16,006	2%	36,605	5%	70,856	9%
Totals	132,124	17%	260,235	34%	379,366	49%	771,727	100%

Table 93. Remodel Bath or Kitchen – Pre-1997, Own

Remodel bath or kitchen – Pre-1997, Own

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
NO	59,873	8%	82,580	11%	124,264	16%	266,717	35%
YES	72,251	9%	177,657	23%	255,102	33%	505,010	65%
Totals	132,124	17%	260,237	34%	379,366	49%	771,727	100%

Table 94. Remodel with Room Addition - Pre-1997, Own

Remodel with room addition – Pre-1997, Own

	< $35K*	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
NO	118,014	15%	227,701	30%	328,691	43%	674,405	87%
YES*	14,111	2%	32,535	4%	50,677	7%	97,323	13%
Totals	132,125	17%	260,236	34%	379,368	49%	771,728	100%

Table 95. Remodel Other – Pre-1997, Own

Remodel other – Pre-1997, Own

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
NO	88,697	11%	176,493	23%	272,565	35%	537,755	70%
YES	43,427	6%	83,743	11%	106,802	14%	233,972	30%
Totals	132,124	17%	260,236	34%	379,367	49%	771,727	100%

Shell – Insulation and Windows

Table 96. Home Has Insulated Attic (Own)

Home has insulated attic (Own)

	YES	NO	NO as % of GT	Total	
Single Family	3,730,258	687,565	13%	4,417,823	81%
Townhouse, Duplex, Row House	222,151	63,767	1%	285,918	5%
Apt Condo 2-4 Units	119,460	48,658	1%	168,118	3%
Apt Condo 5+ Units	123,068	108,653	2%	231,721	4%
Mobile Home	193,220	122,145	2%	315,365	6%
Other	33,631	11,742	0%	45,373	1%
Total	4,421,788	1,042,531	19%	5,464,318	100%
Percent of GT	*81%*	*19%*			

Table 97. Home Has Insulated Attic (Rent)

Home has insulated attic (Rent)

	YES	NO	NO as % of GT	Total	
Single Family	382,720	339,199	12%	721,919	26%
Townhouse, Duplex, Row House	119,649	145,313	5%	264,962	10%
Apt Condo 2-4 Units	150,350	399,644	14%	549,994	20%
Apt Condo 5+ Units	344,846	844,697	30%	1,189,543	43%
Mobile Home	18,050	11,771	0%	29,821	1%
Other*	10,544	21,808	1%	32,352	1%
Total	1,026,158	1,762,433	63%	2,788,591	100%
Percent of GT	*37%*	*63%*			

Table 98. Inches of Attic Insulation (Own)

Inches of attic insulation (Own)

	0-3"	0-3" as % of GT	4-6"	7-10 +"	Totals	
Single Family	771,129	*21%*	1,735,166	641,115	3,147,410	85%
Townhouse, Duplex, Row House	62,671	*2%*	91,628	24,843	179,142	5%
Apt Condo 2-4 Units	25,308	*1%*	41,342	13,098	79,748	2%
Apt Condo 5+ Units	36,339	*1%*	41,457	13,202	90,998	2%
Mobile Home	91,236	*2%*	58,904	8,662	158,802	4%
Other*	9,924	*0%*	15,864	2,593	28,381	1%
Total	996,606	*27%*	1,984,361	703,514	3,684,481	100%
Percent of GT	*27%*		*54%*	*19%*		

Table 99. Inches of Attic Insulation by Income Group (Own)

Inches of attic insulation by income group - Own

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
0-3 INCHES	278,252	8%	350,101	10%	323,294	9%	951,647	28%
4-6 INCHES	361,550	11%	607,216	18%	856,352	25%	1,825,119	53%
7-10 INCHES	77,990	2%	165,978	5%	266,573	8%	510,541	15%
10 + INCHES	27,419	1%	53,275	2%	64,910	2%	145,603	4%
Totals	745,211	22%	1,176,570	34%	1,511,129	44%	3,432,910	100%

Table 100. Home Has Insulated Exterior Walls (Own)

Home has insulated exterior walls (Own)

	YES, ALL EXT WALLS	YES, SOME EXT WALLS	NO, EXT WALLS	NO as % of GT	Totals	
Single Family	2,718,830	728,132	908,849	17%	4,355,811	80%
Townhouse, Duplex, Row House	173,999	63,281	53,777	1%	291,057	5%
Apt Condo 2-4 Units	109,333	25,631	34,246	1%	169,210	3%
Apt Condo 5+ Units	142,829	45,524	51,469	1%	239,822	4%
Mobile Home	189,202	56,621	83,214	2%	329,037	6%
Other*	26,310	11,392	10,713	0%	48,415	1%
Total	3,360,504	930,580	1,142,269	21%	5,433,353	100%
Percent of GT	*62%*	*17%*	*21%*			

Table 101. Home Has Insulated Exterior Walls (Rent)

Home has insulated exterior walls (Rent)

	YES, ALL EXT WALLS	YES, SOME EXT WALLS	NO, EXT WALLS	NO as % of GT	Totals	
Single Family	262,479	123,350	329,690	11%	715,519	24%
Townhouse, Duplex, Row House	97,235	49,302	132,938	5%	279,475	9%
Apt Condo 2-4 Units	230,299	72,454	284,894	10%	587,647	20%
Apt Condo 5+ Units	486,208	170,145	636,061	22%	1,292,414	44%
Mobile Home	11,634	14,244	7,723	0%	33,601	1%
Other*	11,518	11,593	18,058	1%	41,169	1%
Total	1,099,373	441,088	1,409,364	48%	2,949,825	100%
Percent of GT	37%	15%	48%			

Table 102. Home Has Insulated Attic (Single Family)

Home has insulated attic (Single Family)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
YES	865,397	20%	1,167,284	27%	1,432,485	33%	3,465,165	79%
NO	393,271	9%	320,487	7%	208,640	5%	922,397	21%
Totals	1,258,668	29%	1,487,771	34%	1,641,125	37%	4,387,562	100%

Table 103. Home Has Insulated Attic (Mobile Homes)

Home has insulated attic (Mobile Homes)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
YES	122,365	41%	41,808	14%	15,053	5%	179,226	61%
NO	92,602	31%	19,099	6%	4,248	1%	115,949	39%
Totals	214,967	73%	60,907	21%	19,301	7%	295,175	100%

Table 104. Home Has Insulated Attic (Town Homes)

Home has insulated attic (Town Homes)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
YES	75,979	16%	87,122	18%	131,286	27%	294,386	62%
NO	106,728	22%	41,422	9%	36,115	8%	184,265	38%
Totals	182,707	38%	128,544	27%	167,401	35%	478,651	100%

Table 105. Window Pane Type (Own)

Window pane type (Own)

	ALL DOUBLE	ALL SINGLE	ALL SINGLE AS % OF GT	MIX SINGLE & DOUBLE	Totals	
Single Family	2,155,092	1,898,101	*33%*	521,103	4,574,296	79%
Townhouse, Duplex, Row House	99,947	183,415	*3%*	36,350	319,712	6%
Apt Condo 2-4 Units	33,945	119,825	*2%*	25,179	178,949	3%
Apt Condo 5+ Units	90,999	180,444	*3%*	14,769	286,212	5%
Mobile Home	67,396	263,643	*5%*	30,280	361,319	6%
Other*	10,925	30,702	*1%*	7,618	49,245	1%
Total	2,458,303	2,676,131	*46%*	635,299	5,769,733	100%
Percent of GT	*43%*	*46%*		*11%*		

Table 106. Window Frame Type (Own)

Window frame type (Own)

	VINYL FRAMES	WOOD FRAMES	METAL FRAMES	METAL AS % OF GT	Totals	
Single Family	1,019,679	963,445	2,574,797	*45%*	4,557,921	79%
Townhouse, Duplex, Row House	45,684	45,708	230,336	*4%*	321,728	6%
Apt Condo 2-4 Units	15,022	28,067	141,142	*2%*	184,231	3%
Apt Condo 5+ Units	22,723	24,060	241,230	*4%*	288,013	5%
Mobile Home	27,596	26,264	307,384	*5%*	361,244	6%
Other*	6,465	8,236	35,162	*1%*	49,863	1%
Total	1,137,169	1,095,779	3,530,051	*61%*	5,762,999	100%
Percent of GT	*20%*	*19%*	*61%*			

Table 107. Window Pane Type (Single Family Own)

Window pane type (Single-family Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
ALL DOUBLE PANE	313,390	8%	587,856	15%	859,194	23%	1,760,441	46%
ALL SINGLE PANE	502,961	13%	575,315	15%	561,957	15%	1,640,233	43%
MIXTURE SINGLE & DOUBLE	92,576	2%	153,391	4%	167,059	4%	413,026	11%
Totals	908,927	24%	1,316,562	35%	1,588,210	42%	3,813,700	100%

Table 108. Window Frame Type (Single Family Own)

Window frame type (Single-family Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
VINYL FRAMES	111,255	3%	262,081	7%	445,357	12%	818,693	22%
WOOD FRAMES	266,252	7%	216,487	6%	321,457	8%	804,196	21%
METAL FRAMES	539,411	14%	824,352	22%	816,046	21%	2,179,808	57%
Totals	916,918	24%	1,302,920	34%	1,582,860	42%	3,802,697	100%

Swimming Pools - Owners

Table 109. Pool Size

Pool size

	Own	Col %	Rent	Col %	Total	
LESS THAN 20000 GAL	251,691	32%	10,069	41%	261,760	33%
20-40000 GAL	486,627	62%	13,793	56%	500,420	62%
40000 + GAL	41,689	5%	597	2%	42,285	5%
Totals	780,007	100%	24,459	100%	804,465	100%

Table 110. Pool, Pay For Energy (Single Family, Own)

Pool, pay for energy (Single Family, Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
YES, PAY ENERGY	64,279	2%	178,352	5%	356,939	9%	599,569	16%
NO (or COMMON AREA*)	823,122	22%	1,125,087	30%	1,235,110	33%	3,183,319	84%
Totals	887,401	23%	1,303,439	34%	1,592,049	42%	3,782,888	100%

Table 111. Age of Discarded Pool Pump (Single Family, Own)

Age of discarded pool pump (Single-family, Own)

	< $35K*	%	$35-75K*	%	$75K+	%	Total	
1 - 10 YRS*	1,410	3%	18,586	36%	9,869	19%	29,864	58%
11-20 YRS*	807	2%	7,108	14%	10,484	20%	18,399	36%
21+ YRS*	0	0%	972	2%	2,544	5%	3,515	7%
Totals	2,217	4%	26,666	52%	22,897	44%	51,778	100%

Table 112. Fuel to Heat Pool (Single Family, Own)

Fuel to heat pool (Single Family, Own)

	< $35K*	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
NOT HEATED	44,251	8%	119,249	21%	180,456	31%	343,956	59%
NATURAL GAS*	2,944	1%	16,102	3%	99,943	17%	118,990	21%
ELECTRICITY*	7,360	1%	4,831	1%	15,992	3%	28,182	5%
HEAT PUMP*	237	0%	3,218	1%	305	0%	3,760	1%
SOLAR HEATER*	6,423	1%	20,493	4%	46,850	8%	73,764	13%
BOTTLED GAS / OTHER *	616	0%	5,040	1%	8,679	2%	9,856	2%
	61,831	11%	168,933	29%	352,225	61%	578,508	100%

Table 113. Frequency Heat Pool Summer (Single Family, Own)

Frequency heat pool summer (Single Family, Own)

	< $35K*	% of GT	$35-75K*	% of GT	$75K+	% of GT	Total	
NEVER OR ONCE A MO	52,696	10%	144,116	27%	260,640	49%	457,452	86%
1-4 TIMES PER WEEK*	704	0%	6,672	1%	19,641	4%	27,017	5%
HEAT CONTINUOUSLY*	5,649	1%	9,623	2%	34,945	7%	50,217	9%
Totals	59,049	11%	160,411	30%	315,226	59%	534,686	100%

Table 114. Frequency Heat Pool Winter (Single Family, Own)

Frequency heat pool winter (Single Family, Own)

	< $35K*	% of GT	$35-75K*	% of GT	$75K+	% of GT	Total	
NEVER OR ONCE A MO	51,410	10%	149,267	29%	290,126	56%	490,803	94%
1-4 TIMES PER WEEK*	0	0%	754	0%	10,181	2%	10,935	2%
HEAT CONTINUOUSLY*	4,677	1%	5,143	1%	8,046	2%	17,866	3%
Totals	56,087	11%	155,164	30%	308,353	59%	519,604	100%

Table 115. Hours per Day Filter Pool Summer (Single Family, Own)

Hours per day filter pool in summer (Single Family, Own)

	< $35K*	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
NONE*	7,082	1%	7,458	1%	1,928	0%	16,468	3%
1-2 HRS PER DAY*	9,605	2%	48,994	9%	49,404	9%	108,004	19%
3-4 HRS PER DAY*	20,039	3%	47,738	8%	131,791	23%	199,567	35%
5-7 HRS PER DAY*	13,123	2%	36,238	6%	115,801	20%	165,162	29%
8-21+ HRS PER DAY*	12,290	2%	24,226	4%	50,364	9%	86,880	15%
Totals	62,139	11%	164,654	29%	349,288	61%	576,081	100%

Table 116. Hours per Day Filter Pool Winter (Single Family, Own)

Hours per day filter pool in winter (Single Family, Own)

	< $35K*	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
NONE*	21,815	4%	58,119	11%	38,923	7%	118,856	22%
1-2 HRS PER DAY*	12,801	2%	31,972	6%	88,630	16%	133,403	24%
3-4 HRS PER DAY*	12,359	2%	48,860	9%	131,066	24%	192,284	35%
5-7 HRS PER DAY*	8,184	1%	16,549	3%	61,129	11%	85,863	16%
8-21+ HRS PER DAY*	4,375	1%	728	0%	15,653	3%	20,756	4%
Totals	59,534	11%	156,228	28%	335,401	61%	551,162	100%

Table 117. Pool Cover (Single Family, Own)

Pool cover (Single Family, Own)

	< $35K*	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
NO	53,444	9%	127,923	21%	264,484	44%	445,852	74%
YES*	10,834	2%	50,427	8%	92,454	15%	153,717	26%
Totals	64,278	11%	178,350	30%	356,938	60%	599,569	100%

Table 118. Pool Timer (Single Family, Own)

Pool timer (Single Family, Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
NO	34,369	6%	82,072	14%	119,019	20%	235,460	39%
YES	29,910	5%	96,280	16%	237,921	40%	364,111	61%
Totals	64,279	11%	178,352	30%	356,940	60%	599,571	100%

Spas and Hot Tubs

Table 119. Spa or Hot Tub (Single Family, Own)

Spa or Hot Tub (Single-family, Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
YES	44,889	1%	143,627	5%	406,128	13%	594,644	19%
IN COMMON or DO NOT USE*	1,438	0%	9,997	0%	11,606	0%	23,041	1%
NO	847,824	22%	1,147,982	30%	1,169,554	31%	3,165,360	84%
Totals	894,151	22%	1,301,606	31%	1,587,288	31%	3,783,045	100%

Table 120. Spa Fuel (Single Family, Own)

Spa fuel (Single-family, Own)

	< $35K*	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
ELECTRICITY	25,203	4%	84,720	15%	196,178	34%	306,101	53%
NATURAL GAS*	7,643	1%	48,200	8%	176,952	31%	232,796	40%
SOLAR + ELECTRICITY*	1,552	0%	997	0%	1,623	0%	4,171	1%
SOLAR + NATURAL GAS*	589	0%	1,272	0%	15,340	3%	17,202	3%
BOTTLED GAS*	293	0%	5,186	1%	11,705	2%	17,184	3%
OTHER*	227	0%	392	0%	787	0%	1,406	0%
Totals	35,507	6%	140,767	24%	402,585	70%	578,860	100%

Table 121. Spa Location (Single Family, Own)

Spa location (Single-family, Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
OUT, IN GROUND*	10,172	2%	56,919	10%	187,469	32%	254,561	44%
OUT, ABOVE GROUND	23,052	4%	76,249	13%	185,167	32%	284,469	49%
INDOOR*	2,125	0%	8,079	1%	29,483	5%	39,686	7%
Totals	35,349	6%	141,247	24%	402,119	69%	578,716	100%

Table 122. Spa Cover (Single Family, Own)

Spa cover (Single-family, Own)

	< $35K*	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
YES	26,470	5%	105,751	18%	241,193	42%	373,414	65%
NO*	8,916	2%	35,450	6%	159,168	28%	203,534	35%
Totals	35,386	6%	141,201	24%	400,361	69%	576,948	100%

Table 123. Frequency of Spa Filtration - Summer (Single Family, Own)

Frequency of spa filtration - summer (Single-family, Own)

	< $35K	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
Never or Rarely*	6,701	1%	27,944	5%	77,212	14%	111,857	20%
WHEN WE USE IT*	175	0%	968	0%	952	0%	2,688	0%
1-3 HRS PER DAY	23,322	4%	98,900	17%	246,573	43%	368,794	65%
4-6 HRS PER DAY*	4,876	1%	11,822	2%	66,800	12%	83,498	15%
Totals	35,074	6%	139,634	25%	391,537	69%	566,837	100%

Table 124. Frequency of Spa Filtration - Winter (Single Family, Own)

Frequency of spa filtration - winter (Single-family, Own)

	< $35K*	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
Never or Rarely*	9,217	2%	35,549	7%	79,161	15%	123,927	23%
WHEN WE USE IT*	12,112	2%	43,798	8%	83,097	16%	139,007	26%
1-3 HRS PER DAY*	5,983	1%	47,188	9%	153,196	29%	206,367	39%
4-6 HRS PER DAY*	3,323	1%	3,862	1%	56,954	11%	65,117	12%
Totals	30,635	6%	130,397	24%	372,408	70%	534,418	100%

Table 125. Frequency of Heat - Summer (Single Family, Own)

Frequency of spa heat - summer (Single-family, Own)

	< $35K*	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
NEVER or 0-2 X MON*	13,108	2%	70,411	12%	165,103	29%	248,622	43%
3-8 TIMES PER MON*	4,709	1%	26,695	5%	77,204	13%	108,608	19%
9+ PER MON*	1,761	0%	3,012	1%	30,976	5%	35,749	6%
MAINTAIN SET TEMP*	15,312	3%	40,097	7%	126,686	22%	182,096	32%
Totals	34,890	6%	140,215	24%	399,969	70%	575,075	100%

Table 126. Frequency of Heat - Winter (Single Family, Own)

Frequency of spa het - winter (Single-family, Own)

	< $35K*	% of GT	$35-75K	% of GT	$75K+	% of GT	Total	
NEVER or 0-2 X MON*	13,108	2%	70,411	12%	165,103	29%	248,622	43%
3-8 TIMES PER MON*	4,709	1%	26,695	5%	77,204	13%	108,608	19%
9+ PER MON*	1,761	0%	3,012	1%	30,976	5%	35,749	6%
MAINTAIN SET TEMP*	15,312	3%	40,097	7%	126,686	22%	182,096	32%
Totals	34,890	6%	140,215	24%	399,969	70%	575,075	100%

Hard-to-Reach: Segmentation by Low-Income & Primary Language

In the tables above a corresponding percentage of Grand Total was displayed for each cell that contained numeric data. These percentages provided a measure that allowed for a ready comparison between each of the data elements in the table. Due to the small relative size of the non-English as primary language respondents, percentages of grand total are not as useful here (in that the English data overpowers differences among and between the others). Therefore, in Appendix 2 the percentage for each data element will be based on the sub-total of the population estimated in each language-group. Also, if *"own" or "rent"* is not specified in the title of the table the ownership filter was not applied to the query.

Selected Low-Income Tables

Table 127. Peak Time Use of Electrical Appliances

Peak time use of electrical appliances

OWN

	<$25K	% of GT	Total
FREQUENTLY	351,326	7%	2,588,150
OCCASIONALLY	317,165	6%	1,672,640
RARELY OR NEVER	173,245	3%	1,068,968
Totals	841,736	16%	5,329,758

RENT

	<$25K	% of GT	Total
FREQUENTLY	554,132	17%	1,325,854
OCCASIONALLY	379,784	11%	907,347
RARELY OR NEVER	505,910	15%	1,106,612
Totals	1,439,826	43%	3,339,813

Table 128. Age of First Refrigerator

Age of first refrigerator

OWN

	<$25K	% of GT
< 8 YRS	421,617	8%
8-10 YRS	193,370	4%
11-20 YRS	214,884	4%
Totals	829,871	16%

RENT

	<$25K	% of GT
< 8 YRS	840,307	27%
8-10 YRS	286,050	9%
11-20 YRS	234,491	7%
Totals	1,360,848	43%

Table 129. Number of Hot Water Washes Per Week

Number of hot water washes per week

times per week (21K or 9% of the the Grand Total C

OWN

	<$25K	% of GT
NONE	488,544	10%
1-4 PER Wk	243,063	5%
5+ PER Wk*	21,197	0%
Totals	752,804	15%

RENT

	<$25K	% of GT
NONE	226,078	18%
1-4 PER Wk	181,050	14%
5+ PER Wk*	29,441	2%
Totals	436,569	34%

Table 130. Maintenance Performed on AC System Last 12 Months

Maintenance preformed on AC system last 12 months

OWN

	<$25K	% of GT
YES	101,433	4%
NO	226,170	9%
Totals	327,603	13%

RENT

	<$25K	% of GT
YES	83,995	10%
NO	239,313	28%
Totals	323,308	38%

Table 131. Age of Room Air Conditioner 1

Age of room air conditioner 1

OWN

	<$25K	% of GT
<4 YRS	66,100	9%
4-8 YRS	51,129	7%
9-13 YRS	38,982	5%
13 + YRS	60,243	8%
Totals	216,454	28%

RENT

	<$25K	% of GT
<4 YRS	89,164	14%
4-8 YRS	42,744	7%
9-13 YRS	56,825	9%
13 + YRS	116,650	19%
Totals	305,383	49%

Table 132. Inches of Attic Insulation - Own

Survey Question: Inches of attic insulation - Own

	<$25K	% of GT
0-3 INCHES	169,267	5%
4-6 INCHES	179,575	5%
7-10 INCHES	39,088	1%
10 + INCHES	18,314	1%
Totals	406,244	12%

Refrigerators

Table 133. Age of First Refrigerator (Own)

First refrigerator (Own)

	English	Col %	Spanish	Col %	Asian	Col %	Other	Col %	Total	
<8 YRS	3,107,986	57%	321,177	64%	134,043	65%	60,246	83%	3,623,452	59%
8-10 YRS*	1,134,867	21%	107,381	22%	39,961	19%	3,323	5%	1,285,531	21%
11+ YRS*	1,165,838	22%	70,059	14%	32,899	16%	9,113	13%	1,277,912	21%
Totals	5,408,691	100%	498,617	100%	206,903	100%	72,682	100%	6,186,895	100%

Table 134. Age of First Refrigerator (Rent)

First refrigerator (Rent)

	English	Col %	Spanish	Col %	Asian	Col %	Other	Col %	Total	
<8 YRS*	1,487,006	62%	489,467	66%	105,190	57%	44,607	56%	2,126,270	62%
8-10 YRS*	514,578	21%	153,046	21%	40,920	22%	15,165	19%	723,709	21%
11+ YRS*	410,017	17%	97,898	13%	38,758	21%	19,800	25%	566,473	17%
Totals	2,411,601	100%	740,411	100%	184,868	100%	79,572	100%	3,416,452	100%

Table 135. Age of Second Refrigerator (Own)

Second refrigerator (Own)

	English	Col %	Spanish	Col %	Asian	Col %	Other	Col %	Total	
<8 YRS*	573,022	46%	34,893	64%	24,271	66%	1,935	26%	634,121	47%
8-10 YRS*	291,974	23%	6,681	12%	5,768	16%	1,533	21%	305,956	23%
11+ YRS*	390,529	31%	12,924	24%	6,465	18%	3,855	53%	413,774	31%
Totals	1,255,525	100%	54,498	100%	36,504	100%	7,323	100%	1,353,851	100%

Freezers

Table 136. Number of Stand Alone Freezers (Own)

Number of stand alone freezers (Own)

	English	Col %	Spanish	Col %	Asian	Col %	Other	Col %	Total	
NONE	3,964,492	74%	462,312	92%	175,206	84%	51,975	75%	4,653,985	75%
ONE FREEZER*	1,359,938	25%	40,839	8%	27,632	13%	16,628	24%	1,445,038	23%
TWO + FREEZERS*	62,870	1%	401	0%	6,243	3%	429	1%	69,943	1%
Totals	5,387,300	100%	503,552	100%	209,081	100%	69,032	100%	6,168,966	100%

Table 137. Number of Stand Alone Freezers (Rent)

Number of stand alone freezers (Rent)

	English	Col %	Spanish	Col %	Asian	Col %	Other	Col %	Total	
NONE	2,345,931	93%	754,673	96%	176,185	90%	74,046	93%	3,350,835	93%
ONE FREEZER*	181,335	7%	35,170	4%	19,319	10%	5,004	6%	240,828	7%
TWO + FREEZERS*	6,027	0%	237	0%	353	0%	205	0%	6,821	0%
Totals	2,533,293	100%	790,080	100%	195,857	100%	79,255	100%	3,598,484	100%

Table 138. Style of First Freezer

Style of first freezer

	English	Col %	Spanish*	Col %	Asian*	Col %	Other*	Col %	Total	
UPRIGHT, FROST FREE*	624,737	40%	30,783	57%	20,783	43%	11,734	55%	688,038	41%
UPRIGHT, MANUAL DEFROST*	524,668	33%	10,316	19%	5,991	13%	5,329	25%	546,304	32%
CHEST, FROST FREE*	177,063	11%	11,540	21%	10,349	22%	3,953	18%	202,904	12%
CHEST, MANUAL DEFROST*	243,450	16%	1,791	3%	10,665	22%	382	2%	256,288	15%
Totals	1,569,918	100%	54,430	100%	47,788	100%	21,398	100%	1,693,534	100%

Table 139. Age of First Freezer

Age of first freezer

	English	Col %	Spanish*	Col %	Asian*	Col %	Other*	Col %	Total	
< 10 YRS*	953,726	63%	50,361	87%	37,316	88%	9,209	43%	1,050,613	64%
11+ YRS*	558,104	37%	7,684	13%	5,207	12%	12,066	57%	583,060	36%
Totals	1,511,830	100%	58,045	100%	42,523	100%	21,275	100%	1,633,673	100%

Clothes Washers

Table 140. Laundry Equipment in Home (Own)

Laundry equipment in home (Own)

	English	Col %	Spanish	Col %	Asian	Col %	Other	Col %	Total	
YES	5,238,412	95%	480,618	94%	202,500	96%	70,703	97%	5,992,233	95%
IN COMMON or DO NOT USE*	259,793	5%	30,653	6%	9,447	4%	1,979	3%	301,873	5%
Totals	5,498,205	100%	511,271	100%	211,947	100%	72,682	100%	6,294,106	100%

Table 141. Laundry Equipment in Home (Rent)

Laundry equipment in home (Rent)

	English	Col %	Spanish	Col %	Asian	Col %	Other	Col %	Total	
YES	1,111,505	43%	256,142	31%	63,012	32%	12,687	16%	1,443,346	39%
IN COMMON or DO NOT USE*	1,493,512	57%	562,499	69%	135,915	68%	67,463	84%	2,259,387	61%
Totals	2,605,017	100%	818,641	100%	198,927	100%	80,150	100%	3,702,733	100%

Table 142. Clothes Washer Age (Own)

Clothes washer age (Own)

	English	Col %	Spanish	Col %	Asian	Col %	Other*	Col %	Total	
< ONE YR*	446,619	9%	43,450	9%	21,051	10%	4,877	7%	515,997	9%
1-5 YRS	2,130,495	41%	261,234	55%	90,252	45%	39,287	56%	2,521,268	43%
6-8 YRS*	1,117,779	22%	103,730	22%	45,998	23%	14,257	20%	1,281,763	22%
9 - 30+ YRS*	1,484,806	29%	66,622	14%	44,673	22%	12,101	17%	1,608,203	27%
Totals	5,179,699	100%	475,036	100%	201,974	100%	70,522	100%	5,927,231	100%

Table 143. Clothes Washer Age (Rent)

Clothes washer age (Rent)

	English	Col %	Spanish	Col %	Asian*	Col %	Other*	Col %	Total	
< ONE YR*	96,012	9%	21,957	9%	11,908	19%	366	3%	130,242	10%
1-5 YRS	453,545	44%	139,527	56%	28,862	46%	5,362	43%	627,296	47%
6-8 YRS*	239,976	23%	69,359	28%	16,535	27%	2,229	18%	328,099	24%
9 - 30+ YRS*	235,457	23%	16,368	7%	4,952	8%	4,420	36%	259,191	19%
Totals	1,024,990	100%	247,211	100%	62,257	100%	12,377	100%	1,344,828	100%

Table 144. Type of Clothes Washer (Own)

Type of clothes washer (Own)

	English	Col %	Spanish	Col %	Asian	Col %	Other	Col %	Total	
TOP LOAD	4,720,245	91%	427,848	90%	169,233	84%	69,024	98%	5,386,349	90%
FRONT LOAD*	494,824	9%	48,646	10%	32,038	16%	1,497	2%	577,005	10%
Totals	5,215,069	100%	476,494	100%	201,271	100%	70,521	100%	5,963,354	100%

Table 145. Type of Clothes Washer (Rent)

Type of clothes washer (Rent)

	English	Col %	Spanish	Col %	Asian	Col %	Other	Col %	Total	
TOP LOAD	1,009,777	93%	226,693	91%	49,576	83%	12,011	99%	1,298,056	93%
FRONT LOAD*	70,918	7%	22,312	9%	10,119	17%	175	1%	103,524	7%
Totals	1,080,695	100%	249,005	100%	59,695	100%	12,186	100%	1,401,580	100%

Table 146. Number of Hot Water Washes Per Week

Number of hot water washes per week

	English	Col %	Spanish	Col %	Asian	Col %	Other	Col %	Total	
NONE	2,934,734	57%	206,815	43%	130,258	65%	39,839	56%	3,311,645	56%
1-4 PER Wk*	2,044,013	39%	226,807	47%	66,422	33%	30,183	43%	2,367,425	40%
5+ PER Wk*	210,504	4%	44,908	9%	5,237	3%	681	1%	261,330	4%
Totals	5,189,251	100%	478,530	100%	201,917	100%	70,703	100%	5,940,400	100%

Air Conditioners

Table 147. Number of Central Air Conditioners (Own)

Number of central air conditioners (Own)

	English	Col %	Spanish	Col %	Asian	Col %	Other	Col %	Total	
NONE*	408,178	13%	31,512	16%	10,101	10%	3,951	15%	453,742	14%
ONE CENTRAL	2,379,019	79%	164,034	81%	78,868	81%	21,692	82%	2,643,614	79%
TWO +*	239,817	8%	5,855	3%	8,517	9%	892	3%	255,080	8%
Totals	3,027,014	100%	201,401	100%	97,486	100%	26,535	100%	3,352,436	100%

Table 148. Number of Central Air Conditioners (Rent)

Number of central air conditioners (Rent)

	English	Col %	Spanish	Col %	Asian	Col %	Other	Col %	Total	
NONE*	148,890	17%	32,211	22%	12,733	21%	5,639	27%	199,473	18%
ONE CENTRAL	701,824	81%	113,599	77%	47,808	79%	15,145	72%	878,375	81%
TWO +*	11,474	1%	772	1%	280	0%	191	1%	12,716	1%
Totals	862,188	100%	146,582	100%	60,821	100%	20,975	100%	1,090,564	100%

Table 149. Age of Main Central Air Conditioner (Own)

Age of main central air conditioner (Own)

	English	Col %	Spanish	Col %	Asian	Col %	Other*	Col %	Total	
< 4 Yrs*	629,102	22%	23,380	13%	27,247	30%	6,138	23%	685,867	22%
4-8 YRS*	759,441	26%	73,023	40%	16,346	18%	9,420	36%	858,230	27%
9-13 YRS*	589,771	21%	39,243	21%	22,687	25%	2,117	8%	653,819	21%
13 - 31+ YRS*	888,171	31%	47,102	26%	25,640	28%	8,839	33%	969,754	31%
Totals	2,866,485	100%	182,748	100%	91,920	100%	26,514	100%	3,167,670	100%

Table 150. Age of Main Central Air Conditioner (Rent)

Age of main central air conditioner (Rent)

	English	Col %	Spanish	Col %	Asian*	Col %	Other*	Col %	Total	
< 4 Yrs*	120,064	18%	21,327	22%	6,610	14%	2,012	10%	150,013	18%
4-8 YRS*	141,911	21%	27,420	28%	13,002	27%	8,798	45%	191,132	23%
9-13 YRS*	132,512	20%	18,284	19%	14,225	30%	6,362	33%	171,384	21%
13 - 31+ YRS*	272,004	41%	30,189	31%	13,568	29%	2,246	12%	318,005	38%
Totals	666,491	100%	97,220	100%	47,405	100%	19,418	100%	830,534	100%

Table 151. Age of Room Air Conditioner –1st (Own)

Age of room air conditioner - 1st (Own)

	English	Col %	Spanish	Col %	Asian*	Col %	Other*	Col %	Total	
< 4 Yrs*	64,584	9%	893	1%	349	2%	209	2%	66,034	7%
4-8 YRS*	145,763	20%	24,322	19%	5,973	28%	916	7%	176,974	20%
9-13 YRS*	183,283	25%	43,342	33%	1,837	9%	6,432	52%	234,893	26%
13 - 31+ YRS*	344,396	47%	61,661	47%	13,065	62%	4,713	38%	423,836	47%
Totals	738,026	100%	130,218	100%	21,224	100%	12,270	100%	901,737	100%

Table 152. Age of Room Air Conditioner –1st (Rent)

Age of room air conditioner - 1st (Rent)

	English	Col %	Spanish	Col %	Asian*	Col %	Other*	Col %	Total	
< 4 Yrs*	64,347	13%	9,701	8%	3,500	10%	0	0%	77,548	11%
4-8 YRS*	99,817	20%	23,030	19%	8,267	25%	6,177	36%	137,291	20%
9-13 YRS*	81,268	16%	19,794	16%	10,239	30%	1,173	7%	112,474	17%
13 - 31+ YRS*	255,906	51%	70,502	57%	11,615	35%	9,947	58%	347,968	52%
Totals	501,338	100%	123,027	100%	33,621	100%	17,297	100%	675,281	100%

Table 153. Maintenance Performed on AC System in Last 12 Months (Own)

Maintenance preformed on ac system - in last 12 months (Own)

	English	Col %	Spanish	Col %	Asian	Col %	Other	Col %	Total	
YES*	819,786	30%	32,797	18%	14,310	14%	4,988	19%	871,882	28%
NO	1,957,247	70%	150,360	82%	86,275	86%	21,490	81%	2,215,372	72%
Totals	2,777,033	100%	183,157	100%	100,585	100%	26,478	100%	3,087,254	100%

Table 154. Maintenance Performed on AC System in Last 12 Months (Rent)

Maintenance preformed on ac system - in last 12 months (Rent)

	English	Col %	Spanish	Col %	Asian	Col %	Other	Col %	Total	
YES*	180,718	24%	21,486	20%	5,012	12%	2,087	11%	209,303	23%
NO*	558,779	76%	86,856	80%	37,759	88%	17,475	89%	700,868	77%
Totals	739,497	100%	108,342	100%	42,771	100%	19,562	100%	910,171	100%

Swimming Pools

Table 155. Swimming Pool

	English	% of Col	Spanish	% of Col	Asian	% of Col	Other	% of Col	Total	
YES, PAY ENERGY*	674,381	18%	31,513	8%	6,397	4%	2,307	5%	714,598	16%
NO or (COMMON AREA)	3,177,780	83%	369,175	92%	148,154	96%	47,212	95%	3,742,320	84%
Totals	3,852,161	100%	400,688	100%	154,551	100%	49,519	100%	4,456,918	100%

Spas and Hot Tubs

Table 156. Spa or Hot Tub (Single Family, Own)

Spa or hot tub (Single Family, Own)

	English	Col %	Spanish	Col %	Asian	Col %	Other	Col %	Total	
YES, PAY ENERGY*	674,965	18%	23,416	6%	8,817	6%	2,545	5%	709,744	16%
NO (or COMMON AREA)	3,180,127	83%	378926	94%	146493	94%	46556	95%	3,752,100	84%
Totals	3,855,092	100%	402,342	100%	155,310	100%	49,101	100%	4,461,844	100%

Table 157. RASS Saturations by Utility Company

	PG&E		SDG&E		SCE		LADWP	
	UEC	Saturation	UEC	Saturation	UEC	Saturation	UEC	Saturation
All Household	6,265	9,265 homes	5,445	2,527 homes	6,102	7,979 homes	4,071	1,382 homes
Conv. Eheat	1,113	0.10	581	0.13	734	0.06	542	0.09
HP Eheat	799	0.02	458	0.03	555	0.01	201	0.03
Aux Eheat	331	0.26	156	0.24	192	0.23	103	0.17
Furnace Fan	180	0.58	91	0.60	115	0.56	71	0.26
Central Air	1,108	0.39	644	0.35	1,494	0.48	1,075	0.29
Room Air	181	0.14	63	0.09	202	0.20	158	0.25
Evap Cooling	469	0.05	277	0.01	797	0.05	372	0.02
Water Heat	2,585	0.09	2,151	0.06	2,342	0.05	1,387	0.05
Solar Water Heater	1,193	0.00	1,501	0.01	1,508	0.00	.	0.00
Dryer	652	0.45	648	0.26	717	0.18	474	0.07
Clothes Washer	97	0.78	75	0.77	129	0.77	125	0.36
Dish Washer	77	0.67	69	0.71	80	0.60	73	0.27
First Refrigerator	788	1.00	780	1.00	801	1.00	754	1.00
Second Refrigerator	1,201	0.19	1,054	0.19	1,210	0.19	933	0.06
Freezer	928	0.23	841	0.17	983	0.15	880	0.05
Pool Pump	2,580	0.08	2,557	0.12	2,772	0.10	3,096	0.02
Spa	428	0.08	445	0.12	495	0.10	423	0.02
Outdoor Lighting	260	0.56	268	0.53	276	0.55	218	0.42
Range/Oven	268	0.61	241	0.49	271	0.27	200	0.17
TV	474	0.95	446	0.94	520	0.96	479	0.94
Spa Electric Heat	1,346	0.05	903	0.06	2,514	0.04	895	0.01
Microw ave	131	0.95	119	0.96	139	0.96	140	0.89
Home Office	152	0.20	159	0.19	141	0.16	134	0.18
PC	602	0.72	614	0.78	515	0.66	516	0.55
Water Bed	787	0.02	925	0.01	818	0.02	848	0.00
Well Pump	829	0.08	831	0.01	952	0.02	890	0.01
Miscellaneous	1,852		1,750		1,912		1,495	

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APPENDIX H. REFERENCES

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