Evaluation, Measurement & Verification Report for Truckee Donner Public Utility District 2008 Energy Efficiency Programs

FINAL REPORT

Prepared for

Truckee Donner Public Utility District

Truckee, California

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1. Executive Summary

This report provides the Evaluation, Measurement, and Verification (EM&V) findings for the Truckee Donner Public Utility District (TDPUD) energy efficiency programs. This study was conducted by Robert Mowris & Associates (RMA) with public benefits and AB2021 funds under the auspices of the Northern California Power Agency (NCPA) and the California Energy Commission. The study is available for download at www.calmac.org. TDPUD implemented 17 energy efficiency programs in 2008 as shown in **Table 1.1**.

Table 1.1 Ex Ante Goals and Ex Post Accomplishments

Description	Ex Ante Goal	Ex Post Accomplishment
Total Installed Measures	85,185	66,445
Residential Lighting Rebate	1,000	1,282
Commercial Lighting Rebate	6,400	978
Energy Star® Appliance Rebate Program	300	294
Electric Water Heater Rebate	40	4
Ground Source Heat Pumps	10	NA
Building Envelope & Duct Testing	40	42
Thermally-efficient Windows	7,000	NA
Refrigerator & Freezer Recycling	75	50
Low/Moderate Income Energy Assistance	60	60
Community Outreach & Schools	200	661
Green Partners – Retail	100	1,418
Green Partners – Restaurant	100	897
Green Partners – Hospitality	1150	3,585
Million CFLs	66,670	55,308
LED Holiday Lights	1,000	1,450
Low Flow Pre-Rinse Spray Valves	40	16
2.0 GPM Showerheads	1,000	400
Net Annual Electricity Savings (kWh/yr)	3,910,119	4,455,607
Net Demand Savings (kW)	1,059	2,705
Net Annual Water Savings (gallon/yr)[1]	2,713,600	982,014
Net Lifecycle Electricity Savings (kWh)	34,272,223	36,792,306
Net Lifecycle Water Savings (gallon)	20,075,136	7,898,070
Total Resource Cost (TRC) Test – EE Reporting Tool	3.44	7.12
TRC Test Costs	$617,018	$577,405
TRC Test Benefits	$2,122,541	$4,111,922
TRC Test Net Benefits	$1,505,523	$3,534,517
Participant Test	0.3	0.8
Participant Test Costs	$570,378	$455,545
Participant Test Benefits	$171,113	$364,436
Participant Test Net Benefits	($399,265)	($91,109)

The programs provided educational information, incentives, and free energy efficiency measures to residential and commercial customers The program ex ante goal was to install 85,185 energy

[1] The study accounts for water savings through the embedded energy of the water valued at 0.008157374 kWh/gallon saved, and these savings are entered into the E3 calculator for water conservation measures.

efficiency measures and conduct follow-up activities to achieve energy savings of 4,887,649 first-year kWh, 1,324 kW, 42,840,297 lifecycle kWh. The TDPUD programs realized 22% fewer measure installations (i.e., 66,445 ex post versus 85,185 ex ante), and exceeded the ex ante Total Resource Cost (TRC) test goal by 107% (i.e., the ex post TRC is 7.12 and the ex ante TRC is 3.44 as shown in **Table 1.1**. The ex post TRC is greater than the ex ante TRC due to greater realized savings per measure and lower measure costs. Some measure costs are three times lower than ex ante measure costs used in the EE Reporting Tool.[2] Ex post accomplishments were verified by checking the tracking database, randomly inspecting 3,959 measures at 94 participant sites (54 more than anticipated and budgeted), installing light loggers on 2,640 fixtures at 29 sites, evaluating billing data for 65 sites, and conducting surveys of participants, non-participants, and non-contacts. The ex ante first-year savings are summarized in **Table 1.2**.

Table 1.2 Ex Ante First-Year Electricity and Gas Savings

Energy Efficiency Measure	Units Estimated	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (gal/yr)	Net-to-Gross Ratio	Net Ex Ante Program Savings (kWh/y)	Net Ex Ante Program Savings (kW)	Net Ex Ante Program Savings (galyr)
Residential Lighting Rebate	1,000	53.12	0.02		0.80	42,496	12.8	
Commercial Lighting Rebate	6,400	75	0.02		0.80	384,000	112.6	
Appliance Rebate Program	300	176.9	0.07		0.80	42,462	17.8	
Electric Water Heater Rebate	40	114.6	0.02		0.80	3,666	0.6	
Ground Source Heat Pumps	10	775.2	0.11		0.80	6,202	0.9	
Building Envelope & Duct Testing	40	49.93	0.10		0.80	1,598	3.2	
Thermally-efficient Windows	7,000	23.3	0.00		0.80	130,743	6.1	
Refrigerator & Freezer Recycling	75	1,076.5	0.23		0.80	64,589	13.9	
Low/Mod. Income Energy Assistance	60	3,000	0.17		0.80	144,000	8.0	
Community Outreach & Schools	200	500	0.02		0.80	80,000	2.6	
Green Partners – Retail	100	53.1	0.02		0.80	4,250	1.3	
Green Partners – Restaurant	100	53.1	0.02		0.80	4,250	1.3	
Green Partners – Hospitality	1150	53.1	0.02		0.80	48,870	14.7	
Million CFLs	66,670	53.1	0.02		0.80	2,833,208	853.4	
LED Holiday Lights	1,000	101.6	0.00		0.80	81,280	2.6	
Low Flow Pre-Rinse Spray Valves	40	308.3	0.04	37,800	0.80	9,866	1.4	1,209,600
2.0 GPM Showerheads	1,000	35.8	0.01	1,494	0.80	28,640	6.2	1,195,200
Total	85,185					3,910,119	1,059	2,404,800

The EM&V ex post first-year savings are summarized in **Table 1.3**. The EM&V ex post savings are based on pre and post-retrofit utility billing data, light logger data, previous evaluation studies, and engineering analyses calibrated to billing data. The EM&V study found first-year net ex post program savings of 4,455,607 ± 199,957 kWh per year, 2,705 ± 96 kW per year, and 982,014 ± 42,201 gallons of water per year at the 90 percent confidence level. The net realization rates are 1.14 ± 0.05 for first-year kWh, 2.55 ± 0.09 for kW, and 0.36 ± 0.02 for first-year gallons of water.

[2] Energy and Environmental Economics (E3), Inc. 2004. EE Reporting Tool 2008 (E3 Calculator). Prepared for the Northern California Power Agency (NCPA) and Southern California Public Power Authority (SCPPA), 353 Sacramento Street, Suite 1700, San Francisco, CA 94111.

Table 1.3 Ex Post First-Year Electricity and Water Savings

Energy Efficiency Measure	Units Installed	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (gal)	Net-to-Gross Ratio	Net Ex Post Program Savings (kWh/y)	Net Ex Post Program Savings (kW)	Net Ex Post Program Savings (gal)
Residential Lighting Rebate	1,282	59.50	0.04		0.80	61,023	42.05	
Commercial Lighting Rebate	978	262	0.05		0.96	245,955	46.50	
Appliance Rebate Program	294	145.8	0.02		0.80	34,284	4.65	
Electric Water Heater Rebate	4	44.5	0.01		1.00	178	0.02	
Ground Source Heat Pumps	0				1.00	0	0.00	
Building Envelope & Duct Testing	42	60.48	0.11		0.89	2,261	4.27	
Thermally-efficient Windows	0				0.96	0	0.00	
Refrigerator & Freezer Recycling	50	1,625.0	0.37		0.84	68,250	15.33	
Low/Mod. Income Energy Assistance	60	1,421	0.55		1.00	85,278	32.80	
Community Outreach & Schools	661	139	0.04	129.7	1.00	91,960	27.90	85,733
Green Partners – Retail	1418	171.7	0.05		0.96	233,733	70.70	
Green Partners – Restaurant	897	175.0	0.07		0.96	150,696	57.41	
Green Partners – Hospitality	3,585	110.6	0.04		0.96	380,804	148.76	
Million CFLs	55,308	59.5	0.04		0.90	2,961,743	2040.87	
LED Holiday Lights	1450	89.0	0.16		0.91	117,486	207.48	
Low Flow Pre-Rinse Spray Valves	16	152.3	0.02	18,668	1.00	2,436	0.34	298,681
2.0 GPM Showerheads	400	48.8	0.01	1,494	1.00	19,520	5.84	597,600
Total	66,445					4,455,607	2,705	982,014
90% Confidence Interval						199,957	96	42,201

The lifecycle electricity and water savings are summarized in **Table 1.4**. The net ex-ante lifecycle savings are 34,272,223 kWh and 20,075,136 gallons of water. The net ex-post lifecycle savings are 36,792,306 ± 1,651,151 kWh and 7,898,070 ± 339,411 gallons of water. The net lifecycle realization rates are 1.07 ± 0.05 for kWh and 0.39 ± 0.02 gallons of water.

Table 1.4 Lifecycle Electricity and Water Savings

Energy Efficiency Measure	Ex Ante Effective Useful Life (EUL)	Net Ex-Ante Lifecycle Program Savings (kWh)	Net Ex-Ante Lifecycle Program Savings (gal)	Ex Post Effective Useful Life (EUL)	Net Ex-Post Lifecycle Program Savings (kWh)	Net Ex-Post Lifecycle Program Savings (gal)	Net Lifecycle Realization Rate (kWh)	Net Lifecycle Realization Rate (gal)
Residential Lighting Rebate	6.72	285,573		7.27	443,639		1.55	
Commercial Lighting Rebate	14	5,376,000		15.19	3,736,502		0.70	
Appliance Rebate Program	15	636,936		15	514,260		0.81	
Electric Water Heater Rebate	15	54,984		15	2,670		0.05	
Ground Source Heat Pumps	25	155,040		25			0.00	
Building Envelope & Duct Testing	15	23,964		15	33,909		1.41	
Thermally-efficient Windows	25	3,268,580		25				
Refrigerator & Freezer Recycling	6	387,533		6	409,500		1.06	
Low/Mod. Income Energy Assistance	15	2,160,000		15	1,279,170		0.59	
Community Outreach & Schools	6.72	537,600	2,075,136	5	459,800	428,665	0.86	0.21
Green Partners – Retail	6.72	28,557		4	934,931			
Green Partners – Restaurant	6.72	28,557		4	602,784		21.11	
Green Partners – Hospitality	6.72	328,409		2	761,608		2.32	
Million CFLs	6.72	19,039,158		7.27	21,531,875		1.13	
LED Holiday Lights	20	1,625,600		50	5,874,278			
Low Flow Pre-Rinse Spray Valves	5	49,332	6,048,000	5	12,180	1,493,405	0.25	0.25
2.0 GPM Showerheads	10	286,400	11,952,000	10	195,200	5,976,000	0.68	0.50
Total		34,272,223	20,075,136		36,792,306	7,898,070	1.07	0.39
90% Confidence Interval					1,651,151	339,411	0.05	0.02

The required energy impact reporting for 2008 programs is provided in **Table 1.5**.

Table 1.5 Required Energy Impact Reporting for 2008 Program

Program ID:		TDPUD Conservation Programs					
Program Name:		All					
Year	Year	Ex-ante Gross Program-Projected Program MWh Savings (1)	Ex-Post Net Evaluation Confirmed Program MWh Savings (2)	Ex-Ante Gross Program-Projected Peak Program MW Savings (1**)	Ex-Post Evaluation Projected Peak MW Savings (2**)	Ex-Ante Gross Program-Projected Program Therm Savings (1)	Ex-Post Net Evaluation Confirmed Program Therm Savings (2)
1	2008	4,888	4,439	1.324	2.705		
2	2009	4,888	4,439	1.317	2.705		
3	2010	4,888	4,058	1.317	2.556		
4	2011	4,888	4,058	1.317	2.556		
5	2012	4,888	3,673	1.317	2.428		
6	2013	4,875	3,579	1.315	2.400		
7	2014	3,740	3,511	0.987	2.384		
8	2015	1,028	1,304	0.190	0.864		
9	2016	1,028	488	0.190	0.302		
10	2017	1,028	488	0.190	0.302		
11	2018	992	485	0.182	0.296		
12	2019	992	485	0.182	0.296		
13	2020	992	485	0.182	0.296		
14	2021	992	485	0.182	0.296		
15	2022	512	485	0.041	0.296		
16	2023	273	164	0.004	0.216		
17	2024	273	117	0.004	0.207		
18	2025	273	117	0.004	0.207		
19	2026	273	117	0.004	0.207		
20	2027	273	117	0.004	0.207		
TOTAL		41,984	33,096				

** Peak MW savings are defined in this evaluation as the weekday peak period Monday through Friday from 2PM to 6PM during the months of May through September.
1. Gross Program-Projected savings are those savings projected by the program before NTG adjustments.
2. Net Evaluation Confirmed savings are those documented via the evaluation and include the evaluation contractor's NTG adjustments.

The TDPUD programs realized 107% greater cost effectiveness than anticipated due to capturing greater savings per measure and greater installations of measures that yield higher savings. The best examples of this winning approach are the Green Partners, Million CFLs, and LED Holiday Lights programs. The Green Partners program realized 371% greater installations than anticipated (i.e., 6361 installed CFLs versus 1,350 anticipated) by establishing community partnerships with retail, restaurant, and hospitality market segments. TDPUD will continue this winning strategy with future programs. The Million CFLs program realized 17% fewer installed CFLs (saving money for other measures), while capturing 11% greater savings than anticipated by replacing higher Wattage incandescent lamps with proper lumen output low Wattage CFLs. The LED Holiday Lights program captured 360% greater savings than anticipated by partnering with the Town of Truckee to replace decorative incandescent outdoor lights with LED lights on historic buildings and trees that operate year round. The Building Envelope & Duct Testing Mitigation program captured 41% greater savings than anticipated with 40% less incentives by using highly skilled local contractors to perform building and duct sealing on very leaky homes (one with electric heat). TDPUD offered successful rebate programs for residential and commercial lighting, water heaters, and Energy Star™ dishwashers, clotheswashers, and refrigerators that generally met or exceeded the ex ante savings goals. As noted above, TDPUD also purchased large quantities of measures at wholesale prices and gave these measures away free to capture significant savings while promoting their other programs. The average measured ex post operating hours for lighting measures were greater than the ex ante assumptions and this provided greater lighting savings. Two programs did not realize any participation: Ground Source Heat Pumps and Thermally-efficient Windows. However, TDPUD retrofitted 60 low/moderate-income senior residences with low-e windows/doors, R49 attic insulation, door sweeps, and pipe insulation to stimulate the local window replacement market. TDPUD provided storage tank rebates for two solar water heating systems, and this study verified the performance of one of these systems to pilot a future TDPUD solar water heating program consistent with AB1470.[3]

Participant and non-participant process surveys were used to obtain general feedback and suggestions. Survey results indicate 88 percent of participants are satisfied with the program based on 624 survey responses to 35 questions from 184 randomly selected participants. Most participants expressed appreciation for free measures and incentives. Process survey responses indicated significant demand for the program with an overall rating of 8.8 ± 0.4 out of 10 points. Participants indicated that they would like to see the program continue to serve TDPUD customers. Non-participant survey results indicate 98 percent would have participated if they had known about the program. Most indicated better advertising would have helped. Process survey results, on-site verification inspections, and field measurements were used to guide the overall process evaluation in terms of investigating operational characteristics of the program and developing specific recommendations to help make the program more cost effective, efficient, and operationally effective. The most important process recommendations are as follows.

- Implement an internet-tracking system to include the following information for each measure: name, address, phone number, e-mail address, account number, incentives paid, measure description (from pull-down list or entered), date installed, pre-existing measure. The internet-tracking system can be used to motivate customers to learn more about energy efficiency and renewable energy, document and verify all installed measures, educate customers about present and future energy efficiency and renewable energy programs, and obtain feedback from customers regarding current and future program offerings.
- Do not pay incentives without verifying that measures are properly installed and operational. One commercial customer received incentives for inefficient T12 lamps.
- Use a third party verification service provider to ensure that all measures are properly installed to increase savings, cost effectiveness, and reduce lost opportunities.
- Educate customers about comparable CFL replacements in terms of lumens. Offer more types of CFLs (i.e., color temperature, reflector, and dimmable, long-life cold-cathode) to increase savings and acceptance.
- Purchase large quantities of pressure-compensating low-flow 1.5 gpm showerheads, low-flow 0.5 to 1.5 gpm aerators, and low-flow pre-rinse spray valves to save water. Low-flow showerheads and

[3] The California Solar Water Heating Efficiency Act (AB1470) authorizes $250 million to transform the solar water heating industry and provide incentives for 200,000 solar water heaters starting in 2010.

aerators save the equivalent of one CFL in pumping electricity annually and pre-rinse spray valves save the equivalent of 10 CFLs not including water heating energy savings.

- Provide better advertising to increase participation including internet information, handouts or fliers that tell customers about the program, funding source, and free services.
- Work with Southwest Gas and propane companies to offer joint programs that save electricity and natural gas (or propane). Offer incentives for Energy Star® solar water heating program or Energy Star® instantaneous water heaters to eliminate electric water heaters (which use 4.5 kW per unit which can be partially avoided with solar electric panels costing approximately $45,000).
- Offer incentives for occupancy sensors for commercial lighting and plug loads and offer rebates for Energy Star® LCD high-definition television (HDTV) sets.
- Based on findings from this and other studies, most residential and commercial customers do not have sufficient capital or motivation to invest in improving the energy efficiency of their homes and businesses. To overcome these market barriers, TDPUD should be continued and expanded to save energy, water, and peak demand and reduce carbon dioxide emissions.

A discussion of actionable recommendations for program changes that can be expected to improve the cost effectiveness of the program, improve overall or specific operations, or improve satisfaction or, of course, all three are provided in the process evaluation section (see section **3.2.3 Process Evaluation Recommendations**).

Section 2 describes the EM&V objectives, including baseline information, energy efficiency measure information, measurement and verification approach, and the evaluation approach. **Section 2** also includes equations used to develop energy and peak demand savings, sample design, methods used to verify proper installation of measures, and methods used to perform field measurements. **Section 3** provides EM&V study findings including load impact results and process evaluation results regarding what works, what doesn’t work, and recommendations to improve the program's services and procedures. **Section 3** also includes measure recommendations to increase savings, achieve greater persistence, and improve customer satisfaction. **Appendix A** provides the Commercial Lighting Survey Instrument. **Appendix B** provides the CFL Decision-Maker Survey Instrument. **Appendix C** provides the Residential Refrigerator Recycling Decision-Maker Survey Instrument. **Appendix D** provides the Energy Star Appliance Decision-Maker Survey Instrument.

2. Required EM&V Objectives and Components

This section discusses how the EM&V study meets the objectives listed in **Table 2.1** including baseline information, energy efficiency measure information, measurement and verification approach, and the evaluation approach.

Table 2.1 Components of an EM&V Plan

Baseline Information ▪ Determine whether or not baseline data exist upon which to base energy savings measurement. Existing baseline studies can be found on the California Measurement Advisory Committee website (http://www.calmac.org/) and/or the California Energy Commission website (http://www.energy.ca.gov/). Detailed sources of baseline data should be cited. ▪ If baseline data do not exist, the implementer will need to conduct a baseline study (gather baseline energy and operating data) on the operation(s) to be affected by the energy efficiency measures proposed. ▪ If the baseline data do not exist and the implementer can show that a baseline study is too difficult, expensive or otherwise impossible to carry out prior to program implementation, the contractor should then provide evidence that baseline data can be produced or acquired during the program implementation. This process should then be detailed in the EM&V Plan.
Energy Efficiency Measure Information ▪ Full description of energy efficiency measures included in the program, including assumptions about important variables and unknowns, especially those affecting energy savings. ▪ Full description of the intended results of the measures.
Measurement and Verification Approach ▪ Reference to appropriate IPMVP option. ▪ Description of any deviation from IPMVP approach. ▪ Schedule for acquiring project-specific data
Evaluation Approach ▪ A list of questions to be answered through the program evaluation. ▪ A list of evaluation tasks/activities to be undertaken during the course of program implementation. ▪ A description of how evaluation will be used to meet all of the Commission objectives described above.

2.1 Baseline Information

Existing studies were used to determine whether or not baseline data exist to reference energy and peak demand savings measurements. Existing baseline data will be obtained from prior EM&V studies, the California Measurement Advisory Committee (CALMAC, http://www.calmac.org), and the California Energy Commission (CEC, http://www.energy.ca.gov). Existing baseline studies are provided in **Table 2.2**.

Table 2.2 Existing Baseline Studies

Study	Description
1	*Evaluation Measurement and Verification Report for the Small Nonresidential Energy Fitness Program #179*, Prepared by Robert Mowris & Associates, April 30 2004.
2	*Measurement & Verification Summary Report for NCPA SB5X Programs* prepared for NCPA and the California Energy Commission, 2005.
3	*Measurement and Verification Report for NCPA SB5X Commercial and Industrial Lighting Programs,* prepared for NCPA, prepared by RMA, 2005.
4	*Measurement and Verification Report for NCPA SB5X Refrigerator Recycling Programs,* prepared for NCPA, prepared by RMA, 2005.
5	*Measurement and Verification Report for NCPA SB5X Residential Compact Fluorescent Lamp Programs,* prepared for NCPA, prepared by RMA, 2005.
6	*Measurement and Verification Report for NCPA SB5X Miscellaneous Programs,* prepared for NCPA, prepared by Robert Mowris & Associates, 2005.
7	Database for Energy Efficiency Resources (DEER) Update Study, Final Report, Prepared For, Southern California Edison, 2131 Walnut Grove Avenue, Rosemead, CA 91770, Prepared by Itron, Inc., 1104 Main Street, Suite 630, Vancouver, Washington 98660. December 2005. Available online at http://eega.cpuc.ca.gov/deer/.
8	E3: Energy and Environmental Economics, Inc. 2008. E3 Calculator. Energy and Environmental Economics, Inc.: San Francisco, Calif. 94104. Available online: http://www.ethree.com/cpuc_cee_tools.html.
9	*California Statewide Residential Appliance Saturation Survey.* Study 300-00-004, prepared for California Energy Commission, prepared by KEMA-XENERGY Inc. Oakland, California, June 2004.

2.2 Energy Efficiency Measure Information

This section provides energy efficiency measure information including assumptions about important variables and unknowns, especially those affecting energy savings. Ex Ante peak demand and energy savings, effective useful lifetime (EUL), net-to-gross ratio, and unit goals for each measure are provided in **Table 2.3**.

Table 2.3 Ex Ante Savings for Measures Installed in TDPUD Service Area

	Description	Unit	Demand Savings per unit kW	Savings per unit kWh	EUL	NTG Ratio	Unit Goals
1	Residential CFL	Fixture	0.020	53.12	6.7	0.80	1,000
2	Commercial T8 w/Elec. Ballast	Fixture	0.020	75.0	14	0.80	6,400
3	Energy Star Appliances	Unit	0.070	176.9	15	0.80	300
4	Refrigerator Recycling	Unit	0.013	72.5	6	0.80	150
5	Efficient Water Heaters	Unit	0.020	114.6	15	0.80	40
6	Ground Source Heat Pump	Unit	0.110	775.2	25	0.80	10

Table 2.3 Ex Ante Savings for Measures Installed in TDPUD Service Area

	Description	Unit	Demand Savings per unit kW	Savings per unit kWh	EUL	NTG Ratio	Unit Goals
7	Building Envelope & Ducts	Unit	0.100	49.93	15	0.80	40
8	Thermally Efficient Windows	Unit	0.001	23.3	15	0.80	7,000
9	Insulation, Windows	Unit	0.167	3,000	15	0.80	60
10	LivingWise Kit (CFL plus Audit)	Unit	0.020	500	6.7	0.80	200
11	Green Partner CFLs	Unit	0.020	53.1	6.7	0.80	1,350
12	Million CFLs	Unit	0.020	53.1	6.7	0.80	66,670
13	LED Holiday Lights	Unit	0.004	127	20	0.80	500
14	Low-Flow Pre-Rinse Spray Valves	Unit	0.040	308.3	5	0.80	40
15	Low-Flow Showerheads	Unit	0.010	35.8	10	0.80	1,000

The intended ex ante energy and peak demand results for the TDPUD programs are 4,887,649 first-year kWh, 1,324 kW, 42,840,297 lifecycle kWh. This was to be accomplished through the installation of 85,188 measures installed either with incentives, bill credits, or measures purchased in volume and given away for free to customers. The EM&V study provides ex post results for the programs. The ex ante total resource cost (TRC) test ratio is 3.44 based on the E3 EE Reporting Tool.

2.2.1 Description of Energy Efficiency Measures

This section provides a full description of each energy efficiency measure including assumptions about important variables and unknowns, especially those affecting energy savings. Energy efficiency measure assumptions were examined in the study. Proper installation of energy efficiency measures was verified during on-site inspections.

1. Screw-in Compact Fluorescent Lamps (CFLs)

Compact fluorescent lamps are designed to replace standard incandescent lamps. They are approximately four times more efficient than incandescent lamps. Screw-in modular lamps have reusable ballasts that typically last for four lamp lives. Commercial applications for compact fluorescent lamps include general lighting, accent and specialty lighting, decorative and portable lighting, utility lighting, and exterior illumination. As with all fluorescent lamps, CFLs emit light when low-pressure mercury vapor is energized inside the lamp, which produces ultraviolet (UV) radiation. The UV radiation is absorbed by a phosphor coating on the inner surface of the lamp, which converts the radiation into light. Ballasts provide initial voltage for starting lamps and regulate lamp current during operation. CFL ballasts are electronic. Incandescent lamps typically use 15 to 100W and can be replaced with CFLs using 4 to 27W. Compact fluorescent lamp fixtures replace standard incandescent lamp fixtures. They use pin type lamps instead of screw-in lamps so they typically last longer than screw-in lamps. Otherwise they are comparable to screw-in CFLs in terms of first-year savings. The average ex ante savings for CFLs are 0.006 kW and 37.3 kWh/yr (based on TDPUD E3 inputs). Ex ante deemed savings for other CFL measures are shown in **Table 2.4**.

Table 2.4 Ex Ante Savings for CFLs

#	Description	Units	Demand Savings per unit kW	Annual Hours of Operation per unit	Savings per unit kWh	Savings per unit therm	EUL	Ex Ante NTGR	Qty.
1a	150W Incandescent to 42W CFL	Unit	0.108	993	107.2	n/a	8.1	0.96	
1b	100W Incand. to 29W CFL	Unit	0.071	993	70.5	n/a	8.1	0.96	
1c	100W Incand. to 26W CFL	Unit	0.074	993	73.5	n/a	8.1	0.96	
1d	75W Incand. to 22W CFL	Unit	0.053	993	52.6	n/a	8.1	0.96	
1e	60W Incand. to 16W CFL	Unit	0.044	993	43.7	n/a	8.1	0.96	
1f	60W Incand. to 13W CFL	Unit	0.047	993	46.7	n/a	8.1	0.96	
1g	40W Incand. to 9W CFL	Unit	0.031	993	30.8	n/a	8.1	0.96	
1h	R-30 65W Incand. to 16W CFL	Unit	0.049	993	48.7	n/a	8.1	0.96	
1i	R-30 65W Incand. to 14W CFL	Unit	0.051	993	50.6	n/a	8.1	0.96	
1j	R-40 75W Incand. to 19W CFL	Unit	0.056	993	55.6	n/a	8.1	0.96	
1k	PAR-38 69W Incan. to 19W CFL	Unit	0.050	993	49.7	n/a	8.1	0.96	
1l	R-20 50W Incand. to 9W CFL	Unit	0.041	993	40.7	n/a	8.1	0.96	
1m	R-20 30W Incand. to 5W CFL	Unit	0.025	993	24.8	n/a	8.1	0.96	
1n	60W Candella to 14W CFL	Unit	0.046	993	45.7	n/a	8.1	0.96	
1o	15W Candella to 4W CFL	Unit	0.011	993	10.9	n/a	8.1	0.96	
1p	60W Globe G-25 to 16W CFL	Unit	0.044	993	43.7	n/a	8.1	0.96	

2. T-8 Lamps/Electronic Ballasts, Delamping, Occupancy Sensors, LED Exit Signs

T-8 lamps with electronic ballasts replace 1½-inch diameter T-12 fluorescent lamps and standard magnetic ballasts. High efficiency components use tri-phosphor 1-inch diameter T-8 lamps (32 W), and electronic ballasts. The average ex ante savings are 0.0436 kW and 121 kWh/yr (based on two lamp fixtures). The ex ante savings for T-8 lamps with electronic ballasts are shown in **Table 2.5**.

Table 2.5 Ex Ante Savings T-8 Lamps with Electronic Ballasts

#	Description	Units	Demand Savings per unit kW	Annual Hours of Operation per unit	Savings per unit kWh	Savings per unit therm	EUL	Ex Ante NTGR	Qty.
2a	Change T12 F40/Mag to T-8 Elec. Ballast – 1 Lamp Fixture	Unit	0.020	4,000	80	n/a	14	0.96	
2b	Change T12 F40/Mag to T-8/Elec. Ballast – 2 Lamp Fixture	Unit	0.024	4,000	96	n/a	14	0.96	
2c	Change T12 F40/Mag to T-8/Elec. Ballast – 3 Lamp Fixture	Unit	0.044	4,000	176	n/a	14	0.96	
2d	Change T12 F40/Mag to T-8/Elec. Ballast – 4 Lamp Fixture	Unit	0.052	4,000	208	n/a	14	0.96	
2e	Change T12 F96/Mag F96 to T-8/Elec. Ballast – 1 Lamp Fixture	Unit	0.017	4,000	68	n/a	14	0.96	
2f	Change T12 F96/Mag to T-8/Elec. Ballast – 1 Lamp Fixture	Unit	0.019	4,000	76	n/a	14	0.96	

Delamping three-lamp to two-lamp fixtures saves 37 percent on lighting and often provides adequate illumination. The assumed average ex ante savings for delamping are 0.094 kW and 256 kWh/yr. The ex ante savings for delamping are shown in **Table 2.6**.

Table 2.6 Ex Ante Savings for Delamping

#	Description	Units	Demand Savings per unit kW	Annual Hours of Operation per unit	Savings per unit kWh	Savings per unit therm	EUL	Ex Ante NTGR	Qty.
2g	Delamp T12 F40/Mag Ballast – 1 Lamp Fixture	Unit	0.044	4,000	176	n/a	16	0.96	
2h	Delamp T12 F40/Mag Ballast – 2 Lamp Fixture	Unit	0.082	4,000	328	n/a	16	0.96	
2i	Delamp T12 F96/Mag Ballast – 1 Lamp Fixture	Unit	0.064	4,000	256	n/a	16	0.96	
2j	Delamp T12 F96/Mag Ballast – 2 Lamp Fixture	Unit	0.128	4,000	512	n/a	16	0.96	

Occupancy sensors are used to automatically turn on and off lights depending upon occupancy conditions. They can be wall mounted or ceiling mounted, passive infrared (PIR) or ultrasonic. Occupancy sensors are reliable, market tested products, but require proper installation and calibration. Understanding the difference in operation between PIR and ultrasonic products is the key to proper installation. Occupancy sensors are applicable in most market sectors except retail and should only be connected to lighting loads that have instant start characteristics (incandescent or fluorescent). The ex ante savings for motion sensors are 0.089 kW and 417 kWh/yr.

LED exit signs are used to replace incandescent or fluorescent exit signs. LED exit signs last up to 16 years, making the technology suitable to all situations, particularly where maintenance is a concern or where relamping is performed. LED exit signs require no maintenance. They are used until they burn out and then the exit sign is replaced. LED exit signs contain light emitting diodes (LED). The LED produces light when low-voltage direct current crosses a suitable semiconductor junction. The color of the light that is produced is determined by the composition of the semiconductor junction. Exit signs typically contain red or green LED lamps. Some exit signs use a diffuser to spread the light emitted by the LED. Typically, LED exit signs consume one to four Watts compared to incandescent exit signs which typically consume 40 Watts. The LED exit sign involves replacing 40W incandescent or 14W fluorescent exit signs with 1W LED (or 2W) exit signs. Average savings for LED exit signs are 0.038 kW and 352 kWh/yr. The ex ante deemed savings for LED exit signs are shown in **Table 2.7**.

Table 2.7 Ex Ante Savings for LED Exit Signs

#	Description	Units	Demand Savings per unit kW	Annual Hours of Operation per unit	Savings per unit kWh	Savings per unit therm	EUL	Ex Ante NTGR	Qty.
2k	Incand. to LED Exit – 1 socket	Unit	0.039	8,760	342	n/a	16	0.96	
2l	Incand. to LED Exit - 2 socket	Unit	0.038	8,760	333	n/a	16	0.96	
2m	Fluorescent to LED Exit	Unit	0.013	8,760	114	n/a	16	0.96	

3. Energy Star® Appliances

Energy Star® qualified appliances incorporate advanced technologies that use 10–50% less energy and water than standard models. Ex ante savings for Energy Star® appliances are shown in Table 2.8. Energy Star® qualified clothes washers save 140 to 280 kWh/yr compared to regular clothes washers (http://www.energystar.gov). Energy Star® qualified dishwashers use at least 41 percent less energy than the federal minimum standard for energy consumption. Replacing a dishwasher manufactured before 1994 with an Energy Star® qualified dishwasher can save 105 to 213 kWh/yr. Energy Star® qualified dishwashers use much less water than conventional models. Energy Star® qualified refrigerators require about half as much energy as models manufactured before 1993. Energy Star® qualified refrigerators provide energy savings without sacrificing the features you want. Energy Star® qualified refrigerator models use at least 20% less energy than required by current federal standards, and 40% less energy than the conventional models sold in 2001. Energy Star® qualified freezer models use at least 10% less energy than required by current federal standards. Qualified freezer models are available in three configurations: 1) upright freezers with automatic defrost, upright freezers with manual defrost, 3) chest freezers with manual defrost only. Energy Star® compact refrigerators and freezers use at least 20% less energy than required by current federal standards. Compacts are models with volumes less than 7.75 cubic feet. The average ex ante savings for Energy Star® appliances are 184.3 kWh/yr and 0.077 kW.

Table 2.8 Ex Ante Savings for Energy Star® Appliances

#	Description	Units	Demand Savings per unit kW	Annual Hours of Operation per unit	Savings per unit kWh	Savings per unit therm	EUL	Ex Ante NTGR	Qty.
3a	Energy Star® Clothes Washer	Unit	0.117	NA	280	n/a	15	0.96	
3b	Energy Star® Dishwasher	Unit	0.089	NA	213	n/a	15	0.96	
3c	Energy Star® Refrigerator	Unit	0.025	NA	60	n/a	15	0.96	
	Energy Star® Appliances	Unit	0.077	NA	184.3	n/a	15	0.96	

4. Refrigerator and Freezer Recycling

Refrigerator and Freezer Recycling Program works with recycling contractor JACO Environmental, to remove existing units to be recycled. In addition to recycling refrigerant, foam, plastic, metals, and other components are also recycled. The effective useful lifetime for refrigerator and freezer recycling is 6 years.[4] The gross savings are based on in-situ 15-minute true RMS power measurements of 91 refrigerators and 16 freezers from an EM&V study conducted for NCPA.[5] Each unit included in the random sample was measured for several days in order to obtain 15-minute average kW measurements during the 2 PM to 6 PM time frame. The peak kW for each unit is taken as the maximum kW that occurs during the 2 PM to 6 PM weekday time frame from the 15-minute data. Daily kWh measurements were extrapolated to develop average M&V full-year unit energy consumption (UEC) values. Participant telephone surveys were used to evaluate program performance criteria and net-to-gross ratios. The net-to-gross ratio for kWh/yr is the average savings that can be credited to the program for removal of a unit as a fraction of a full year UEC. A separate net-to-gross ratio for kW was developed to estimate peak demand savings. The sample mean baseline full-year unit energy consumption for refrigerators and freezers is 1,682 kWh/yr ± 123 kWh/yr and the sample mean

[4] See *Statewide Residential Appliance Recycling Program*, PY2004/PY2005 Energy Efficiency Program Proposal, R. 01-08-028, prepared by Pacific Gas and Electric Company, prepared for the California Public Utilities Commission September 2003. Available Online at: ftp://ftp.cpuc.ca.gov/eep/pge1/.

[5] *Measurement and Verification Report for NCPA SB5X Refrigerator Recycling Programs*, prepared for NCPA, prepared by RMA, 2005.

baseline kW is 0.362 kW ± 0.023 kW at the 90 percent confidence level. TDPUD assumed annual savings of 72.5 kWh/yr and peak demand savings 0.013 kW.

5. Efficient Water Heaters (Solar Water Heaters, Geothermal Water Heaters)

Efficient electric water heaters include removing an existing electric water heater and replacing it with a high efficiency electric water heater or a solar or geothermal heat pump water heater. To qualify for the rebate electric water heaters less than 60 gallons must have an Energy Factor of .93 or higher. Electric water heaters 60 gallons and larger must have an Energy Factor of .91 or higher. Qualifying solar and geothermal heat pump water heaters must displace electric water heaters. The 2004 Federal Standards are 0.9304 EF for 30 gallon units, 0.9172 EF for 40 gallon units, and 0.904 EF for 50 gallon units.[6] Average electric water heater unit energy consumption (UEC) is 3,354 kWh/year.[7] The incremental costs for electric resistance storage water heaters for a 0.02 EF improvement in are approximately $70 to $80 per unit. Savings are 180.3 kWh/yr going from 0.88 EF to 0.93 EF with a UEC of 3,354 kWh/year. TDPUD assumed annual savings of 143.2 kWh/yr and peak demand savings 0.025 kW. Savings for solar water heaters are 50 to 70% or 1,677 to 2,348 kWh/yr at a cost of $6,000 (assuming two four feet by ten feet solar panels, at least 100 gallons of storage, pumps, and controls) with a simple payback of 16 years. Geothermal heat pump water heaters can save 20 to 30% with an installed cost of $10,000 and a simple payback of 64 years.

6. Ground Source Heat Pump

Ground source heat pumps exchange heat with the ground instead of the outdoor air. The temperature of the ground remains relatively constant throughout the year, even though the outdoor air temperature may fluctuate greatly with the change of seasons. At a depth of approximately six feet, for example, the temperature of soil in most of the world's regions remains stable between 45 and 70 degrees Fahrenheit (°F). This is why well water drawn from below ground tastes cool even on the hottest summer days. In winter, it is much easier to capture heat from the soil at a moderate 50°F temperature than from the atmosphere when the air temperature is below freezing. This is also why GSHP systems can provide warm air through a home's ventilation system, even when the outdoor air temperature is extremely cold. Conversely, in summer, the relatively cool ground can absorb the home's waste heat more readily than the hot outdoor air. An EM&V study of ground source heat pumps performed for Redding Electric Utility found savings of -1,355 kWh/year and 2.1 kW and 546 therms/year (savings are negative based on gas baseline). Assuming an electric space heating baseline, the savings will be different. TDPUD assumed an electric space heating baseline and annual savings of 775.2 kWh/yr and peak demand savings 0.110 kW.

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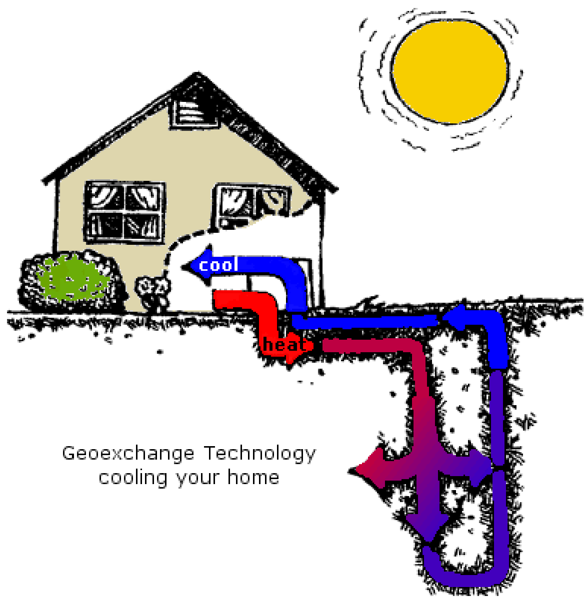
[6] See Energy Conservation Program for Consumer Products: Energy Conservation Standards for Water Heaters. Final Rule. Federal Register, v. 66, #11, pp. 4473 – 4497, http://www.eere.energy.gov/buildings/appliance_standards/residential/pdfs/water_heater_fr.pdf.

[7] *California Statewide Residential Appliance Saturation Survey.* Study 300-00-004, prepared for California Energy Commission, prepared by KEMA-XENERGY Inc. Oakland, California, June 2004.

The GSHP system circulates water through polyethylene pipes buried in the ground (ground loop), using a small circulating pump. The soil heats the water as it flows through the buried pipes. The warmed water is then passed through the GSHP located in the building, where heat is taken out of the water by the refrigerant system in the heat pump. The refrigerant system concentrates the heat to produce refrigerant at a high temperature. The high temperature refrigerant is then passed through a coil (similar to a car radiator) and a blower directs the building's air through the coil to produce hot air which heats the building.

To cool a building, the heat pump reverses the flow of the refrigerant system and cold refrigerant is passed through the coil as warm building air is blown across it. This process absorbs heat out of the building air and heats the refrigerant. This heat is then rejected out of the refrigerant system and into water in the ground loop system where the water is circulated through pipes buried in the ground. While water is circulating through the buried pipes it passes heat back to the earth, and cooler water is carried back to the heat pump in the building to absorb more heat.



7. Building Envelope Repair and Duct Test and Sealing

Building envelope repair involves pressurization testing of the building to 50 Pascal and then sealing leaks in the building shell to reduce total building leakage from 0.5 to less than 0.3 air changes per hour (ACH). Building leakage is tested using a blower door. Duct test and seal involves sealing both supply and return ducts to a leakage reduction of 60 cfm/ton or 14% of measured total system flow at 25 Pascal pressure (supply and return). Duct testing is performed using duct pressurization equipment. The assumed baseline is 29% duct leakage going to 15% for a 14% reduction or 60 cfm/ton. TDPUD assumed ex ante savings of 62.4 kWh/year and 0.125 kW.

8. Thermally Efficient Windows

TDPUD defines thermally efficient windows as double or triple-pane low-emissivity windows with vinyl or wood clad frames (aluminum framed windows do not qualify). In order to qualify, the windows replaced must be single-pane windows and the customer must be currently using a permanent electric space heating system. TDPUD should define a minimum R-value or u-value for qualifying windows. For double-pane low-emissivity windows, the minimum should be R-3 or 0.33 Btu/hr-ft^2-°F. TDPUD assumed ex ante savings of 3085.7 kWh/year-home and 0.143 kW.

9. Insulation and Thermally Efficient Windows

Attic insulation involves installing R-38 or greater blown-in insulation into uninsulated attics or attics with existing insulation less than R-11. Wall insulation involves installing R-11 (3.5 inch wall studs) or R19 (6.5 inch wall studs) into uninsulated walls. TDPUD assumed ex ante savings of 3000 kWh/year and 0.167 kW. Thermally efficient windows are defined above.

10. LivingWise™ Kit

The LivingWise™ kit includes the following measures: CFL, 2.0 gpm showerhead, 2.0 gpm kitchen aerator, electroluminescent night light, air filter alarm, home energy audit form, and energy cost/water quiz calculator. TDPUD assumed savings associated with one CFL plus actions taken by participants to conserve energy based on the energy audit. The TDPUD assumed ex ante savings are 500 kWh/year and 0.085 kW.

11. LED Holiday Lights

The Light Emitting Diode (LED) holiday lights use 0.021 Watts per bulb and a 20 feet string of 60 LED bulbs uses 2.1 Watts. Traditional C7 incandescent holiday light strings use 5 Watts per bulb and a 20 feet string of 40 use 200 Watts and M5 incandescent mini lights use 0.5 Watts per bulb so a 20 feet string of 100 use 50 Watts. LED savings compared to C7 incandescent are 197.9 Watts per 20 feet string, and LED savings compared to M5 mini incandescent are 47.9 Watts. LEDs last 50,000 to 100,000 hours and the limited heat output makes for safer illumination of indoor trees. Town of Truckee installed 800 1.9W E27-X8_G LED G12 (1.5 inch diameter) lamps (http://www.superbrightleds.com/cgi-bin/store/commerce.cgi?product=MR16) to replace 10W incandescent E27 G12 lamps (http://www.buylighting.com/G12-Colored-Globes-s/310.htm). Town of Truckee also installed 600 0.3W LED lamps (0.25 inch diameter) to replace 2W Incandescent mini T10 lamps. The TDPUD ex ante savings per string of LED holiday lights are 127 kWh/year and 0.004 kW. The Town of Truckee ex ante savings for LED lamps is 0.0057 kW/lamp and 25.03 kWh/year-lamp or 8 kW and 35,040 kWh per year for all 1400 lamps with an estimate life of 6 years (30,000 hours).

12. Low-Flow Pre-Rinse Spray Valves

Low-flow pre-rinse spray valves (PSRV) are used in restaurants and grocery stores to rinse food from dishes prior to washing dishes manually or in a dishwasher. Standard PSRVs are rated at 2.2 gpm at 80 pounds per square inch gauge (psig). Low-flow PSRVs are rated at 1.6 gpm at 80 psig flowing pressure. Low-flow PSRVs reduce water flow by 28%. The effective useful life is 5 years.

13. Low-Flow Showerheads

Low-flow showerheads replace standard 2.5 gpm or greater units. Low-flow showerheads are rated at 2.0 gpm or less at a flowing pressure of 80 pounds per square inch gauge (psig). Low-flow showerheads are assumed to reduce water flow by 20%. The effective useful life is 10 years.

2.3 Measurement and Verification Approach

The measurement and verification approach is based on the *International Performance Measurement & Verification Protocols* (IPMVP) defined **Table 2.9**.[8] Ex post energy savings for each measure are determined using IPMVP Option A, B, and C. Statistical analyses are used to extrapolate energy and peak demand savings at the sample level to the program level.

Table 2.9 IPMVP M&V Options

M&V Option	Savings Calculation	Typical Applications
Option A. Partially Measured Retrofit Isolation Savings are determined by partial field measurement of energy use of systems to which a measure was applied, separate from site energy use. Measurements may be either short-term or continuous. Partial measurement means some but not all parameters may be stipulated, if total impact of possible stipulation errors is not significant to resultant savings.	Engineering calculations using short term or continuous post-retrofit measurements or stipulations.	Pre- and post-retrofit lighting fixture wattages are measured and unit energy savings are based on stipulated deemed savings times the ratio of average ex post to ex ante lighting fixture wattages.
Option B. Retrofit Isolation Savings are determined by field measurement of the energy use of the systems to which the measure was applied; separate from the energy use of the rest of the facility. Short-term or continuous measurements are taken throughout the post-retrofit period.	Engineering calculations using short term or continuous measurements	For CFLs or T8 fixtures electricity use is measured with a Watt meter to verify pre- and post-retrofit power. Hours of operation are estimated using light loggers or participant interviews.
Option C. Whole Facility Savings are determined by measuring energy use (and production) at the whole facility level. Short-term or continuous measurements are taken throughout the post-retrofit period. Continuous measurements are based on whole-facility billing data.	Analysis of whole facility utility meter or sub-meter data using techniques from simple comparison to regression or conditional demand analysis.	Weather-sensitive measure energy savings are based on utility billing data for 12-month base year and minimum 12-month post-retrofit period.
Option D. Calibrated Simulation Savings are determined through simulation of the energy use of components or the whole facility. Simulation routines must be calibrated to model actual energy performance measured in the facility.	Energy use simulation, calibrated with hourly or monthly utility billing data and/or end-use metering.	Project affecting many systems where pre- or post data are unavailable. Utility meters measure pre- or post-retrofit energy use and savings are based on calibrated simulations.

Gross ex post savings for each measure are calculated based on information or measurements collected in the sample of on-site inspections, telephone surveys, engineering analyses, or stipulated values. **Sample mean savings estimates** are calculated using **Equation 1**.

[8] See *International Performance Measurement & Verification Protocols*, DOE/GO-102000-1132, October 2000.

Eq. 1 $\bar{y}_i = \text{Mean Savings} = \frac{1}{n_i}\sum_{j=1}^{n_i} y_j$

Where,

$\bar{y}_i =$ Mean savings for measure "i" in the sample (i.e., kWh/yr, kW).

$n_i =$ Number of measures "i" in the sample.

Savings will be adjusted based on the proportion of measures, $\hat{p}_i$ **,** found properly installed during verification inspections.

Eq. 2 $\text{Adjusted savings} = \hat{p}_i \bar{y}_i$

Where,

$\hat{p}_i =$ Proportion $= \frac{n_{verified}}{n_i}$

$n_{verified} =$ Number of verified measures in the sample.

The standard error, se_i**, of the measure sample mean** is calculated using **Equation 3, Equation 4** or both depending on the measure.[9]

Eq. 3 $se_{i_p} = \text{Standard Error of the Proportion} = \sqrt{\frac{\hat{p}_i(1-\hat{p}_i)}{n_i}}$

The standard error of mean savings is calculated using **Equation 4**.

Eq. 4 $se_{i_s} = \text{Standard Error of Mean Savings} = \sqrt{\frac{\sum_{j=1}^{n}(y_j - \bar{y})^2}{n(n-1)}}$

The measure error bounds at the 80 to 90 percent confidence level are calculated using **Equation 5** combining the applicable standard errors from **Equations 3** and **4**.

Eq. 5 $\text{Measure Error Bound} = \hat{p}_i \bar{y}_i (1 \pm (t)\sqrt{se_{i_p}^2 + se_{i_s}^2})$

Where,

[9] The standard error for all measures will be calculated based on the proportion of measures found properly installed from the on-site surveys. In addition, the standard error of the mean savings will also be calculated for measures where weighted average savings for each climate zone are available. These two standard errors will then be combined to characterize the statistical precision of the sample mean as an estimator of the population mean. The population total will be estimated by multiplying both the sample mean and the corresponding combined error bound by the number of units in the population as per sampling procedures from *The California Evaluation Framework*, Chapter 13: Sampling, prepared for the CPUC, prepared by Hall, N., Barata, S., Chernick, P., Jacobs, P., Keating, K., Kushler, M., Migdal, L., Nadel, S., Prahl, R., Reed, J., Vine, E., Waterbury, S., Wright, R. February 2004.

t = The value of the normal deviate corresponding to the desired confidence probability of 1.645 at the 90% confidence.

Savings for all measures "m" in the program are calculated using **Equation 6**.

Eq. 6 $$\hat{Y} = \text{Program Savings } = \sum_{i=1}^{m} \left(N_{p_i} \times \hat{p}_i \bar{y}_i \right)$$

Where,

N_{p_i} = Number of "i" measures in the entire program population.

The program error bound for all measures is calculated using **Equation 7**.

Eq. 7 $$\text{Program Error Bound } = \sum_{i=1}^{m} N_{p_i} \left\{ \hat{p}_i \bar{y}_i \left(1 \pm (t) \sqrt{se_{i_p}^2 + se_{i_s}^2} \right) \right\}$$

Net savings are calculated as gross savings times the NCPA-accepted net-to-gross ratios from the E3 Calculator. Impact results (kWh, kW, and therm) are displayed in terms of savings per year.

2.4 Cost Effectiveness Approach

The proposed evaluation includes an assessment of the cost effectiveness inputs used by TDPUD (i.e., E3 Calculator) in preparation of the program. The following inputs are reviewed for accuracy:

- Electricity kWh Savings;
- Peak demand kW Savings (although not tied to the TRC);
- Natural gas savings;
- Gross Incremental Measure Cost (Gross IMC);
- Effective Useful Life (EUL); and
- Net to Gross Ratio (NTGR).

TDPUD used several sources and methods to develop the workbook inputs for each measure. For measures using deemed savings we verified the accuracy of deemed parameters. For inputs taken directly from the E3 Calculator pertaining to EUL and Net to Gross Ratio, we reviewed these inputs for accuracy and applicability to E3 or other sources (i.e., CPUC Energy Efficiency Policy Manual, CEC, etc.).

2.5 Measure Verification Approach

The measure verification approach relies on TDPUD customer site visits and telephone surveys, billing data, field measurements, light logger data, and on-site surveys. A description of the verification approach for each measure is provided in **Table 2.10**. IPMVP Options A, B, C, and D were used to evaluate energy and peak demand savings for the program. Measurements were short-term, and some, but not all parameters were stipulated, as long as the total impact of possible stipulation errors was not significant to the resultant savings.

Table 2.10 Verification Approach for TDPUD Measures

Measure	Measurement and Verification Approach
Compact Fluorescent Lamps	Energy and peak demand savings based on customer in-person and telephone surveys, site verification, light logger and power measurements.
Commercial T8 Fixtures with Electronic Ballasts	Energy and peak demand savings based on customer in-person and telephone surveys, site verification, light logger data, and field measurements.
Energy Star Appliances	Energy and peak demand savings based on customer in-person and telephone surveys, site verification, verification of model numbers and Energy Star data (http://www.energystar.gov/index.cfm?c=clotheswash.pr_clothes_washers, http://www.energystar.gov/index.cfm?c=dishwash.pr_dishwashers, and http://www.energystar.gov/index.cfm?c=refrig.pr_refrigerators).
Refrigerator Recycling	Energy and peak demand savings based on customer surveys, site verification, and field measurements.
Electric Water Heaters (and Solar water heaters)	Energy and peak demand savings based on customer surveys, site verification, field measurements, billing data, and previous EM&V studies.
Ground Source Heat Pumps	Energy and peak demand savings based on previous EM&V studies.
Building Envelope & Ducts	Energy and peak demand savings based on customer surveys, site verification, duct and house pressurization tests and field measurements.
Thermally Efficient Windows and insulation	Energy and peak demand savings based on customer surveys, site verification and billing data.
LivingWise Kit (CFL plus Audit)	Energy and peak demand savings based on customer surveys, site verification engineering analyses, and EM&V studies.
LED Holiday Lights	Energy and peak demand savings based on customer surveys, field verification, field measurements, engineering analyses, and EM&V studies.
Pre-Rinse Spray Valves	Energy and peak demand savings based on customer surveys, field verification, engineering analyses, and EM&V studies.
Low-Flow Showerheads	Energy and peak demand savings based on field measurements, engineering analyses, and EM&V studies.

Field measurement equipment tolerances are shown in **Table 2.11**.

Table 2.11 Field Measurement Equipment Tolerances

Field Measurement	Measurement Equipment	Tolerances
Light loggers (hours of operation)	Digital time-of-use meter.	On/Off: ± 1 minute/month
Power in kilowatts (kW) of air conditioners or CFLs	True RMS 4-channel power data loggers and 4-channel power analyzer.	Data loggers, CTs, PTs: ± 1% Power analyzer: ± 1%
Temperature in degrees Fahrenheit (°F) of solar water heater.	4-channel temperature data loggers with 10K thermisters.	Data logger: ± 0.1°F Thermisters: ± 0.2°F
Duct Leakage in cfm at 25 Pascal (Pa)	Digital pressure gauge, controller, fan, extension duct, and flow conditioner.	Fan flow: ± 3%
Building envelope leakage in cfm at 50 Pa and Effective Leakage Area (ELA) in square inches.	Digital pressure gauge, controller, fan, and blower door.	Air leakage and ELA: ± 3%
Airflow in cubic feet per minute (cfm) across air conditioner evaporator coil	Digital pressure gauge and fan-powered flow hood, flow meter pitot tube array, and electronic balometer.	Fan-powered flowhood: ± 3% Flow meter array: ± 7% Electronic balometer: ± 4%
Flow rate in gallons per minute (gpm) and flowing pressure (psi) of showerheads or aerators	Flow meter and flowing pressure gauge. Handheld flow device.	Flow rate (0.5 to 15 gpm): ± 7% Flowing Pressure (0 to 160 psi): ± 7% Micro-Wier (0 to 4 gpm): ± 1%

2.6 Sampling Design Approach

The statistical sample design approach for the load impact and process evaluations involved selecting a random sample of customers from the program population. Samples were selected to obtain a reasonable level of precision and accuracy at the 90 percent confidence level. The proposed sample design was based on statistical survey sampling methods.[10] Sampling methods were used to analyze the data and extrapolate mean savings estimates from the sample measurements to the population of all program participants and to evaluate the statistical precision of the results.[11] Selecting participants for the sample was guided by the statistical sampling plan.

The sample size necessary to obtain the desired 10% to 20% relative precision for program mean savings estimates is calculated using **Equation 8**.

Eq. 8 Sample Size = $n_i = \frac{t^2 C_{vi}^{\;2}}{r^2}$

Where,

n_i = Required sample size for measure "i",

t = The value of the normal deviate corresponding to the desired confidence probability of 1.28 to 1.645 at the 80 to 90% confidence level,

r = Desired relative precision, 10% to 20%.

C_{vi} = Coefficient of variation, $\frac{s_i}{\bar{y}_i}$, for measure "i."

For small populations, the sample size is corrected using the finite population correction (FPC) equation as follows.[12]

Eq. 9 FPC Sample Size = $n_{FPC\,i} = \frac{n_i}{1+(n_i - 1)/N}$

Where,

[10] Hall, N., Barata, S., Chernick, P., Jacobs, P., Keating, K., Kushler, M., Migdal, L., Nadel, S., Prahl, R., Reed, J., Vine, E., Waterbury, S., Wright, R. 2004. *The California Evaluation Framework*, Appendix to Chapter 7: 191-195. Uncertainty Calculation. San Francisco, Calif.: California Public Utilities Commission. See Table 5c, Protocols for the General Approach to Load Impact Measurement, page 14, Evaluation design decisions related to sample design will be determined by the following protocols: if the number of program participants is greater than 200 for residential programs, a sample must be randomly drawn and be sufficiently large to achieve a minimum precision of plus/minus 10% at the 90% confidence level, based on total annual energy use. A minimum of 200 for residential programs must be included in the analysis dataset for each applicable end-use. *Protocols and Procedures for Verification of Costs, Benefits, and Shareholder Earnings from Demand-Side Management Programs*, as adopted by the California Public Utilities Commission Decision 93-05-063, Revised March 1998.

[11] Cochran, William G. *Sampling Techniques*. New York: John Wiley & Sons, 1977, Kish, Leslie. *Survey Sampling*. New York: John Wiley & Sons, 1965. Thompson, Steven K. *Sampling*. New York: John Wiley & Sons, 1992.

[12] Ibid.

$n_{FPC\,i}$ = Sample size for measure "i" with finite population correction.

Similar measures were grouped together to reduce the overall sample size requirements necessary to achieve the desired level of confidence and yield the greatest accuracy at the lowest cost. The statistical sample sizes are shown in **Table 2.12**. The sample size is based on relative savings per measure assuming a coefficient of variation (Cv) of 0.5 and relative precision of 0.1 to 0.2 to achieve the desired 80 to 90 percent confidence.

Table 2.12 Statistical Sample Size for TDPUD Measures

Measure Description	Ex Ante Units	Proposed EM&V Sample	Ex Post Installed Units	EM&V Units Inspected	Ex Post Coefficient of Variation (Cv)	Ex Post Relative Precision (r)
Residential CFL	67,670	40	56,590	223	0.017	0.0008
Commercial T8 w/Elec. Ballast	6400	40	978	978	0.019	0.0010
Energy Star Appliances	300	10	294	12	0.035	0.0034
Refrigerator Recycling	75	10	50	10	0.086	0.0200
Efficient Water Heaters	40	1	4	1	0.304	0.2500
Ground Source Heat Pump	10	0	0	N/A	N/A	N/A
Building Envelope & Ducts	40	4	42	5	0.094	0.0238
Thermally Efficient Windows	60	60	0	N/A	N/A	N/A
Insulation	60	60	60	60	0.078	0.0167
LivingWise Kit	200	18	200	229	0.024	0.0015
Green Partner CFLs	1350	10	6,361	2,169	0.016	0.0007
LED Holiday Lights	1000	10	1,450	10	0.016	0.0007
Low Flow Pre-Rinse Spray Valves	40	40	16	40	0.152	0.0625
2.0 GPM Showerheads	1,000	10	400	20	0.030	0.0025
Participant Surveys	N/A	68	N/A	184	N/A	N/A
Non-Participant Surveys	N/A	40	N/A	55	N/A	N/A

2.7 Process Evaluation Approach

The evaluation approach used process surveys to measure participant satisfaction, and obtain suggestions to improve the program's services and procedures. Process surveys, on-site inspections, and field measurements were used to guide the overall process evaluation in terms of investigating operational characteristics of the program and developing specific recommendations to help make the program more cost effective, efficient and operationally effective. The process evaluation examined how to install a comprehensive package of measures for each customer within the constraints of the program. Interview questions assessed how the program influenced awareness of linkages between efficiency improvements and bill savings and increased comfort for customers. A sample of 184 participants and 55 non-participants were asked process questions. The participant and non-participant surveys are provided in the **Appendices**. Participants were asked why and how they decided to participate in the program. Non-participants were asked why they chose not to participate. This was done to identify reasons why program marketing efforts were not successful with some customers as well as to identify additional hard-to-reach market barriers (i.e., incentives or other inducements to achieve greater participation). The process survey evaluation includes a summary of what works, what doesn't work, and the level of need for the program. The evaluation identified the rejection rate/acceptance rate and size of the rejecter pool. This information was used to define if there were issues that need to be addressed. On-going feedback was provided based on installation quality.

The process evaluation used surveys to measure participant satisfaction, and obtain suggestions to improve the program's services and procedures. Process surveys, on-site inspections, and field measurements were used to guide the overall process evaluation in terms of investigating operational characteristics of the program and developing specific recommendations to help make the program more cost effective, efficient and operationally effective. Interview questions assessed how the program influenced awareness of linkages between efficiency improvements and bill savings and increased comfort for customers. Participants were asked why and how they decided to participate in the program. This was done to identify reasons why program marketing efforts were not successful with some customers as well as to identify additional market barriers (i.e., incentives or other inducements to achieve greater participation). Analysis of process evaluation survey data includes a summary of what works, what doesn’t work, and the level of need for the program.

2.7.1 List of Questions Answered by the Study

The following questions are answered by the study.

1. **Are measures being installed properly?**

   The study answered this question by conducting 180 participant surveys and by performing 3,959 verification inspections at a random sample of 94 participant sites. Participants indicated that measures were properly installed as indicated by the rating of 9.5 ± 0.4 on a scale of 1 to 10 regarding the quality of work performed by installers. Light loggers were installed at 30 sites to measure hours of operation. These were left at the sites for a period of up to four weeks and then rotated to other sites. Twenty-eight (28) were successfully downloaded to monitor hours of operation on 2,640 fixtures. In addition, billing analysis for 65 sites provided additional verification that measures were installed properly. These efforts provided useful information in developing best practices recommendations to ensure measures are installed properly (see **Section 3.2.3**).

2. **Are the ex ante measure assumptions appropriate and relevant with respect to actual measures being installed in the program?**

   The study answered this question by performing on-site measurements at participant sites of window installation, attic insulation, duct leakage, whole building infiltration, solar water heater operation, lighting fixture installation, lighting levels, lighting wattage, and lighting hours of usage. The study verified measures are properly installed at a random sample of customer sites. The study evaluated baseline UEC values and ex ante energy savings estimates using on-site measurements and inspections, engineering analysis, billing data and building energy simulations (i.e., IPMVP Options A, C, and D). The baseline UEC values were evaluated and refined, and ex post savings estimates are provided for each measure based on research performed for this study. The study performed an analysis of the quantity and type of measures that were installed or adopted by program participants by conducting on-site inspections and audits at 94 participant sites to determine if the ex ante measure assumptions are appropriate and relevant.

3. **Are the ex ante energy and peak demand savings estimates per measure appropriate and relevant?**

   The study answered this question by comparing the baseline and measure assumptions using on-site measurements of customer sites. Ex ante and ex post energy and peak demand savings for each measure were evaluated using IPMVP Options A, B, C, and D. Ex post estimates of savings are provided for each measure (except for measures not installed or with zero participation).

4. **Is the ex ante net-to-gross ratio appropriate and relevant to this "hard-to-reach" energy savings program?**

   The study conducted participant surveys to evaluate the net-to-gross ratios (NTGR). The ex ante NTGRs are 0.80. The study conducted participant NTGR surveys and developed specific NTGRs for commercial lighting (0.96), electric water heater rebate (1.0), refrigerator recycling (0.84), Green Partner (0.96), Million CFL (0.90), LED Holiday Lights (0.91), Low-flow Pre-Rinse Spray Valves (1.0), and Low-flow Showerheads (1.0). Otherwise, the study used published values from the EE Reporting Tool and Table 4.2 of the CPUC Energy Efficiency Policy Manual.[13]

5. **Are the total program savings estimates accurate?**

   The study answered this question by developing ex post energy and peak demand savings for the program at the 80 to 90 percent confidence level.

6. **Are customers satisfied with the program implementation and are customers satisfied with the measures that were offered and installed in the program?**

   The study answered this question by summarizing customer satisfaction responses to process survey questions. Participant satisfaction was found to be generally very high (see **Section 3.2** for more information).

7. **Are there some customers who choose not to participate in the program?**

   The study answered this question by conducting telephone interviews with non-participating single family customers. The following questions were included.

   1. What reasons are there for not participating and how might conditions be revised to motivate participation?
   2. Why have you decided not to install similar measures such as compact fluorescent lamps, T8 lamps/electronic ballasts, Energy Star® appliances, refrigerator recycling, duct/building envelope sealing, efficient windows, low-flow showerheads/pre-rinse spray valves, attic insulation, efficient water heaters, and pipe wrap?
   3. Would you have participated if you owned the building (i.e., tenants) or if the program provided more information, rebates, and marketing?
   4. Would you have participated if you knew the program installed free energy efficiency measures in your home or business (e.g., green partners, million CFLs)?

[13] *Energy Efficiency Policy Manual*, Chapter 4, page 23, prepared by the California Public Utilities Commission, 2001.

8. Is there a continuing need for the program?

The study answered this question by evaluating ex post savings and responses from the in-person and telephone process surveys of participants and non-participants. The TDPUD provided energy efficiency services to 6,520 customers and overall participant satisfaction with the program was 88 ± 0.44 percent. Ex post measure savings and implementation costs were used to develop ex post Total Resource Cost (TRC) test values for the program using the CPUC cost effectiveness worksheets. Approximately 98 percent of non-participants would have participated if they knew the programs provided rebates, information and free compact fluorescent lamps, indicating a continuing need for the program.

9. Are there measurable program multiplier effects?

Program multiplier effects questions are used to measure program participants sharing information learned from the program with non-participants, and if sharing of information is acted upon in a way that results in the installation of similar measures within a non-participant population. For example, the TDPUD programs provide free compact fluorescent lamps, water saving showerheads, and aerators. The TDPUD programs also provide rebates for efficient commercial lighting, Energy Star® appliances, refrigerator recycling, efficient windows, attic insulation, infiltration reduction, duct sealing, CFLs, or other measures and educates customers on the value of these and other measures. Based on process survey responses, 42 percent of interviewed customers shared program information with 3.8 times as many people. Approximately 11 percent of these people decided to install similar measures or participate in the TDPUD programs. The program helped expand impacts beyond the participant group to a larger group through direct installation and rebates of TDPUD measures. The multiplier effect for the program is estimated at 4.2 percent.[14] Programs that link technologies with educational measures can have multiplier effects as high as 25-30 percent including the sharing of program information to a population that is several times larger than the participant population. The following questions were included in the participant process surveys.

1. Have you shared program information with any of your friends, neighbors, or business associates about the benefits of screw-in CFLs, LED Exit Signs, hardwired T-8/electronic ballasted fluorescent fixtures, or other measures offered in the program?
2. With how many people have you shared this information in the last 12 months?
3. About how many of these people have installed any of these measures?

[14] Spillover of 4.2 percent is calculated based on 57 people adopting at least one spillover measure based on information shared by a group of 15 participants who adopted 90 measures (i.e., $57 \times (1 \div 90) \div 15 = 0.042$).

2.7.2 List of Tasks Undertaken by the Study

The following nine (9) tasks were undertaken by the study.

Task 1. Prepare EM&V Plan

The EM&V Plan contained a description of all activities required to complete the study.

Task 2. Market Assessments or Baseline Analyses

The market assessment, baseline analyses and existing saturation survey data were used to evaluate baseline UEC values and ex ante energy savings (i.e., IPMVP Options A).

Task 3. Develop Survey Instruments

Verification, audit, and process survey instruments were designed to collect necessary data to achieve the study objectives.

Task 4. Phone or In-person Surveys

Phone or in-person process surveys were conducted with participants and non-participants.

Task 5. On-site Surveys/Site Inspections (N/A)

On-site surveys and site inspections were conducted to collect data to determine load impacts. Verification of retained energy efficiency measures were conducted as per the sampling plan and progressively throughout the project. Verification included on-site inspections and telephone calls to participants.

Task 6. Install Metering or Monitoring Equipment (N/A)

Metering or monitoring equipment was installed to measure load impacts. Metering equipment included data loggers to measure temperature, electric power, motor operation, and light loggers to measure hours of operation. In addition spot measurements of performance were made to verify proper installation of measures and savings according to IPMVP Options A, B, C, and D. Lighting loggers were left in place for 1 to 4 weeks to develop a basis for annual extrapolation (length of time depended on type of business and permission of customers).

Task 7. Analyze Survey Data

For the impact evaluation the analyses quantified kW and kWh savings for each site. Statistical analysis was used to extrapolate these savings to the program as a whole. *For the process evaluation* the telephone surveys were analyzed to identify what works, what doesn't work, and the level of need for the program. Analyses of interview responses included an assessment of market barriers to energy efficiency, participant satisfaction, and suggestions to improve the program.

Task 8. Provide Feedback to Implementer

The progress reports provided preliminary impact evaluation results as well as process evaluation results including on-going feedback and guidance to TDPUD on EM&V findings that might improve the program process and procedures.

Task 9. Prepare Draft and Final Reports

The draft and final reports included a description of the study methodology and all deliverables. The reports provided results of the process and impact evaluation including gross and net energy savings for each measure and the program as well as results.

2.7.3 How Study will meet CPUC EEPM Objectives

The study met the following objectives described in the CPUC EEPM (pg. 31).

- **Measure the level of energy and peak demand savings achieved.**

  The study met this objective by performing detailed on-site visits for a statistically significant sample of participants to gather pre- and post-installation measurements for energy efficiency measures installed under the program. Sites in the statistical sample included verification of proper installation of program measures and operation of equipment the measures were installed on (i.e., lighting and HVAC equipment). EM&V efforts included gathering enough information and measurements to develop savings estimates for each measure and number of small commercial businesses served by the program. Statistical analysis was used to extrapolate energy savings at the sample level to the program level. This step included an assessment of the relative precision of program-level savings, mean savings estimates, standard deviations, and confidence intervals. This analysis included an assessment of major assumptions used to calculate program ex ante savings.

- **Measure cost-effectiveness.**

  The study met this objective by developing ex post energy and peak demand savings for each measure. Ex post measure savings and implementation costs were used to develop ex post Total Resource Cost (TRC) test values for each measure using the E3 EE Reporting Tool worksheets.

- **Provide up-front market assessments and baseline analysis.**

  The study met this objective by performing baseline analyses including an evaluation of the baseline unit energy consumption values for lighting and space cooling. The telephone survey interviews included questions about market barriers to energy efficiency and the success of the program in meeting the needs of TDPUD customers.

- **Provide ongoing feedback and corrective or constructive guidance regarding the implementation of programs.**

  The study met this objective by performing on-site inspections to verify that measures are being installed properly. Results of on-site inspections were used to provide ongoing feedback and constructive guidance regarding implementation of the programs. This included improvements to the installation efforts and procedures. Inspections also documented that activities are being completed as per the contract requirements.

- **Measure indicators of the effectiveness of the programs, including testing of the assumptions that underlie the program theory and approach.**

  The study met this objective by performing a process evaluation of the program including surveys of participants. The TDPUD seeks to reduce energy consumption and energy-related costs by identifying energy conservation measures and providing rebates (bill credits) or direct installation of cost-effective energy conservation measures (lighting, etc.) at no cost to customers. The TDPUD customers install cost-effective energy conservation measures. Those who desire to install additional recommended measures will be assisted in finding qualified contractors, locating financing opportunities, and participation in other TDPUD energy programs The TDPUD programs were developed to address real and perceived barriers of its customers to access energy efficiency measures and effectively deal with increasing energy costs and diminishing profits. Key performance metrics are as follows: 1) Will customers installation energy efficiency measures? 2) Will customers take advantage of TDPUD rebates in the form of bill credits or referrals to qualified contractors, financing, or other programs to install measures? 3) Will customers install any other measures identified in TDPUD marketing materials or website? 4) Will customers implement recommended conservation practices from audits? The EM&V study will evaluate whether the program is performing in accordance with its program theory. The EM&V study will also evaluate the program logic behind the approach used to implement the program.

- **Assess the overall levels of performance and success of the program.**

  The study provides ex post energy and peak demand savings at the 90 percent confidence. The 90/10 confidence was adjusted for measures with a high degree of variation. The study determined participant satisfaction and ways to improve the program. Some non-participating customers were interviewed to evaluate why they chose not to participate.

- **Help to assess whether there is a continuing need for the program.**

  Telephone surveys were conducted with participants and non-participants. Interviews assessed how the program influenced awareness of linkages between efficiency improvements and bill savings and increased comfort for customers. The study also identified what works, what doesn’t work, and the level of need for the program.

3. EM&V Findings

This section provides load impact results for the program and for each measure. This section also provides the process evaluation results based on participant and non-participant surveys and recommendations regarding what works, what doesn't work, and the continuing need of the program. Also provided are recommendations for each measure to increase savings, achieve greater persistence of savings, and improve customer satisfaction.

3.1 Load Impact Results

The program ex ante goal was to install 85,185 energy efficiency measures to achieve energy savings of 4,887,649 first-year kWh, 1,324 kW, 42,840,297 lifecycle kWh. TDPUD programs realized 22% fewer measure installations (i.e., 66,445 ex post versus 85,185 ex ante) but exceeded the ex ante Total Resource Cost test goal by 107% (i.e., 7.12 versus 3.44) as shown in **Table 3.1**.

Table 3.1 Ex Ante Goals and Ex Post Accomplishments

Description	Ex Ante Goal	Ex Post Accomplishment
Total Installed Measures	85,185	66,445
Residential Lighting Rebate	1,000	1,282
Commercial Lighting Rebate	6,400	978
Energy Star® Appliance Rebate Program	300	294
Electric Water Heater Rebate	40	4
Ground Source Heat Pumps	10	NA
Building Envelope & Duct Testing	40	42
Thermally-efficient Windows	7,000	NA
Refrigerator & Freezer Recycling	75	50
Low/Moderate Income Energy Assistance	60	60
Community Outreach & Schools	200	661
Green Partners – Retail	100	1,418
Green Partners – Restaurant	100	897
Green Partners – Hospitality	1150	3,585
Million CFLs	66,670	55,308
LED Holiday Lights	1,000	1,450
Low Flow Pre-Rinse Spray Valves	40	16
2.0 GPM Showerheads	1,000	400
Net Annual Electricity Savings (kWh/yr)	3,910,119	4,455,607
Net Demand Savings (kW)	1,059	2,705
Net Annual Water Savings (gallon/yr)[15]	2,713,600	982,014
Net Lifecycle Electricity Savings (kWh)	34,272,223	36,792,306
Net Lifecycle Water Savings (gallon)	20,075,136	7,898,070
Total Resource Cost (TRC) Test – EE Reporting Tool	3.44	7.12
TRC Test Costs	$617,018	$577,405
TRC Test Benefits	$2,122,541	$4,111,922
TRC Test Net Benefits	$1,505,523	$3,534,517
Participant Test	0.3	0.8
Participant Test Costs	$570,378	$455,545
Participant Test Benefits	$171,113	$364,436
Participant Test Net Benefits	($399,265)	($91,109)

[15] The study accounts for water savings through the embedded energy of the water valued at 0.008157374 kWh/gallon saved, and these savings are entered into the E3 calculator for water conservation measures.

The ex post TRC is greater than the ex ante due to greater realized savings per measure and lower measure costs.[16] Some measure costs are three times lower than ex ante measure costs used in the EE Reporting Tool.[17] Ex post accomplishments were verified by checking the tracking database, randomly inspecting 3,959 measures at 94 participant sites (47 more than anticipated and budgeted), installing light loggers on 2,640 fixtures at 29 sites, evaluating billing data for 65 sites, and conducting surveys of participants, non-participants, and non-contacts. The ex ante first-year savings are summarized in **Table 3.2**.

Table 3.2 Ex Ante First-Year Electricity and Gas Savings

Energy Efficiency Measure	Units Estimated	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (gal/yr)	Net-to-Gross Ratio	Net Ex Ante Program Savings (kWh/y)	Net Ex Ante Program Savings (kW)	Net Ex Ante Program Savings (galyr)
Residential Lighting Rebate	1,000	53.12	0.02		0.80	42,496	12.8	
Commercial Lighting Rebate	6,400	75	0.02		0.80	384,000	112.6	
Appliance Rebate Program	300	176.9	0.07		0.80	42,462	17.8	
Electric Water Heater Rebate	40	114.6	0.02		0.80	3,666	0.6	
Ground Source Heat Pumps	10	775.2	0.11		0.80	6,202	0.9	
Building Envelope & Duct Testing	40	49.93	0.10		0.80	1,598	3.2	
Thermally-efficient Windows	7,000	23.3	0.00		0.80	130,743	6.1	
Refrigerator & Freezer Recycling	75	1,076.5	0.23		0.80	64,589	13.9	
Low/Mod. Income Energy Assistance	60	3,000	0.17		0.80	144,000	8.0	
Community Outreach & Schools	200	500	0.02		0.80	80,000	2.6	
Green Partners – Retail	100	53.1	0.02		0.80	4,250	1.3	
Green Partners – Restaurant	100	53.1	0.02		0.80	4,250	1.3	
Green Partners – Hospitality	1150	53.1	0.02		0.80	48,870	14.7	
Million CFLs	66,670	53.1	0.02		0.80	2,833,208	853.4	
LED Holiday Lights	1,000	101.6	0.00		0.80	81,280	2.6	
Low Flow Pre-Rinse Spray Valves	40	308.3	0.04	37,800	0.80	9,866	1.4	1,209,600
2.0 GPM Showerheads	1,000	35.8	0.01	1,494	0.80	28,640	6.2	1,195,200
Total	85,185					3,910,119	1,059	2,404,800

The EM&V ex post first-year savings are summarized in **Table 3.3**. The EM&V ex post savings are based on pre and post-retrofit utility billing data, light logger data, previous evaluation studies, and engineering analyses calibrated to billing data. The EM&V study found first-year net ex post program savings of 4,455,607 ± 199,957 kWh per year, 2,705 ± 96 kW per year, and 982,014 ± 42,201 gallons of water per year at the 90 percent confidence level. The net realization rates are 1.14 ± 0.05 for first-year kWh, 2.55 ± 0.09 for kW, and 0.36 ± 0.02 for first-year gallons of water.

[16] TDPUD purchased large quanitities of the following measures at wholesale prices: CFLs, LED holiday lights, low-flow showerheads, low-flow aerators, and low-flow pre-rinse spray valves. These measures were provided to TDPUD customers for free through various customer volunteer events (i.e., Earth Day, Truckee Day, Home Shows, etc.) along with information about rebate programs, energy efficiency education, Energy Star™ products, and free on-site audits.

[17] Ibid.

Table 3.3 Ex Post First-Year Electricity and Water Savings

Energy Efficiency Measure	Units Installed	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (gal)	Net-to-Gross Ratio	Net Ex Post Program Savings (kWh/y)	Net Ex Post Program Savings (kW)	Net Ex Post Program Savings (gal)
Residential Lighting Rebate	1,282	59.50	0.04		0.80	61,023	42.05	
Commercial Lighting Rebate	978	262	0.05		0.96	245,955	46.50	
Appliance Rebate Program	294	145.8	0.02		0.80	34,284	4.65	
Electric Water Heater Rebate	4	44.5	0.01		1.00	178	0.02	
Ground Source Heat Pumps	0				1.00	0	0.00	
Building Envelope & Duct Testing	42	60.48	0.11		0.89	2,261	4.27	
Thermally-efficient Windows	0				0.96	0	0.00	
Refrigerator & Freezer Recycling	50	1,625.0	0.37		0.84	68,250	15.33	
Low/Mod. Income Energy Assistance	60	1,421	0.55		1.00	85,278	32.80	
Community Outreach & Schools	661	139	0.04	129.7	1.00	91,960	27.90	85,733
Green Partners – Retail	1418	171.7	0.05		0.96	233,733	70.70	
Green Partners – Restaurant	897	175.0	0.07		0.96	150,696	57.41	
Green Partners – Hospitality	3,585	110.6	0.04		0.96	380,804	148.76	
Million CFLs	55,308	59.5	0.04		0.90	2,961,743	2040.87	
LED Holiday Lights	1450	89.0	0.16		0.91	117,486	207.48	
Low Flow Pre-Rinse Spray Valves	16	152.3	0.02	18,668	1.00	2,436	0.34	298,681
2.0 GPM Showerheads	400	48.8	0.01	1,494	1.00	19,520	5.84	597,600
Total	66,445					4,455,607	2,705	982,014
90% Confidence Interval						199,957	96	42,201

The lifecycle electricity and gas savings are summarized in **Table 3.4**. The net ex-ante lifecycle savings are 34,272,223 kWh and 20,075,136 gallons of water. The net ex-post lifecycle savings are 36,792,306 ± 1,651,151 kWh and 7,898,070 ± 339,411 gallons of water. The net lifecycle realization rates are 1.07 ± 0.05 for kWh and 0.39 ± 0.02 gallons of water.

Table 3.4 Lifecycle Electricity and Water Savings

Energy Efficiency Measure	Ex Ante Effective Useful Life (EUL)	Net Ex-Ante Lifecycle Program Savings (kWh)	Net Ex-Ante Lifecycle Program Savings (gal)	Ex Post Effective Useful Life (EUL)	Net Ex-Post Lifecycle Program Savings (kWh)	Net Ex-Post Lifecycle Program Savings (gal)	Net Lifecycle Realization Rate (kWh)	Net Lifecycle Realization Rate (gal)
Residential Lighting Rebate	6.72	285,573		7.27	443,639		1.55	
Commercial Lighting Rebate	14	5,376,000		15.19	3,736,502		0.70	
Appliance Rebate Program	15	636,936		15	514,260		0.81	
Electric Water Heater Rebate	15	54,984		15	2,670		0.05	
Ground Source Heat Pumps	25	155,040		25			0.00	
Building Envelope & Duct Testing	15	23,964		15	33,909		1.41	
Thermally-efficient Windows	25	3,268,580		25				
Refrigerator & Freezer Recycling	6	387,533		6	409,500		1.06	
Low/Mod. Income Energy Assistance	15	2,160,000		15	1,279,170		0.59	
Community Outreach & Schools	6.72	537,600	2,075,136	5	459,800	428,665	0.86	0.21
Green Partners – Retail	6.72	28,557		4	934,931			
Green Partners – Restaurant	6.72	28,557		4	602,784		21.11	
Green Partners – Hospitality	6.72	328,409		2	761,608		2.32	
Million CFLs	6.72	19,039,158		7.27	21,531,875		1.13	
LED Holiday Lights	20	1,625,600		50	5,874,278			
Low Flow Pre-Rinse Spray Valves	5	49,332	6,048,000	5	12,180	1,493,405	0.25	0.25
2.0 GPM Showerheads	10	286,400	11,952,000	10	195,200	5,976,000	0.68	0.50
Total		34,272,223	20,075,136		36,792,306	7,898,070	1.07	0.39
90% Confidence Interval					1,651,151	339,411	0.05	0.02

The required energy impact reporting for 2008 programs is provided in **Table 3.5**.

Table 3.5 Required Energy Impact Reporting for 2008 Program

Program ID:		TDPUD Conservation Programs					
Program Name:		All					
Year	Year	Ex-ante Gross Program-Projected Program MWh Savings (1)	Ex-Post Net Evaluation Confirmed Program MWh Savings (2)	Ex-Ante Gross Program-Projected Peak Program MW Savings (1**)	Ex-Post Evaluation Projected Peak MW Savings (2**)	Ex-Ante Gross Program-Projected Program Therm Savings (1)	Ex-Post Net Evaluation Confirmed Program Therm Savings (2)
1	2008	4,888	4,439	1.324	2.705		
2	2009	4,888	4,439	1.317	2.705		
3	2010	4,888	4,058	1.317	2.556		
4	2011	4,888	4,058	1.317	2.556		
5	2012	4,888	3,673	1.317	2.428		
6	2013	4,875	3,579	1.315	2.400		
7	2014	3,740	3,511	0.987	2.384		
8	2015	1,028	1,304	0.190	0.864		
9	2016	1,028	488	0.190	0.302		
10	2017	1,028	488	0.190	0.302		
11	2018	992	485	0.182	0.296		
12	2019	992	485	0.182	0.296		
13	2020	992	485	0.182	0.296		
14	2021	992	485	0.182	0.296		
15	2022	512	485	0.041	0.296		
16	2023	273	164	0.004	0.216		
17	2024	273	117	0.004	0.207		
18	2025	273	117	0.004	0.207		
19	2026	273	117	0.004	0.207		
20	2027	273	117	0.004	0.207		
TOTAL		41,984	33,096				

** Peak MW savings are defined in this evaluation as the weekday peak period Monday through Friday from 2PM to 6PM during the months of May through September.

1. Gross Program-Projected savings are those savings projected by the program before NTG adjustments.
2. Net Evaluation Confirmed savings are those documented via the evaluation and include the evaluation contractor's NTG adjustments.

The TDPUD programs realized 107% greater cost effectiveness than anticipated due to capturing greater savings per measure and greater installations of measures that yield higher savings. The best examples of this winning approach are the Green Partners, Million CFLs, and LED Holiday Lights programs. The Green Partners program realized 371% greater installations than anticipated (i.e., 6361 installed CFLs versus 1,350 anticipated) by establishing community partnerships with retail, restaurant, and hospitality market segments. TDPUD will continue this winning strategy with future programs. The Million CFLs program realized 17% fewer installed CFLs (saving money for other measures), while capturing 11% greater savings than anticipated by replacing higher Wattage incandescent lamps with proper lumen output low Wattage CFLs. The LED Holiday Lights program captured 360% greater savings than anticipated by partnering with the Town of Truckee to replace decorative incandescent outdoor lights with LED lights on historic buildings and trees that operate year round. The Building Envelope & Duct Testing Mitigation program captured 41% greater savings than anticipated with 40% less incentives by using highly skilled local contractors to perform building and duct sealing on very leaky homes (one with electric heat). TDPUD offered successful rebate programs for residential and commercial lighting, water heaters, and Energy Star™ dishwashers, clotheswashers, and refrigerators that generally met or exceeded the ex ante savings goals. As noted above, TDPUD also purchased large quantities of measures at wholesale prices and gave these measures away free to capture significant savings while promoting their other programs. The average measured ex post operating hours for lighting measures were greater than the ex ante assumptions and this provided greater lighting savings. Two programs did not realize any participation: Ground Source Heat Pumps and Thermally-efficient Windows. However, TDPUD retrofitted 60 low/moderate-income senior residences with low-e windows/doors, R49 attic insulation, door sweeps, and pipe insulation to stimulate the local window replacement market. TDPUD provided storage tank rebates for two solar water heating systems, and this study verified the performance of one of these systems to pilot a future TDPUD solar water heating program consistent with AB1470.

3.1.1 Load Impacts for Residential Lighting Rebates

Load impacts for residential lighting rebates are based on field inspections of Energy Star® CFLs and interviews with 75 TDPUD residential customers. The ex ante and ex post unit savings are shown in **Table 3.6**. The ex ante goal for Energy Star® CFL rebates is 1,000 units and the study verified 1,282 measures from the TDPUD rebate applications. The ex ante net-to-gross ratio is 0.8. The ex post NTGR is 0.80 ± 0.03 based on decision maker surveys of 40 participants indicating 20% of participants were free riders (i.e., received rebates for lighting measures they said they would have installed without rebates). The average ex post operating hours are 1,100 ± 65 hours/yr based on participant survey data for 40 customers.[18] The ex ante effective useful lifetime is 6.72 years and the ex post EUL is 7.27 years per year assuming 8,000 lifecycle operational hours. The total ex ante savings are 53,120 first-year kWh and 16 kW and 356,966 lifecycle kWh. The total net ex post savings are 61,023 ± 3,590 first-year kWh, 55.4 ± 2.1 kW, and 443,639 ± 26,099 kWh lifecycle kWh at the 90 percent confidence level. Differences between ex ante and net ex post savings are due to different annual hours of operation and net to gross ratios based on survey responses. The residential lighting rebate program exceeded the CFL installation goal by 28%, first-year kWh savings by 14%, kW savings by 346%, and lifecycle kWh savings by 24%.

Table 3.6 Energy Star® CFLs Ex Ante and Ex Post Savings

Energy Efficiency Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Ex Ante Effective Useful Life (yrs)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Ex Post Effective Useful Life (yrs)
Energy Star® Screw-In CFL	53	0.016	6.72	59.5 ± 3.5	0.054 ± 0.002	7.27

[18] Average hours of operation are 3.01 ± 0.18 hours per day or 1,100 ± 65 hours per year based on 40 TDPUD participant surveys. This compares favorably to operating hours of 1,624 ± 298 hours/yr based on light logger data for 1,173 fixtures at 66 residential sites from a previous EM&V study (see Evaluation, Measurement, and Verification Report for the Moderate Income Comprehensive Attic Insulation Program #1082-04, Study ID: BOE0001.01, Prepared for California Public Utilities Commission, San Francisco, CA, and BO Enterprises, Inc., Los Gatos, CA, Prepared by Robert Mowris & Associates, Olympic Valley, CA, June 12, 2008, Available online: www.calmac.org).

3.1.2 Load Impacts for Commercial Lighting Rebates

Load impacts for commercial lighting rebates are based on field inspections of 1,475 measures at 19 participant sites (census), electric power measurements, and lighting logger measurements of 518 fixtures consistent with IPMVP Option B. Pre- and post-retrofit fixture quantities, hours of operation and savings are shown in **Table 3.7**. The TDPUD assumed gross ex ante savings are 480,000 kWh/yr, 140.8 kW and 6,720,000 lifecycle kWh. Approximately 21 percent of the TDPUD ex ante first-year savings are from an Energy Management System (EMS) installed at site 9. The EMS installed at site 9 is designed to save energy through reducing lighting hours of operation, increasing the summer cooling system setpoint from 70°F to 75°F and increasing the use of natural outdoor cooling through improved economizer control. A detailed audit was performed at site 9 including installation of lighting loggers and billing analyses per IPMVP Option B and D. Based on engineering and billing analyses for site 9, the pre-retrofit energy use is 573,280 kWh per year and the post-retrofit energy use is 469,750 with savings of 103,530 ± 10,353 kWh per year (see **Table 3.8**). The ex ante net-to-gross ratio is 0.80. The ex post NTGR is 0.96 ± 0.01 based on decision maker surveys of 19 participants. The ex ante effective useful lifetime (EUL) is 14 years. The ex post EUL is 15.19 years based on average annual hours of operation of 3,532 ± 587 hours per year and 50,000 lifecycle operational hours before failure. The total net ex post savings are 245,955 ± 23,595 first-year kWh, 46.5 ± 4.6 kW, and 3,736,502 ± 358,408 kWh lifecycle kWh at the 90 percent confidence level. The ex post savings are approximately 49% less than gross ex ante for kWh savings and 67% less for kW savings. Differences between ex ante and net ex post savings are due to fewer measures installed than anticipated. The ex ante goal was 6,400 measures and the study verified 1,475 measures installed or 77% fewer measures than anticipated.

Table 3.7 Load Impacts for Commercial Lighting Rebate Program

Site	Pre-retrofit	Pre-Qty	Pre-Hrs	Pre W/Fix	Pre kW	Pre kWh/y	Post-Retrofit	Post-Qty	Post-Hrs	Post W/Fix	Post kW	Post kWh/y	KW Savings	kWh Savings
1	60W Incand.	34	4676	60	2.040	9,539.0	16W PAR30	34	4676	15	0.510	2,384.8	1.530	7,154.3
3	T12 2x4'	4	5545	96	0.384	2,129.3	T8 2x4'	4	5545	61	0.244	1,353.0	0.140	776.3
3	T12 4x4'	7	5545	189	1.323	7,336.0	T8 4x4'	7	5545	108	0.756	4,192.0	0.567	3,144.0
3	T12 2x3'	7	5545	60	0.420	2,328.9	T8 2x3'	7	5545	50	0.350	1,940.8	0.070	388.2
3	75W Incand.	27	5545	75	2.025	11,228.6	13W CFL	27	5545	13	0.351	1,946.3	1.674	9,282.3
3	60W Incand.	20	5545	60	1.200	6,654.0	13W CFL	20	5545	13	0.260	1,441.7	0.940	5,212.3
3	75W Incand.	5	5545	75	0.375	2,079.4	13W CFL	5	5545	13	0.065	360.4	0.310	1,719.0
4	100W PAR38	16	2600	100	1.600	4,160.0	23W CFL R38	16	2600	23	0.368	956.8	1.232	3,203.2
4	100W PAR38	13	2600	100	1.300	3,380.0	23W CFL R38	13	2600	23	0.299	777.4	1.001	2,602.6
4	60W Incand.	3	2600	60	0.180	468.0	13W CFL	3	2600	13	0.039	101.4	0.141	366.6
4	T12 2x4'	8	2600	96	0.768	1,996.8	T8 2x4'	8	2600	61	0.488	1,268.8	0.280	728.0
4	60W Incand.	4	2600	60	0.240	624.0	13W CFL	4	2600	13	0.052	135.2	0.188	488.8
4	T12 1x3'	7	2600	42	0.294	764.4	T8 1x3'	7	2600	26	0.182	473.2	0.112	291.2
4	T12 1x2'	2	2600	28	0.056	145.6	T8 1x2"	2	2600	17	0.034	88.4	0.022	57.2
4	T12 2x4'	1	2600	96	0.096	249.6	T8 2x4'	1	2600	61	0.061	158.6	0.035	91.0
4	T12 U-Tube	12	2600	43	0.516	1,341.6	T8 U-Tube	12	2600	32	0.384	998.4	0.132	343.2
4	60W Incand.	2	2600	60	0.120	312.0	13W CFL	2	2600	13	0.026	67.6	0.094	244.4
4	60W Incand.	4	2600	60	0.240	624.0	13W CFL	4	2600	13	0.052	135.2	0.188	488.8
4	T12 U-Tube	8	2600	43	0.344	894.4	T8 U-Tube	8	2600	32	0.256	665.6	0.088	228.8
4	T12 2x4'	2	2600	96	0.192	499.2	T8 2x4'	2	2600	61	0.122	317.2	0.070	182.0
4	60W Incand.	2	2600	60	0.120	312.0	13W CFL	2	2600	13	0.026	67.6	0.094	244.4
4	T12 U-Tube	24	2600	43	1.032	2,683.2	T8 U-Tube	24	2600	32	0.768	1,996.8	0.264	686.4
4	60W Incand.	4	2600	60	0.240	624.0	13W CFL	4	2600	13	0.052	135.2	0.188	488.8
4	T12 U-Tube	28	2600	43	1.204	3,130.4	T8 U-Tube	28	2600	32	0.896	2,329.6	0.308	800.8
4	60W Incand.	1	2600	60	0.060	156.0	13W CFL	1	2600	13	0.013	33.8	0.047	122.2
4	60W Incand.	1	2600	60	0.060	156.0	13W CFL	1	2600	13	0.013	33.8	0.047	122.2
4	T12 2x4'	1	2600	96	0.096	249.6	T8 2x4'	1	2600	61	0.061	158.6	0.035	91.0
4	T12 4x4'	1	2600	189	0.189	491.4	T8 4x4'	1	2600	108	0.108	280.8	0.081	210.6
4	60W Incand.	6	2600	60	0.360	936.0	13W CFL	6	2600	13	0.078	202.8	0.282	733.2
4	60W Incand.	9	2600	60	0.540	1,404.0	13W CFL	9	2600	13	0.117	304.2	0.423	1,099.8
4	T12 1x3'	9	2600	42	0.378	982.8	T8 1x3"	9	2600	26	0.234	608.4	0.144	374.4
4	400W HPS	8	2600	400	3.200	8,320.0	105W CFL	8	2600	105	0.840	2,184.0	2.360	6,136.0

Table 3.7 Load Impacts for Commercial Lighting Rebate Program

Site	Pre-retrofit	Pre-Qty	Pre-Hrs	Pre W/Fix	Pre kW	Pre kWh/y	Post-Retrofit	Post-Qty	Post-Hrs	Post W/Fix	Post kW	Post kWh/y	KW Savings	kWh Savings
4	T12 4x4'	6	2600	189	1.134	2,948.4	T5 4x4"	6	2600	108	0.648	1,684.8	0.486	1,263.6
4	T12 4x4'	8	2600	189	1.512	3,931.2	T8 4x4'	8	2600	108	0.864	2,246.4	0.648	1,684.8
4	T12 4x4'	3	2600	189	0.567	1,474.2	T8 4x4'	3	2600	108	0.324	842.4	0.243	631.8
4	T12 2x4'	2	2600	96	0.192	499.2	T8 2x4'	2	2600	61	0.122	317.2	0.070	182.0
4	T12 2x4'	5	2600	96	0.480	1,248.0	T8 2x4'	5	2600	61	0.305	793.0	0.175	455.0
4	T12 4x4'	1	2600	189	0.189	491.4	T8 4x4'	1	2600	108	0.108	280.8	0.081	210.6
4	T12 2x4'	8	2600	96	0.768	1,996.8	T8 2x4'	8	2600	61	0.488	1,268.8	0.280	728.0
4	100W Incand.	1	2600	100	0.100	260.0	23W CFL	1	2600	23	0.023	59.8	0.077	200.2
4	T12 3x4'	1	2600	116	0.116	301.6	T8 3x4'	1	2600	90	0.090	234.0	0.026	67.6
4	T12 3x4'	3	2600	116	0.348	904.8	T8 3x4'	3	2600	90	0.270	702.0	0.078	202.8
4	T12 4x4'	1	2600	189	0.189	491.4	T8 4x4'	1	2600	108	0.108	280.8	0.081	210.6
4	T12 4x4'	4	2600	189	0.756	1,965.6	T5 4x4"	4	2600	108	0.432	1,123.2	0.324	842.4
4	T12 4x4'	4	2600	189	0.756	1,965.6	T5 4x4"	4	2600	108	0.432	1,123.2	0.324	842.4
4	T12 4x4'	4	2600	189	0.756	1,965.6	T8 4x4'	4	2600	108	0.432	1,123.2	0.324	842.4
4	400W HPS	8	1095	400	3.200	3,504.0	105W CFL	8	1095	105	0.840	919.8	2.360	2,584.2
4	T12 4x4'	24	1095	189	4.536	4,966.9	T5 4x4'	24	1095	108	2.592	2,838.2	1.944	2,128.7
4	400W HPS	9	2600	400	3.600	9,360.0	105W CFL	9	2600	105	0.945	2,457.0	2.655	6,903.0
4	T12 2x4'	5	2600	96	0.480	1,248.0	T5 2x4'	5	2600	61	0.305	793.0	0.175	455.0
4	T12 2x4'	10	2600	96	0.960	2,496.0	T5 2x4'	10	2600	61	0.610	1,586.0	0.350	910.0
4	T12 2x4'	5	2600	96	0.480	1,248.0	T5 2x4'	5	2600	61	0.305	793.0	0.175	455.0
4	100W PAR38	20	2600	96	1.920	4,992.0	26W CFL	20	2600	61	1.220	3,172.0	0.700	1,820.0
4	T12 3x4'	7	2600	143	1.001	2,602.6	T8 3x4'	7	2600	90	0.630	1,638.0	0.371	964.6
4	T12 3x4'	4	2600	143	0.572	1,487.2	T8 3x4'	4	2600	90	0.360	936.0	0.212	551.2
4	T12 3x4'	4	2600	143	0.572	1,487.2	T8 3x4'	4	2600	90	0.360	936.0	0.212	551.2
4	T12 3x4'	1	2600	143	0.143	371.8	T8 3x4'	1	2600	90	0.090	234.0	0.053	137.8
4	T12 3x4'	1	2600	143	0.143	371.8	T8 3x4'	1	2600	90	0.090	234.0	0.053	137.8
4	T12 2x4'	1	2600	96	0.096	249.6	T8 2x4'	1	2600	61	0.061	158.6	0.035	91.0
4	T12 3x4'	6	2600	143	0.858	2,230.8	T8 3x4'	6	2600	90	0.540	1,404.0	0.318	826.8
4	T12 3x4'	9	2600	143	1.287	3,346.2	T8 3x4'	9	2600	90	0.810	2,106.0	0.477	1,240.2
4	60W Incand.	3	2600	60	0.180	468.0	13W CFL	3	2600	13	0.039	101.4	0.141	366.6
4	T12 2x4'	1	2600	96	0.096	249.6	T8 2x4'	1	2600	61	0.061	158.6	0.035	91.0
4	T12 2x4'	2	2600	96	0.192	499.2	T8 2x4'	2	2600	21	0.042	109.2	0.150	390.0
4	T12 2x4'	2	2600	96	0.192	499.2	T8 2x4'	2	2600	61	0.122	317.2	0.070	182.0
4	T12 3x4'	18	2600	143	2.574	6,692.4	T8 3x4'	18	2600	90	1.620	4,212.0	0.954	2,480.4
4	100W Incand.	1	4380	100	0.100	438.0	23W CFL	1	4380	23	0.023	100.7	0.077	337.3
4	100W Incand.	1	8760	100	0.100	876.0	23W CFL	1	8760	23	0.023	201.5	0.077	674.5
5	T12 2x8'	8	1577	128	1.024	1,614.8	T8 2x8'	8	1577	111	0.888	1,400.4	0.136	214.5
5	T12 2x4'	1	1577	96	0.096	151.4	T8 2x4'	1	1577	61	0.061	96.2	0.035	55.2
5	T12 3x4'	4	1577	143	0.572	902.0	T8 3x4'	4	1577	90	0.360	567.7	0.212	334.3
5	T12 4x4'	3	1577	189	0.567	894.2	T8 4x4'	3	1577	108	0.324	510.9	0.243	383.2
5	100W Incand.	4	1577	100	0.400	630.8	23W CFL	4	1577	23	0.092	145.1	0.308	485.7
6	T12 2x8'	41	3048	128	5.248	15,995.9	T8 2x8'	41	3048	111	4.551	13,871.4	0.697	2,124.5
6	T12 2x4'	2	3048	96	0.192	585.2	T8 2x4'	2	3048	61	0.122	371.9	0.070	213.4
6	T12 1x8'	4	3048	75	0.300	914.4	T8 1x8'	4	3048	61	0.244	743.7	0.056	170.7
7	T12 3x4'	9	1910	143	1.287	2,458.2	T8 3x4'	9	1910	90	0.810	1,547.1	0.477	911.1
7	T12 4x4'	2	1910	189	0.378	722.0	T8 4x4'	2	1910	108	0.216	412.6	0.162	309.4
8	60W PAR20	65	3872	60	3.900	15,100.8	16W CFL R20	65	3872	16	1.040	4,026.9	2.860	11,073.9
8	60W PAR20	4	8760	60	0.240	2,102.4	16W CFL R20	4	8760	16	0.064	560.6	0.176	1,541.8
10	T12 2x4'	2	8760	96	0.192	1,681.9	T8 2x4'	2	8760	61	0.122	1,068.7	0.070	613.2
10	T12 2x4'	3	8760	96	0.288	2,522.9	T8 2x4'	3	8760	61	0.183	1,603.1	0.105	919.8
10	T12 2x4'	13	8760	96	1.248	10,932.5	T8 2x4'	13	8760	61	0.793	6,946.7	0.455	3,985.8
10	T12 2x4'	6	8760	96	0.576	5,045.8	T8 2x4'	6	8760	61	0.366	3,206.2	0.210	1,839.6
10	T12 2x4'	16	8760	96	1.536	13,455.4	T8 2x4'	16	8760	61	0.976	8,549.8	0.560	4,905.6
10	T12 2x4'	3	8760	96	0.288	2,522.9	T8 2x4'	3	8760	61	0.183	1,603.1	0.105	919.8
10	T12 2x4'	5	8760	96	0.480	4,204.8	T8 2x4'	5	8760	61	0.305	2,671.8	0.175	1,533.0
11	T12 2x4'	24	3250	96	2.304	7,488.0	T8 2x4'	24	3250	61	1.464	4,758.0	0.840	2,730.0
11	T12 4x4'	28	3250	128	3.584	11,648.0	T8 4x4'	28	3250	122	3.416	11,102.0	0.168	546.0
12	HID 400	8	1875	465	3.720	6,975.0	T8 6x4'	8	1875	172	1.376	2,580.0	2.344	4,395.0
12	T12 2x4'	2	1875	96	0.192	360.0	T8 2x4'	2	1875	61	0.122	228.8	0.070	131.3
13	T12 2x4'	2	2242	96	0.192	430.5	T8 2x4'	2	2242	61	0.122	273.5	0.070	156.9
13	T12 4x4'	3	2242	189	0.567	1,271.2	T8 4x4'	3	2242	108	0.324	726.4	0.243	544.8
13	T12 2x8'	2	2242	128	0.256	574.0	T8 2x8'	2	2242	111	0.222	497.7	0.034	76.2
13	T12 4x4'	1	2242	189	0.189	423.7	T8 4x4'	1	2242	108	0.108	242.1	0.081	181.6
13	T12 4x4'	3	2242	189	0.567	1,271.2	T8 4x4'	3	2242	108	0.324	726.4	0.243	544.8
13	T12 4x4'	3	2242	189	0.567	1,271.2	T8 4x4'	3	2242	108	0.324	726.4	0.243	544.8
14	T12 2x4'	15	1717	96	1.440	2,472.5	T8 2x4'	15	1717	61	0.915	1,571.1	0.525	901.4
15	T12 6x4'	9	3276	284	2.556	8,373.5	T8 6x4'	9	3276	192	1.728	5,660.9	0.828	2,712.5
15	T12 2x4'	10	3276	96	0.960	3,145.0	T8 2x4'	10	3276	61	0.610	1,998.4	0.350	1,146.6
15	T12 6x4'	20	3276	284	5.680	18,607.7	T8 6x4'	20	3276	192	3.840	12,579.8	1.840	6,027.8

Table 3.7 Load Impacts for Commercial Lighting Rebate Program

Site	Pre-retrofit	Pre-Qty	Pre-Hrs	Pre W/Fix	Pre kW	Pre kWh/y	Post-Retrofit	Post-Qty	Post-Hrs	Post W/Fix	Post kW	Post kWh/y	KW Savings	kWh Savings
15	T12 2x4'	10	3276	96	0.960	3,145.0	T8 2x4'	10	3276	61	0.610	1,998.4	0.350	1,146.6
15	T12 4x4'	6	3276	189	1.134	3,715.0	T8 4x4'	6	3276	108	0.648	2,122.8	0.486	1,592.1
15	T12 2x4'	14	3276	96	1.344	4,402.9	T8 2x4'	14	3276	61	0.854	2,797.7	0.490	1,605.2
15	T12 2x4'	10	3276	96	0.960	3,145.0	T8 2x4'	10	3276	61	0.610	1,998.4	0.350	1,146.6
15	T12 4x4'	5	3276	189	0.945	3,095.8	T8 4x4'	5	3276	108	0.540	1,769.0	0.405	1,326.8
15	T12 2x4'	13	3276	96	1.248	4,088.4	T8 2x4'	13	3276	61	0.793	2,597.9	0.455	1,490.6
15	T12 2x4'	8	3276	96	0.768	2,516.0	T8 2x4'	8	3276	61	0.488	1,598.7	0.280	917.3
15	T12 2x4'	2	3276	96	0.192	629.0	T8 2x4'	2	3276	61	0.122	399.7	0.070	229.3
16	T12 4x4'	17	2488	189	3.213	7,993.9	T8 4x4'	17	2488	108	1.836	4,568.0	1.377	3,426.0
22	T12 2x4'	31	4564	96	2.976	13,582.5	T8 2x4'	31	4564	61	1.891	8,630.5	1.085	4,951.9
22	T12 4x4'	1	4564	189	0.189	862.6	T8 4x4'	1	4564	108	0.108	492.9	0.081	369.7
22	T12 4x4'	1	4564	189	0.189	862.6	T8 4x4'	1	4564	108	0.108	492.9	0.081	369.7
22	T12 1x5'	2	4564	63	0.126	575.1	T8 1x5'	2	4564	43	0.086	392.5	0.040	182.6
Total	Lighting	918			108.2	341,691.9		918			59.7	189,018.9	48.4	152,673
Ave.													0.053	166.3
9	No EMS	557				573,280	EMS	557				469,750	0.000	103,530
Total		1,475						1,475					48.4	256,203

Table 3.8 Gross Ex Post Energy Savings for Site 9

Month	Actual TDPUD Billing Data 2007 (kWh)	Actual TDPUD Billing Data 2008 (kWh)	Actual TDPUD Billing Data 2009 (kWh)	Estimated Billing Data 2009 (kWh)	Gross Ex Post Savings (kWh)	Notes
Jan	43,520		36,960	36,960	6,560	
Feb	44,480			36,548	7,932	Extrapolated
Mar	40,800			32,224	8,576	Extrapolated
Apr	35,840			28,990	6,850	Extrapolated
May	45,120			38,058	7,062	Extrapolated
Jun	52,000			39,520	12,480	Extrapolated
Jul	56,960	44,640		44,640	12,320	Assumed 2008
Aug	55,200	46,560		46,560	8,640	Assumed 2008
Sep	57,760	46,720		46,720	11,040	Assumed 2008
Oct	55,520	43,850		43,850	11,670	Assumed 2008
Nov	45,760	37,600		37,600	8,160	Assumed 2008
Dec	40,320	38,080		38,080	2,240	Assumed 2008
Total	573,280			469,750	103,530 ± 10,350	Estimate +/-10%

3.1.3 Load Impacts for Appliance Rebates

Load impacts for appliance rebates are based on annual energy use for models listed in the Energy Star® database based on telephone surveys conducted with 22 participants consistent with IPMVP Option A (verification of stipulated savings). Baseline and post-retrofit fixture quantities, hours of operation and savings are shown in **Table 3.9**.[19] The TDPUD gross ex ante savings are 53,078 kWh/yr, 22.2 kW and 796,176 lifecycle kWh based on 300 units. The ex ante net-to-gross ratio is 0.80. The ex post NTGR is 0.80 ± 0.03 based on the California Appliance Replacement Program and decision maker surveys of 22 participants. The ex ante and ex post effective useful lifetime (EUL) is 15 years.

[19] The Energy Star® baseline is the US federal standard for energy consumption in kWh/year required of a refrigerator, dishwasher, or clotheswasher established on July 1, 2001. The National Appliance Energy Conservation Act (NAECA) dictates the minimum standards for energy consumption in refrigerators and freezers. The standard varies depending on the size and configuration of the product.

The total net ex post savings are 34,284 ± 2334 first-year kWh, 4.7 ± 0.24 kW, and 514,260 ± 35,010 kWh lifecycle kWh at the 90 percent confidence level for 294 units. The ex post savings are approximately 35% less than ex ante for kWh savings and 79% less for kW savings. Differences between ex ante and net ex post savings are due to fewer measures installed than anticipated and lower savings per measure.

Table 3.9 Gross Ex Post Energy Savings for Appliances

#	Appliance Type	Manufacturer	NAECA Baseline Annual Energy Use (kWh/yr)	Energy Star Annual Energy Use (kWh/yr)	Gross Ex Post Peak Demand Savings (kW)	Gross Ex Post Energy Savings (kWh/yr)
1	Refrigerator	Kenmore	595	476	0.015	119
2	Refrigerator	Kenmore	461	367	0.012	94
3	Refrigerator	Whirlpool	443	354	0.012	89
4	Refrigerator	Maytag	574	456	0.015	118
5	Refrigerator	Samsung	694	540	0.020	154
6	Refrigerator	Maytag	574	456	0.015	118
7	Refrigerator	Kitchenaide	706	565	0.018	141
8	Refrigerator	GE	569	455	0.015	114
9	Refrigerator	Kitchenaide	777	621	0.020	156
10	Refrigerator	Whirlpool	676	539	0.018	137
11	Refrigerator	Kenmore	672	537	0.018	135
	Average				0.016 ± 0.001	125 ± 10.9
12	Clothes Washer	GE	482	313	0.024	169
13	Dishwasher	GE	481	330	0.021	151
14	Clothes Washer	Frigidaire	356	203	0.022	153
15	Clothes Washer	Kenmore	451	278	0.024	173
16	Dishwasher	Maytag	472	334	0.019	138
17	Dishwasher	UNK	469	306	0.023	163
18	Clothes Washer	Whirlpool	300	169	0.018	131
19	Dishwasher	Maytag	472	334	0.019	138
20	Dishwasher	Kitchenaide	530	334	0.028	196
21	Dishwasher	GE	482	313	0.024	169
22	Dishwasher	Miele	473	320	0.022	153
	Average				0.022 ± 0.001	158 ± 9.4

3.1.4 Load Impacts for Electric Water Heater Rebates

Load impacts for electric water heater rebates are based on the difference between average annual energy use for standard efficiency water heaters and energy efficient water heaters consistent with IPMVP Option A (verification of stipulated savings). The 2004 Federal Standards are 0.9304 EF for 30 gallon units, 0.9172 EF for 40 gallon units, and 0.904 EF for 50 gallon units.[20] Average electric water heater unit energy consumption (UEC) is 3,354 kWh/year.[21] The incremental costs for electric resistance storage water heaters for a 0.02 EF improvement are approximately $70 to $80 per unit. The program provided incentives for three 40-gallon units and one 65-gallon unit. The TDPUD ex ante unit savings are 143.2 kWh/yr and 0.025 kW. The baseline energy factor, energy use, and gross

[20] See Energy Conservation Program for Consumer Products: Energy Conservation Standards for Water Heaters. Final Rule. Federal Register, v. 66, #11, pp. 4473 – 4497, http://www.eere.energy.gov/buildings/appliance_standards/residential/pdfs/water_heater_fr.pdf.

[21] *California Statewide Residential Appliance Saturation Survey.* Study 300-00-004, prepared for California Energy Commission, prepared by KEMA-XENERGY Inc. Oakland, California, June 2004.

energy savings are shown in **Table 3.10**.[22] The TDPUD electric water heater program gross ex ante savings are 4,582 kWh/yr, 0.8 kW and 68,736 lifecycle kWh based on 40 efficient electric water heaters. The ex ante net-to-gross ratio is 0.80, and the ex post NTGR is 1.0 based participant decision maker surveys. The ex ante and ex post effective useful lifetime (EUL) is 15 years. The total net ex post savings are 178 ± 17.8 first-year kWh, 0.024 ± 0.003 kW, and 2,670 ± 267 kWh lifecycle kWh at the 90 percent confidence level. The ex post savings are approximately 96% less than ex ante savings. Differences between ex ante and net ex post savings are primarily due to 90% fewer installed measures than anticipated (i.e., 4 instead of 40) and lower savings per unit.

Table 3.10 Gross Ex Post Energy Savings for Electric Water Heater Rebates

#	Water Heater Storage Volume	NAECA Baseline Energy Factor	NAECA Baseline Annual Energy Use (kWh/yr)	Efficient Electric Water Heater Annual Energy Use (kWh/yr)	Gross Peak Demand Savings (kW)	Gross Energy Savings (kWh/yr)
1	40 gallon	0.9172	3,218	3,174	0.006	44
2	40 gallon	0.9172	3,218	3,174	0.006	44
3	50 gallon	0.9054	3,265	3,220	0.006	45
4	50 gallon	0.9054	3,265	3,220	0.006	45
	Total				0.024 ± 0.003	178 ± 17.8

3.1.5 Load Impacts for Ground Source Heat Pump Rebates

No ground source heat pump rebate applications were received by TDPUD. Therefore, there are no load impacts for ground source heat pumps.

3.1.6 Load Impacts for Building Envelope & Duct Testing

Load impacts for building envelope and duct testing are based on field inspections of measures at 3 participant sites (census), engineering analysis and billing data consistent with IPMVP Option B and D. The program provided 42 rebates for testing and mitigation in 2008 with a total of 4 duct mitigations and 4 building mitigations. Field measurements for three participant sites and gross ex post energy savings are shown in **Table 3.11**.[23] Three of the sites received duct mitigation with average duct leakage reduction of 38.9%. Two sites received building mitigation with an average reduction of 0.41 air changes per hour (ACH). The TDPUD building envelope and duct testing program ex ante savings are 1,997 kWh/yr, 4 kW and 29,952 lifecycle kWh based on 40 homes receiving a combination of building envelope and/or duct testing and mitigation. The ex ante net-to-gross ratio is 0.80, and the ex post NTGR is 0.89 based on the California Residential Contractor Program. The ex ante and ex post effective useful lifetime (EUL) is 15 years. The savings for three sites are extrapolated to 4 duct

[22] Ibid.

[23] Site 1 is heated with electricity and natural gas. Sites 2 and 3 are heated with natural gas. At sites 1 and 2, the duct mitigation savings represent 90% of the total savings. Energy savings vary depending on the severity of the pre-existing duct and building enevelop leakage, occupancy, heating schedule, and vintage of home (i.e., heating system efficiency, building insulation, window type, orientation, thermal mass, etc).

mitigation sites and 4 building mitigation sites. The total net ex post savings are 2,259 ± 226 first-year kWh, 3.9 ± 0.4 kW, and 33,892 ± 3,389 kWh lifecycle kWh at the 90 percent confidence level. The ex post kWh savings are approximately 13% greater than ex ante savings and the peak demand savings are comparable to ex ante. Differences between ex ante and net ex post savings are due to fewer installed measures than anticipated.

Table 3.11 Gross Ex Post Energy Savings for Building Envelope & Duct Testing

#	Pre-Mitigation Duct Test (%)	Post-Mitigation Duct Test (%)	Duct Mitigation Leakage Reduction (%)	Pre-Mitigation Blower Door Test (ACH)	Post-Mitigation Blower Door Test (ACH)	Building Mitigation Leakage Reduction (ACH)	Gross Peak Demand Savings (kW)	Gross Energy Savings (kWh/yr)	Gross Energy Savings (Therm/yr)
1	82.6%	33.0%	49.6%	0.81	0.32	0.49	3.21	1,644	201
2	69.0%	16.1%	52.9%	0.84	0.52	0.32	0.36	209	294
3	30.0%	15.8%	14.2%	NA	NA	NA	0.09	51	54
Ave.	60.5%	21.6%	38.9%	0.82	0.42	0.41	1.2 ± 0.24	635 ± 140	183 ± 40

3.1.7 Load Impacts for Thermally Efficient Windows

No thermally efficient window rebate applications were received by TDPUD. Therefore, there are no load impacts for thermally efficient windows.

3.1.8 Load Impacts for Refrigerator & Freezer Recycling

Load impacts for refrigerator recycling are based on electric power measurements of 107 units (weighted 85% refrigerators and 15% freezers) consistent with IPMVP Option B. The gross ex post savings are based on in-situ 15-minute true RMS power measurements of 91 refrigerators and 16 freezers. Each unit included in the random sample was measured for several days in order to obtain 15-minute average kW measurements during the 2 PM to 6 PM time frame. The peak kW for each unit is taken as the maximum kW that occurs during the 2 PM to 6 PM weekday time frame from the 15-minute data. Daily kWh measurements were extrapolated to develop average M&V full-year unit energy consumption (UEC) values. Metering results for 91 recycled refrigerators and 16 recycled freezers are shown in **Table 3.12**.[24] Statistical analysis of the refrigerator and freezer data is shown in **Table 3.13**. The average gross ex post full-year unit energy consumption for 91 refrigerators and 16 freezers is 1,682 kWh/yr ± 122 kWh/yr and 0.362 kW ± 0.02 kW at the 90 percent confidence level. The mean refrigerator savings are 1,625 kWh/yr ± 134 kWh/yr and 0.365 kW ± 0.03 kW at the 90 percent confidence level. The mean freezer savings are 2,009 kWh/yr ± 241 kWh/yr and 0.348 kW ± 0.06 kW at the 90 percent confidence level. The TDPUD refrigerator & freezer recycling program ex ante savings are 80,736 kWh/yr, 17.4 kW and 484,416 lifecycle kWh based on 75 units. The ex ante net-to-gross ratio is 0.80, and the ex post NTGR is 0.84 ± 0.09 based on 11 participant decision maker surveys. The ex ante and ex post effective useful lifetime (EUL) is 6 years. The total net ex post

[24] *Measurement and Verification Report for NCPA SB5X Refrigerator Recycling Programs,* prepared for Northern California Power Agency, Roseville, CA, prepared by Robert Mowris & Associates, Olympic Valley, CA 2005. Available online: www.calmac.org.

savings are 70,644 ± 5,124 first-year kWh, 15.2 ± 0.84 kW, and 423,864 ± 30,744 kWh lifecycle kWh at the 90 percent confidence level based on 50 recycled refrigerators. The ex post kWh savings are approximately 12.5% less than ex ante savings. Differences between ex ante and net ex post savings are primarily due to fewer installed measures than anticipated (i.e., 50 versus 75 assumed by TDPUD).

Table 3.12 Summary of Field Metering Data for 91 Refrigerators and 16 Freezers

#	*kWh/yr*	*kW*	Make	Model	Size	Style	Defrost	Age
1	1,143	0.268	Frigidaire	FRD-16BI	22	BFTR	FF	1978
2	1,814	0.404	Sears	2537603712	20	SBS	FF	1974
3	2,928	0.628	Montgomery Ward	HMG289606A	28	SBS	FF	1976
4	1,069	0.372	Frigidaire	FPE-19V3JWO	19.1	SBS	FF	1979
5	1,755	0.500	Hotpoint	CSX22BC	21.7	SBS	FF	1979
6	1,803	0.404	Amana	SR119B-L	19	SBS	FF	1979
7	2,578	0.936	GE	TFF24DMB	24	SBS	FF	1979
8	1,512	0.376	JCPenny	86706224	21.8	SBS	FF	1979
9	1,762	0.513	Kenmore	106.8602	n/a	SBS	FF	1980
10	2,086	0.400	Kenmore	8611460	19.1	SBS	FF	1980
11	1,907	0.296	MagicChef	RC24CACAI	25	SBS	FF	1980
12	2,323	0.424	Signature	HMG227303H	22	SBS	FF	1980
13	3,252	0.772	GE	TFF24RVD	23.5	SBS	FF	1980
14	1,358	0.472	GE	TFFADWP	22	SBS	FF	1981
15	4,359	0.532	GE	TFG24RVD	25	SBS	FF	1981
16	855	0.168	Hotpoint	CSF20EBC	19.6	SBS	FF	1982
17	2,422	0.448	GE	TFF24RCM	23.5	SBS	FF	1982
18	1,831	0.782	Kenmore	106.8620680	22	SBS	FF	1983
19	1,893	0.480	Amana	SR25N-AG	25	SBS	FF	1985
20	721	0.160	Amana	SX25JL	25	SBS	FF	1985
21	2,242	0.424	Kenmore	106.8620G82	22.2	SBS	FF	1985
22	1,914	0.340	Whirlpool	FD25DQXVDO2	25	SBS	FF	1986
23	1,310	0.496	Hotpoint	CSX24DHR	23.5	SBS	FF	1986
24	1,088	0.280	Whirlpool	FD25SMXLU10	25	SBS	FF	1988
25	1,736	0.268	Amana	SBI20MW	21	SBS	FF	1989
26	1,255	0.344	Frigidaire		20.3	SBS	FF	1990
27	1,167	0.220	Hotpoint	CS622GLL	22	SBS	FF	1990
28	1,506	0.284	GE	TRF22RKD	22	SBS	FF	1990
29	1,840	0.424	Amana	SR250-L	25	SBS	FF	1990
30	2,245	0.292	GE	TFX22PLK	22	SBS	FF	1990
31	1,143	0.348	Kenmore	363.9505	24	SBS	FF	1990
32	1,603	0.326	Whirlpool	ED19AK	19	SBS	FF	1990
33	2,246	0.284	Norse	CDNS24V9A	24	SBS	FF	1991
34	2,585	0.498	GE	TFX27FHC	27	SBS	FF	1991
35	1,255	0.284	Hotpoint	CSX22DLB	21.6	SBS	FF	1992
36	2,097	0.592	GE	TFX27FJB	26.7	SBS	FF	1993
37	2,558	0.580	Whirlpool	EHD252SMRI	24.9	SBS	FF	1993
38	1,495	0.308	KitchenAid	KSAB22QABL	22	SBS	FF	1993
39	2,846	0.460	GE	TFF22RSD	22.2	SBS	FF	1994
40	1,492	0.371	Montgomery Ward		22	SBS	FF	
41	4,737	0.614	Whirlpool	ELD251MMDR1	25	SBS	FF	
42	2,800	0.416	White-Westinghse	RS2298801	23	SBS	FF	
43	1,879	0.504	Sears	1066676601	16	TFBR	FF	1968
44	3,006	0.429	GE	TBF-21RVD	21	TFBR	M	1977
45	1,648	0.272	Kelvinator	TDK160FNW7	18	TFBR	FF	1978
46	953	0.296	Whirlpool	EET202MKNRO	19.6	TFBR	FF	1981
47	2,521	0.297	Montgomery Ward	HNG1942-4	19	TFBR	FF	1982
48	1,115	0.296	J.C. Penny	867.0121.4210	21	TFBR	FF	1982
49	1,720	0.207	Kenmore	106.874	19.2	TFBR	FF	1983
50	1,031	0.280	Westinghouse	RT187ACW1	14	TFBR	FF	1983
51	1,069	0.556	Whirlpool	ET22MK1LN11	22	TFBR	FF	1983
52	1,910	0.392	Montgomery Ward	HMG1452	14	TFBR	FF	1983
53	781	0.367	Magic Chef	RB17GA-3A	17	TFBR	FF	1983

Table 3.12 Summary of Field Metering Data for 91 Refrigerators and 16 Freezers

#	*kWh/yr*	*kW*	Make	Model	Size	Style	Defrost	Age
54	1,599	0.364	GE	TBF17DBB1	17	TFBR	FF	1983
55	1,679	0.404	Amana	D75597	20	TFBR	FF	1984
56	1,388	0.252	Kenmore	7689360	19.2	TFBR	FF	1985
57	1,818	0.396	Whirlpool	EPT14IELO	14	TFBR	FF	1986
58	3,749	0.571	Frigidaire	FPCT-205TS	21	TFBR	FF	1986
59	1,243	0.305	Kenmore	E63052543	18	TFBR	FF	1987
60	822	0.332	GE	TBX21ZKC	21	TFBR	FF	1987
61	1,157	0.242	Whirlpool	EHT141AKNRO	14	TFBR	FF	1987
62	1,385	0.398	Kenmore	106.8688	18	TFBR	FF	1988
63	977	0.292	Kenmore	1068739580	18	TFBR	FF	1988
64	513	0.120	Kenmore	8637710	17	TFBR	FF	1989
65	1,642	0.388	Whirlpool	EET151JTWLO	15	TFBR	FF	1989
66	1,349	0.156	Sanyo	SR1520N	15	TFBR	FF	1989
67	1,562	0.399	GE	TBX20AZHB	20	TFBR	FF	1990
68	838	0.368	Hotpoint	CTX18G	18.2	TFBR	FF	1991
69	691	0.184	Amana	TC20HL	19.7	TFBR	FF	1991
70	542	0.136	Whirlpool	ET14JKXMNL5	14.1	TFBR	FF	1991
71	884	0.236	Kenmore	106.9701	20	TFBR	FF	1991
72	387	0.156	Whirlpool	ET22DKSXWOO	21.7	TFBR	FF	1992
73	793	0.264	Whirlpool	ET22PKXWN10	19	TFBR	FF	1992
74	1,488	0.396	GE	TBX20ZJB	20	TFBR	FF	1992
75	1,825	0.236	Whirlpool	ET18CKXMNRO	18	TFBR	FF	1993
76	790	0.241	Amana	TXI21A3W	17	TFBR	FF	1993
77	993	0.209	Kenmore	363.9662	20	TFBR	FF	1993
78	1,240	0.146	Amana	TX18Q2W	23	TFBR	FF	1994
79	946	0.202	Frigidaire	MRT18GRGWO	18	TFBR	FF	1998
80	1,760	0.503	Whirlpool	ED1171NKGR2	17	TFBR	FF	2001
81	1,041	0.319	Gibson	RT19F3WMGC	19	TFBR	FF	
82	1,046	0.535	MagicChef	RB19EA-1A	19	TFBR	FF	
83	1,166	0.254	Kenmore	E11822410	20	TFBR	FF	
84	1,054	0.202	GE	FB14SCB	18	TFBR	FF	
85	1,773	0.436	Hotpoint	CTF15CC	18	TFBR	FF	
86	1,512	0.432	Whirlpool	EET202MKG	19.6	TFBR	FF	
87	663	0.394	Kenmore	106.9729	18	TFBR	FF	
88	1,156	0.378	Admiral	HMG191247	18.6	TFBR	FF	
89	1,116	0.229	Frigidaire		15	TFBR	M	
90	1,256	0.222	Norge	NNT196G2A	19	TFBR	FF	
91	1,838	0.231	GE	TB14SLO	19	TFBR	M	
92	1,262	0.340	Sears	198713640	24	CF	M	1974
93	2,585	0.650	Marquette	1965-68		UF	M	1965
94	1,751	0.336	Frigidaire	UFD-156W	27	UF	M	1968
95	3,153	0.440	Sears	106724240	19	UF	FF	1976
96	1,618	0.328	Signature	FFT464000H	18	UF	M	1978
97	1,775	0.228	Frigidaire	UF-160	16	UF	FF	1980
98	1,907	0.244	GE	CA276YCW	21	UF	M	1982
99	1,857	0.280	GE	CA276YCW	21	UF	M	1982
100	2,278	0.294	Continental	SF199	19	UF	M	1982
101	2,938	0.345	Kenmore	7577283130	27	UF	M	1982
102	1,289	0.246	Montgomery Ward	FFT-4969	19	UF	M	
103	1,751	0.205	Gibson	FV21M1DHFA	21	UF	M	
104	2,516	0.312	Frigidaire	UF-211	21	UF	M	
105	1,531	0.686	Montgomery Ward	FFT464007B	16	UF	M	
106	2,515	0.364	Kenmore	7577293130	27	UF	M	
107	1,411	0.268	Kelvinator	HCM253K-1	25	UF	M	
Mean	1,682	0.362			20.5			
Std. Dev.	771	0.146						
90% Confid	122	0.02						
Cv	0.46	0.40						

Table 3.13 Statistical Results for Refrigerator and Freezer Metering Data

Description	M&V Gross Savings kWh/yr	M&V Gross Savings kW
Refrigerator Average	**1,625**	**0.365**
Refrigerator STDEV	778	0.148
90% Confidence Interval	134	0.03
Freezers Average	**2,009**	**0.348**
Freezers STDEV	585	0.138
90% Confidence Interval	241	0.06
Total Refrigerators and Freezers Average	**1,682**	**0.362**
STDEV	771	0.146
90% Confidence Interval	122	0.023

3.1.9 Load Impacts for Low/Moderate Income Energy Assistance

Load impacts low/moderate income energy assistance are based on field inspections of the Senior Center site (census), engineering analysis and billing data analysis consistent with IPMVP Option B and C. Pre- and post-retrofit billing data and gross ex post savings are shown in **Table 3.14**. The TDPUD gross ex ante savings are 180,000 kWh/yr, 10 kW and 2,700,000 lifecycle kWh. The measures installed at the Senior Center site include low-emissivity windows and doors, R49 attic insulation (from R11), water heater pipe insulation, door sweeps, and CFLs. A detailed audit was performed at site 9 including installation of lighting loggers and billing analyses per IPMVP Option B and D. Based on engineering and billing analyses for the site, the pre-retrofit energy use is 601,245 kWh per year and the estimated post-retrofit energy use is 518,660 with savings of 85,278 ± 8,528 kWh per year.[25] The ex ante net-to-gross ratio is 0.80, and the ex post NTGR is 1.0. The ex ante and ex post effective useful lifetime (EUL) is 15 years. The total net ex post savings are 85,278 ± 8,528 first-year kWh per year, 32.8 ± 3.3 kW and 1,279,174 ± 127,920 lifecycle kWh at the 90 percent confidence level.[26] The ex post kWh savings are approximately 56% less than ex ante savings and the ex post kW savings are 228% greater than ex ante kW savings. Differences are due to ex post savings based on billing data.

Table 3.14 Gross Ex Post Energy Savings – Senior Center Site

Month	Actual TDPUD Billing Data 2007 (kWh)	Actual TDPUD Billing Data 2008 (kWh)	Actual TDPUD Billing Data 2009 (kWh)	Estimated Billing Data 2009 (kWh)	Gross Ex Post Savings (kWh)	Notes
Jan	77,375		69,816	69,816	7,559	Assumed 2009
Feb	80,327			69,799	10,528	Extrapolated
Mar	63,175			49,051	14,124	Extrapolated
Apr	54,527			48,034	6,493	Extrapolated
May	43,562			33,008	10,554	Extrapolated
Jun	34,785			33,106	1,679	Extrapolated
Jul	27,509			26,821	688	Extrapolated
Aug	25,825			25,179	646	Extrapolated
Sep	29,873	28,545		28,545	1,328	Assumed 2008
Oct	43,450	31,401		32,612	10,838	Adjusted 2008
Nov	53,385	45,432		47,185	6,200	Adjusted 2008
Dec	67,452	50,849		52,811	14,641	Adjusted 2008
Total	601,245			515,967	85,278 ± 8,528	Estimate +/-10%

[25] Estimated billing data for 2009 is based on actual 2009 or 2008 data and extrapolated data based on engineering analysis and weather data.

[26] The kW savings are based on electric heating savings assuming 1,100 heating degree days and 50% diversity factor.

3.1.10 Load Impacts for Community Outreach & Schools

The community outreach and schools program consists of two elements: 1) CFLs given to community and non-profit organizations, and 2) school-based energy education (i.e., LivingWise™) kits provided to public school teachers to educate middle school students about energy and water efficiency. The LivingWise™ kit includes the following measures: CFL, 2.0 gpm showerhead, 2.0 gpm kitchen aerator, electroluminescent night light, air filter alarm, home energy audit form, and energy cost/water quiz calculator. Load impacts for the CFLs are based on field inspections of 211 measures at 4 participant sites and light logger measurements of 10 fixtures consistent with IPMVP Option B. The TDPUD gross ex ante savings are 100,000 kWh/yr, 3.2 kW, 308,800 first-year gallons of water, 672,000 lifecycle kWh and 3,088,000 lifecycle gallons of water. Load impacts for the school-based energy education kits are based on telephone surveys and analysis of 18 of the 200 LivingWise kits consistent with IPMVP Option A and B. Pre- and post-retrofit fixture quantities, hours of operation and savings for the CFL measures are shown in **Table 3.15**. The ex ante net-to-gross ratio is 0.80, and the ex post NTGR is 1.0 based on participant surveys. The ex ante effective useful lifetime (EUL) is 6.72 years, and the ex post EUL is 5 years. The CFL annual hours of operation are 3,094 ± 492 hours per year. Based on 461 CFLs installed, the net ex post savings for CFLs are 68,145 ± 10,826 first-year kWh, 23.6 ± 3.71 kW, and 340,725 ± 54,130 kWh lifecycle kWh at the 90 percent confidence level. The embedded energy of water pumping and treatment is valued at 0.008157374 kWh per gallon based on total 2007 electricity usage for water pumping and water treatment or 19,202,459 kWh per year and total water sales of 2.354 billion gallons.[27] The net ex post savings for the 200 LivingWise kits are 23,815 ± 4,050 first-year kWh, 4.26 ± 0.7 kW, 144,075 ± 20,250 kWh lifecycle kWh, 85,733 ± 14,597 first-year gallons, and 428,665 ± 72,985 lifecycle gallons of water at the 90 percent confidence level as shown in **Table 3.16**.[28] The total net ex post savings for community outreach and schools are 91,960 ± 14,876 first-year kWh, 27.9 ± 4.42 kW, 459,800 ± 74,380 kWh lifecycle kWh, 85,733 ± 14,597 first-year gallons, and 428,665 ± 72,985 lifecycle gallons of water at the 90 percent confidence level. The ex post savings are approximately 8% less than ex ante for kWh savings and 8.7 times higher for kW savings with additional water savings (not assumed in the ex ante estimates). Differences between ex ante and net ex post savings are due to a lower number of installations for the LivingWise™ kits. Only 11% of children installed the efficient showerhead and 26% installed the aerators due to already having comparable showerheads and aerators installed or unwillingness to install the LivingWise™ showerheads and aerators. Approximately 44% installed the filter alarm, 72% installed the kitchen aerator, and 89% installed the electroluminescent night light.

Table 3.15 Load Impacts for Community Outreach & Schools – CFLs

Site	Pre-retrofit	Pre-Qty	Pre-Hrs	Pre W/Fix	Pre kW	Pre kWh/y	Post-Retrofit CFL	Post-Qty	Post-Hrs	Post W/Fix	Post kW	Post kWh/y	KW Savings	kWh Savings
23	75W PAR30	4	3864	100	0.400	1,545.6	14W PAR30	4	3864	14	0.056	216.4	0.344	1,329.2
23	75W PAR30	2	3864	100	0.200	772.8	14W PAR30	2	3864	14	0.028	108.2	0.172	664.6
23	75W PAR30	8	3864	100	0.800	3,091.2	14W PAR30	8	3864	14	0.112	432.8	0.688	2,658.4
23	75W PAR30	4	3864	100	0.400	1,545.6	14W PAR30	4	3864	14	0.056	216.4	0.344	1,329.2
25	60W PAR20	10	3650	60	0.600	2,190.0	14W PAR20	10	3650	14	0.140	511.0	0.460	1,679.0

[27] The TDPUD 2007 water pumping usage is 11,329,894 kWh per year and water treatment energy is 7,872,565 kWh.

[28] Electricity savings for water savings assume 0.0048008 kWh/gallon based on 2.36 billion gallons of water used by TDPUD in 2007 and 11,329,894 kWh/year used by TDPUD in 2007 to deliver water. This does not include the approximately 6,429,726 kWh/year used by TTSA for waste water treatment.

Table 3.15 Load Impacts for Community Outreach & Schools – CFLs

Site	Pre-retrofit	Pre-Qty	Pre-Hrs	Pre W/Fix	Pre kW	Pre kWh/y	Post-Retrofit CFL	Post-Qty	Post-Hrs	Post W/Fix	Post kW	Post kWh/y	KW Savings	kWh Savings
25	60W Incand.	7	3650	60	0.420	1,533.0	14W CFL	7	3650	14	0.098	357.7	0.322	1,175.3
25	60W Incand.	24	5475	60	1.440	7,884.0	14W CFL	24	5475	14	0.336	1,839.6	1.104	6,044.4
25	60W Incand.	14	5475	60	0.840	4,599.0	13W CFL	14	5475	13	0.182	996.5	0.658	3,602.6
25	60W Incand.	4	1825	60	0.240	438.0	13W CFL	4	1825	13	0.052	94.9	0.188	343.1
25	60W PAR20	30	1825	60	1.800	3,285.0	14W PAR20	30	1825	14	0.420	766.5	1.380	2,518.5
25	60W Incand.	11	500	60	0.660	330.0	13W CFL	11	500	13	0.143	71.5	0.517	258.5
25	60W Incand.	6	3650	60	0.360	1,314.0	14W CFL	6	3650	14	0.084	306.6	0.276	1,007.4
25	40W Incand.	7	3650	40	0.280	1,022.0	7W CFL	7	3650	7	0.049	178.9	0.231	843.2
25	60W Incand.	14	4380	60	0.840	3,679.2	13W CFL	14	4380	13	0.182	797.2	0.658	2,882.0
25	100W PAR38	8	4380	100	0.800	3,504.0	23W PAR38	8	4380	23	0.184	805.9	0.616	2,698.1
36	60W PAR20	3	2558	90	0.270	690.7	13W CFL	3	2558	13	0.039	99.8	0.231	590.9
36	60W PAR20	1	2558	52	0.052	133.0	13W CFL	1	2558	13	0.013	33.3	0.039	99.8
36	60W PAR20	2	2558	60	0.120	307.0	13W CFL	2	2558	13	0.026	66.5	0.094	240.5
36	60W PAR20	3	2558	90	0.270	690.7	13W CFL	3	2558	13	0.039	99.8	0.231	590.9
36	60W PAR20	1	2558	60	0.060	153.5	13W CFL	1	2558	13	0.013	33.3	0.047	120.2
37	60W	39	684	60	2.340	1,600.6	13W CFL	39	684	13	0.507	346.8	1.833	1,253.8
37	100W Colored	9	684	100	0.900	615.6	9W CFL Color	9	684	9	0.081	55.4	0.819	560.2
Total		211						211					11.3	32,490
Ave.													0.053	154.0

Table 3.16 Load Impacts for Community Outreach & Schools – LivingWise™ Kits

Measure	Qty	Gross Ex Post Savings (kW)	Gross Ex Post Savings (kWh)	Gross Ex Post Lifecycle Savings (kWh)	Effective Useful Life (EUL)	Gross Water Savings (gallons)	Gross Water Lifecycle Savings (gallons)	Gross Ex Post Water Savings (kWh)	Gross Ex Post Water Lifecycle Savings (kWh)
CFL	200	1.88	11,762	98,801	8.4				
Limelight	200	0.65	4,038	23,017	5.7				
Showerhead	22	0.56	3,956	39,556	10	26,400	264,000	215	2,154
Aerator	53	0.4	2,827	28,267	10	59,333	593,330	484	4,840
Filter Alarm	200	0.67	533	1,600	3				
Ex Post Total	675	4.16	23,116	191,241	8.3	85,733	857,330	699	6,994

3.1.11 Load Impacts for Green Partners – Retail

Load impacts for the Green Partners – Retail are based on field inspections of 645 measures at 12 participant sites and light logger measurements of 347 fixtures consistent with IPMVP Option B. Based on the assumption that 100 CFLs would be installed, the TDPUD assumed ex ante savings are 5,312 kWh/yr, 1.6 kW and 35,697 lifecycle kWh. Pre- and post-retrofit fixture quantities, hours of operation and savings for the CFL measures are shown in **Table 3.17**. The ex ante net-to-gross ratio is 0.80, and the ex post NTGR is 0.96 based on participant surveys. The ex ante effective useful lifetime (EUL) is 6.72 years and the ex post EUL for Green Partner commercial CFLs is 4 years. The CFL average annual hours of operation are 3,135 ± 303 hours per year. Based on 1,418 CFLs installed, the net ex post savings for CFLs are 233,733 ± 22,591 first-year kWh, 70.8 ± 6.8 kW, and 934,932 ± 90,364 kWh lifecycle kWh at the 90 percent confidence level. The ex post savings are approximately 44 times greater than ex ante savings. Differences between ex ante and net ex post savings are due to 14 times more CFLs installed units than anticipated and 2.1 times greater first-year savings.

Table 3.17 Load Impacts for Green Partners – Retail CFLs

Site	Pre-retrofit	Pre-Qty	Pre-Hrs	Pre W/Fix	Pre kW	Pre kWh/y	Post-Retrofit CFL	Post-Qty	Post-Hrs	Post W/Fix	Post kW	Post kWh/y	KW Savings	kWh Savings
18	40W Incand.	20	4914	40	0.800	3,931.2	9W CFL	20	4914	9	0.180	884.5	0.620	3,046.7
18	40W Incand.	9	4914	40	0.360	1,769.0	9W CFL	9	4914	9	0.081	398.0	0.279	1,371.0
18	60 W Incand.	8	4914	60	0.480	2,358.7	14W CFL	8	4914	14	0.112	550.4	0.368	1,808.4
18	60 W Incand.	26	4914	60	1.560	7,665.8	14W CFL	26	4914	14	0.364	1,788.7	1.196	5,877.1
18	60 W Incand.	80	4914	60	4.800	23,587.2	14W CFL	80	4914	14	1.120	5,503.7	3.680	18,083.5
18	60 W Incand.	8	4914	60	0.480	2,358.7	14W CFL	8	4914	14	0.112	550.4	0.368	1,808.4
18	60 W Incand.	33	4914	60	1.980	9,729.7	14W CFL	33	4914	14	0.462	2,270.3	1.518	7,459.5
18	60 W Incand.	11	260	60	0.660	171.6	14W CFL	11	260	14	0.154	40.0	0.506	131.6
19	40W Incand.	20	1600	40	0.800	1,280.0	9W CFL	20	1600	9	0.180	288.0	0.620	992.0
19	60W Incand.	4	1600	60	0.240	384.0	14W CFL	4	1600	14	0.056	89.6	0.184	294.4
19	60W Incand.	4	1600	60	0.240	384.0	14W CFL	4	1600	14	0.056	89.6	0.184	294.4
19	60W Incand.	76	1600	60	4.560	7,296.0	14W CFL	76	1600	14	1.064	1,702.4	3.496	5,593.6
21	60W PAR30	27	3721	60	1.620	6,028.3	16W PAR30	27	3721	16	0.432	1,607.5	1.188	4,420.5
21	100W PAR38	32	3721	100	3.200	11,907.7	23W PAR38	32	3721	23	0.736	2,738.7	2.464	9,168.5
21	60W PAR30	34	3721	60	2.040	7,591.1	14W PAR30	34	3721	14	0.476	1,771.2	1.564	5,819.6
21	60W PAR30	4	3721	60	0.240	893.1	14W PAR30	4	3721	14	0.056	208.4	0.184	684.7
21	100W Incand.	1	3721	100	0.100	372.1	26W CFL	1	3721	26	0.026	96.7	0.074	275.4
26	60W Incand.	16	2900	60	0.960	2,784.0	13W CFL	16	2900	13	0.208	603.2	0.752	2,180.8
26	60W PAR30	58	2900	60	3.480	10,092.0	14W PAR30	58	2900	14	0.812	2,354.8	2.668	7,737.2
27	100W Incand.	19	3993	100	1.900	7,586.7	23W PAR38	19	3993	23	0.437	1,744.9	1.463	5,841.8
28	50W PAR30	8	4485	100	0.800	3,588.0	14W PAR30	8	4485	14	0.112	502.3	0.688	3,085.7
28	60W Incand.	5	4485	75	0.375	1,681.9	13W CFL	5	4485	13	0.065	291.5	0.310	1,390.4
32	60W PAR20	6	2137	60	0.360	769.3	14W PAR30	6	2137	14	0.084	179.5	0.276	589.8
32	100W PAR38	23	2137	60	1.380	2,949.1	23W PAR38	23	2137	14	0.322	688.1	1.058	2,260.9
33	75W PAR30	19	2654	100	1.900	5,042.6	14W PAR30	19	2654	14	0.266	706.0	1.634	4,336.6
33	100W PAR38	4	3650	100	0.400	1,460.0	23W PAR38	4	3650	23	0.092	335.8	0.308	1,124.2
34	100W PAR38	16	1734	100	1.600	2,774.4	23W PAR38	16	1734	23	0.368	638.1	1.232	2,136.3
34	75W PAR30	6	1734	30	0.180	312.1	14W PAR30	6	1734	14	0.084	145.7	0.096	166.5
35	60W PAR20	17	2830	100	1.700	4,811.0	14W PAR20	17	2830	14	0.238	673.5	1.462	4,137.5
35	60W PAR20	5	2830	100	0.500	1,415.0	14W PAR20	5	2830	14	0.070	198.1	0.430	1,216.9
35	60W PAR20	1	2830	75	0.075	212.3	13W CFL	1	2830	13	0.013	36.8	0.062	175.5
35	60W PAR20	6	2830	75	0.450	1,273.5	13W CFL	6	2830	13	0.078	220.7	0.372	1,052.8
35	60W PAR20	2	2830	75	0.150	424.5	13W CFL	2	2830	13	0.026	73.6	0.124	350.9
35	60W PAR20	2	2830	75	0.150	424.5	13W CFL	2	2830	13	0.026	73.6	0.124	350.9
38	60W PAR30	3	1600	60	0.180	288.0	14W PAR30	3	1600	14	0.042	67.2	0.138	220.8
39	100W PAR38	4	2917	100	0.400	1,166.8	23W PAR38	4	2917	23	0.092	268.4	0.308	898.4
39	60W Incand.	2	2917	60	0.120	350.0	13W CFL	2	2917	13	0.026	75.8	0.094	274.2
39	100W PAR38	3	2917	100	0.300	875.1	23W PAR38	3	2917	23	0.069	201.3	0.231	673.8
39	60W Incand.	12	2917	60	0.720	2,100.2	13W CFL	12	2917	13	0.156	455.1	0.564	1,645.2
39	60W Incand.	8	2917	60	0.480	1,400.2	13W CFL	8	2917	13	0.104	303.4	0.376	1,096.8
39	100W PAR38	3	2917	100	0.300	875.1	23W PAR38	3	2917	23	0.069	201.3	0.231	673.8
Total		645						645					33.5	110,747
Ave.													0.052	171.7

3.1.12 Load Impacts for Green Partners – Restaurant

Load impacts for the Green Partners – Restaurant are based on field inspections of 21 measures at 1 participant sites and light logger measurements of 21 fixtures consistent with IPMVP Option B. The TDPUD assumed ex ante savings are 5,312 kWh/yr, 1.6 kW and 35,697 lifecycle kWh. Pre- and post-retrofit fixture quantities, hours of operation and savings for the CFL measures are shown in **Table 3.18**. The ex ante net-to-gross ratio is 0.80, and the ex post NTGR is 0.96 based on participant surveys. The ex ante effective useful lifetime (EUL) is 6.72 years and the ex post EUL for Green Partner commercial CFLs is 4 years based on average annual hours of operation of 2,603 ± 260 hours per year. The net ex post savings for CFLs are 150,696 ± 25,620 first-year kWh, 59.8 ± 8.5 kW, and 602,784 ± 102,480 kWh lifecycle kWh at the 90 percent confidence level. The ex post savings are approximately 21 times greater than ex ante savings. Differences between ex ante and net ex post savings are due to significantly greater installed units than anticipated (i.e., 6.2 times more CFLs).

Table 3.18 Load Impacts for Green Partners – Restaurant CFLs

Site	Pre-retrofit	Pre-Qty	Pre-Hours	Pre W/Fix	Pre kW	Pre kWh/y	Post-Retrofit CFL	Post-Qty	Post-Hours	Post W/Fix	Post kW	Post kWh/y	KW Savings	kWh Savings
40	60W Incand. PAR30	2	2603	65	0.130	338.4	16W PAR30 Dimmable	2	2603	16	0.032	83.3	0.098	255.1
40	60W Incand. PAR30	11	2603	100	1.100	2,863.3	16W PAR30 Dimmable	11	2603	16	0.176	458.1	0.924	2,405.2
40	60W Incand.	1	2603	60	0.060	156.2	13W CFL	1	2603	13	0.013	33.8	0.047	122.3
40	60W Incand. PAR30	4	2603	65	0.260	676.8	16W PAR30 Dimmable	4	2603	16	0.064	166.6	0.196	510.2
40	60W Incand. PAR30	3	2603	65	0.195	507.6	16W PAR30 Dimmable	3	2603	16	0.048	124.9	0.147	382.6
Total		21						21					1.4	3,675
Ave.													0.067	175.0

3.1.13 Load Impacts for Green Partners – Hospitality

Load impacts for the Green Partners – Hosptiality are based on field inspections of 1,092 measures at 4 participant sites and light logger measurements of 526 fixtures consistent with IPMVP Option B. The TDPUD assumed ex ante savings are 61,088 kWh/yr, 18.4 kW and 410,511 lifecycle kWh. Pre- and post-retrofit fixture quantities, hours of operation and savings for the CFL measures are shown in **Table 3.19**. The ex ante net-to-gross ratio is 0.80, and the ex post NTGR is 0.96 based on participant surveys. The ex ante effective useful lifetime (EUL) is 6.72 years and the ex post EUL for Green Partner commercial CFLs is 2 years based on average annual hours of operation of 6,015 ± 1,306 hours per year. The net ex post savings for CFLs are 380,801 ± 82,691 first-year kWh, 148.7 ± 32.2 kW, and 761,602 ± 165,382 kWh lifecycle kWh at the 90 percent confidence level. The ex post savings are approximately 6 times greater than ex ante savings. Differences between ex ante and net ex post savings are due to significantly greater installed units than anticipated (i.e., 3.1 times more CFLs).

Table 3.19 Load Impacts for Green Partners – Hospitality CFLs

Site	Pre-retrofit	Pre-Qty	Pre-Hrs	Pre W/Fix	Pre kW	Pre kWh/y	Post-Retrofit CFL	Post-Qty	Post-Hrs	Post W/Fix	Post kW	Post kWh/y	KW Savings	kWh Savings
20	65W Incand.	240	1898	60	14.400	27,331.2	CFL 13W	240	1898	13	3.120	5,921.8	11.280	21,409.4
20	40W Globe	280	1898	40	11.200	21,257.6	9W Globe	280	1898	9	2.520	4,783.0	8.680	16,474.6
24	65W PAR30	5	8760	65	0.325	2,847.0	14W PAR30	5	8760	14	0.070	613.2	0.255	2,233.8
24	100W Incand.	5	8760	100	0.500	4,380.0	23W CFL	5	8760	23	0.115	1,007.4	0.385	3,372.6
24	100W Incand.	11	8760	100	1.100	9,636.0	23W CFL	11	8760	23	0.253	2,216.3	0.847	7,419.7
24	60W Incand.	1	8760	75	0.075	657.0	13W CFL	1	8760	13	0.013	113.9	0.062	543.1
24	65W PAR30	45	2449	50	2.250	5,510.3	14W PAR30	45	2449	14	0.630	1,542.9	1.620	3,967.4
24	60W Incand.	5	2449	50	0.250	612.3	13W CFL	5	2449	13	0.065	159.2	0.185	453.1
24	100W Incand.	5	8760	100	0.500	4,380.0	23W CFL	5	8760	23	0.115	1,007.4	0.385	3,372.6
24	100W PAR38	1	8760	50	0.050	438.0	23W PAR38	1	8760	23	0.023	201.5	0.027	236.5
24	60W Incand.	200	1898	60	12.000	22,776.0	13W CFL	200	1898	13	2.600	4,934.8	9.400	17,841.2
29	65W Incand.	44	1898	65	2.860	5,428.3	13W CFL	44	1898	13	0.572	1,085.7	2.288	4,342.6
29	65W Incand.	2	8760	65	0.130	1,138.8	13W CFL	2	8760	13	0.026	227.8	0.104	911.0
30	65W Incand.	20	1898	60	1.200	2,277.6	13W CFL	20	1898	13	0.260	493.5	0.940	1,784.1
30	65W Incand.	6	1898	60	0.360	683.3	13W CFL	6	1898	13	0.078	148.0	0.282	535.2
30	65W Incand.	24	8760	60	1.440	12,614.4	13W CFL	24	8760	13	0.312	2,733.1	1.128	9,881.3
30	65W Incand.	18	8760	60	1.080	9,460.8	13W CFL	18	8760	13	0.234	2,049.8	0.846	7,411.0
30	65W Incand.	8	8760	60	0.480	4,204.8	13W CFL	8	8760	13	0.104	911.0	0.376	3,293.8
30	65W Incand.	172	1898	60	10.320	19,587.4	13W CFL	172	1898	13	2.236	4,243.9	8.084	15,343.4
Total		1,092						1,092					47.2	120,827
Ave.													0.043	110.6

3.1.14 Load Impacts for Million CFLs

Load impacts for Million CFLs are based on field inspections of Energy Star® CFLs and interviews with TDPUD residential customers. The ex ante and ex post unit savings are shown in **Table 3.20**.

The ex ante goal for Energy Star® CFL rebates is 66,670 units and the study verified 55,308 measures from the TDPUD purchase orders. The ex ante net-to-gross ratio is 1.0 (TDPUD assumed zero free riders). The ex post NTGR is 0.90 ± 0.04 based on findings from 40 participant surveys. The average ex post operating hours are 1,100 ± 65 hours/yr based on participant survey data for 40 customers.[29] The ex ante effective useful lifetime is 6.72 years and the ex post EUL is 7.27 years per year assuming 8,000 lifecycle operational hours. The total net ex ante savings are 3,541,510 first-year kWh and 1066.7 kW and 23,798,950 lifecycle kWh for 66,670 units. The total net ex post savings are 2,961,743 ± 174,220 first-year kWh, 2,688 ± 99.6 kW, and 21,531,875 ± 1,266,581 kWh lifecycle kWh at the 90 percent confidence level. The ex post savings are approximately 16% less than ex ante savings. Differences between ex ante and net ex post savings are due to 17% fewer installed units than anticipated.

Table 3.20 Load Impacts for Million CFLs

Energy Efficiency Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Ex Ante Effective Useful Life (yrs)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Ex Post Effective Useful Life (yrs)
Energy Star® Screw-In CFL	53	0.016	6.72	59.5 ± 3.5	0.054 ± 0.002	7.27

3.1.15 Load Impacts for LED Holiday Lights

Load impacts for the Light Emitting Diode (LED) holiday lights are based on field inspections of 10 measures at 4 participant sites consistent with IPMVP Option B. The TDPUD assumed ex ante savings are 101,600 kWh/yr, 3.2 kW and 2,032,000 lifecycle kWh. Pre- and post-retrofit fixture quantities, hours of operation and savings for the LED holiday lights are shown in **Table 3.21**. The ex ante net-to-gross ratio is 0.80, and the ex post NTGR is 0.91 ± 0.01 based on participant surveys. The ex ante effective useful lifetime (EUL) is 20 years and the ex post EUL is 50.7 years based on manufacturer data of 30,000 lifecycle operational hours Mean Life Before Failure (MLBF) for LEDs (actual MLBF is 50,000 hours, but at 30,000 hours the light output starts to decline). The net ex post savings for CFLs are 117,486 ± 27,010 first-year kWh, 218.5 ± 50.2 kW, and 5,874,300 ± 1,350,500 kWh lifecycle kWh at the 90 percent confidence level. The ex post savings are approximately 1.3 times greater than ex ante kWh savings, 68 times greater than ex ante kW savings, and 3.3 times greater for lifecycle kWh savings. Differences between ex ante and net ex post savings are due to 2.8 times more installed units than anticipated, greater kW savings (i.e., LED lamps are more efficient than assumed), and longer life than anticipated.

[29] Average hours of operation are 3.01 ± 0.18 hours per day or 1,100 ± 65 hours per year based on 40 TDPUD participant surveys. This compares favorably to operating hours of 1,624 ± 298 hours/yr based on light logger data for 1,173 fixtures at 66 residential sites from a previous EM&V study (see Evaluation, Measurement, and Verification Report for the Moderate Income Comprehensive Attic Insulation Program #1082-04, Study ID: BOE0001.01, Prepared for California Public Utilities Commission, San Francisco, CA, and BO Enterprises, Inc., Los Gatos, CA, Prepared by Robert Mowris & Associates, Olympic Valley, CA, June 12, 2008, Available online: www.calmac.org).

Table 3.21 Load Impacts for LED Holiday Lights

Site	Pre-retrofit	Pre-Qty	Pre-Hrs	Pre W/Fix	Pre kW	Pre kWh/y	Post-Retrofit CFL	Post-Qty	Post-Hrs	Post W/Fix	Post kW	Post kWh/y	KW Savings	kWh Savings
1	Incand. String 100 qty. 0.5W M5 Lamp 20''	750	480	50	37.500	18,000.0	LED Holiday String 60 qty. 0.021W 20'	750	480	2.1	1.575	756.0	35.925	17,244.0
2	Incand. String 40 5W C7 Lamp 20'	250	480	200	50.000	24,000.0	LED Holiday String 60 qty. 0.021W 20'	250	480	2.1	0.525	252.0	49.475	23,748.0
3	Incand. String 330 qty. 0.5W M5 Lamp 66'	340	480	165	56.100	26,928.0	LED Holiday String 200 qty. 0.021W Lamp 66'	340	480	7	2.380	1,142.4	53.720	25,785.6
4	Incand. String 132 qty. 5W C7 Lamp 66'	110	480	660	72.600	34,848.0	LED Holiday String 200 qty. 0.021W Lamp 66'	110	480	7	0.770	369.6	71.830	34,478.4
5	10W Incand. G10 Xmas	640	4,380	10	6.400	28,032.0	LED E27 G10 Bulb	640	4,380	1.9	1.216	5,326.1	5.184	22,705.9
6	10W Incand. G10 Xmas	160	480	10	1.600	768.0	LED E27 G10 Bulb	160	480	1.9	0.304	145.9	1.296	622.1
7	2W Incand. Mini T10	600	4,380	2	1.200	5,256.0	LED Mini T10	600	4,380	0.3	0.180	788.4	1.020	4,467.6
Total		2,850						2,850					218.5	129,052
Ave.													0.077	45.3

3.1.16 Load Impacts for Pre-Rinse Spray Valves

Load impacts for pre-rinse spray valves (PSRV) are evaluated based on field verification inspections of 40 units, measurements of pre- and post-retrofit flow rates, engineering estimates and evaluation studies per IPMVP Option A and B.[30] An evaluation study by Tso and Koeller provides average pre- and post-retrofit flow rates and average daily usage for PSRVs installed at approximately 7,000 restaurants, institutional sites, grocery stores, religious organizations, civic and social organizations, and hotels/motels. The average pre-retrofit flow rate is 2.92 ± 0.02 gpm and the average post-retrofit flow rate is 1.34 ± 0.001 gpm. The average mixed water temperature is 114.1°F. For restaurants, the average usage per day is 0.79 hours for standard PSRVs and 1.02 hours for low-flow PSRVs. For groceries, the average usage per day is 0.11 hours for standard PSRVs and 0.14 hours for low-flow PSRVs. The TDPUD PSRV program gave away 40 low-flow PSRV units with rated flow of 1.6 gpm at 80 pounds per square inch gauge (psig) flowing pressure. These are the same low-flow PSRV units described in the Tso and Koeller study with average in-situ flow rates of 1.34 gpm. The program savings are shown in **Table 3.22**. Embedded energy for water pumping and treatment is valued at 0.008157374 kWh per gallon based on total 2007 electricity usage for water pumping and water treatment or 19,202,459 kWh per year and total water sales of 2.354 billion gallons.[31] The TDPUD program gave away forty 1.6 gpm low-flow PSRV units to 35 restaurants, 1 community center, and 4 schools. The EM&V study visited all of the sites and found 40% of the units installed (i.e., 16 of 40) at restaurants with no other units installed. All restaurants had gas water heaters. The ex ante NTGR is 0.80 and the ex post NTGR is 1.0. The ex ante and ex post EUL is 5 years. The TDPUD ex ante savings are 12,333 first-year kWh, 1.7 kW, and 61,665 lifecycle kWh, 1,512,000 first-year gallons and 7,560,000 lifecycle gallons based on 40 low-flow PSRV units installed at sites with electric water

[30] Tso, B., Koeller, J. 2005. *Pre-Rinse Spray Valve Programs: How Are They Really Doing?* P.O. Box 804127, Chicago, Illinois: Alliance for Water Efficiency. Available online: http://www.allianceforwaterefficiency.org/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=978.

[31] The TDPUD 2007 water pumping usage is 11,329,894 kWh per year and water treatment energy is 7,872,565 kWh.

heaters. The net ex post savings are 2,436 ± 62 first-year kWh, 0.34 ± 0.01 kW, and 12,180 ± 312 kWh lifecycle kWh, 298,681 ± 7602 first-year gallons, and 1,493,455 ± 38,011 lifecycle gallons of water at the 90 percent confidence level based on 16 units installed. The ex post savings are approximately 80% less than ex ante kWh savings due to fewer installed units than anticipated.

Table 3.22 Low-flow Pre-Rinse Spray Valves Ex Ante and Ex Post Program Savings

Measure	Give Away Qty.	Gross Ex-Ante Water (gal/y)	Gross Ex-Ante Savings (kWh/y)	Gross Ex-Ante Savings (kW)	Gross Ex-Ante Lifecycle Savings (kWh)	Ex Post Qty.	Gross Ex-Post Water (gal/y)	Gross Ex Post Savings (kWh/y)	Gross Ex Post Savings (kW)	Gross Ex Post Life Lifecycle Savings (kWh)
Low-Flow PSRV-Restaurant	35	1,323,000	10,792	1.52	53,960	16	298,681	2,436	0.34	12,180
Low-Flow PSRV-Community	1	37,800	308	0.04	1,540	0	0	0	0.00	0
Low-Flow PSRV-Grocery	4	151,200	1,233	0.17	6,165	0	0	0	0.00	0
Total	40	1,512,000	12,333	1.7	61,665	16	298,681 ± 7,659	2,436 ± 62	0.34 ± 0.01	12,180 ± 312

3.1.17 Load Impacts for Efficient Showerheads

Load impacts for efficient showerheads are evaluated using field measurements of pre- and post-retrofit flow rates of 116 units from a previous EM&V study per IPMVP Option A and B.[32] The program gave away efficient showerheads rated at 2.0 gallons per minute (gpm) at 80 pounds per square inch (psi) to replace non-conserving showerheads. Pre- and post-retrofit measurements of flow rates (gpm) and flowing pressure (psi) were made with flow meters as per ASME A112.18.1/CSA B125.1-2005. These measurements were checked using a micro weir. The previous EM&V study found average pre-retrofit showerhead flow rates of 2.8 ± 0.177 gpm at 52.9 ± 3.5 psi flowing pressure and average post-retrofit flow rates of 2.0 ± 0.03 gpm at 65.4 ± 1.3 psi flowing pressure.[33] The ex post savings are based on the average 28.65% reduction in flow rate and the average percentage of usage attributable to showering (i.e., 23% for gas and 26% for electric water heating) multiplied times the baseline water heating Unit Energy Consumption (UEC) of 3,079 kWh per year for electric water heaters and 193 therms per year for gas water heaters (*California Statewide Residential Appliance Saturation Survey*. Study 300-00-004, prepared for California Energy Commission, prepared by KEMA-XENERGY Inc. Oakland, California, June 2004.). The ex ante and ex post unit savings are shown in **Table 3.23**. The program savings are shown in **Table 3.24**. Embedded energy for water pumping and treatment is valued at 0.008157374 kWh per gallon (as noted above). The TDPUD program gave away 1,000 2.0 gpm showerheads. Insufficient time and budget were available to verify how many were installed by TDPUD customers. A similar TDPUD program gave away pre-rinse spray valves and field inspections found 40% were installed. This study assumes that at least 40% of the 2.0 gpm showerheads are installed representing a total of 400 out of 1,000 showerheads given away. This

[32] Evaluation, Measurement, and Verification Report for the Moderate Income Comprehensive Attic Insulation Program #1082-04, Study ID: BOE0001.01, Prepared for California Public Utilities Commission, San Francisco, CA, and BO Enterprises, Inc., Los Gatos, CA, Prepared by Robert Mowris & Associates, Olympic Valley, CA, June 12, 2008, Available online: www.calmac.org).

[33] Ibid.

study further assumes that 20% (80 units) are installed at homes with electric water heaters and 80% (320 units) are installed at homes with gas water heaters. The ex ante NTGR is 0.80 and the ex post NTGR is 1.0. The ex ante and ex post EUL is 10 years. The TDPUD ex ante savings are 35,800 first-year kWh, 7.8 kW, 358,000 lifecycle kWh, 1,494,000 first-year gallons and 14,940,000 lifecycle gallons of water based on 1,000 showerheads being installed in homes with electric water heaters. The net ex post savings are 19,520 ± 1,269 first-year kWh, 5.84 ± 0.45 kW, 195,200 ± 12,693 lifecycle kWh, 597,600 ± 38,860 first-year gallons of water and 5,976,000 ± 388,600 lifecycle gallons of water and at the 90 percent confidence level based on 400 units installed. The ex post savings are approximately 44% less than ex ante kWh savings due to fewer installed units.

Table 3.23 Low-flow Showerheads Ex Ante and Ex Post Unit Savings

Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (gallons)	Gross Ex-Post Unit Water Savings (kWh)	Gross Ex-Post Unit Savings (therm)
2 gpm @ 80 psi Showerhead-Gas DHW			10		0.002	1495 ± 97	12.2 ± 0.5	13 ± 0.8
2 gpm @ 80 psi Showerhead-Elec DHW	179	0.039		183.0 ± 11.9	0.026 ± 0.002	1495 ± 97	12.2 ± 0.5	

Table 3.24 Low-flow Showerheads Ex Ante and Ex Post Program Savings

Measure	Give Away Qty.	Gross Ex-Ante Water (gal/y)	Gross Ex-Ante Savings (kWh/y)	Gross Ex-Ante Savings (kW)	Gross Ex-Ante Lifecycle Savings (kWh)	Ex Post Qty.	Gross Ex-Post Water (gal/y)	Gross Ex Post Savings (kWh/y)	Gross Ex Post Savings (kW)	Gross Ex Post Life Lifecycle Savings (kWh)
2 gpm@80 psi Showerhd-Gas DHW	800	1,195,200	0	0	0	320	478,080	3,904	0.64	36,160
2 gpm@80 psi Showerhd-Elec DHW	200	298,800	35,800	7.8	358,000	80	119,520	15,616	5.2	155,440
Total	1,000	1,494,000	35,800	7.8	358,000	400	597,600 ±38,860	19,520 ±1,269	5.84 ±0.45	195,200 ±12,693

3.2 Verification Inspection Findings

Verification inspections were conducted for the study from December 2008 through February 2009. Results of the on-site verification inspections were used in the impact evaluation to estimate the overall energy savings. Ninety-three (94) on-site inspections were completed (54 more than budgeted). Inspections at each site were conducted for the following measures: T8 and LED commercial lighting fixtures, residential and commercial CFLs, attic insulation, duct sealing, whole house air infiltration reduction, electric and solar water heaters, and Energy Star® appliances. Building infiltration was checked at two sites and duct leakage was checked at 4 sites and all sites passed the inspection. On-site inspections and survey responses were used to evaluate pre- and post-retrofit lighting fixture wattages. A total of 3,388 measures were inspected. Electric power measurements were made on a number of fixtures at different sites as shown in **Table 3.25**.

Table 3.25 Field Measurements of Lighting Fixture Average Power

Description	String	1 lamp W	2 lamp W	3 lamp W	4 lamp W
T12 F40 (4 ft) with magnetic ballast		57	96	143	189
T8 F32 (4 ft) with 4 lamp electronic ballast		41	64	90	108
T8 F32 (4 ft) with 2 lamp electronic ballast		39	61		
T12 F34 (4 ft) with magnetic ballast		43	78	116	154
T8 F32 (4 ft) with 4 lamp electronic ballast		41	64	90	108
T8 F32 (4 ft) with 2 lamp electronic ballast		39	61		
T12 F96 (8 ft) with magnetic ballast		75	128		
T8 F96 (8 ft) with electronic ballast		61	111		
LED Exit Sign		1.5			
LED Exit Sign		0.8			
Incandescent Exit Sign		40			
LED Holiday String (60 qty. 0.021W LED Lamp 20 ft)	2.1				
LED Holiday String (200 qty. 0.021W LED Lamp 66 ft)	7.0				
Incand. Holiday String (100 qty. 0.5W M5 Lamp 20 ft)	50				
Incand. Holiday String (330 qty. 0.5W M5 Lamp 66 ft)	165				
Incand. Holiday String (40 5W C7 Lamp 20 ft)	200				
Incand. Holiday String (132 5W C7 Lamp 66 ft)	660				
Incand. Holiday String (40 7W C9 Lamp 20 ft)	280				
Incand. Holiday String (132 7W C9 Lamp 66 ft)	924				

Light loggers were installed at 30 sites to measure hours of operation. These were left at the sites for a period of up to four weeks. Data loggers at two (2) sites were tampered with by the occupants and the data was lost. Twenty eight (28) data loggers were successfully downloaded to monitor hours of operation on 2,640 fixtures. Lighting hours of operation are based on data from twenty-eight (28) light loggers as shown in **Table 3.26**. The average EM&V ex post hours of operation are 3,533 ± 588 hours per year which compares favorably to the TDPUD ex ante assumption of 3,409 hours per year.

Table 3.26 Light Logger Measurements of Lighting Hours of Operation

Site #	Business Description	Program	Percent On	Hrs/day	Hrs/year
1	Restaurant	T8 - Commercial Lighting	50.6	12.14	4676
2	Retail	T8 - Commercial Lighting	36.9	8.86	3410
3	Restaurant	T8 - Commercial Lighting	63.3	15.19	5545
5	Retail	T8 - Commercial Lighting	18	4.32	1577
6	Retail	T8 - Commercial Lighting	34.8	8.35	3048
7	Office	T8 - Commercial Lighting	21.8	5.23	1910
8	Retail	T8 - Commercial Lighting	44.2	10.61	3872
9	Retail	T8 - Commercial Lighting	68.6	16.46	6009
11	Retail	T8 - Commercial Lighting	37.1	8.90	3250
12	Retail	T8 - Commercial Lighting	21.4	5.14	1875
13	Health	T8 - Commercial Lighting	25.6	6.14	2242
14	Retail	T8 - Commercial Lighting	19.6	4.70	1717
15	Office	T8 - Commercial Lighting	37.4	8.98	3276
16	Office	T8 - Commercial Lighting	28.4	6.82	2488
17	Office	T8 - Commercial Lighting	27.1	6.50	2374
18	Office	CFL - Green Partner	56.1	13.46	4914
22	Retail	T8 - Commercial Lighting	52.1	12.50	4564
24	Hospitality	CFL - Green Partner	100.0	24.00	8760
28	Retail	CFL - Green Partner	51.2	12.29	4485
30	Hospitality	CFL - Green Partner	100.0	24.00	8760
31	Health	CFL - Green Partner	31.2	7.49	2733
32	Retail	CFL - Green Partner	24.4	5.86	2137
33	Retail	CFL - Green Partner	30.3	7.27	2654
34	Retail	CFL - Green Partner	19.8	4.75	1734
35	Retail	CFL - Green Partner	32.3	7.75	2830
36	Retail	CFL - Green Partner	29.2	7.01	2558
39	Restaurant	CFL - Green Partner	33.3	7.99	2917
40	Restaurant	CFL - Green Partner	29.7	7.13	2603
	Average	EM&V Ex Post	40.16	9.64	3533 ± 588
		TDPUD Ex Ante			3409

Survey responses were used to evaluate operating conditions and equipment efficiency before and after TDPUD installed measures. Responses were used to evaluate ex ante assumptions and determine an appropriate ex post savings estimate. On-site verification of the remaining measures along with engineering analysis and existing studies were used to determine appropriate ex post savings estimates for the other measures.

3.3 Participant Survey Results

This study uses participant surveys to estimate the net-to-gross ratios for kWh and kW savings. Participant surveys were completed for 195 participants in the TDPUD programs.

3.3.1 Participant Survey Methodology

Participant surveys were used to evaluate retention (i.e., measures still installed), pre-retrofit Watts, hours of operation, and time-of-use (i.e., turned on from 2-6PM). The participant surveys were also used to evaluate net-to-gross (NTG) ratios for calculating net kW and kWh savings. The NTG ratio is used to estimate the fraction of free riders who would have otherwise implemented lighting improvements in the absence of the program. For most programs, nine participant survey questions were used to assess net-to-gross ratios as shown in **Table 3.27**. The NTG ratio score for each completed participant survey is the average score based on answers to questions 5 through 13. No score is assigned to responses of “don’t know”, “refused to answer,” or “other.”

Table 3.27 Net-to-Gross Ratio Participant Survey Questions and Scoring (CFLs)

#	Question	Answer	Score
1	Are you using the CFLs that you received from the utility program (i.e., are CFLs being retained)?	Yes, No	1=Y, 2 =0
2	What size (i.e., Wattage) bulbs did you replace with the new CFLs?	60W, 75W, 100W	
3	How many hours per day do you use the CFLs?	<3, 4.5, 6, DK	
3a	Are the CFLs turned on from 2-6PM (i.e., peak period)?	Yes, No	1=Y, 2=N
5	Did you understand the value of the program BEFORE or AFTER you installed the efficiency upgrades?	Before	1
		After	0
6	Did you install the lighting efficiency upgrade BEFORE or AFTER you heard about the Rebate Program?	Before	0
		After	1
7	On a scale from 0 to 10, with 0 being no influence at all and 10 being very influential, how much influence did the Utility or Rebate have on your decision to install the efficiency upgrades?	0 to 10	0=0, 10=1
8	If the rebates had not been available, how likely is it you would have done exactly the *same* thing. Please use a scale from 0 to 10, with 0 being not at all likely and 10 being very likely.	0 to 10	0=1, 10=0
9	What role did the Utility Program play in your decision to install the upgrades?	1 = Reminded	0.25
		2 = Speeded Up (i.e., early replacement)	0.5
		3 = Showed Benefits Didn’t Know Before	1
		4 = Clarified Benefits	0.75
		5 = No role	0
10	The Utility Program was nice but it was unnecessary to get the efficiency upgrades installed.	0 to 10	0=1, 10=0
11	The Utility Program was a critical factor in installing the efficiency upgrades.	0 to 10	0=0, 10=1
12	We would not have installed the efficiency upgrades without the Utility Program.	0 to 10	0=0, 10=1
13	If you had not received the [rebate or service] from the Utility, would you have installed upgrades?	Within 6 months	0
		< 1 year	0.125
		1 to 2 years	0.25
		2 to 3 years	0.5
		3 to 4 years	0.75
		4 or more years	1
		Never	1

3.3.2 Participant Survey Methodology for Refrigerator Recycling

For refrigerator recycling, the NTG ratio is calculated using attribution and part use factors. The attribution factor is used to estimate the fraction of free riders who would have otherwise recycled and rendered their refrigerator or freezer inoperable in the absence of the program. The part-use factor is used to estimate the fraction of the year that units would have been operated if they were not picked up and recycled and operation during summer peak electrical demand. The NTG ratios for kWh and kW savings are calculated using attribution and part-use factors as shown in **Equation 1**.[34]

Eq. 1 $NTGR = AF \times PF$

Where,

NTGR = Net-To-Gross Ratio for kWh savings,

AF = Attribution Factor defined as the number of units that would not have been recycled without the program divided by the total number of units recycled through the program,

PF = Part-use Factor for kWh and kW defined as the fraction of the year that units would have been operated if they were not picked up and recycled.

Six participant survey questions are used to assess the attribution factor and free riders as shown in **Table 3.28**. The attribution score is based on the following set of rules.

1. If the answer to question 12 is "kept as spare and used," then the attribution is 1, irrespective of answers to other questions.
2. If the answer to question 16 is "no" (i.e., were not planning to recycle old unit before heard about program), then the attribution is 1 as long as the answer to question 7 is "no."
3. Otherwise if the answer to question 7 is yes, the attribution is 0.58 (i.e., assuming the old unit continues to be used as a spare).[35]
4. If the answer to question 16 is "yes," then attribution is the average score based on answers to questions 12 through 16. The attribution average score cannot exceed 0.58 if the answer to question 7 is yes. No score is assigned to responses of "don't know", "refused to answer," or "other."

Table 3.28 Attribution Factor Participant Survey Questions and Scoring

#	Question	Answer	Score
7	Was purchasing a new refrigerator or freezer the major reason for recycling your old unit?	Yes	0.58
		No	1
12	What would you have done with your old unit if the recycling service had not been available?	Kept and used	1
		Kept unplugged	
		Given away	1
		Recycled	0
		Other pickup	0.5
		Left when moved	0.5
13	The Utility Program was nice but it was unnecessary to get me to permanently remove my old refrigerator(s). (Assign number between 0 and 10 where 0 is complete disagreement and 10 is complete agreement.)	0 to 10	0=1, 10=0
14	We would not have recycled our old refrigerator(s) without the Utility Program.	0 to 10	0=0, 10=1

[34] Conventional net-to-gross ratios reflect what customers would have done in the absence of the program. The study measures net-to-gross ratios for recycled refrigerators using attribution and part-use factors to calculate net kW and kWh impacts since refrigerator energy use is reported for a full year.

[35] Purchasing a new unit and keeping the old unit as a spare is scored as 0.58 (i.e., 1 – 700/1682) based on NAECA standard average new use of 700 kWh/yr and 0.15 kW compared to average old use of 1,682 kWh/yr and 0.362 kW (see *Qualifying List of Energy Star Refrigerators and NAECA Standards for Refrigerators* from 4.9 to 38.9 cubic feet, http://www.energystar.gov/index.cfm?c=refrig.pr_refrigerators).

Table 3.28 Attribution Factor Participant Survey Questions and Scoring

#	Question	Answer	Score
	(Assign number between 0 and 10 where 0 is complete disagreement and 10 is complete agreement.)		
15	If the Program had not been available would you have gotten rid of your refrigerator(s) permanently?	Within 6 months	0
		< 1 year	0.125
		1 to 2 years	0.25
		2 to 3 years	0.5
		3 to 4 years	0.75
		4 or more years	1
		Never	1
16	Were you planning to recycle or dispose of your old refrigerator before you heard about the Program?	Yes	0
		No	1

Two participant questions are used to develop part-use factors as shown in **Table 3.29**.

1. Answers to question 11 are used to estimate the Part-use Factor for kWh defined as the fraction of the year that units would have been operated if they were not picked up and recycled.
2. Answers to question 11a are used to estimate the Part-use Factor for kW defined as the fraction of time that units would have operated in the summer during peak electrical demand periods.

The average score for these questions in the participant sample are multiplied times the average attribution factor to estimate the average net-to-gross ratios for kW and kWh savings.

Table 3.29 Part-use Factor Participant Survey Questions and Scoring

#	Question	Answer	Score
11	If you had not recycled the unit, about how many months during the next year would it have been turned on? (Read List, Enter Months as Fractions, i.e., 9 months = 9/12 = 0.75)	kWh/yr Part-use	0 to 1
11a	If answer to Q.11 is less than one year ask if unit was turned on during the Summer (i.e., May to October).	Summer	1
		Winter	0

3.3.3 Findings of the Participant Surveys

Results of the participant surveys for refrigerator recycling are presented in **Table 3.30**. The net-to-gross ratios vary from 0.80 to 1.0 with a savings weighted average of 0.91 ± 0.3. The participant findings indicate that approximately 9% of customers in Truckee say they “would have installed the energy efficiency measures without the program information and incentives.”

Table 3.30 Findings of Participant Surveys for TDPUD Programs

#	TDPUD Program	Sample Size	Actual Units	Ex Ante Savings kWh/yr	Ex Ante Savings kW	Net-to-Gross Ratio
1a	Residential Lighting Rebate	40	1282	53,120	16	0.80 ± 0.03
1b	Commercial Lighting Rebate	19	978	480,000	140.8	0.96 ± 0.01
1c	Appliance Rebate Program	22	297	53,078	22.2	0.80 ± 0.03
1d	Electric Water Heater Rebate	2	4	4,582	0.8	1.0 ± 0.00
1e	Ground Source Heat Pumps		0	7,752	1.1	NA
1f	Building Envelope & Duct Testing	3	42	1,997	4	0.89 ± 0.22
1g	Thermally-efficient Windows	1	0	163,429	7.6	0.96 ± 0.01
2	Refrigerator & Freezer Recycling	11	50	80,736	17.4	0.84 ± 0.09
3	Low/Moderate Income Energy Assistance	1	60	180,000	10	1.0
4	Community Outreach & Schools	22	661	100,000	3.2	1.0
5	Green Partners – Retail	17	1418	5,312	1.6	0.96 ± 0.01

Table 3.30 Findings of Participant Surveys for TDPUD Programs

#	TDPUD Program	Sample Size	Actual Units	Ex Ante Savings kWh/yr	Ex Ante Savings kW	Net-to-Gross Ratio
6	Green Partners - Restaurant	3	897	5,312	1.6	0.96 ± 0.01
7	Green Partners - Hospitality	3	3585	61,088	18.4	0.96 ± 0.01
10	Million CFLs	40	55,308	3,541,510	1066.7	0.90 ± 0.04
11	LED Holiday Lighting	11	1480	101,600	3.2	0.91 ± 0.05
	Weighted Average	195	66,062	4,839,516	1,315	0.91 ± 0.03

Results of the participant surveys for each program are presented in **Table 3.31**. The average refrigerator recycling attribution factor is 0.86 and the average part-use factor is 0.98. The average net-to-gross ratio for refrigerator recycling is 0.84 ± 0.09 for kWh and kW savings.

Table 3.31 Findings of Participant Surveys for Refrigerator Recycling

Customer	Recycled Refrigerator Volume (c.f.)	Recycled Refrigerator Age (yrs)	Attribution Factor	Part-use Factor kWh/yr	Net-to-Gross Ratio
1	20	UNK	1.00	1.00	1.00
2	14	1980	0.42	1.00	0.42
3	UNK	1993	0.76	1.00	0.76
4	26	1988	1.00	1.00	1.00
5	UNK	1988	1.00	1.00	1.00
6	20	UNK	1.00	1.00	1.00
7	UNK	1998	0.74	0.91	0.67
8	22	1998	0.78	1.00	0.78
9	UNK	1988	1.00	1.00	1.00
10	22	1996	0.90	0.91	0.82
11	22	1996	0.83	1.00	0.83
Total	21	1991	0.86	0.98	0.84 ± 0.09

3.2 Process Evaluation Results

Process evaluation recommendations are based on process surveys conducted in-person with 184 participants and 55 non-participants. The process surveys were used to evaluate participant satisfaction and obtain suggestions to improve the program's services and procedures. Interview questions assessed how the program influenced awareness of linkages between efficiency improvements, bill savings, and increased comfort for customers. Participants were asked why and how they decided to participate in the program. Non-participants were asked why they chose not to participate. Non-contacted customers were asked if they would have participated had they been made aware of the program. The surveys identified reasons why program marketing efforts were not successful with non-participants as well as to identify additional hard-to-reach market barriers. The process survey instruments are provided in Appendix A, B, C, and D.

3.2.1 Participant Survey Results

Participant survey results are summarized to answer the following questions from the EM&V plan.

1. **Are participants satisfied with services or information provided by the program?**

   Participant satisfaction is very high as indicated by the following survey responses.

- Overall Satisfaction with Program – 88 percent satisfaction rating (i.e., average score of 8.8 ± 0.44 out of 10 points).
- Courteous and Professional Staff – 92 percent satisfaction rating (i.e., 9.2 ± 0.35 out of 10 points).
- Increased Understanding of Link between Energy Efficiency, Savings, and Comfort - 70 ± 8 percent, indicating TDPUD energy education efforts are generally doing a good job.

2. Are customers satisfied with measures offered or installed by the program?

Customers were satisfied with measures as indicated by the following ratings.

- 89 percent of customers are still using the measures installed by the program (i.e., 69 out of 78 surveyed customers were still using all installed measures). Three customers reported CFLs that burned out (total of 20 out of 2,169 installed or 0.9%).
- 88 percent of customers were satisfied with measures offered or installed by the program ((i.e., average score of 8.8 ± 0.44 out of 10 points).

3. Are customers satisfied with services or information provided by the program?

Customer satisfaction with the services or information provided by the program is indicated by the following customer ratings.

- 90 ± 8 percent usefulness rating.
- 93 ± 8 percent presentation rating.
- 88 ± 8 percent accuracy rating.
- 70 ± 8 percent rating of program increasing understanding of the linkage between energy efficiency, bill savings, and comfort.
- 100 percent of participants indicated that others would benefit from the program.

4. What are the participant demographics?

- Average conditioned floor area is 4,494 ft^2 ± 2936 ft^2.
- Average number of employees is 15 ± 5.
- 46% owned the business and 53% are tenants.
- 100 percent spoke English well enough to understand and answer the questions.
- Participants had the following primary languages: 100% English.

5. Do participants have any suggestions to improve the program?

56 percent of participants provided comments or suggestions to improve the program.

- 82% offered suggestions of praise such as “Very pleased!” “Do all businesses and homes in town!” “PUD is good to work with. Scott Terrell was great and so was the contractor.” “Good program - hope it encourages others.” “TDPUD was very helpful when he called to inquire and the form and rebate were easy to complete.” “Turnaround was quick – rebate application process was straight forward.”
- 18% said the program would benefit from better advertising.

- 14% wanted “better information about efficient lighting that also looks good aesthetically and provides better quality lighting.” “Provide more information about dimmable CFLs.”
- 12% said they wanted “more information about measures other than lighting to save energy.
- 6% said the “CFLs are not bright enough.” “Five burned out.”
- One customer said “TDPUD's decision to reject rebate application did not consider small refrigerator for A-frame cabin. The purchased unit is more efficient than Energy Star by virtue of its small size.”

6. Did participants share information with friends or neighbors about the benefits of measures offered by the program (i.e., multiplier effects)?

Based on process survey responses, 42 percent of interviewed customers shared program information with 3.8 times as many people. Approximately 11 percent of these people decided to install similar measures or participate in the TDPUD programs. The program helped expand impacts beyond the participant group to a larger group through direct installation and rebates of TDPUD measures. The multiplier effect for the program is estimated at 4.2 percent.[36] Programs that link technologies with educational measures can have multiplier effects as high as 25-30 percent including the sharing of program information to a population that is several times larger than the participant population.

3.2.2 Non-Participant Survey Results

Non-participant process survey results are summarized to in order to answer the following questions from the CPUC-approved EM&V plan.

1. Is there a continuing need for the program?

The following responses indicate a continuing need for the program.

- 82 percent of participants were very satisfied with the program and said they would like the TDPUD to “do all businesses and homes in town!”
- 98 percent of non-participants would have participated if they knew the programs provided rebates, information and free compact fluorescent lamps, showerheads, and pre-rinse spray valves, indicating a continuing need for the program.

2. Why have customers chosen not to participate (i.e., market barriers)?

- 53% didn’t participate due to not knowing about the program (i.e., information costs).
- 13% were renters or did not own the building (i.e., misplaced or split incentive) or were sold non-Energy Star appliances that didn’t qualify for the rebate programs (i.e., performance uncertainty).

[36] Spillover of 4.2 percent is calculated based on 57 people adopting at least one spillover measure based on information shared by a group of 15 participants who adopted 90 measures (i.e., $57 \times (1 \div 90) \div 15 = 0.042$).

3. Do non-participants have any suggestions to improve participation?

All non-participants provided suggestions to improve participation.

- 50% suggested better advertising and information would help. Typical responses include: "Increase advertising and promotion in local newspapers and radio, especially to new homeowners and low income families." "Include advertising with electric bill and on website." "Give free CFLs and rebates to poor families, especially poor families with small children. They need it the most."
- 8% said they wanted "free CFLs delivered to homes."
- 5% said they wanted lists of eligible dishwashers, clotheswashers, and refrigerators available at local appliance stores like Czyz's, Home Depot, Lowes, Sears, etc." "Send checklist of each qualifying appliance to send rebate form in without going to office, or provide online rebate application forms."

4. What are the non-participant hard-to-reach demographics?

Non-participants had the following hard-to-reach demographics.

- 42% of non-participants are owners and 58% are renters.
- Average age is 38 ± 4 years.
- 88% owned the home and 12% are renters.
- Non-participants had the following primary languages: 100% English.
- Average income of non-participants is $50,143 ± $9,080.

The following section provides process evaluation recommendations to improve the program.

3.2.3 Process Evaluation Recommendations

The following process evaluation recommendations are provided as per the EM&V plan regarding what works, what doesn't work, and suggestions to improve the program's services and procedures.

3.2.3.1 General Program Recommendations

The following general program recommendations are provided to improve the program's services, procedures, and cost effectiveness.

1. Implement an internet-tracking system to include the following information for each measure: name, address, phone number, e-mail address, account number, incentives paid, measure description (from pull-down list or entered), date installed, pre-existing measure. The internet-tracking system can be used to motivate customers to learn more about energy efficiency and renewable energy, document and verify all installed measures, educate customers about present and future energy efficiency and renewable energy programs, and obtain feedback from customers regarding current and future program offerings.
2. Do not pay incentives without verifying that the measures are properly installed and operational. One commercial customer received incentives for inefficient T12 lamps.

3. Use a third party measurement and verification service provider to ensure that all measures are properly installed to increase savings, cost effectiveness, and reduce lost opportunities.
4. Educate customers about comparable CFL replacements in terms of lumens. Offer more types of CFLs (i.e., color temperature, reflector, and dimmable, long-life cold-cathode) to increase savings and acceptance.
5. Purchase large quantities of pressure-compensating low-flow 1.5 gpm showerheads, low-flow 0.5 to 1.5 gpm aerators, and low-flow pre-rinse spray valves to save water. Low-flow showerheads and aerators save the equivalent of one CFL in pumping electricity annually and pre-rinse spray valves save the equivalent of 10 CFLs not including water heating energy savings.
6. Provide better advertising to increase participation including internet information, handouts or fliers that tell customers about the program, funding source, and free services.
7. Offer incentives for occupancy sensors for commercial lighting and plug loads and offer rebates for Energy Star® LCD high-definition television (HDTV) sets.
8. Work with Southwest Gas and propane companies to offer joint programs that save electricity and natural gas (or propane). Offer incentives for Energy Star® solar water heating program or Energy Star® instantaneous water heaters to eliminate electric water heaters (which use 4.5 kW per unit which can be partially avoided with solar electric panels costing approximately $45,000).
9. Based on findings from this and other studies, most residential and commercial customers do not have sufficient capital or motivation to invest in improving the energy efficiency of their homes and businesses. To overcome these market barriers, TDPUD should be continued and expanded to save energy, water, and peak demand and reduce carbon dioxide emissions,
10. Participants provided the following suggestions to improve the program.
    - "Provide better advertising to increase participation including handouts or fliers telling customers about the program and free services."
    - "Provide more information about efficient lighting that also looks good aesthetically and provides better quality lighting."
    - "Provide more information about dimmable CFLs."
    - "Provide lists of eligible dishwashers, clotheswashers, and refrigerators available at local appliance stores like Czyz's, Home Depot, Lowes, Sears, etc." "Send checklist of each qualifying appliance to send rebate form in without going to office, or provide online rebate application forms."

3.2.3.2 Recommendations for Database

Implement an online electronic program tracking system to include the following information for each measure: name, address, phone number, e-mail address, account number, incentives paid, measure description (from pull-down list or entered), date installed, pre-existing measure. This would allow for easier analysis and reporting for EM&V purposes.

3.2.3.3 Recommendations for Building Envelope and Duct Sealing

Provide building envelope and duct leakage reduction target values for customers and provide stickers and information about benefits such as reduced energy bills, improved comfort, and better indoor air quality. Require pre and post leakage measurements to qualify for incentives and minimum thresholds for leakage reduction of at least 15% for building envelope and duct sealing.

3.2.3.4 Recommendations for CFLs and CFL Torchieres

Some customers complained that the CFLs were not bright enough. Check to make sure CFLs provide enough light for customers and improve acceptance and retention. If not, install higher Wattage CFLs. Purchase CFL torchieres in volume quantities to give away for free to replace high-Wattage incandescent torchieres. Explain the benefits of operating dimmable CFL and CFL torchieres at lower light levels to save energy.

3.2.3.5 Recommendations for Low-Flow Showerheads

Some customers complained that installed low-flow showerheads didn't provide enough flow. Check to make sure low-flow showerheads provide enough flow for customers. Provide pressure-compensating low-flow showerheads that deliver greater force at lower flow rates to improve customer satisfaction. Offer customers at least three different types of pressure-compensating low-flow showerheads (including hand-held) to maintain consistent flow rates (between 1.0 and no greater than 2.0 gpm) from 30 to 80 psig flowing pressure and improve acceptance and retention.

3.2.3.6 Recommendations for Low-Flow Aerators

Some customers complained that the installed low-flow aerators didn't provide enough flow especially in kitchen sinks. Check to make sure low-flow aerators provide enough flow for customers. Provide pressure-compensating low-flow aerators specifically designed for kitchens and vanities that are satisfactory to customers to maintain consistent flow rates (no greater than 2.2 gpm) from 30 to 60 psig flowing pressure.

3.2.3.7 Recommendations for Water Heater Insulation

TDPUD should evaluate the use of high R-value (i.e., R-14) low-emissivity (low-e) reflective closed-cell foam insulation for water heaters to overcome clearance issues (if compatible with the California Conventional Home Weatherization Installation Standards and ASTM E84, ASTM C534, UL723, NFPA255, UL181A-P, or UL-181B-FX).

3.2.3.8 Recommendations for Pipe Insulation

TDPUD should evaluate the use of low-emissivity (low-e) reflective closed-cell foam insulation for pipes to overcome clearance issues (if compatible with the California Conventional Home Weatherization Installation Standards and ASTM E84, ASTM C534, UL723, NFPA255, UL181A-P, or UL-181B-FX).

3.2.3.9 Other Cost Effective Measures to Consider

TDPUD should consider other cost effective measures for the future as follows.

1. Develop a TDPUD energy education program to achieve better results with bulk purchased CFLs, showerheads, aerators, etc. Students can do the survey online using a “green partners” EM&V website (to be developed). This survey would include more information about all TDPUD programs to motivate people to do more measures relevant to TDPUD. The energy education program can also be expanded to other students especially for Earth Day.
2. Increase attic insulation to R-60 to increase energy and peak demand savings
3. Provide incentives for radiant barriers to reduce summer cooling loads and reduce attic temperatures which can reach 140°F on hot summer days in Truckee.
4. Work with Southwest Gas and propane companies to offer joint programs that save electricity and natural gas (or propane). Offer incentives for Energy Star® solar water heaters with a minimum of 1.5 gallons of dedicated solar storage per square foot of collector area. Offer incentives for Energy Star instantaneous water heaters to eliminate electric water heaters (which use 4.5 kW per unit which can only be partially avoided with solar electric panels costing approximately $45,000).
5. Offer incentives for occupancy sensors for commercial lighting and plug loads. Educate consumers to enable Energy Star® saving mode on LCD high-definition television (HDTV) sets. Most HDTVs are shipped with the Energy Star® saving mode disabled. Savings are 40W to 170W or 88 to 370 kWh per year per HDTV. Energy Star® saving mode also extends HDTV lamp life.
6. Offer more types of CFLs including low mercury (<1 mg/lamp), cold-cathode (i.e., instant on and 25,000 hour life), warm-white 2700K and full-spectrum 5100K color temperatures, reflector CFLs (R30, R40, PAR30, PAR38), and fully-dimmable CFLs to increase savings, acceptance and persistence of CFL savings.
7. Purchase large quantities of pressure-compensating low-flow 1.5 gpm showerheads, low-flow 0.5 to 1.5 gpm aerators, and low-flow pre-rinse spray valves to save water. Low-flow showerheads and aerators save the equivalent of one CFL in pumping electricity annually and pre-rinse spray valves save the equivalent of 10 CFLs not including water heating energy savings.
8. Lowering hot water temperatures is a low-cost measure with significant savings opportunities. If implemented make sure to capture pre/post hot water temperature readings in the TDPUD database for verification.
9. Evaluate the use of low-emissivity reflective closed-cell foam insulation for water heater tanks and pipes and to overcome clearance issues For pipes insulate on the first 1 to 5 feet of the hot pipe coming out of the storage tank and the first 1 to 5 feet going into the storage tank or the first major bend as per California Energy Commission standards.
10. Participating customers suggested offering more measures such as Energy wall insulation, ceiling fans, whole house fans and high performance windows.

Appendix A: Commercial Lighting Survey Instrument

Interview Instructions for Process Survey

1. Purpose

The purpose of the Process Survey is to evaluate what works, what doesn't work, customer satisfaction, and suggestions for improvement in the program's services and procedures.

2. Selection of Respondent

1. **Participants** must be the person responsible for allowing program measures to be installed at the site. If this person is unavailable locate someone who is at least familiar with how that decision was made. Participant question #20 is used to verify that participant is a small-business with one or more of the following attributes: 1) Primary language non-English; 2) <10 employees; 3) Lease; 4) Use <100 kW or <10,000 therm/yr; or 5) Located outside Sacramento/San Francisco Bay Area.
2. **Non-participants** must be a small-business in the local utility service area that was unaware of the program or decided not to allow program measures to be installed at their facility (see non-participant survey at end). Non--participant question 3 is used to verify one or more of the following attributes: 1) Primary language non-English; 2) <10 employees; 3) Lease; 4) Use <100 kW or <10,000 therms/yr; or 5) Located outside TDPUD.

3. Two Types of Sites

This survey will be used for two types of sites:

1. **On-Site EM&V Only**. Sites that receive an EM&V on-site inspection or process survey.
2. **Telephone Only**. Sites that only receive a telephone survey (participants or non-participants).

4. How to Start a Survey

Complete the following steps to start one of these surveys:

1. Review TDPUD customer file information (for participants).
2. Make sure you understand what was installed with incentives from TDPUD prior to initiating the visit or call.
3. Participant Survey Introduction.
   Say: "Hello! My name is [________], and I am conducting a survey regarding the TDPUD Incentive Program. The program provided incentives for energy efficiency improvements for your business. Funding for the program is from TDPUD public benefits funds. Would you mind spending 10 minutes to answer a few questions to help us evaluate and improve the program?
4. Non-participant Survey Introduction.
   Say: "Hello! My name is [________], and I am conducting a survey regarding the TDPUD Program that was funded by public benefits funding from TDPUD customers in 2007 and 2008. You didn't participate in the program, but your feedback will help us evaluate and improve the program. The program installed a package of energy conservation measures including: 1) Ten to twelve screw-in, 27-watt CFLs; 2) Two LED Exit Signs; 3) One hardwired T-8/electronic ballasted fluorescent fixture replacement of incandescent fixtures; and 4) Removed or delamped unnecessary incandescent or fluorescent lamps. Would you mind spending 10 minutes to answer a few questions?

TDPUD PARTICIPANT SURVEY #______

Business___________________________________ Name ______________________________ Title __________

Address ___________________________________ City ___________________________________ ZIP ________

Phone Number_______________________ Survey Date ___________________________Surveyor Initials ________

Participant Survey

1. Do you remember TDPUD installing no-cost energy efficiency improvements at your facility?
   ___ **1** (Yes) ___ **2** (No) **98** Don't Know **99** Refused to Answer

2. How would you rate the crew in terms of being courteous and professional on a scale from 1 to 10?
   ___ Response (**1 is low and 10 is high**) **98** Don't Know **99** Refused to Answer

3. Was the work scheduled and completed within a reasonable timeframe?
   ___ **1** (Yes) ___ **2** (No) **98** Don't Know **99** Refused to Answer

4. How long was the technician at your facility?
   ___ 1 hr ___2 hrs ___3 hrs ___4 hrs ___>4 hrs **98** Don't Know **99** Refused to Answer

5. Did you receive *Energy Audit Reports* from TDPUD ? ___ **1** (Yes) ___ **2** (No, ***Skip to Q8***) **98** DK **99** Refused
   If yes, how would you rate the *Energy Audit Reports* in terms of usefulness on a scale from 1 to 10?
   ___ Response (**1 is low and 10 is high**) **98** Don't Know **99** Refused to Answer

6. How would you rate the *Energy Audit Reports* in terms of presentation on a scale from 1 to 10?
   ___ Response (**1 is low and 10 is high**) **98** Don't Know **99** Refused to Answer

7. How would you rate the *Energy Audit Reports* in terms of accuracy on a scale from 1 to 10?
   ___ Response (**1 is low and 10 is high**) **98** Don't Know **99** Refused to Answer

8. Did you receive *Energy Audit* advice to obtain financing or rebates? ___ **1** (Yes) ___ **2** (No) **98** DK **99** Refused
   If yes, how satisfied were you with the *Energy Fitness* advice on a scale from 1 to 10?
   ___ Financing Advice (**1=low, 10=high**) ___ Rebate Advice (**1=low, 10=high**) **98** DK **99** Refused

9. How would you rate the overall service you received on a scale from 1 to 10?
   ___ Response (**1 is low and 10 is high**) **98** Don't Know **99** Refused to Answer

10. How would you rate the program in terms of increasing your understanding of the linkage between energy efficiency, bill savings, and comfort?
    ___ Response (**1 is low and 10 is high**) **98** Don't Know **99** Refused to Answer

11. To the best of your knowledge was everything installed correctly?
    ___ **1** (Yes) ___ **2** (No) **98** Don't Know **99** Refused to Answer

12. Are you still using all the measures that were installed?
    ___ **1** (Yes) ___ **2** (No) **98** Don't Know **99** Refused to Answer

    Please list measures not used? ____

13. Were there any measures that were not installed (i.e., check TDPUD database to verify measures were installed such as screw-in CFLs, LED Exit Signs, hardwired T-8/electronic ballasted fluorescent fixtures, etc.)?
    ___ **1** (Yes) ___ **2** (No) **98** Don't Know **99** Refused to Answer

    Please list measures not installed? ____

14. Have you shared information with any of your business associates about the benefits of screw-in CFLs, LED Exit Signs, hardwired T-8/electronic ballasted fluorescent fixtures, or other measures from the *Fitness Report*?
    ___ **1** (Yes) ___ **2** (No) **98** Don't Know **99** Refused to Answer

    With how many other businesses have you shared this information in the last 12 months? _________________

    About how many of these people have installed any of these measures? _______________________________

15. Do you know any other businesses that would benefit from this program (name/address)? _________________

    ____

TDPUD PARTICIPANT SURVEY (cont'd) #______

16. What make and model or size (i.e., ton) air conditioner do you have? (Deduce tons from model number.)
______________ Make ___________________ Model ____tons **98** Don't Know **99** Refused to Answer

17. How many hours per day do you use the CFLs or Lighting Fixtures? **98** (DK) **99** (Refused)

Location	Old Type	Old Qty.	Old Hrs	Old W/Fix	New Type	New Qty.	Old Hrs	New W/Fix
1.			hrs	W			hrs	W
2.			hrs	W			hrs	W
3.			hrs	W			hrs	W
4.			hrs	W			hrs	W
5.			hrs	W			hrs	W
6.			hrs	W			hrs	W
7.			hrs	W			hrs	W
8.			hrs	W			hrs	W
9.			hrs	W			hrs	W
10.			hrs	W			hrs	W

Type: 1 = CFL; 2 = LED Exit; 3 = Replace Incandescent with Fluorescent; 4 = Delamp T12-Mag with T8-EB; 5 = Replace T12-Mag with T-8-EB

18. Did you receive an Energy audit checklist of opportunities for saving energy at your facility?
___ **1** (Yes) ___ **2** (No) **98** Don't Know **99** Refused to Answer

Have you adopted any measures since the TDPUD *Energy* audit was performed? (Ask six months after audit.)

#	Energy Audit Measures	Baseline	Measure	Hrs/yr	Savings	Adopted	Cust.
1	Seasonal Maintenance (Clean Air Filters)	Dirty Filters/Coil	Clean Filters/Coils		7%		
2	HVAC Tune-up	Incorrect Ref. Charge	Correct Ref. Charge		13%		
3	Duct Testing and Sealing and Insulation	Leaky No Insulation	Seal/Insul. Ducts		Seal 14%/ 3%		
4	Programmable Thermostat	None	Setback/setup		20%		
5	Energy Efficient HVAC Equipment	7.4 SEER/7.7 EER	11 SEER/10.3 EER		25-33%		
6	Reflective Window Film	Clear: 0.83 SHGC	Film: 0.47 SHGC		14%		
7	Advanced Evaporative cooler	DX Air Cond.	Evap. Cooler		49%		
8	Ceiling Fan	None	Ceiling Fan		10%		
9	Delamp. (3-T12ES/Mag to 2-T12ES/Mag)	133W	82W		39%		
10	Delamp Other						
11	Occ. Sensors in Areas with Intermittent Use	3,200 hours	1,500 hours		53%		
12	Lower Water Heater Temperature	130F	120F		8%		
13	Time Clock for Electric Water Heater	8,760 hrs/y	4,380 hrs/y		4%		
14	Insulate Tank & Pipes	No Insulation	R8 Tank and R4 Pipe		10%		
15	Infiltration Reduction (leaks, weatherstripping)	0.5 ACH	0.4 ACH		2%		
16	R-30 Ceiling Insulation	None	R-30		10-20%		
17	R-11 to R-19 Wall Insulation	R-11	R-19		-		
18	High Performance Windows	Single Pane	Low-E		30%		
19	Auto-Closers on Exit Doors	None	Auto Closer		1%		
20	Insulated Ice Machine Dispenser Box	Uninsulated Box	Insulated Box		20%		
21	Auto-Closers for Cooler Boxes	None	Auto Closer		2%		
22	Strip Curtain for Walk-in Boxes	None	Strip Curtain		3%		
23	Vender Miser	No Control	Vender Miser Control		30-55%		
24	Glass Cooler Door Gaskets	Leaky Gasket	Tight Gasket		2%		
25	Energy Star Computers & Copiers (or controls)	None	Power Management		10%		

19. Please provide your thermostat settings before and after TDPUD performed an audit?

Weekday Cooling Schedule				Weekend Cooling Schedule				Weekday Heating Schedule				Weekend Heating Schedule			
OLD Time	OLD Temp	NEW Time	NEW Temp	OLD Time	OLD Temp	NEW Time	NEW Temp	OLD Time	OLD Temp	NEW Time	NEW Temp	OLD Time	OLD Temp	NEW Time	NEW Temp
	°F		°F		°F		°F		°F		°F		°F		°F
	°F		°F		°F		°F		°F		°F		°F		°F
	°F		°F		°F		°F		°F		°F		°F		°F
	°F		°F		°F		°F		°F		°F		°F		°F

20. Please provide the following demographic information (*obtain utility bill data from TDPUD*)?
_________Language ____# Employees Own Lease _______ Floor Area ____kW _________kWh/yr _________therm/yr **99** Refused

21. Do you have any suggestions to improve the program?
___ **1** (Yes) ___ **2** (No) **98** Don't Know **99** Refused to Answer

If so, please provide the suggestion(s). ____

TDPUD NON-PARTICIPANT SURVEY #______

Business ___________________________________ Name________________________________ Title __________

Address____________________________________ City ____________________________________ ZIP _______

Phone Number _______________________ Survey Date___________________________ Surveyor Initials _______

Non-Participant Survey

I am conducting a survey regarding a TDPUD Program in 2007 or 2008. You didn't participate in the program, but your feedback will help us evaluate and improve the program. The program installed a package of energy conservation measures including: 1) Ten to twelve screw-in, 27-watt CFLs; 2) Two LED Exit Signs; 3) One hardwired T-8/electronic ballasted fluorescent fixture replacement of incandescent fixtures; and 4) Removed or delamped unnecessary incandescent or fluorescent lamps. Would you mind spending 5 minutes to answer a few questions?

1. Would you have participated if you knew the program installed no-cost/low-cost energy efficiency improvements measures in businesses like yours?

   ___ **1** (Yes) ___ **2** (No) **98** Don't Know **99** Refused to Answer

2. Please tell me why you choose not to participant in the program?
   (Read list – Multiple answers are okay.)

   1 Didn't know about the program (i.e., information cost).

   2 Didn't understand energy savings benefits of the program (i.e., performance uncertainty).

   3 Don't own the building (i.e., renter–misplaced or split incentive).

   4 Unable to be available for crew to perform work (i.e., hassle cost).

   Would you have participated if someone else you know (i.e., an employee) could have been present at your business when contacted by TDPUD?

   ___ **1** (Yes) ___ **2** (No) **98** Don't Know **99** Refused to Answer

   5 Would you have participated if the program provided services at other times?

   ___ Evenings ___ Saturdays ___Sundays **98** Don't Know **99** Refused to Answer

   6 Other ____

   98 Don't Know **99** Refused to Answer

3. Please provide the following demographic information?

   _________Language ____# Employees Own Lease ______ Floor Area ____kW ________kWh/yr ________therm/yr **99** Refused

4. Do you have any suggestions that might have helped you participate in the program?

   ___ **1** (Yes) ___ **2** (No) **98** Don't Know **99** Refused to Answer

   If so, please provide the suggestion(s). ____

   ____

Appendix B: CFL Decision-Maker Survey Instrument

Interview Instructions for Decision-Maker Survey

1. Purpose

The purpose of the Decision-Maker Survey is to obtain sufficient information to estimate the Net-to-Gross Ratio (NTGR).

2. Selection of Respondent

The **decision-maker** must be the person who decided to install or implement rebated measures.

3. Two Types of Sites

This survey will be used for two types of sites:

1. **On-Site M&V Only**. Sites that receive an on-site inspection for the M&V evaluation.
2. **Telephone Only**. Sites that only receive a telephone survey.

4. How to Start a Survey

Complete the following steps to start one of these surveys:

1. Review file information for the site (if available).
2. Make sure you understand what was installed prior to initiating the call or visit.
3. Contact the person and explain the purpose of the Survey. Tell them that the data provided by them will be kept strictly confidential and will not be shared with anyone.

DECISION-MAKER SURVEY

Customer Name: ______________________________ Date: ______________________________

Business Name: ______________________________ Contact: ______________________________

Phone Number: ______________________________ City: ______________________________

Start Call Time: ______________________________ End Call time: ______________________________

Surveyor Initials: ______________________________ Survey Completed: Y NA R WB BN

Y = yes, NA = no answer, R = refused, WB = wrong business, BN = bad number

The purpose of the decision-maker survey is to obtain information necessary to calculate a net-to-gross ratio. You will need to interview the customer who was responsible for the decision to implement measures at the site. If this person is not available attempt to locate someone who is at least familiar with how that decision was made.

Introduction

Say: "Hello. My name is [_____] and I am conducting a telephone survey regarding the TDPUD energy efficiency programs. Would you mind spending 5 minutes to answer a few questions to help us evaluate the Compact Fluorescent Lamp (CFL) program."

Begin Survey

1. Are you using the Compact Fluorescent Lamps (CFLs) [**or other measures**] that you received from the utility program [**or purchased with a utility rebate**]? If they say "no," then say - Are you aware that CFLs save 75% on your lighting costs (for example a typical CFL costs $2/year compared to a 60W incandescent bulb that costs $10/year to operate)?

   ___ **1** (Yes) ___ **2** (No) **98** Don't Know **99** Refused to Answer

2. What size light bulbs did you replace with the new CFLs?

   ___ **1** (60 W) ___ **2** (75 W) ___ **3** (100W) **98** Don't Know **99** Refused to Answer

3. How many hours per day do you use the CFLs? Are the CFLs turned on 2-6PM WDs? ____ Yes/No

   ___ **1** (<3 hrs) ___ **2** (4-5 hrs) ___ **3** (>6 hrs) **98** Don't Know **99** Refused to Answer

4. When and how did you first learn about the Utility CFL Program?

   ____

   1 Didn't know there was a program (**Go to Q.6**)

5. Keeping that in mind, did you understand the value of the program BEFORE or AFTER you installed the CFLs? (**Circle One**)

   1 Before **2** After (**Go to Q.7**) **98** Don't Know **99** Refused to Answer

6. Did you install CFL(s) BEFORE or AFTER you received information, rebates or CFL(s) from the utility? (**Circle One**)

   1 Before **2** After **98** Don't Know **99** Refused to Answer

DECISION-MAKER SURVEY (Continued)

7. On a scale from 0 to 10, with 0 being no influence at all and 10 being very influential, how much influence did the Utility or Rebate have on your decision to install the CFL(s)?

   ___ Response (**0-10**)   **98** Don't Know   **99** Refused to Answer

8. If the CFL(s) had not been available, how likely is it you would have done exactly the *same* thing. Please use a scale from 0 to 10, with 0 being not at all likely and 10 being very likely.

   ___ Response (**0-10**)   **98** Don't Know   **99** Refused to Answer

   Notes: ____

Special Instruction for Contradictory Responses: If [**Q.7 is 0,1,2** *and* **Q.8 is 0,1,2**] *or* [**Q.7 is 8,9,10** *and* **Q.8 is 8,9,10**]. Probe for the reason. However, it is important not to communicate a challenging attitude when posing the question. For example, say,

When you answered "8" for the question about the influence of the rebate or service, I interpreted that to mean that the Utility Program was important to your decision. Then, when you answered "8" for how likely you would be to take the same action *without* the rebate or service, it sounds like the Utility was *not* very important. I want to check to see if I understand your answers or if the questions may have been unclear.

If they volunteer a helpful answer at this point, respond by changing the appropriate answer. If not, follow up with something like: "Would you explain in your own words, the role the Utility Program played in your decision to take this action?

If possible translate their answer into responses for **Questions 7** and **8** and check these responses with the respondent for accuracy. If the answer doesn't allow you to decide what answer should be changed, write the answer down and continue the interview.

Answer: ____

9. What role did the Utility Program play in your decision to install the CFLs? [Prompt by reading list if the respondent has trouble answering.]

   1 Reminded us of something we already knew
   2 Speeded up process of what we would have done anyway (i.e., early replacement)
   3 Showed us the benefits of this action that we didn't know before
   4 Clarified benefits that we were *somewhat* aware of before
   5 Recommendation had no role
   6 Other ____
   98 Don't Know
   99 Refused to Answer

DECISION-MAKER SURVEY (Continued)

Say: Here are some statements that may be more or less applicable for your home or business about the Utility Program CFL giveaway [**or recommendation**]. Please assign a number between 0 and 10 to register how applicable it is. A 10 indicates that you fully agree, and 0 indicates that you completely disagree.

10. The Utility Program was nice but it was unnecessary to get the CFL(s) installed.

    ___ Response (**0-10**) **98** Don't Know **99** Refused to Answer

10. The Utility Program was a critical factor in installing the CFL(s).

    ___ Response (**0-10**) **98** Don't Know **99** Refused to Answer

11. We would not have installed the CFL(s) without the Utility Program.

    ___ Response (**0-10**) **98** Don't Know **99** Refused to Answer

Special Instruction for Contradictory Responses: If [**Q.10 is 0,1,2,** *and* **Q.11/12 is 8,9,10**] *or* [**Q.10 is 8,9,10** *and* **Q.11/12 is 0,1,2**].

When you answered "8, 9 or 10" for the question about "the Utility Program being 'nice' but unnecessary," I interpreted that to mean that the Utility Program was unimportant to your decision. Then, you answered "8, 9 or 10" for "the Utility Program being a critical factor." I want to check to see if I understand your response. If they volunteer a helpful answer, respond by changing the appropriate answer. If not, follow up with something like: "Would you explain in your own words, why the Utility Program was a critical factor in your decision?"

If possible translate their answer into responses for **Questions 10/11/12**. If the answer doesn't allow you to decide what answer should be changed, write the answer down and continue the interview.

Answer: ____

12. If you had not received the CFL [rebate or service] from the Utility, would you have installed CFLs [**or other measures**]...

    1 ..within 6 months?
    2 ..6 months to 1 year?
    3 ..one to two years later?
    4 ..two to three years later?
    5 ..three to four years later?
    6 ..four or more years later?
    7 ..Never
    98 ..Don't Know - **Try less precise response, if still "don't know" use 98**
        8 ...less than one year?
        9 ...one year or more?
    99 ...Refused to Answer

    Time relative to the installation date. For customers with more than one measure ask if their response is the same. If not, obtain a response for each measure. Write answers in margins and enter answers on a new line in the Excel spreadsheet.

TDPUD NON-PARTICIPANT SURVEY

Name ____

Address____________________________________ City ____________________________________ ZIP _______

Phone Number _______________________ Survey Date___________________________ Surveyor Initials _______

Non-Participant Survey

I am conducting a survey regarding a TDPUD Program in 2007 or 2008. You didn’t participate in the program, but your feedback will help us evaluate and improve the program. The program provided free Compact Fluorescent Lamps (CFL) to customers like you. CFLs use 75% less energy than conventional incandescent lamps. Would you mind spending 5 minutes to answer a few questions?

1. Would you have participated in the TDPUD CFL Program if you knew the program provided free CFLs for customers like you to save 75% on your lighting costs (for example a typical CFL costs $2/year to operate compared to a 60W incandescent bulb that costs $10/year)?

   ___ **1** (Yes)   ___ **2** (No)   **98** Don’t Know   **99** Refused to Answer

2. Please tell me why you choose not to participant in the CFL Program?
   (Read list – Multiple answers are okay.)

   1 Didn’t know about CFLs or the CFL program or (i.e., information cost).

   2 Didn’t understand energy savings benefits of the program (i.e., performance uncertainty).

   3 Don’t own the building (i.e., renter–misplaced or split incentive).

   4 Too busy to consider CFLs (i.e., hassle cost).

   5 Other ____

   98 Don’t Know   **99** Refused to Answer

3. Please provide the following demographic information?
   _________Language ____Own Lease _____Income ____Age ____Male or Female _______ **99** Refused

4. Do you have any suggestions that might have helped you participate in the program?

   ___ **1** (Yes)   ___ **2** (No)   **98** Don’t Know   **99** Refused to Answer

   If so, please provide the suggestion(s). ____

   ____

Appendix C: Residential Refrigerator Recycling Decision-Maker Survey Instrument

Interview Instructions for Decision-Maker Survey

1. Purpose

The purpose of the Decision-Maker Survey is to obtain sufficient information to improve the program and calculate gross savings and the Net-to-Gross Ratio (NTGR). You will need to interview the customer who was responsible for the decision to recycle the refrigerator. If this person is unavailable attempt to locate someone who is at least familiar with how that decision was made.

2. Selection of Respondent

The **decision-maker** must be the person who decided to participate in the program.

3. How to Start a Survey

Complete the following steps to start one of these surveys:

4. Check database information to avoid asking unnecessary questions (if available).
5. Telephone person and explain purpose of the Survey. Tell them that survey results are strictly confidential and will not be shared with anyone.

REFRIGERATOR RECYCLING DECISION-MAKER SURVEY

Customer Name:______________________________ Date: ____
Phone Number:_______________________________ City/Utility:___________________________________
Start Call Time: _____________________________ End Call time:_________________________________
Surveyor Initials: ____________________________ Survey Completed: Y NA R NP BN

Y = yes, NA = no answer, R = refused, WB = non-participant, BN = bad number

Introduction

Say: "Hello. My name is _______ and I'm conducting a survey regarding the TDPUD Refrigerator Recycling Programs. This survey will take less than 10 minutes." **If respondent is unsure say:** "This program helped customers recycle their old refrigerators or freezers. Do you recall participating in this program?" **If yes, begin survey. If no, thank respondent and terminate call.**

Begin Survey

1. How did you learn about the Utility Refrigerator Recycling Program?

(**Do Not Read List and Check all that apply**)

1 Newspaper advertisement
2 TV advertisement
3 Radio advertisement
4 Advertising on side of truck
5 Utility bill insert/information with utility bill
6 Separate mailing
7 Toll-free 800 telephone number
8 Media stories about the program
9 From a friend, relative or neighbor
10 Appliance retailer
11 Don't Know
12 Somewhere else (SPECIFY) _____________

2. Why did you decide to participate in the Program?

(Do Not Read List and Check all that apply)

1 Save electricity (i.e., Conservation)
2 Save money on electric bill
3 Incentive from utility (if applicable)
4 Refrigerator was unnecessary
5 Convenience of free pick-up service (if applicable)
6 Environmentally safe disposal (i.e., Recycling)
7 Recommendation of a friend/relative
8 Recommendation of a retailer/dealer
9 Don't Know
10 Other ______________

REFRIGERATOR RECYCLING DECISION-MAKER SURVEY (cont'd)

3. What was the approximate size of the recycled unit in cubic feet (i.e., 18, 20, 22, 24 c.f.)?

   _____ (Size in Cubic Feet) ___ **98** Don't Know

4. What was the approximate age of the recycled unit?

   _____ (Year of Manufacturer, e.g., 1980) ___ **98** Don't Know

5. What was the style of the recycled unit?
   - **1** Side-by-Side Refrigerator
   - **2** Top Freezer, Bottom Refrigerator
   - **3** Bottom Freezer, Top Refrigerator
   - **4** Single Door Refrigerator
   - **5** Upright Freezer
   - **6** Chest Freezer
   - **7** Don't Know

6. What type of defrost did the recycled unit have? Was the defrost type …

   ___ **1** (Manual) ___ **2** (Automatic) ___ **98** (Don't Know)

7. Was purchasing a new refrigerator or freezer the major reason for recycling your old unit?

   ___ **1** (Yes) ___ **2** (No) ___ **98** (Don't Know)

8. At the time when you recycled the unit, was it the main refrigerator or freezer for your household or was it being used as a spare?

   ___ **1** (Main Unit) ___ **2** (Spare) ___ **98** Don't Know

9. If spare, how long was it used as spare? (**Enter Months as Fractions, i.e., 9 months = 9/12 = 0.75)**

   ___ **1** (Years) ___ **2** (Months) ___ **98** Don't Know

10. At the time the unit was recycled, what condition was it in?

    ___ **1** (Working) ___ **2** (Working, but needed repairs) ___ **3** (Not Working) ___ **98** Don't Know

11. If you had not recycled the unit, about how many months during the next year would it have been plugged in? (**Read List, Enter Months as Fractions, i.e., 9 months = 9/12 = 0.75)**

    ___ **1** (All Year) ___ **2** (Number of Months) ___ **3** (None)
    ___ **98** Don't Know

    If answer to **Q.11** is less than one year ask if unit was plugged in during the Summer.

    ___ **1** (Summer) ___ **2** (Winter) ___ **98** Don't Know

REFRIGERATOR RECYCLING DECISION-MAKER SURVEY (cont'd)

12. What would you have done with your old unit if the recycling service had not been available? (**Accept only one answer.**)
    - **1** Kept as spare and used
    - **2** Kept unit but unplugged it
    - **3** Given unit away or donated to charity
    - **4** Taken unit to recycling center where it would be disabled or disposed
    - **5** Hired someone to pick up unit
    - **6** Participated in local government refrigerator pick-up program
    - **7** Have appliance retailer pick up unit
    - **8** Left unit in house when moved
    - **9** Don't Know
    - **10** Other___________________

Say: Here are some statements with which you may agree or disagree regarding your participation in the Utility Refrigerator Recycling Program. Please assign a number between 0 and 10 where a 10 indicates that you completely agree, and 0 indicates that you completely disagree.

13. The Utility Program was nice but it was unnecessary to get me to permanently remove my old refrigerator(s).

    ___ Response (**0-10**)　　**98** Don't Know　　**99** Refused to Answer

14. We would not have recycled our old refrigerator(s) without the Utility Program.

    ___ Response (**0-10**)　　**98** Don't Know　　**99** Refused to Answer

Special Instruction for Contradictory Responses: If [**Q.13 is 0**,**1**,**2**, *and* **Q.14 is 8**,**9**,**10**] *or* [**Q.13 is 8,9,10** *and* **Q.14 is 0,1,2**].

When you answered "8, 9 or 10" for the question about "the Utility Program being 'nice' but unnecessary," I interpreted that to mean that the Utility Program was unimportant to your decision. Then, you answered "8, 9 or 10" for "not recycling your old refrigerator without the Utility Program." I want to check to see if I understand your answers or if the questions are clear.

If they volunteer a helpful answer, respond by changing the appropriate answer. If not, follow up with something like: "Would you explain in your own words, why the Utility Program was a critical factor in your decision?"

If possible translate their answer into responses for **Questions 13/14**. If the answer doesn't allow you to decide what answer should be changed, write the answer down and continue the interview.

Answer: ____

REFRIGERATOR RECYCLING DECISION-MAKER SURVEY (cont'd)

15. If the Utility Refrigerator Recycling Program had not been available would you have gotten rid of your refrigerator(s) permanently..

    1 ..within 6 months?
    2 ..6 months to 1 year?
    3 ..one to two years later?
    4 ..two to three years later?
    5 ..three to four years later?
    6 ..four or more years later?
    7 ..Never
    98 ..Don't Know **- Try less precise response, if still "don't know" use 98**
        8 ...less than one year?
        9 ...one year or more?
    99 ...Refused to Answer

16. Were you planning to recycle or dispose of your old refrigerator(s) **before** you heard about the Utility Program?

    ___ **1** (Yes) ___ **2** (No) ___ **98** (Don't Know)

17. Using a 10 point scale where "10" means you were very satisfied and "0" means you were very dissatisfied, please tell me your overall satisfaction with the Refrigerator Recycling Program.

    ___ Response (**0-10**) ___ **98** (Don't Know)

18. Do you have any comments or suggestions regarding the Refrigerator Recycling Program?

    ___ **1** (Yes) ___ **2** (No)

    Comments/Suggestions: ____

Appendix D: Energy Star Appliance Decision-Maker Survey Instrument

Interview Instructions for Decision-Maker Survey

1. Purpose

The purpose of the Decision-Maker Survey is to obtain sufficient information to improve the program and calculate gross savings and the Net-to-Gross Ratio (NTGR). You will need to interview the customer who was responsible for the decision to install the Energy Star clothes washers, dishwashers and refrigerators. If this person is unavailable attempt to locate someone who is at least familiar with how that decision was made.

2. Selection of Respondent

The **decision-maker** must be the person who decided to participate in the program.

3. How to Start a Survey

Complete the following steps to start one of these surveys:

6. Check database information to avoid asking unnecessary questions (if available).
7. Telephone person and explain purpose of the Survey. Tell them that survey results are strictly confidential and will not be shared with anyone.

ENERGY STAR APPLIANCE DECISION-MAKER SURVEY

Customer Name: ____________________________ Date: _____________________________________
Phone Number: ____________________________ City/Utility: ________________________________
Start Call Time: ____________________________ End Call time: ______________________________
Surveyor Initials: ____________________________ Survey Completed: Y NA R NP BN

Y = yes, NA = no answer, R = refused, WB = non-participant, BN = bad number

Introduction

Say: "Hello. My name is _______ and I'm conducting a survey regarding the TDPUD Appliance Rebate Program. This survey will take less than 10 minutes." **If respondent is unsure say:** "This program provided a rebate of $100 per unit for Energy Star clothes washers, dishwashers and refrigerators. Do you recall participating in this program?" **If yes, begin survey. If no, thank respondent and terminate call.**

Begin Survey

1. How did you learn about the utility Energy Star Appliance Rebate Program?
   (**Do Not Read List and Check all that apply**)
   - **1** Newspaper advertisement
   - **2** TV advertisement
   - **3** Radio advertisement
   - **4** Advertising on side of truck
   - **5** Utility bill insert/information with utility bill
   - **6** Separate mailing
   - **7** Toll-free 800 telephone number
   - **8** Media stories about the program
   - **9** From a friend, relative or neighbor
   - **10** Appliance retailer
   - **11** Don't Know
   - **12** Somewhere else (SPECIFY) ____________

2. Why did you decide to participate in the Program?
   (**Do Not Read List and Check all that apply**)
   - **1** Save electricity (i.e., Conservation)
   - **2** Save money on electric bill
   - **3** Incentive from utility (if applicable)
   - **4** Convenience of rebate (if applicable)
   - **5** Environmentally better product (i.e., reduces energy use and carbon emissions)
   - **6** Recommendation of a friend/relative
   - **7** Recommendation of a retailer/dealer
   - **8** Don't Know
   - **9** Other ______________

3. Please provide the following demographic information?
   _______Language ___Own Lease _____Income ___Age ___Male or Female ___ **99** Refused

ENERGY STAR APPLIANCE DECISION-MAKER SURVEY (cont'd)

4. What type of Energy Star appliance did you purchase?

   ___ Dishwasher ___ Clothswasher ___ Refrigerator ___ **98** Don't Know

5. What was the make and model of the new Energy Star appliance (check spreadsheet)?

   _____ Make _____ Model ___ **98** Don't Know

6. Are you still using the Energy Star Appliance that was **purchased with a utility rebate**?

   ____ Yes ____ No ___ **98** Don't Know

7. For clothswashers/dishwashers, how many weeks/year are you at the home (SKIP if refrigerator)?

   ____ (Full-time resident) ____ (Part-time and weeks/yr) ___ **98** Don't Know

8. If clothswasher, what percentage of loads are hot, warm, and cold?

   ____ (Hot %) ____ (Warm %) ____ (Cold %) ___ **98** Don't Know

9. If clothswasher, Energy Star assumes 392 loads per year (8 per week times 49 weeks). How many loads do you think you do per year (important for part-time residents)?

   ____ (Energy Star or 392/yr) ____ (% More) ____ (% Less) ___ **98** Don't Know

10. Enter energy use and savings per unit into spreadsheet (use Energy Star spreadsheets)?

    _____ Energy Use (kWh/yr) _____ Savings (kWh/yr) ___ **98** Don't Know

11. If refrigerator, what was the size in cubic feet (i.e., 18, 20, 22, 24 c.f.)?

    _____ (Size in Cubic Feet) ___ **98** Don't Know

12. Was the old unit in working condition?

    ___ **1** (Working) ___ **2** (Working, but needed repairs) ___ **3** (Not Working) ___ **98** Don't Know

13. Did you keep the old refrigerator as a spare or recycle it?

    ___ **1** (Spare) ___ **2** (Recycled and by whom – enter name) ___ **98** (Don't Know)

14. What was the approximate age of the old or recycled unit?

    _____ (Year of Manufacturer, e.g., 1980) ___ **98** Don't Know

15. What type of defrost did the recycled unit have? Was the defrost type …

    ___ **1** (Manual) ___ **2** (Automatic) ___ **98** (Don't Know)

16. If you had not recycled the unit, about how many months during the next year would it have been plugged in? (**Enter Months as Fractions, i.e., 9 months = 9/12 = 0.75)**

    ___ **1** (All Year) ___ **2** (Number of Months) ___ **3** (None) ___ **98** Don't Know

17. If answer to **Q.15** is less than one year, ask if unit was plugged in during Summer months.

    ___ **1** (Summer) ___ **2** (Winter) ___ **98** Don't Know

ENERGY STAR APPLIANCE DECISION-MAKER SURVEY (cont'd)

18. What would you have done with your old unit if the recycling service had not been available? (**Accept only one answer.**)

    1 Kept as spare and used
    2 Kept unit but unplugged it
    3 Given unit away or donated to charity
    4 Taken unit to recycling center where it would be disabled or disposed
    5 Hired someone to pick up unit
    6 Participated in local government refrigerator pick-up program
    7 Have appliance retailer pick up unit
    8 Left unit in house when moved
    9 Don't Know
    10 Other___________________

Say: Here are some statements with which you may agree or disagree regarding your participation in the utility Energy Star Appliance Rebate Program. Please assign a number between 0 and 10 where a 10 indicates that you completely agree, and 0 indicates that you completely disagree.

19. The utility program was nice but unnecessary to get me to purchase the new Energy Star Appliance(s).

    ___ Response (**0-10**)   **98** Don't Know   **99** Refused to Answer

20. We would not have purchased a new Energy Star Appliance without the Utility Program.

    ___ Response (**0-10**)   **98** Don't Know   **99** Refused to Answer

Special Instruction for Contradictory Responses: If [**Q.19 is 0,1,2,** *and* **Q.20 is 8,9,10**] *or* [**Q.19 is 8,9,10** *and* **Q.20 is 0,1,2**].

When you answered "8, 9 or 10" for the question about "the Utility Program being 'nice' but unnecessary," I interpreted that to mean that the Utility Program was unimportant to your decision. Then, you answered "8, 9 or 10" for "not purchasing an Energy Star appliance without the Utility Program." I want to check to see if I understand your answers or if the questions are clear.

If they volunteer a helpful answer, respond by changing the appropriate answer. If not, follow up with something like: "Would you explain in your own words, why the Utility Program was a critical factor in your decision?"

If possible translate their answer into responses for **Questions 19/20**. If the answer doesn't allow you to decide what answer should be changed, write the answer down and continue the interview.

Answer: ____

21. Using a 10 point scale where "10" means you were very satisfied and "0" means you were very dissatisfied, please tell me your overall satisfaction with the utility Energy Star Appliance Program.

    ___ Response (**0-10**)   ___ **98** (Don't Know)

22. Do you have any comments or suggestions regarding the utility Energy Star Appliance Program?

    ___ **1** (Yes)   ___ **2** (No)

    Comments/Suggestions:____

TDPUD NON-PARTICIPANT SURVEY

Name ____

Address______________________________ City_______________________________ ZIP _______

Phone Number ___________________ Survey Date_____________________ Surveyor Initials _______

Non-Participant Survey

I am conducting a survey regarding a TDPUD Program in 2007 or 2008. You didn't participate in the program, but your feedback will help us evaluate and improve the program. The program provided a rebate of $100 per unit for Energy Star clothes washers, dishwashers and refrigerators. Energy Star Appliances are 10 to 100% more efficient than conventional appliances. Would you mind spending 5 minutes to answer a few questions?

1. Would you have participated in the TDPUD Energy Star Appliance Rebate Program if you knew the program provided $100 incentives for Energy Star appliances for customers like you?

   ___ **1** (Yes) ___ **2** (No) **98** Don't Know **99** Refused to Answer

2. Please tell me why you choose not to participant in the Energy Star Appliance Rebate Program? (Read list – Multiple answers are okay.)

   1 Didn't know about the program or didn't need a new appliance (i.e., information cost).

   2 Didn't understand energy savings benefits of the program (i.e., performance uncertainty).

   3 Don't own the appliances or building (i.e., renter–misplaced or split incentive).

   4 Bought a new appliance, but too busy to buy an Energy Star appliance (i.e., hassle cost).

   5 Other ____

   98 Don't Know **99** Refused to Answer

3. Please provide the following demographic information?

   _________Language ____Own Lease _____Income ____Age ____Male or Female _______ **99** Refused

4. Do you have any suggestions that might have helped you participate in the program?

   ___ **1** (Yes) ___ **2** (No) **98** Don't Know **99** Refused to Answer

   If so, please provide the suggestion(s). ____