Evaluation, Measurement & Verification Report for Truckee Donner Public Utility District 2010 Energy Efficiency Programs

FINAL REPORT

Prepared for

Truckee Donner Public Utility District

Truckee, California

Prepared by

Principal Investigators: Robert Mowris, Ean Jones

Verified, Incorporated

Truckee, California

March 15, 2011

Funded with Public Benefits Funds

TABLE OF CONTENTS

Acknowledgements

This M&V study was funded by public benefits under the auspices of the Truckee Donner Public Utilities District, Northern California Power Agency, and the California Energy Commission. Field research at customer sites, electric power metering, utility billing data analyses, and customer participant surveys were made possible with the cooperation of the following individuals: Steven Poncelet, Scott Terrell, and Julie Nelson. Robert Mowris, B.S., M.S., P.E., managed the study. Robert Mowris designed the EM&V plans, electric power metering equipment, survey instruments, engineering analysis software, and database. Robert Mowris, Ean Jones, B.S., and Ryan Schau, B.S., performed the field inspections. Robert Mowris performed the engineering analyses, statistical analyses, and wrote the reports. Steven Poncelet and Scott Terrell are the TDPUD study managers.

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 Verified, Incorporated, with public benefits 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 26 energy efficiency programs in 2010 as shown in **Table 1.1**. The programs provided educational information, incentives, and free energy efficiency measures to residential and commercial customers. The program ex ante goal was to install 59,716 energy efficiency measures and TDPUD accomplished 71,947 installed measures and this is 20.5% greater than the ex ante goal.

Table 1.1 Ex Ante Goals and Ex Post Accomplishments

Description	Ex Ante Goal	Ex Post Accomplishment
Total Installed Measures	**59,716**	**71,947**
1. Residential CFLs	1,000	223
2. Clothes Washers	200	254
3. Dishwashers	150	213
4. Refrigerator/Freezers	200	242
5. Refrigerator Recycling	25	26
6. Building Envelope Testing	20	5
7. Duct System Testing	20	10
8. Building Envelope Mitigation	10	3
9. Duct System Mitigation	10	3
10. Window Thermal Efficiency	10	0
11. Commercial Projects	10	14
12. Ground Source Heat Pumps	1	1
13. EE Electric Water Heating/Solar	10	9
14. Low-Mod. Income Assist/ESP	200	175
15. Green Schools Program/Kits	1,800	1,800
16. Residential Energy Survey (RES)	100	48
17. Business Green Partners	200	1,469
18. Keep Your Cool	50	36
19. Business LED Pilot	1,000	229
20. LED Business Accent Lighting	700	185
21. LED Exit Sign Direct Install	200	56
22. Residential Green Partners	5,000	3,671
23. Neighborhood Block Party	100	0
24. Million CFLs	40,000	53,304[1]
25. LED Light Swap	750	2,587
26. Misc. Water Efficiency	7,950	7,384[2]

[1] The electricity savings for 23,498 CFLs purchased through the Million CFLs program are credited to the Green Schools program which installed 21,600 CFLs, Low/Medium Income Assistance Energy Saving Partners program which installed 1,513 CFLs and Residential Green Partners which installed 385 CFLs.

[2] 4797 showerheads and aerators purchased by the Miscellaneous Water Efficiency program and installed in the Green Schools program (4,131), Low/Medium Income Assistance Energy Saving Partners program (506), and Residential Green Partners (160).

TDPUD achieved 4.3% greater lifecycle electricity savings with ex post savings of 37,081,572 kWh versus ex ante goal of 35,546,221 kWh. TDPUD exceeded the ex ante E3 Calculator Total Resource Cost (TRC) test goal by 17% with an ex post TRC of 5.14 and the ex ante TRC of 4.4 as shown in **Table 1.2**.[3] The ex post TRC is greater than the ex ante TRC due to 20.5% more measures and lower measure costs due to purchasing measures in bulk and innovative programs. Ex post accomplishments were verified by checking the tracking database, randomly inspecting 1,131 measures at 40 participant sites, and conducting surveys of participants, non-participants, and non-contacts. The EM&V ex post savings are based on site inspections, engineering analysis, and previous evaluation studies of TDPUD programs including light logger data from 2,640 fixtures at 29 sites and pre and post-retrofit utility billing data from 65 sites.

Table 1.2 Ex Ante Goals and Ex Post E3 Cost Effectiveness

Description	Ex Ante Goal	Ex Post Accomplishment
Net Annual Electricity Savings (kWh/yr)	3,665,087	4,007,032
Net Demand Savings (kW)	1,123	1,155
Net Lifecycle Electricity Savings (kWh)	35,546,221	37,081,572
Net Annual Therm Savings (therm/yr)	40,780	37,891
Net Lifecycle Therm Savings (therm)	439,184	378,936
Net Annual Water Savings (gallon/yr)[4]	13,637,465	13,041,224
Net Lifecycle Water Savings (gallon)	141,624,630	130,285,584
Total Resource Cost (TRC) Test – E3	**4.4**	**5.14**
TRC Test Costs	$798,785	$732,691
TRC Test Benefits	$3,504,944	$3,769,485
TRC Test Net Benefits	$2,706,159	$3,036,794
Participant Test	**0.9**	**1.0**
Participant Test Costs	$536,362	$462,250
Participant Test Benefits	$459,985	$464,281
Participant Test Net Benefits	($76,377)	$2,031

The ex ante first-year savings are summarized in **Table 1.3**. The first-year net ex ante program savings are 3,665,087 kWh per year, 1,123 kW per year, 38,815 therms per year, and 12,728,736 gallons of water per year.

Table 1.3 Ex Ante First-Year Electricity, Natural Gas, and Water Savings

Energy Efficiency Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm)	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 (therm)	Net Ex Ante Program Savings (galyr)
1. Residential CFLs	10.6	0.003			0.8	8,499	2.4		
2. Energy Star Clothes Washers	194.6	0.075			0.8	31,134	12		
3. Energy Star Dishwashers	235.9	0.093			0.8	28,304	11.2		
4. Energy Star Refrigerators	176.9	0.070			0.8	28,304	11.2		

[3] Energy and Environmental Economics (E3), Inc. 2010. EE Reporting Tool 2010 (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.

[4] 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.

Table 1.3 Ex Ante First-Year Electricity, Natural Gas, and Water Savings

Energy Efficiency Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm)	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 (therm)	Net Ex Ante Program Savings (galyr)
5. Refrigerator Recycling	1,076.5	0.240			0.84	22,607	5		
6. Building Envelope Testing	0.0	0.000			0.9	0	0		
7. Duct System Testing	0.0	0.000			0.9	0	0		
8. Building Envelope Mitigation	10.0	0.000	11		0.9	90	0	31	
9. Duct System Mitigation	25.0	0.100	28		0.9	225	0.9	77	
10. Window Thermal Efficiency	160.0	0.531			0.8	1,280	4.2		
11. Commercial Lighting Projects	17,700.0	8.700			0.96	169,920	83.5		
12. Ground Source Heat Pumps	775.0	0.000			0.9	698	0		
13. EE Electric Water Heat/Solar	57.3	0.000			1	573	0		
14. Low-Mod Income Assist/ESP	600.0	0.181	17	1,962	0.8	96,000	28.9	2,447	295,771
15. Green Schools Program/Kits	510.0	0.154	1		0.8	734,331	221.2	1,360	
16. Residential Energy Survey	466.9	0.141	20	2,336	0.8	37,354	11.3	613	77,263
17. Business Green Partners	53.1	0.015			0.96	10,199	2.9		
18. Keep Your Cool	2,400.0	1.200			0.8	96,000	48		
19. Business LED Pilot	26.6	0.008			0.96	25,498	7.7		
20. LED Business Accent Lights	22.8	0.007			0.96	15,299	4.8		
21. LED Exit Sign Direct Install	13.3	0.005			0.96	2,550	1		
22. Residential Green Partners	53.1	0.016			0.96	254,976	76.8		
23. Neighborhood Block Party	53.1	0.020			0.8	4,250	1.6		
24. Million CFLs	58.4	0.018			0.8	1,869,824	563.2		
25. LED Light Swap	35.4	0.011			0.91	24,170	7.3		
26. Misc. Water Efficiency	31.9	0.003	6	1,943	0.8	203,004	17.9	34,287	12,355,702
Total						3,665,087	1,123	38,815	12,728,736

The EM&V ex post first-year savings are summarized in **Table 1.4**. The EM&V study found first-year net ex post program savings of 4,007,032 ± 155,497 kWh per year, 1,155 ± 92 kW per year, 37,891 ± 3,196 therms per year, and 13,041,224 ± 1,148,351 gallons (1,743,358 ± 153,512 CCF) of water per year at the 90 percent confidence level. The net first-year realization rates are 1.09 ± 0.04 for kWh, 1.03 ± 0.08 for kW, 0.98 ± 0.08 for therms, and 1.02 ± 0.09 for water.

Table 1.4 Ex Post First-Year Electricity, Natural Gas, and Water Savings

Energy Efficiency Measure	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm)	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 (therm)	Net Ex Post Program Savings (gal)
1. Residential CFLs	59.5	0.054			0.80	10,615	9.63		
2. Clothes Washers	129.8	0.018	6	5,637	0.80	26,384	3.60	1,280	1,145,438
3. Dishwashers	48.8	0.007	1	430	0.80	8,317	1.24	227	73,272
4. Refrigerator/Freezers	121.0	0.017			0.80	23,427	3.25		
5. Refrigerator Recycling	1,682.0	0.362			0.84	36,735	7.91		
6. Building Envelope Testing	0.0	0.000			0.90	0	0.00		
7. Duct System Testing	0.0	0.000			0.90	0	0.00		
8. Building Envelope Mitigation	82.0	0.068	93		0.90	221	0.18	251	
9. Duct System Mitigation	59.0	0.049	67		0.90	159	0.13	181	
10. Window Thermal Efficiency	160.0	0.531			0.80	0	0.00		
11. Commercial Light Projects	22,125.8	10.899			0.96	297,371	146.48		
12. Ground Source Heat Pumps	25,025.0	13.766			0.90	22,523	12.39		
13. EE Electric Wtr Heat/Solar	178.0	0.024			0.80	1,282	0.17		
14. Low-Mod Income Asst/ESP	836.2	0.180	16	1,962	0.80	117,066	25.17	2,273	274,714
15. Green Schools Program/Kits	714.4	0.162	1		0.80	1,028,699	233.39	1,263	0
16. Residential Energy Survey	811.7	0.174	19	2,336	0.64	24,934	5.34	570	71,762
17. Business Green Partners	56.5	0.051			0.96	79,679	71.92		

Table 1.4 Ex Post First-Year Electricity, Natural Gas, and Water Savings

Energy Efficiency Measure	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm)	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 (therm)	Net Ex Post Program Savings (gal)
18. Keep Your Cool	10,026.0	4.970			0.96	346,497	171.78		
19. Business LED Pilot	96.2	0.030			0.96	21,149	6.60		
20. LED Business Accent Lights	19.6	0.007			0.96	3,481	1.24		
21. LED Exit Sign Direct Install	109.5	0.013			0.96	5,887	0.67		
22. Residential Green Partners	61.2	0.014			0.64	143,866	32.63		
23. Neighborhood Block Party	0.0	0.000			0.80	0	0.00		
24. Million CFLs	59.5	0.014			0.80	1,418,766	321.90		
25. LED Light Swap	23.9	0.022			0.91	56,330	52.16		
26. Misc. Water Efficiency	56.5	0.008	5	1,943	0.80	333,646	47.04	31,846	11,476,038
Total						4,007,032	1,155	37,891	13,041,224
90% Confidence Interval						155,497	92	3,196	1,148,351
Realization Rate						1.09 ± 0.04	1.03 ± 0.08	0.98 ± 0.08	1.02 ± 0.09

The lifecycle electricity and water savings are summarized in **Table 1.5**. The net ex-ante lifecycle program savings are 35,546,221 kWh, 384,586 therms, and 126,914,325 gallons of water. The net ex-post lifecycle program savings are 37,081,572 ± 1,349,301 kWh, 378,936 ± 31,958 therms, and 130,285,584 ± 11,482,865 gallons of water (17,416,649 ± 1,535,036 CCF). The net lifecycle realization rates are 1.04 ± 0.04 for kWh, 0.99 ± 0.08 for therms, and 1.02 ± 0.09 for water.

Table 1.5 Lifecycle Electricity, Natural Gas, 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 (therm)	Net Ex-Ante Lifecycle Program Savings (gal)	Ex Post EUL	Net Ex-Post Lifecycle Program Savings (kWh)	Net Ex-Post Lifecycle Program Savings (therm)	Net Ex-Post Lifecycle Program Savings (gal)
1. Residential CFLs	9	76,493			9	95,533		
2. Clothes Washers	10	311,344			10	263,841	12,802	11,454,384
3. Dishwashers	13	367,952			13	108,119	2,946	952,536
4. Refrigerator/Freezers	18	509,472			18	421,689		
5. Refrigerator Recycling	6	135,642			6	220,409		
6. Building Envelope Testing	5	0			5	0		
7. Duct System Testing	5	0			5	0		
8. Building Envelope Mitigation	18	1,620	551		18	3,985	4,520	
9. Duct System Mitigation	18	4,050	1,380		18	2,867	3,256	
10. Window Thermal Efficiency	25	32,000			25	0		
11. Commercial Projects	11	1,869,120			11	3,271,078		
12. Ground Source Heat Pumps	15	10,463			15	337,838		
13. EE Electric Water Heat/Solar	15	8,595			15	19,224		
14. Low-Mod Income Assist/ESP	15	1,440,000	22,026	2,661,939	9	1,053,592	20,458	2,472,422
15. Green Schools Program/Kits	10	7,343,309	12,236	0	9	9,258,293	11,365	0
16. Residential Energy Survey	15	560,306	5,519	695,364	9	224,409	5,126	645,857
17. Business Green Partners	10	101,990			3	239,036		
18. Keep Your Cool	8	768,000			8	2,771,978		
19. Business LED Pilot	16	407,962			16	338,378		
20. LED Business Accent Lighting	16	244,777			16	55,695		
21. LED Exit Sign Direct Install	16	40,796			16	94,188		
22. Residential Green Partners	9	2,294,784			9	1,294,798		
23. Neighborhood Block Party	9	38,246			9	0		
24. Million CFLs	9	16,828,416			9	12,768,890		
25. LED Light Swap	5	120,848			16	901,275		
26. Misc. Water Efficiency	10	2,030,037	342,873	123,557,022	10	3,336,456	318,462	114,760,384

Table 1.5 Lifecycle Electricity, Natural Gas, 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 (therm)	Net Ex-Ante Lifecycle Program Savings (gal)	Ex Post EUL	Net Ex-Post Lifecycle Program Savings (kWh)	Net Ex-Post Lifecycle Program Savings (therm)	Net Ex-Post Lifecycle Program Savings (gal)
Total		35,546,221	384,586	126,914,325		37,081,572	378,936	130,285,584
90% Confidence Interval						1349,301	31,958	11,482,865
Realization Rate						1.04 ± 0.04	0.99 ± 0.08	1.02 ± 0.09

The required energy impact reporting for 2010 programs is provided in **Table 1.6**.

Table 1.6 Required Energy and Water Impact Reporting for 2010 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)	Ex-Ante Gross Program-Projected Program Water CCF Savings (1)	Ex-Post Net Evaluation Confirmed Program Water CCF Savings (2)
1	2011	4476	4007	1.365	1.155	48,504	37,891	2,126,981	1,743,358
2	2012	4476	4007	1.365	1.155	48,504	37,891	2,126,981	1,743,358
3	2013	4476	4007	1.365	1.155	48,504	37,891	2,126,981	1,743,358
4	2014	4476	3927	1.365	1.083	48,504	37,891	2,126,981	1,743,358
5	2015	4476	3927	1.365	1.083	48,504	37,891	2,126,981	1,743,358
6	2016	4450	3927	1.357	1.083	48,504	37,891	2,126,981	1,743,358
7	2017	4423	3891	1.351	1.075	48,504	37,891	2,126,981	1,743,358
8	2018	4423	3891	1.351	1.075	48,504	37,891	2,126,981	1,743,358
9	2019	4303	3544	1.291	0.903	48,504	37,891	2,126,981	1,743,358
10	2020	1684	800	0.502	0.275	48,504	33,785	2,064,646	1,697,041
11	2021	463	440	0.186	0.225	3,945	659	0	9,795
12	2022	286	143	0.099	0.078	3,945	659	0	9,795
13	2023	286	143	0.099	0.078	3,945	659	0	9,795
14	2024	251	134	0.085	0.077	3,945	432	0	0
15	2025	251	134	0.085	0.077	3,945	432	0	0
16	2026	82	111	0.034	0.064	119	432	0	0
17	2027	37	24	0.020	0.004	119	432	0	0
18	2028	37	24	0.020	0.004	119	432	0	0
19	2029	2	0	0.005	0.000	0	0	0	0
20	2030	2	0	0.005	0.000	0	0	0	0
Total		43,360	37,081			505,119	378,936	21,207,472	17,416,649

** 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 energy efficiency program portfolio ranked by ex post TRC is shown in **Table 1.7**.

Table 1.7 TDPUD Energy Efficiency Program Portfolio Ranked by Ex Post TRC

	Net Demand Savings (kW)	Net Coincident Peak Savings (kW)	Net Annual Energy Savings (kWh)	Net Lifecycle Energy Savings (kWh)	Net Lifecycle Gas Savings (MMBtu)	Net Lifecycle GHG Reduction (Tons)	Utility Cost ($/kWh)	Total Resource ($/kWh)	Ex Post TRC
TOTAL EE PORTFOLIO	3,166	1,155	4,007,032	37,081,572	37,894	19,880	0.02	0.02	5.14
26. Misc. Water Efficiency	47	47.04	333,646	3,336,456	31,846	1,785	0.01	0.01	16.4
15. Green Schools Kits	934	233.39	1,028,699	9,258,293	1,137	4,942	0.01	0.01	16.3
24. Million CFLs	1,288	321.90	1,418,766	12,768,890		6,816	0.01	0.01	12.6
5. Refrigerator Recycling	8	7.91	36,735	220,409		120	0.02	0.01	10.4
1. Residential CFLs	10	9.63	10,615	95,533		51	0.01	0.01	9.5
12. Ground Source HP	12	12.39	22,523	337,838		188	0.03	0.03	5.4
20. LED Bus. Accent Lights	1	1.24	3,481	55,695		31	0.03	0.03	4.8
11. Commercial Projects	146	146.48	297,371	3,271,078		1,813	0.04	0.04	4.0
22. Res. Green Partners	131	32.63	143,866	1,294,798		691	0.04	0.04	2.9
18. Keep Your Cool	172	171.78	346,497	2,771,978		1,461	0.05	0.05	2.4
25. LED Light Swap	209	52.16	56,330	901,275		481	0.09	0.09	1.7
6-9. Bldg. Env./Duct Repair		0.32	381	6,853	778	4	1.14	1.14	1.6
19. Business LED Pilot	7	6.60	21,149	338,378		188	0.11	0.11	1.5
17. Bus. Green Partners	72	71.92	79,679	239,036		132	0.08	0.08	1.4
4. Refrigerator/Freezers	3	3.25	23,427	421,689		229	0.06	0.06	1.4
13. EE Elec. Wtr Heat/Solar		0.17	1,282	19,224		10	0.09	0.10	1.4
21. LED Exit Sign Install	1	0.67	5,887	94,188		50	0.11	0.11	1.3
14. Low-Mod Income ESP	101	25.17	117,066	1,053,592	2,046	562	0.10	0.10	1.3
16. Res. Energy Survey	21	5.34	24,934	224,409	513	120	0.11	0.11	1.2
2. Clothes Washers	4	3.60	26,384	263,841	1,280	146	0.15	0.15	1.1
3. Dishwashers	1	1.24	8,317	108,119	295	60	0.29	0.29	0.6
10. Window Thermal Eff.							0.00	0.00	0.0
23. Neighbor Block Party							0.00	0.00	0.0

The TDPUD energy efficiency portfolio utility cost is $0.02/kWh and the net lifecycle green house gas (GHG) reductions are 19,880 tons. TDPUD programs realized a 5.14 TRC which is 17% greater than anticipated due to installing 20.5% more measures through innovative community-based programs. The top ten programs have an average TRC of 8.5. The Miscellaneous Water Efficiency program realized a TRC of 16.4 and 64% greater savings due to electricity savings from water pumping and therm savings from units installed at sites with gas water heaters. The Green Schools program realized a TRC of 16.3 and 26% greater savings than anticipated by distributing conservation kits in reusable canvas bags to all K-8 students throughout the TDPUD service area (6 schools). The conservation kits were prepared by the Sierra Watershed Education Partnership and distributed at school assemblies by the Truckee High School Bright Schools/Envirolution club. The Million CFLs program realized a TRC of 12.6 and 30% greater savings by purchasing CFLs in bulk at low cost and distributing and installing CFLs through multiple programs. The Refrigerator Recycling program realized a TRC of 10.4 and 62.5% greater savings than anticipated due to recycling one more unit and 56% greater unit savings based on measured data from 50 recycled units (in the 2005 EM&V study). Residential CFLs realized a TRC of 9.5 and 24.9% greater savings than anticipated due to greater unit savings. Ground Source Heat Pumps have a projected TRC of 5.4 based on greater savings but the unit is awaiting installation by the Towne of Truckee. LED Business Accent Lighting realized a TRC of 4.8 and 24.9% greater savings than anticipated due to greater unit savings. Commercial Lighting Projects realized a TRC of 4.0 and 75% greater savings than anticipated due to 40% more projects and 25% greater savings per site. Residential Green Partners realized a TRC of 2.9 and 43.6% less savings than anticipated due 26.4% fewer units

installed. Keep Your Cool realized a TRC of 2.4 and 261% greater savings than anticipated due to greater unit savings and direct installation by the Efficiency Services Group, an experienced energy services company. The LED Holiday Light Swap program realized a TRC of 1.7 and 750% greater savings than anticipated due to installing 244.9% more lights (quantity of 2,587 ex post versus 750 ex ante) and 3.2 times longer EUL (16 years ex post versus 5 years ex ante). Low-Moderate Income Assistance/Energy Saving Partners realized a TRC of 1.3 due to greater unit savings and providing a customized audit for each customer site with free measures for each site based on the audit. TDPUD offered a wide range of innovative and successful programs for residential and commercial lighting, water heaters, and Energy Star™ 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. Two programs did not realize any participation: Thermally-efficient Windows and Energy Efficient Neighborhoods. TDPUD partnered with several organizations in Truckee to implement projects including: Sierra Watershed Education Partnership, Truckee High School Bright Schools/Envirolution club, Sierra Business Council, Sierra Green Building Association, Truckee Climate Action Network, Town of Truckee, Truckee Home & Building Show, Tahoe-Truckee USD, Nevada County, Truckee River Watershed Council, Truckee Chamber and the Truckee Downtown Merchant's Association.

Participant and non-participant process surveys were used to obtain general feedback and suggestions. Survey results indicate 93.6 percent of participants are satisfied with the program based on 922 survey responses to 35 questions from 40 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 9.65 ± 0.25 out of 10 points. Participants indicated that they would like to see improved programs to better serve TDPUD customers. Non-participant survey results indicate 70 percent would have participated if they had known about the program with 15% declining due to already having compact fluorescent lamps installed, and 15% being too busy or not understanding energy efficiency program benefits. Most customers indicated better advertising, education (i.e., information about savings), and more variety of measures 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), make, model number, USDOE FTC energy label rating (kWh/yr), CEE rating (Consortium for Energy Efficiency, www.cee1.orgm Tier 1, 2 or 3), efficiency rating (AFUE, MEF, WF, EF, etc.), 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.

- Offer incentives based on CEE Tier levels (Tier 2 for dishwashers and Tier 2 and 3 for clotheswashers and refrigerators). Identify products based on CEE Tiers levels through the www.tdpud.org website and work cooperatively with retailers to advertise CEE Tier ratings that exceed Energy Star®.
- Improve the residential energy surveys and energy saving partner surveys by having the surveyor install measures and provide more energy efficient lamps such as dimmable CFLs, candelabra, reflectors, and 3-way bulbs 13/23/40W CFL to replace 50/100/150W incandescent.
- Work with Southwest Gas to develop jointly funded programs and incentives for measures that save gas, electricity, and water such as CEE Tier 2 dishwashers, CEE Tier 2 and 3 clotheswashers, Energy Star® duct sealing, building envelope repair, WaterSense® showerheads and aerators, Energy Star® furnaces, Energy Star® water heaters, Energy Star® solar water heaters, and solar sun spaces or passive solar heating.
- Develop and implement an internet verification system to ensure that measures are properly installed to increase savings, cost effectiveness, and reduce lost opportunities.
- Educate customers about comparable CFL and LED replacements in terms of lumens. 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), 3-way 13/23/40W, and fully-dimmable CFLs, and candelabra, to increase savings, acceptance and persistence of CFL savings.
- Purchase large quantities of US EPA® Water Sense® 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.
- Consider incentives for US EPA® Water Sense® (class V) 1.28 gallon per flush toilets.
- Offer incentives for efficient motor systems such as electronic commutated (EC) motors or brushless permanent magnet (BPM) motors and efficient fans and motor systems.
- Implement quarterly neighborhood energy efficiency BBQ block party offering CFLs, WaterSense showerheads, aerators, toilets, and comprehensive measures at neighborhood leadership homes such as duct sealing, building envelope repair, insulation, Energy Star® window upgrades, EC motor furnace fans, and Energy Star® programmable thermostats.
- Implement the California Energy Upgrade program (https://energyupgradeca.org/overview) in TDPUS which includes a $2,000 incentive for saving 20% with 6 prescriptive measures and up to $5000 for saving 50% with custom measures. The 20% prescriptive measures include: 1) building envelope repair to 0.35 ACH, 2) duct sealing to 10%, 3) attic insulation to R60 (with radiant barrier), 4) WaterSense showerheads/aerators, 5) water heater wrap, 5) pipe insulation, and 6) CO/smoke alarm.
- Rename the duct mitigation program to the Energy Star® ducts (15% reduction with Tier 2 of 10% similar to California Energy Upgrade) and rename the window thermal efficiency program to the Energy Star® windows program.

- Offer incentives for passive solar heating and sun spaces with thermal mass, super insulation (attic, wall, floor, and radiant barriers) with the TDPUD building envelope repair and duct sealing programs. Consider at least one pilot demonstration sun space project in 2011 at the Senior Center where billing data for one unit with a temporary plastic sun space enclosure reduced the heating bill by 50%.
- Consider offering incentives for conservation gardens and landscaping to save water using the Patricia S. Sutton TDPUD Conservation Garden as an example.
- Provide better advertising to increase participation including bill inserts, internet information, handouts or fliers that tell customers about the program, funding source, and free services.
- Offer incentives for occupancy sensors for commercial lighting and plug loads and offer rebates for Energy Star® LED 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 energy efficiency programs 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 participant and non participant decision-maker survey instrument for the TDPUD Energy Saving Partner, Residential Energy Survey, and Residential Green Partner programs.

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 Truckee Donner Public Utility District 2008 Energy Efficiency Programs*, Prepared by Robert Mowris & Associates, February 2009.
2	*Evaluation Measurement and Verification Report for the Small Nonresidential Energy Fitness Program #179*, Prepared by Robert Mowris & Associates, April 30 2004.
3	*Measurement & Verification Summary Report for NCPA SB5X Programs* prepared for NCPA and the California Energy Commission, 2005.
4	*Measurement and Verification Report for NCPA SB5X Commercial and Industrial Lighting Programs*, prepared for NCPA, prepared by RMA, 2005.
5	*Measurement and Verification Report for NCPA SB5X Refrigerator Recycling Programs*, prepared for NCPA, prepared by RMA, 2005.
6	*Measurement and Verification Report for NCPA SB5X Residential Compact Fluorescent Lamp Programs*, prepared for NCPA, prepared by RMA, 2005.
7	*Measurement and Verification Report for NCPA SB5X Miscellaneous Programs*, prepared for NCPA, prepared by Robert Mowris & Associates, 2005.
8	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/.
9	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.
10	Energy Efficient Showerhead and Faucet Aerator Metering Study Multifamily Residences: A Measurement and Evaluation Report. October 1994. Prepared by SBW Consulting, Inc. Prepared for BPA. http://www.bpa.gov/energy/n/reports/evaluation/residential/faucet_aerator.cfm.
11	*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 energy, peak demand, water 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

Measure	Unit	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm)	Gross Ex-Ante Unit Savings (gal/yr)	EUL	NTG Ratio	Unit Goals
1. Residential CFLs	Unit	10.6	0.003			9	0.8	1,000
2. Clothes Washers	Unit	194.6	0.075			10	0.8	200
3. Dishwashers	Unit	235.9	0.093			13	0.8	150
4. Refrigerator/Freezers	Unit	176.9	0.070			18	0.8	200
5. Refrigerator Recycling	Unit	1,076.5	0.240			6	0.84	25
6. Building Envelope Testing	Unit	0.0	0.000			5	0.9	20
7. Duct System Testing	Unit	0.0	0.000			5	0.9	20
8. Building Envelope Mitigation	Unit	10.0	0.000	4		18	0.9	10
9. Duct System Mitigation	Unit	25.0	0.100	10		18	0.9	10
10. Window Thermal Efficiency	Unit	160.0	0.531			25	0.8	10
11. Commercial Projects	Site	17,700.0	8.700			11	0.96	10
12. Ground Source Heat Pumps	Unit	775.0	0.000			15	0.9	1
13. EE Electric Water Heating/Solar	Unit	57.3	0.000			15	1	10
14. Low-Mod. Income Assist/ESP	Site	600.0	0.181	35	5,610	15	0.8	200
15. Green Schools Program/Kits	Kit	510.0	0.154	14	2,770	10	0.8	1,800
16. Residential Energy Survey	Site	466.9	0.141	39	6,182	15	0.8	100
17. Business Green Partners	Unit	53.1	0.015			10	0.96	200
18. Keep Your Cool	Site	2,400.0	1.200			8	0.8	50
19. Business LED Pilot	Unit	26.6	0.008			16	0.96	1,000
20. LED Business Accent Lighting	Unit	22.8	0.007			16	0.96	700
21. LED Exit Sign Direct Install	Unit	13.3	0.005			16	0.96	200
22. Residential Green Partners	Site	53.1	0.016			9	0.96	5,000
23. Neighborhood Block Party	Site	53.1	0.020			9	0.8	100
24. Million CFLs	Unit	58.4	0.018			9	0.8	40,000
25. LED Light Swap	Unit	35.4	0.011			5	0.91	750
26. Misc. Water Efficiency	Unit	31.9	0.003	7	3,722	10	0.8	7,950

The intended ex ante energy and peak demand results for the TDPUD programs are 3,665,087 first-year kWh, 1,123 kW, 35,546,221 lifecycle kWh. This was to be accomplished through the installation of 59,716 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 4.4 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. Residential Compact Fluorescent Lamps (CFL)

The Residential CFL program provides rebates to TDPUD residential customers to replace existing incandescent and halogen lamps with compact fluorescent lamps (CFL) or light emitting diode (LED) lamps. The rebate of $2 per CFL or LED is a credit on the customer's bill. Multi-family customers must purchase and install at least 5 CFLs and single-family customers must purchase and install at least 10 CFLs to receive the $2 per bulb rebate. 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 250W or more and can be replaced with CFLs using 4 to 65W. 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 "Residential CFL" average ex ante savings are 10.6 kWh/yr and 0.003 kW, and the "Million CFL" average ex ante savings are 59.5 kWh/yr and 0.018 kW. Ex ante deemed savings for other CFL measures included in the TDPUD programs are shown in **Table 2.4**.

Table 2.4 Ex Ante Savings for CFLs

#	Description	Units	Savings per unit kWh	Demand Savings per unit kW	Annual Hours of Operation per unit	Savings per unit therm	Savings per unit Gallons	EUL	Ex Ante NTGR
1	Residential CFL	Unit	10.6	0.003	193.6	n/a	n/a	9.0	0.8
24	Spiral 13/60 (Million CFL)	Unit	59.5	0.018	1,102.1	n/a	n/a	9.0	0.8
	Spiral 13/60	Unit	59.5	0.054	1,101.9	n/a	n/a	9.0	0.8
	Spiral 23/100	Unit	84.8	0.077	1,101.3	n/a	n/a	9.0	0.8
	Globe G25 9/40	Unit	32	0.029	1,103.4	n/a	n/a	9.0	0.8
	R20 14/50	Unit	39.7	0.036	1,102.8	n/a	n/a	9.0	0.8
	R30 15/65 **	Unit	55.1	0.05	1,102.0	n/a	n/a	9.0	0.8
	R30 15/65Dim **	Unit	55.1	0.05	1,102.0	n/a	n/a	9.0	0.8
	PAR38 23/90 **	Unit	73.8	0.067	1,101.5	n/a	n/a	9.0	0.8
	PAR38 23/120 **	Unit	106.9	0.097	1,102.1	n/a	n/a	9.0	0.8

2. Energy Star® Clothewashers, Dishwashers, and Refrigerators

Rebates are provided for Energy Star qualifying clothes washers, dishwashers and refrigerators/freezers. The rebate of $100 per unit is mailed to qualifying customers. Energy Star® qualified appliances incorporate advanced technologies that use 20% less energy than the US Federal Standard (www.energystar.gov). The Consortium for Energy Efficiency (CEE, www.cee1.org) provides high-efficiency specifications for appliances that are more efficient than the Federal Standard. Energy Star® and CEE provided lists of qualifying appliances.

The Energy Star® and CEE efficiency levels for clotheswashers are shown in **Table 2.5**.

Table 2.5 Energy Star and CEE Tier Efficiency Levels for Clotheswashers

#	Description	Modified Energy Factor (MEF)[1]	Water Factor (WF)[2]
	Federal Standard	1.26	9.5
0	Energy Star®	2.00	6.0
1	CEE Tier 1	2.00	6.0
2	CEE Tier 2	2.20	4.5
3	CEE Tier 3	2.40	4.0

Note: 1. MEF is a combination of Energy Factor and Remaining Moisture Content. MEF measures energy consumption of the total laundry cycle (washing and drying). It indicates how many cubic feet of laundry can be washed and dried with one kWh of electricity; the higher the number, the greater the efficiency.

Note 2. WF is the number of gallons needed for each cubic foot of laundry. A lower number indicates lower consumption and more efficient use of water.

The Energy Star® and CEE efficiency levels for dishwashers are shown in **Table 2.6**.

Table 2.6 Energy Star and CEE Tier Efficiency Levels for Dishwashers

#	Description	Minimum Energy Factor	Maximum kWh/year	Maximum gallons/cycle
	Standard Dishwashers[1]			
	Federal Standard	No Requirement	355	6.50
0	Energy Star®	No Requirement	324	5.80
1	CEE Tier 1	0.72	307	5.00
2	CEE Tier 2	0.75	295	4.25
	Compact Dishwashers[2]			
	Federal Standard	No Requirement	260	4.50
0	Energy Star®	No Requirement	234	4.00
1	CEE Tier 1	1.00	222	3.50

Note 1. Standard dishwashers hold fewer than eight place settings.

Note 2. Compact dishwashers hold eight or more place settings.

The Energy Star® and CEE efficiency levels for refrigerators are shown in **Table 2.7**.

Table 2.7 Energy Star and CEE Tier Efficiency Levels for Refrigerators

#	Description	Compact Refrigerator[1] Efficiency Above Federal Standard	Mid- and Full-Size[2] Refrigerator Efficiency Above Federal Standard
0	Energy Star®	20%	20%
1	CEE Tier 1	20%	20%
2	CEE Tier 2	25%	25%
3	CEE Tier 3	30%	30%

Note 1. Compact refrigerators have interior volume smaller than 7.75 ft^3.

Note 2. Mid- and full-size refrigerators have interior volume greater than or equal to 7.75 ft^3.

Ex ante savings for TDPUD 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 10 to 40 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 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 are 194.6 kWh/yr and 0.075 kW for Energy Star® clotheswashers, 235.9 kWh/yr and 0.093 kW for Energy Star® dishwashers, and 176.9 kWh/yr and 0.070 kW for Energy Star® refrigerators.

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
3a	Energy Star® Clothes Washer	Unit	0.075	NA	194.6	n/a	15	0.8
3b	Energy Star® Dishwasher	Unit	0.093	NA	235.9	n/a	15	0.8
3c	Energy Star® Refrigerator	Unit	0.070	NA	176.9	n/a	15	0.8

3. Refrigerator and Freezer Recycling

The Refrigerator and Freezer Recycling Program works with recycling contractor JACO Environmental, to remove and recycle existing units. Customers may receive a cash rebate for allowing TDPUD to remove and recycle their first, second, third or fourth refrigerator or freezer. Once approved, TDPUD will have the refrigerator/freezer recycling company make an appointment with the customer to pick up the old refrigerators and/or freezers from their home or business. Qualifying customers receive a $30 rebate for each refrigerator or freezer being removed and 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.[5] TDPUD assumed annual ex ante energy savings of 1,076.5 kWh/yr and 0.240 kW.

4. Building Envelope and Duct System Mitigation

The Building Envelope and Duct System Mitigation program provides rebates for pressurization testing and sealing of the building envelope (i.e., floors, walls and ceiling) and/or duct system. A leakage test and the building envelope and/or distribution system mitigation must be completed and documented to receive rebates. The testing rebate is $75 per home or business receiving a duct test or blower door test to measure the air leakage. 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 1.0 or more air changes per hour (ACH) to less than 0.3 ACH. Building leakage is tested using a blower door. Duct test and seal involves sealing the

[5] 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/.

forced air unit (FAU) and supply/return ducts to 15% (or less) of the measured total system air flow at 25 Pascal pressure (supply and return). Duct testing is performed using duct pressurization equipment and duct sealing is performed using UL-rated metal or mastic tape or UL-rated mastic sealant. The assumed baseline is 29% duct leakage going to 15% for a 14% reduction or 60 cfm/ton. TDPUD assumed ex ante savings for building envelope mitigation of 10 kWh/year, 0 kW, and 4 therm/year and for duct mitigation 25 kWh/year, 0.1 kW, and 10 therm/year.

5. Window Thermal Efficiency

The Thermally Efficient Windows program provides rebates for double or triple-pane low-emissivity windows with vinyl or wood clad frames (aluminum framed windows do not qualify unless they have documented thermal break built into the aluminum frame which increases its r-value to level similar to vinyl and wood-framed windows). Customers who install qualifying windows and window frames will receive a cash rebate. In order to qualify, the existing windows being replaced must be single-pane windows and the customer must be currently using a permanent electric space heating system as their primary source of heating. The incentive is $5 per square feet of thermally-efficient windows and frames. 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 160 kWh/year-unit and 0.531 kW/unit.

6. Attic and Wall Insulation

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 did not implement any attic or wall insulation rebates in 2010.

7. Commercial Lighting Projects (T-8 Lamps/Electronic Ballasts, Delamping, Occupancy Sensors, LED Exit Signs)

The Commercial Lighting Projects program provides incentives to TDPUD commercial customers to replace their existing inefficient lamps and/or lighting systems with energy efficient lamps or lighting systems. Commercial customers receive a rebate equal to 1/3 the cost of qualifying lighting measures/fixtures purchased and installed up to a maximum rebate of $10,000 per customer applicant. The rebate applies to both the capital purchase of lighting measures as well as the labor cost to install the energy efficient lamps and lighting fixtures. Standard lamp/fixtures must be replaced with T8, T5, or T2 lamps with electronic ballasts as well as induction, LED or other more energy-efficient lighting options. 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 121 kWh/yr and 0.0436 kW (based on two lamp fixtures). The ex ante savings for T-8 lamps with electronic ballasts are shown in **Table 2.9**. TDPUD assumed average gross ex ante savings per project of 17,700 kWh/year and 8.7 kW.

Table 2.9 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
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. TDPUD assumed average ex ante savings for delamping of 256 kWh/year and 0.094 kW. The ex ante savings for delamping are shown in **Table 2.10**.

Table 2.10 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
2g	Delamp T12 F40/Mag Ballast – 1 Lamp	Unit	0.044	4,000	176	n/a	16	0.96
2h	Delamp T12 F40/Mag Ballast – 2 Lamp	Unit	0.082	4,000	328	n/a	16	0.96
2i	Delamp T12 F96/Mag Ballast – 1 Lamp	Unit	0.064	4,000	256	n/a	16	0.96
2j	Delamp T12 F96/Mag Ballast – 2 Lamp	Unit	0.128	4,000	512	n/a	16	0.96

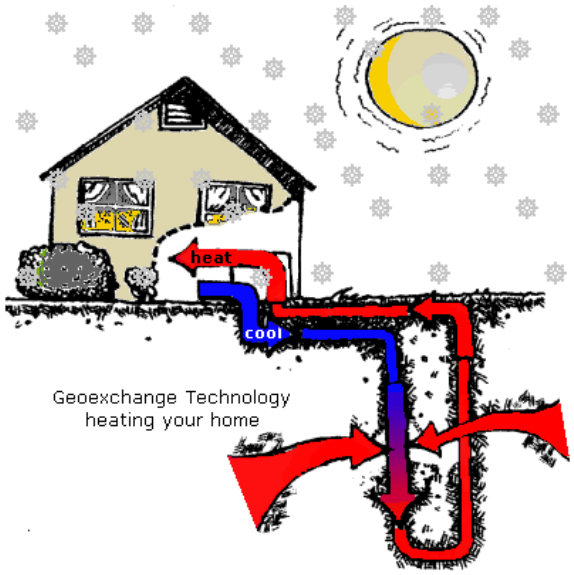
Occupancy sensors are used to automatically turn on and off lights depending upon occupancy conditions. They can be wall mounted or ceiling mounted, passive infrared (PIR) or ultrasonic. Occupancy sensors are reliable, market tested products, but require proper installation and calibration. Understanding 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 savings for motion sensors are 0.089 kW and 417 kWh/yr.

8. Ground Source Heat Pump

The Ground Source Heat Pump Program provides rebates for the purchase and installation of a new ground source heat pump system. The rebate of $200 per ton per unit is a rebate check mailed directly to the customer. 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

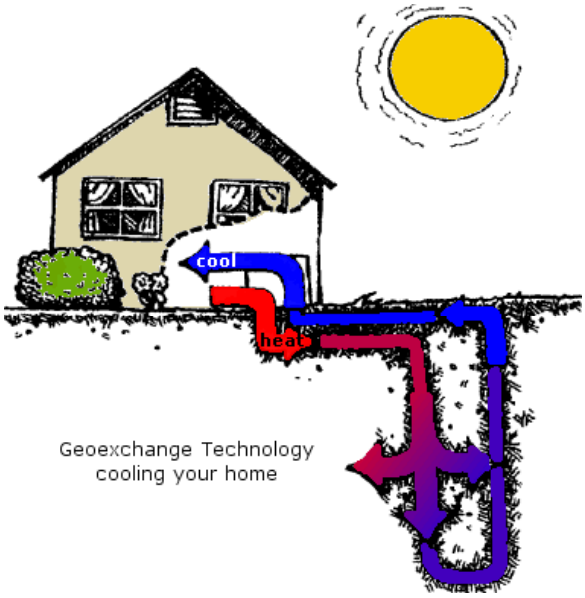
world's regions remains stable between 45 and 70 degrees Fahrenheit (°F). This is why well water drawn from below ground tastes cool even on the hottest summer days. In winter, it is much easier to capture heat from the soil at a moderate 50°F temperature than from the atmosphere when the air temperature 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. Comparing the GSHP to a conventional heating, ventilating and air conditioning (HVAC) system with gas heating will increase electricity use for heating and yield negative electricity savings. 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).[6] The GSHP savings are positive with an electric space heating baseline. TDPUD assumed an electric space heating baseline and annual ex ante savings of 775 kWh/year and peak demand savings 0.0 kW.

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.



[6] Mowris, R., Blankenship, A., Jones, E. 2004a. EM&V Report for the Residential Ground Source Heat Pump Program. Prepared for Redding Electric Company, Redding, Calif

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.



9. Energy Efficient Water Heaters (Solar Water Heaters, Geothermal Water Heaters)

The Energy Efficient Electric, Solar and Geothermal Water Heater Rebate program provides a rebate of $2 per gallon rebate for removing an existing electric water heater and replacing it with a high efficiency electric water heater, 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.[7] Average electric water heater unit energy consumption (UEC) is 3,354 kWh/year.[8] 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. TDPUD assumed average ex ante unit savings of 57.2 kWh/year and 0 kW. The ex ante effective useful lifetime is 15 years.

[7] 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.

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

10. Low-Moderate Income Assistance Energy Saving Partners (ESP)

The Low-Moderate Income Assistance Energy Savings Partners (ESP) program provides income qualifying TDPUD customers with a free energy survey and free energy and water conservation measures. The program targets income-qualifying customers who meet the Nevada County's income guidelines or who have had a documented 25% or more reduction in income in the last 12 months. Program participants will receive comprehensive energy efficiency measures such as CFLs, pipe insulation, water heater jackets, door sweeps, weather-stripping, and water efficiency measures. ESP participants receive up to a one-time $200 voucher based on their highest electric bill in the last 12 months not to exceed $200. The program marketing efforts include information in the TDPUD bill, newspapers, and flyers and through the agencies that provide them with assistance. TDPUD contracted with the Family Resource Center of Tahoe-Truckee and the Sierra Green Building Association to qualify customers and perform the residential energy surveys. TDPUD assumed average ex ante site savings of 600 kWh/year, 0.181 kW, 17 therm/year, and 1,962 gallons/year. The ex ante effective useful lifetime is 15 years.

11. Green Schools Conservation Kits

The Green Schools Program consisted of providing all K-8 students at 6 schools throughout the TDPUD electric service area with Conservation kits consisting of CFL 60 Watt equivalent spiral 12-packs, low-flow showerhead, 2 faucet aerators, water heater pipe insulation elbow, toilet leak detection kits, 2 LED night lights, shower use timer and conservation education materials. The kits are prepared by the Sierra Watershed Education Partnership and given away at school assemblies by the Truckee High School Bright Schools/Envirolution environment club during community Trashion Fashion shows. Measures are distributed to the students in re-useable canvas bags. TDPUD assumed average ex ante kit savings of 510 kWh/year, 0.154 kW, and 1 therm/year. The effective useful lifetime is 10 years.

12. Residential Energy Survey

The Residential Energy Survey (RES) program provides free energy audits surveys and conservation measures for any TDPUD residential electric customer. RES is a component of the District's Energy Savings Program (ESP), but with no income-qualifying guidelines or direct financial assistance. The same measures are given away during the on-site energy audit performed by auditors from the Sierra Green Building Association. TDPUD assumed average ex ante site savings of 466.9 kWh/year, 0.141 kW, 20 therm/year, and 2,336 gallons/year. The ex ante effective useful lifetime is 15 years.

13. Business Green Partners

The Business Green Partners program provides free energy and water-saving measures to retail, restaurant, hospitality and other TDPUD business customers. A "Green Partner" label is provided to participating customer/partners to show that the business meets minimum program requirements. This program is heavily dependent on direct contact with the owners and managers of these businesses. Participating customers/demonstration sites show how efficient lighting works. TDPUD works with restaurants to install energy efficient lighting, dishwashing

(machines and pre-rinse spray valves), refrigeration, and HVAC. TDPUD also works with hotels, motels, and resorts and other businesses to implement energy efficient lighting, controls, HVAC, water heating, pool/spa, restaurant, renewable energy and green building technologies. TDPUD assumed average ex ante savings of 53.1 kWh/year and 0.015 kW. The ex ante effective useful lifetime is 10 years.

14. Keep Your Cool

Keep Your Cool program provides direct-install energy efficiency measures for display refrigeration systems at commercial convenience, grocery and other Truckee-area stores using commercial-grade refrigeration equipment. The measures that we're installed in 2010 through KYC include: new refrigeration gaskets, cooler case strip curtains, automatic door closers for walk-in coolers, electronically-commutated refrigeration motors. The KYC program will continue in 2011 with the same plus some new refrigeration energy-efficiency measures. Truckee businesses must be TDPUD electric customers in order to participate. TDPUD assumed average ex ante site savings of 2,400 kWh/year and 1.2 kW. The ex ante effective useful lifetime is 8 years.

15. Business LED Pilot

The Business LED Pilot program involves working with Truckee business customers on trying out a multitude of different LED lights, both screw-in and plug-in. TDPUD so far has provided business with LED R & PAR 20, 30 and 38 lamps and MR-16s, both dimmable and non-dimmable. The purpose of the program is to educate and demonstrate the LED lighting technology to the community and to see what lamps and applications work best to replace less energy-efficient lighting technologies. TDPUD assumed average ex ante savings of 26.6 kWh/year and 0.008 kW. The ex ante effective useful lifetime is 16 years.

15. Business LED Accent Lights

The Business Light Emitting Diode (LED) Accent Lighting program provides Truckee businesses with .6 to 2 Watt LED lights to replace 7.5-10 Watt incandescent strand lights. In order for customers to receive the new high efficiency LED strand bulbs, they must have an existing commercial-grade light strand to switch out the old bulbs to the new ones. TDPUD assumed average ex ante savings of 22.8 kWh/year and 0.008 kW. The ex ante effective useful lifetime is 16 years.

16. LED Exit Signs

The Light Emitting Diode (LED) Exit Sign Direct Install program provides direct installation of LED energy efficient exit sign retrofit kits for Truckee businesses. TDPUD is able to re-use the older, existing exit signs with retrofit kits that are used to replace incandescent and fluorescent lights in Truckee's businesses existing exit signs. The ability to re-use existing exit signs reduces waste/disposal, reduces the cost of the program and increases the program's cost-effectiveness. 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. 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. TDPUD assumed average ex ante savings for LED exit signs of 13.3 kWh/year and 0.005 kW. The assumed ex ante effective useful lifetime is 16 years. The estimated energy savings for three different LED exit signs are shown in **Table 2.11**.

Table 2.11 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
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

17. Residential Green Partners

The Residential Green Partners program provides information and free energy and water-saving measures to residential customers. The main focus of the program is to hand out 6 different specialty CFL lamps in addition to the CFL 12-packs handed out to all TDPUD customers. The six lamps provided free to customers include: 23 Watt Spirals/100 Watt replacements, 11 Watt globe lights/40 Watt replacements, 13 Watt R-20s/50 watt replacement reflector lamps, 15 Watt R-30s, both dimmable and non-dimmable /65 Watt replacements and 23 Watt PAR lamp/120 Watt replacements. This program involves customers stopping by the TDPUD Conservation office and selecting any mix of 12 of these bulbs for free. Customers may try the bulbs and trade them for other bulbs within the mix. The program gives customers the opportunity to figure out what CFLs they like best and to purchase additional ones from retailers and take advantage of TDPUD's residential CFL $2/bulb lighting rebate program. TDPUD assumed average ex ante savings of 53.1 kWh/year and 0.016 kW. The ex ante effective useful lifetime is 9 years.

18. Neighborhood Block Party

The Neighborhood Block Party is a collaborative event with other public agencies and provides information, energy surveys, and free energy and water saving measures to residential customers through well organized and advertised block parties. The Block Parties are held in two Truckee neighborhoods each year and provide local service providers an opportunity to exhibit and share information about their community services. TDPUD has its own exhibit which includes a table full of the give-a-way energy and water efficiency measures including the offer for a free home energy survey on the spot. TDPUD assumed ex ante unit savings of 53.1 kWh/year and 0.02 kW. The effective useful life is 9 years.

19. Million CFLs

The Million CFL program includes free CFL 12-packs with 60 Watt equivalent spirals and information regarding the recycling of non-working and broken CFLs to prevent mercury from going to landfills. The goal is to install one million CFLs over 10 years by providing free CFL 12-packs and other high efficiency lights. There are approximately 600,000 to 1,000,000 inefficient lamps including incandescent screw-in, MR16, inefficient fluorescent, HID, ect. in the TDPUD service area. Most residential sites have 25 to 150 incandescent light bulbs per dwelling unit. TDPUD will provide all residential customers with a 12 pack of CFLs which includes handing them out at the Truckee Home & Building Show and other community events. Commercial customers have approximately 50-200 or more incandescent light bulbs per site. TDPUD provides all businesses with a 12 pack of CFLs and hands them out at Truckee business events such as Chamber Mixers. TDPUD staff occasionally goes door to door to visit businesses providing them with the 12 packs along with a package of information about current TDPUD program offerings. TDPUD also purchases a large selection of efficient lighting to include specialty lighting such as dimmable CFLs, cold-temp CFLs and a variety of other CFLs replacing less efficient lighting sources. The "Million CFL" average ex ante savings are 59.5 kWh/yr and 0.018 kW.

20. LED Holiday Lights

The Light Emitting Diode (LED) Holiday Light Swap program provides LED Holiday Light Strands to swap out for incandescent strands. Customers can drop off and exchange old Christmas tree lights and receive up to three LED holiday light strands at the TDPUD. Marketing for the program mainly consists of radio spots, newspaper notices and word-of-mouth. TDPUD has also developed an LED Christmas Light demonstration project in downtown. TDPUD worked with the Town of Truckee to provide LED lights for the Train Depot and annual holiday tree/Bud Fish tree. 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). TDPUD assumed ex ante unit savings of 35.4 kWh/year and 0.011 kW. The EUL is 5 years.

21. Miscellaneous Water Efficiency Measures

The Miscellaneous Water Efficiency program purchased 7,384 water efficiency measures including 3,350 low-flow showerheads (1.5 gpm), 682 low-flow kitchen swivel aerators (1.5 gpm), and 3,352 low-flow bath aerators (0.5 gpm). Low-flow showerheads replace standard showerheads with flow rates equal to or greater than 2.5 gpm at a flowing pressure of 80 pounds

per square inch gauge (psig).[9] Low-flow showerheads are assumed to reduce water flow by 40% (i.e., 1-1.5/2.5=0.4). Low-flow kitchen swivel aerators replace standard kitchen aerators with flow rates equal to or greater than 2.2 gpm at a flowing pressure of 60 psig. Low-flow kitchen swivel aerators are assumed to reduce water flow by 31.8% (i.e., 1-1.5/2.2=0.318). Low-flow bath aerators replace standard bath aerators with flow rates equal to or greater than 2.2 gpm at a flowing pressure of 60 psig. Low-flow bath aerators are assumed to reduce water flow by 77.3% (i.e., 1-0.5/2.2=0.773). TDPUD assumed ex ante unit savings of 31.9 kWh/year, 0.003 kW, 6 therm/year, and 1,943 gallons/year. 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 2.12**.[10] 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 2.12 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 systems where pre- or post data are unavailable. Utility meters measure pre- or post-retrofit energy use and savings are based on calibrated simulations.

[9] EPAct 1992 standard for showerheads and aerators applies to commercial and residential. Showerhead and aerators flow rate standards are defined in American Society of Mechanical Engineers (ASME) A112.18.1/CSA-B125.1-1992/2005. New York, NY: Available online: http://files.asme.org/Catalog/Codes/PrintBook/14122.pdf.

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

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

Eq. 1 $\bar{y}_i$ = 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 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.[11]

Eq. 3 se_{i_p} = 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} = Standard Error of Mean Savings $= \sqrt{\frac{\sum_{j=1}^{n}(y_j-\bar{y})^2}{n(n-1)}}$

[11] 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.

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

Where,

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;
- Water 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 previous EM&V studies, TDPUD customer site visits and 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 2.13**. 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. Due to budget constraints some 2010 programs were evaluated using previous EM&V studies.

Table 2.13 Verification Approach for TDPUD Measures

Measure	Measurement and Verification Approach
1. Compact Fluorescent Lamps	Energy and peak demand savings based on previous EM&V studies, customer surveys, and site verification.
2-4. Energy Star Appliances	Energy and peak demand savings based on previous surveys and Energy Star data (www.energystar.gov/index.cfm?c=clotheswash.pr_clothes_washers, www.energystar.gov/index.cfm?c=dishwash.pr_dishwashers, and www.energystar.gov/index.cfm?c=refrig.pr_refrigerators).
5. Refrigerator Recycling	Energy and peak demand savings based on previous EM&V studies.
6-9. Building Envelope & Ducts	Energy and peak demand savings based on previous EM&V studies.
11. Commercial Lighting	Energy and peak demand savings based on previous EM&V studies.
12. Ground Source Heat Pumps	Energy and peak demand savings based on previous EM&V studies.
13. Electric Water Heaters (and Solar water heaters)	Energy and peak demand savings based on previous EM&V studies.
14. Low/Moderate Income ESP	Energy and peak demand savings based on previous EM&V studies, customer surveys, and site verification.
15. Green Schools Kit (CFLs, etc.)	Energy and peak demand savings based on previous EM&V studies.
16. Residential Energy Survey	Energy and peak demand savings based on previous EM&V studies, customer surveys, and site verification.
17. Business Green Partners	Energy and peak demand savings based on previous EM&V studies.
18. Keep Your Cool	Energy and peak demand savings based on previous EM&V studies.
19. Business LED Pilot	Energy and peak demand savings based on previous EM&V studies.
20. LED Business Accent Lights	Energy and peak demand savings based on previous EM&V studies.
21. LED Business Accent Lights	Energy and peak demand savings based on previous EM&V studies.
22. LED Exit Sign Direct Install	Energy and peak demand savings based on previous EM&V studies.
23. Residential Green Partners	Energy and peak demand savings based on previous EM&V studies, customer surveys, and site verification.
24. Million CFLs	Energy and peak demand savings based on previous EM&V studies, customer surveys, and site verification.
25. LED Light Swap	Energy and peak demand savings based on previous EM&V studies.
26. Miscellaneous Water Efficiency (showerheads and aerators)	Energy and peak demand savings based on previous EM&V studies, customer surveys, and site verification.

Field measurement equipment tolerances are shown in **Table 2.14**.

Table 2.14 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%

Table 2.14 Field Measurement Equipment Tolerances

Field Measurement	Measurement Equipment	Tolerances
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% confidence level. The proposed sample design was based on statistical survey sampling methods.[12] 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.[13] 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 $$\text{Sample Size} = n_i = \frac{t^2 C_{vi}^2}{r^2}$$

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."

[12] 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.

[13] 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.

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

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

Where,

n_{FPCi} = 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 for programs that were inspected in 2010 are shown in **Table 2.15**. 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 80 to 90% confidence.

Table 2.15 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)
1. Residential CFLs	1,000	N/A	223	40	0.23	0.059
2. Clothes Washers	200	N/A	254	N/A	0.39	0.100
3. Dishwashers	150	N/A	213	N/A	0.31	0.080
4. Refrigerator/Freezers	200	N/A	242	N/A	0.34	0.087
5. Refrigerator Recycling	25	N/A	26	N/A	0.46	0.119
6. Building Envelope Testing	20	N/A	5	N/A	N/A	N/A
7. Duct System Testing	20	N/A	10	N/A	N/A	N/A
8. Building Envelope Mitigation	10	N/A	3	N/A	0.85	0.221
9. Duct System Mitigation	10	N/A	3	N/A	0.85	0.220
10. Window Thermal Efficiency	10	N/A	0	N/A	N/A	N/A
11. Commercial Projects	10	N/A	14	N/A	0.12	0.030
12. Ground Source Heat Pumps	1	N/A	1	N/A	1.57	0.409
13. EE Electric Water Heat/Solar	10	N/A	9	N/A	0.38	0.100
14. Low-Mod. Income Assist/ESP	200	10	175	17	0.24	0.063
15. Green Schools Program/Kits	1,800	N/A	1,800	N/A	0.23	0.060
16. Residential Energy Survey	100	4	48	4	0.24	0.063
17. Business Green Partners	200	N/A	1,469	N/A	0.23	0.059
18. Keep Your Cool	50	N/A	36	N/A	1.15	0.316
19. Business LED Pilot	1,000	N/A	229	N/A	0.42	0.109
20. LED Bus. Accent Lighting	700	N/A	185	N/A	0.42	0.109
21. LED Exit Sign Direct Install	200	N/A	56	N/A	0.08	0.020
22. Residential Green Partners	5,000	40	3,671	120	0.23	0.059
23. Neighborhood Block Party	100	N/A	0	N/A	N/A	N/A
24. Million CFLs	40,000	200	53,304[14]	231	0.23	0.059
25. LED Light Swap	750	N/A	2,587	N/A	0.02	0.004
26. Misc. Water Efficiency	7,950	19	7,384[15]	19	0.03	0.008

[14] The electricity savings for 23,498 CFLs purchased through the Million CFLs program are credited to the Green Schools program which installed 21,600 CFLs, Low/Medium Income Assistance Energy Saving Partners program which installed 1,513 CFLs and Residential Green Partners which installed 385 CFLs.

[15] Savings for 4797 showerheads and aerators purchased by the Miscellaneous Water Efficiency program are credited to the Green Schools program which installed 4,131, Low/Medium Income Assistance Energy Saving Partners program which installed 506, and Residential Green Partners which installed 160.

Table 2.15 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)
Participant Surveys	N/A	40	N/A	40	0.10	0.026
Non-Participant Surveys	N/A	40	N/A	40	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 40 participants and 40 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 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 effective. Interview questions assessed how the program influenced awareness of linkages between efficiency 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 40 participant surveys and inspecting 761 measures at a random sample of 40 participant sites. Participants indicated that measures

were properly installed as indicated by the rating of 9.6 ± 0.3 on a scale of 1 to 10 regarding the quality of work performed by installers. Light loggers were previously installed at 30 sites in the 2009 EM&V study 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 the 2009 EM&V study, 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 inspections of 761 measures at a random sample of 40 participant sites. The 2011 EM&V study inspected the following measures: door sweeps, weatherstripping, showerheads, kitchen/bath aerators, water heater insulation, pipe insulation/elbow/tees, insulation tape, CFLs (spiral, globes, reflectors, parabolic reflectors, dimmable), toilet leak detection kits, and toilet tank banks. The 2009 EM&V study inspected the following measures: 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 40 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 Low-Income Assistance Energy Saving Partners (0.64), Residential Energy Surveys (0.64), and Residential Green Partners (0.64). The 2009 EM&V study evaluated NTGRs for the following programs Commercial Lighting Projects (0.96), Electric

Water Heater/Solar 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.[16]

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% 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 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, Energy Star® appliances, refrigerator recycling, duct/building envelope sealing, T8 lamps/electronic ballasts, low-flow showerheads/aerators, 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)?

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 process surveys of participants and non-participants. The TDPUD provided energy efficiency services to 7,034 customers and overall participant satisfaction with the program was 93.6 ± 3.1 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 70 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.

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

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 CFLs, LEDs, efficient commercial lighting, Energy Star® appliances, refrigerator recycling, efficient windows, attic insulation, infiltration reduction, duct sealing, showerheads, aerators, or other measures and educates customers on the value of these and other measures. Based on process survey responses, 60 percent of interviewed customers shared program information with 18 times as many people. Approximately 20 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 5.3 percent.[17] 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?

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

[17] Spillover of 5.3 percent is calculated based on 431 people adopting at least one spillover measure based on information shared by a group of 24 participants who adopted 342 measures (i.e., $431 \times (1 \div 342) \div 24 = 0.053$).

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 surveys of participants.

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

The 2009 EM&V study installed metering and monitoring equipment 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 survey responses 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 provide 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. 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 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.**

  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

TDPUD implemented 26 energy efficiency programs in 2010 as shown in **Table 3.1**. The program ex ante goal was to install 59,716 energy efficiency measures and TDPUD accomplished 71,947 installed measures and this is 20.5% greater than the ex ante goal.

Table 3.1 Ex Ante Goals and Ex Post Accomplishments

Description	Ex Ante Goal	Ex Post Accomplishment
Total Installed Measures	**59,716**	**71,947**
1. Residential CFLs	1,000	223
2. Clothes Washers	200	254
3. Dishwashers	150	213
4. Refrigerator/Freezers	200	242
5. Refrigerator Recycling	25	26
6. Building Envelope Testing	20	5
7. Duct System Testing	20	10
8. Building Envelope Mitigation	10	3
9. Duct System Mitigation	10	3
10. Window Thermal Efficiency	10	0
11. Commercial Projects	10	14
12. Ground Source Heat Pumps	1	1
13. EE Electric Water Heating/Solar	10	9
14. Low-Mod. Income Assist/ESP	200	175
15. Green Schools Program/Kits	1,800	1,800
16. Residential Energy Survey (RES)	100	48
17. Business Green Partners	200	1,469
18. Keep Your Cool	50	36
19. Business LED Pilot	1,000	229
20. LED Business Accent Lighting	700	185
21. LED Exit Sign Direct Install	200	56
22. Residential Green Partners	5,000	3,671
23. Neighborhood Block Party	100	0
24. Million CFLs	40,000	53,304[18]
25. LED Light Swap	750	2,587
26. Misc. Water Efficiency	7,950	7,384[19]

[18] The electricity savings for 23,498 CFLs purchased through the Million CFLs program are credited to the Green Schools program which installed 21,600 CFLs, Low/Medium Income Assistance Energy Saving Partners program which installed 1,513 CFLs and Residential Green Partners which installed 385 CFLs.

[19] 4797 showerheads and aerators purchased by the Miscellaneous Water Efficiency program and installed in the Green Schools program (4,131), Low/Medium Income Assistance Energy Saving Partners program (506), and Residential Green Partners (160).

TDPUD achieved 4.3% greater lifecycle electricity savings with ex post savings of 37,081,572 kWh versus ex ante goal of 35,546,221 kWh. TDPUD exceeded the ex ante E3 Calculator Total Resource Cost (TRC) test goal by 17% with an ex post TRC of 5.14 and the ex ante TRC of 4.4 as shown in **Table 3.2**.[20] The ex post TRC is greater than the ex ante TRC due to 20.5% more measures and lower measure costs due to purchasing measures in bulk and innovative programs. Ex post accomplishments were verified by checking the tracking database, randomly inspecting 1,131 measures at 40 participant sites, and conducting surveys of participants, non-participants, and non-contacts. The EM&V ex post savings are based on site inspections, engineering analysis, and previous evaluation studies of TDPUD programs including light logger data from 2,640 fixtures at 29 sites and pre and post-retrofit utility billing data from 65 sites.

Table 3.2 Ex Ante Goals and Ex Post E3 Cost Effectiveness

Description	Ex Ante Goal	Ex Post Accomplishment
Net Annual Electricity Savings (kWh/yr)	3,665,087	4,007,032
Net Demand Savings (kW)	1,123	1,155
Net Lifecycle Electricity Savings (kWh)	35,546,221	37,081,572
Net Annual Therm Savings (therm/yr)	40,780	37,891
Net Lifecycle Therm Savings (therm)	439,184	378,936
Net Annual Water Savings (gallon/yr)[21]	13,637,465	13,041,224
Net Lifecycle Water Savings (gallon)	141,624,630	130,285,584
Total Resource Cost (TRC) Test – E3	**4.4**	**5.14**
TRC Test Costs	$798,785	$732,691
TRC Test Benefits	$3,504,944	$3,769,485
TRC Test Net Benefits	$2,706,159	$3,036,794
Participant Test	**0.9**	**1.0**
Participant Test Costs	$536,362	$462,250
Participant Test Benefits	$459,985	$464,281
Participant Test Net Benefits	($76,377)	$2,031

The ex ante first-year savings are summarized in **Table 3.3**. The first-year net ex ante program savings are 3,665,087 kWh per year, 1,123 kW per year, 38,815 therms per year, and 12,728,736 gallons of water per year.

Table 3.3 Ex Ante First-Year Electricity, Natural Gas, and Water Savings

Energy Efficiency Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm)	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 (therm)	Net Ex Ante Program Savings (galyr)
1. Residential CFLs	10.6	0.003			0.8	8,499	2.4		
2. Energy Star Clothes Washers	194.6	0.075			0.8	31,134	12		
3. Energy Star Dishwashers	235.9	0.093			0.8	28,304	11.2		
4. Energy Star Refrigerators	176.9	0.070			0.8	28,304	11.2		

[20] Energy and Environmental Economics (E3), Inc. 2010. EE Reporting Tool 2010 (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.

[21] 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.

Table 3.3 Ex Ante First-Year Electricity, Natural Gas, and Water Savings

Energy Efficiency Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm)	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 (therm)	Net Ex Ante Program Savings (galyr)
5. Refrigerator Recycling	1,076.5	0.240			0.84	22,607	5		
6. Building Envelope Testing	0.0	0.000			0.9	0	0		
7. Duct System Testing	0.0	0.000			0.9	0	0		
8. Building Envelope Mitigation	10.0	0.000	11		0.9	90	0	31	
9. Duct System Mitigation	25.0	0.100	28		0.9	225	0.9	77	
10. Window Thermal Efficiency	160.0	0.531			0.8	1,280	4.2		
11. Commercial Lighting Projects	17,700.0	8.700			0.96	169,920	83.5		
12. Ground Source Heat Pumps	775.0	0.000			0.9	698	0		
13. EE Electric Water Heat/Solar	57.3	0.000			1	573	0		
14. Low-Mod Income Assist/ESP	600.0	0.181	17	1,962	0.8	96,000	28.9	2,447	295,771
15. Green Schools Program/Kits	510.0	0.154	1		0.8	734,331	221.2	1,360	
16. Residential Energy Survey	466.9	0.141	20	2,336	0.8	37,354	11.3	613	77,263
17. Business Green Partners	53.1	0.015			0.96	10,199	2.9		
18. Keep Your Cool	2,400.0	1.200			0.8	96,000	48		
19. Business LED Pilot	26.6	0.008			0.96	25,498	7.7		
20. LED Business Accent Lights	22.8	0.007			0.96	15,299	4.8		
21. LED Exit Sign Direct Install	13.3	0.005			0.96	2,550	1		
22. Residential Green Partners	53.1	0.016			0.96	254,976	76.8		
23. Neighborhood Block Party	53.1	0.020			0.8	4,250	1.6		
24. Million CFLs	58.4	0.018			0.8	1,869,824	563.2		
25. LED Light Swap	35.4	0.011			0.91	24,170	7.3		
26. Misc. Water Efficiency	31.9	0.003	6	1,943	0.8	203,004	17.9	34,287	12,355,702
Total						3,665,087	1,123	38,815	12,728,736

The EM&V ex post first-year savings are summarized in **Table 3.4**. The EM&V study found first-year net ex post program savings of 4,007,032 ± 155,497 kWh per year, 1,155 ± 92 kW per year, 37,891 ± 3,196 therms per year, and 13,041,224 ± 1,148,351 gallons (1,743,358 ± 153,512 CCF) of water per year at the 90 percent confidence level. The net first-year realization rates are 1.09 ± 0.04 for kWh, 1.03 ± 0.08 for kW, 0.98 ± 0.08 for therms, and 1.02 ± 0.09 for water.

Table 3.4 Ex Post First-Year Electricity, Natural Gas, and Water Savings

Energy Efficiency Measure	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm)	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 (therm)	Net Ex Post Program Savings (gal)
1. Residential CFLs	59.5	0.054			0.80	10,615	9.63		
2. Clothes Washers	129.8	0.018	6	5,637	0.80	26,384	3.60	1,280	1,145,438
3. Dishwashers	48.8	0.007	1	430	0.80	8,317	1.24	227	73,272
4. Refrigerator/Freezers	121.0	0.017			0.80	23,427	3.25		
5. Refrigerator Recycling	1,682.0	0.362			0.84	36,735	7.91		
6. Building Envelope Testing	0.0	0.000			0.90	0	0.00		
7. Duct System Testing	0.0	0.000			0.90	0	0.00		
8. Building Envelope Mitigation	82.0	0.068	93		0.90	221	0.18	251	
9. Duct System Mitigation	59.0	0.049	67		0.90	159	0.13	181	
10. Window Thermal Efficiency	160.0	0.531			0.80	0	0.00		
11. Commercial Light Projects	22,125.8	10.899			0.96	297,371	146.48		
12. Ground Source Heat Pumps	25,025.0	13.766			0.90	22,523	12.39		
13. EE Electric Wtr Heat/Solar	178.0	0.024			0.80	1,282	0.17		
14. Low-Mod Income Asst/ESP	836.2	0.180	16	1,962	0.80	117,066	25.17	2,273	274,714
15. Green Schools Program/Kits	714.4	0.162	1		0.80	1,028,699	233.39	1,263	0
16. Residential Energy Survey	811.7	0.174	19	2,336	0.64	24,934	5.34	570	71,762
17. Business Green Partners	56.5	0.051			0.96	79,679	71.92		

Table 3.4 Ex Post First-Year Electricity, Natural Gas, and Water Savings

Energy Efficiency Measure	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm)	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 (therm)	Net Ex Post Program Savings (gal)
18. Keep Your Cool	10,026.0	4.970			0.96	346,497	171.78		
19. Business LED Pilot	96.2	0.030			0.96	21,149	6.60		
20. LED Business Accent Lights	19.6	0.007			0.96	3,481	1.24		
21. LED Exit Sign Direct Install	109.5	0.013			0.96	5,887	0.67		
22. Residential Green Partners	61.2	0.014			0.64	143,866	32.63		
23. Neighborhood Block Party	0.0	0.000			0.80	0	0.00		
24. Million CFLs	59.5	0.014			0.80	1,418,766	321.90		
25. LED Light Swap	23.9	0.022			0.91	56,330	52.16		
26. Misc. Water Efficiency	56.5	0.008	5	1,943	0.80	333,646	47.04	31,846	11,476,038
Total						4,007,032	1,155	37,891	13,041,224
90% Confidence Interval						155,497	92	3,196	1,148,351
Realization Rate						1.09 ± 0.04	1.03 ± 0.08	0.98 ± 0.08	1.02 ± 0.09

The lifecycle electricity and water savings are summarized in **Table 3.5**. The net ex-ante lifecycle program savings are 35,546,221 kWh, 384,586 therms, and 126,914,325 gallons of water. The net ex-post lifecycle program savings are 37,081,572 ± 1,349,301 kWh, 378,936 ± 31,958 therms, and 130,285,584 ± 11,482,865 gallons of water (17,416,649 ± 1,535,036 CCF). The net lifecycle realization rates are 1.04 ± 0.04 for kWh, 0.99 ± 0.08 for therms, and 1.02 ± 0.09 for water.

Table 3.5 Lifecycle Electricity, Natural Gas, 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 (therm)	Net Ex-Ante Lifecycle Program Savings (gal)	Ex Post EUL	Net Ex-Post Lifecycle Program Savings (kWh)	Net Ex-Post Lifecycle Program Savings (therm)	Net Ex-Post Lifecycle Program Savings (gal)
1. Residential CFLs	9	76,493			9	95,533		
2. Clothes Washers	10	311,344			10	263,841	12,802	11,454,384
3. Dishwashers	13	367,952			13	108,119	2,946	952,536
4. Refrigerator/Freezers	18	509,472			18	421,689		
5. Refrigerator Recycling	6	135,642			6	220,409		
6. Building Envelope Testing	5	0			5	0		
7. Duct System Testing	5	0			5	0		
8. Building Envelope Mitigation	18	1,620	551		18	3,985	4,520	
9. Duct System Mitigation	18	4,050	1,380		18	2,867	3,256	
10. Window Thermal Efficiency	25	32,000			25	0		
11. Commercial Projects	11	1,869,120			11	3,271,078		
12. Ground Source Heat Pumps	15	10,463			15	337,838		
13. EE Electric Water Heat/Solar	15	8,595			15	19,224		
14. Low-Mod Income Assist/ESP	15	1,440,000	22,026	2,661,939	9	1,053,592	20,458	2,472,422
15. Green Schools Program/Kits	10	7,343,309	12,236	0	9	9,258,293	11,365	0
16. Residential Energy Survey	15	560,306	5,519	695,364	9	224,409	5,126	645,857
17. Business Green Partners	10	101,990			3	239,036		
18. Keep Your Cool	8	768,000			8	2,771,978		
19. Business LED Pilot	16	407,962			16	338,378		
20. LED Business Accent Lighting	16	244,777			16	55,695		
21. LED Exit Sign Direct Install	16	40,796			16	94,188		
22. Residential Green Partners	9	2,294,784			9	1,294,798		
23. Neighborhood Block Party	9	38,246			9	0		
24. Million CFLs	9	16,828,416			9	12,768,890		
25. LED Light Swap	5	120,848			16	901,275		
26. Misc. Water Efficiency	10	2,030,037	342,873	123,557,022	10	3,336,456	318,462	114,760,384

Table 3.5 Lifecycle Electricity, Natural Gas, 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 (therm)	Net Ex-Ante Lifecycle Program Savings (gal)	Ex Post EUL	Net Ex-Post Lifecycle Program Savings (kWh)	Net Ex-Post Lifecycle Program Savings (therm)	Net Ex-Post Lifecycle Program Savings (gal)
Total		35,546,221	384,586	126,914,325		37,081,572	378,936	130,285,584
90% Confidence Interval						1349,301	31,958	11,482,865
Realization Rate						1.04 ± 0.04	0.99 ± 0.08	1.02 ± 0.09

The required energy impact reporting for 2010 programs is provided in **Table 3.6**.

Table 3.6 Required Energy and Water Impact Reporting for 2010 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)	Ex-Ante Gross Program-Projected Program Water CCF Savings (1)	Ex-Post Net Evaluation Confirmed Program Water CCF Savings (2)
1	2011	4476	4007	1.365	1.155	48,504	37,891	2,126,981	1,743,358
2	2012	4476	4007	1.365	1.155	48,504	37,891	2,126,981	1,743,358
3	2013	4476	4007	1.365	1.155	48,504	37,891	2,126,981	1,743,358
4	2014	4476	3927	1.365	1.083	48,504	37,891	2,126,981	1,743,358
5	2015	4476	3927	1.365	1.083	48,504	37,891	2,126,981	1,743,358
6	2016	4450	3927	1.357	1.083	48,504	37,891	2,126,981	1,743,358
7	2017	4423	3891	1.351	1.075	48,504	37,891	2,126,981	1,743,358
8	2018	4423	3891	1.351	1.075	48,504	37,891	2,126,981	1,743,358
9	2019	4303	3544	1.291	0.903	48,504	37,891	2,126,981	1,743,358
10	2020	1684	800	0.502	0.275	48,504	33,785	2,064,646	1,697,041
11	2021	463	440	0.186	0.225	3,945	659	0	9,795
12	2022	286	143	0.099	0.078	3,945	659	0	9,795
13	2023	286	143	0.099	0.078	3,945	659	0	9,795
14	2024	251	134	0.085	0.077	3,945	432	0	0
15	2025	251	134	0.085	0.077	3,945	432	0	0
16	2026	82	111	0.034	0.064	119	432	0	0
17	2027	37	24	0.020	0.004	119	432	0	0
18	2028	37	24	0.020	0.004	119	432	0	0
19	2029	2	0	0.005	0.000	0	0	0	0
20	2030	2	0	0.005	0.000	0	0	0	0
Total		43,360	37,081			505,119	378,936	21,207,472	17,416,649

** 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 energy efficiency program portfolio ranked by ex post TRC is shown in **Table 3.7**.

Table 3.7 TDPUD Energy Efficiency Program Portfolio Ranked by Ex Post TRC

	Net Demand Savings (kW)	Net Coincident Peak Savings (kW)	Net Annual Energy Savings (kWh)	Net Lifecycle Energy Savings (kWh)	Net Lifecycle Gas Savings (MMBtu)	Net Lifecycle GHG Reduction (Tons)	Utility Cost ($/kWh)	Total Resource ($/kWh)	Ex Post TRC
TOTAL EE PORTFOLIO	3,166	1,155	4,007,032	37,081,572	37,894	19,880	0.02	0.02	5.14
26. Misc. Water Efficiency	47	47.04	333,646	3,336,456	31,846	1,785	0.01	0.01	16.4
15. Green Schools Kits	934	233.39	1,028,699	9,258,293	1,137	4,942	0.01	0.01	16.3
24. Million CFLs	1,288	321.90	1,418,766	12,768,890		6,816	0.01	0.01	12.6
5. Refrigerator Recycling	8	7.91	36,735	220,409		120	0.02	0.01	10.4
1. Residential CFLs	10	9.63	10,615	95,533		51	0.01	0.01	9.5
12. Ground Source HP	12	12.39	22,523	337,838		188	0.03	0.03	5.4
20. LED Bus. Accent Lights	1	1.24	3,481	55,695		31	0.03	0.03	4.8
11. Commercial Projects	146	146.48	297,371	3,271,078		1,813	0.04	0.04	4.0
22. Res. Green Partners	131	32.63	143,866	1,294,798		691	0.04	0.04	2.9
18. Keep Your Cool	172	171.78	346,497	2,771,978		1,461	0.05	0.05	2.4
25. LED Light Swap	209	52.16	56,330	901,275		481	0.09	0.09	1.7
6-9. Bldg. Env./Duct Repair		0.32	381	6,853	778	4	1.14	1.14	1.6
19. Business LED Pilot	7	6.60	21,149	338,378		188	0.11	0.11	1.5
17. Bus. Green Partners	72	71.92	79,679	239,036		132	0.08	0.08	1.4
4. Refrigerator/Freezers	3	3.25	23,427	421,689		229	0.06	0.06	1.4
13. EE Elec. Wtr Heat/Solar		0.17	1,282	19,224		10	0.09	0.10	1.4
21. LED Exit Sign Install	1	0.67	5,887	94,188		50	0.11	0.11	1.3
14. Low-Mod Income ESP	101	25.17	117,066	1,053,592	2,046	562	0.10	0.10	1.3
16. Res. Energy Survey	21	5.34	24,934	224,409	513	120	0.11	0.11	1.2
2. Clothes Washers	4	3.60	26,384	263,841	1,280	146	0.15	0.15	1.1
3. Dishwashers	1	1.24	8,317	108,119	295	60	0.29	0.29	0.6
10. Window Thermal Eff.							0.00	0.00	0.0
23. Neighbor Block Party							0.00	0.00	0.0

The TDPUD energy efficiency portfolio utility cost is $0.02/kWh and the net lifecycle green house gas (GHG) reductions are 19,880 tons. TDPUD programs realized a 5.14 TRC which is 17% greater than anticipated due to installing 20.5% more measures through innovative community-based programs. The top ten programs have an average TRC of 8.5. The Miscellaneous Water Efficiency program realized a TRC of 16.4 and 64% greater savings due to electricity savings from water pumping and therm savings from units installed at sites with gas water heaters. The Green Schools program realized a TRC of 16.3 and 26% greater savings than anticipated by distributing conservation kits in reusable canvas bags to all K-8 students throughout the TDPUD service area (6 schools). The conservation kits were prepared by the Sierra Watershed Education Partnership and distributed at school assemblies by the Truckee High School Bright Schools/Envirolution club. The Million CFLs program realized a TRC of 12.6 and 30% greater savings by purchasing CFLs in bulk at low cost and distributing and installing CFLs through multiple programs. The Refrigerator Recycling program realized a TRC of 10.4 and 62.5% greater savings than anticipated due to recycling one more unit and 56% greater unit savings based on measured data from 50 recycled units (in the 2005 EM&V study). Residential CFLs realized a TRC of 9.5 and 24.9% greater savings than anticipated due to greater unit savings. Ground Source Heat Pumps have a projected TRC of 5.4 based on greater savings but the unit is awaiting installation by the Towne of Truckee. LED Business Accent Lighting realized a TRC of 4.8 and 24.9% greater savings than anticipated due to greater unit savings. Commercial Lighting Projects realized a TRC of 4.0 and 75% greater savings than anticipated due to 40% more projects and 25% greater savings per site. Residential Green Partners realized a TRC of 2.9 and 43.6% less savings than anticipated due 26.4% fewer units

installed. Keep Your Cool realized a TRC of 2.4 and 261% greater savings than anticipated due to greater unit savings and direct installation by the Efficiency Services Group, an experienced energy services company. The LED Holiday Light Swap program realized a TRC of 1.7 and 750% greater savings than anticipated due to installing 244.9% more lights (quantity of 2,587 ex post versus 750 ex ante) and 3.2 times longer EUL (16 years ex post versus 5 years ex ante). Low-Moderate Income Assistance/Energy Saving Partners realized a TRC of 1.3 due to greater unit savings and providing a customized audit for each customer site with free measures for each site based on the audit. TDPUD offered a wide range of innovative and successful programs for residential and commercial lighting, water heaters, and Energy Star™ 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. Two programs did not realize any participation: Thermally-efficient Windows and Energy Efficient Neighborhoods. TDPUD partnered with several organizations in Truckee to implement projects including: Sierra Watershed Education Partnership, Truckee High School Bright Schools/Envirolution club, Sierra Business Council, Sierra Green Building Association, Truckee Climate Action Network, Town of Truckee, Truckee Home & Building Show, Tahoe-Truckee USD, Nevada County, Truckee River Watershed Council, Truckee Chamber and the Truckee Downtown Merchant's Association.

3.1.1 Load Impacts for Residential Lighting

Load impacts for residential lighting are based on field inspections of Energy Star® CFLs, interviews with 40 TDPUD residential customers, and verification of rebates paid to TDPUD customers. Residential lighting rebates were issued for the following CFLs: 1) Spiral 13W CFL (replace 60W), 2) Spiral 23W CFL (replace 100W), 3) Globe G259/40W (replace 40W), 4) R2014/14W (replace 65W), 5) R30 15W (replace 65W), 6) R30 15W Dimmable (replace 60W), 7) PAR38 23W (replace 90W or 120W). The ex ante and ex post unit savings are shown in **Table 3.8**. The ex ante goal for Energy Star® CFL rebates is 1,000 units and the study verified 223 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.[22] The ex ante effective useful lifetime is 6.72 years and the ex post EUL is 9 years per year assuming 10,000 lifecycle operational hours. The total ex ante savings are 8,499 first-year kWh and 2.4 kW and 76,493 lifecycle kWh. The total net ex post savings are 10,615 ± 624.4 first-year kWh, 9.63 ± 0.357 kW, and 95,533 ± 5,619.6 kWh lifecycle kWh at the 90% confidence level. The ex post savings are approximately 58.5% less than ex ante for kWh savings and 100.7% greater than ex ante kW savings. Differences

[22] 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 is consistent with 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).

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.

Table 3.8 Energy Star® CFLs Ex Ante and Ex Post Savings

Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
1. Residential CFLs	32	0.006			59.5 ± 3.5	0.054 ± 0.002		

3.1.2 Load Impacts for Energy Star® Clotheswashers

Load impacts for Energy Star® clotheswashers are based on annual energy use for models listed in the Energy Star® database and verification of the TDPUD database consistent with IPMVP Option A (verification of stipulated savings). The US National Appliance Energy Conservation Act (NAECA) standard unit baseline and Energy Star® qualified annual energy and water use and average savings are shown in **Table 3.9**.[23] The ex ante and ex post unit savings are shown in **Table 3.10**. The ex ante and ex post NTGR is 0.80 and the EUL is 10 years. The TDPUD net ex ante savings are 31,134 kWh/yr, 12 kW and 311,344 lifecycle kWh based on 200 units. The ex post NTGR is 0.80 ± 0.03 based on the California Appliance Replacement Program and decision maker surveys of 22 participants. The total net ex post savings are 26,384 ± 698 first-year kWh, 3.6 ± 0.18 kW, 1,280 ± 33.9 first-year therm, 1,145,438 ± 30,297 first-year gallons of water, 263,841 ± 6,978 lifecycle kWh, 12,802 ± 339 lifecycle therm, and 11,454,384 ± 302,968 lifecycle kWh at the 90% confidence level for 254 units. The ex post savings are approximately 15% less than ex ante for kWh savings and 70% less than ex ante kW savings. Lower electricity savings are offset by gas and water savings that increase the TRC to 1.1.

Table 3.9 Annual Energy and Water Use for Clotheswashers

Description	Annual Electric Use (kWh/y)	Peak Demand (kW)	Total Annual Gas Use (therm)	Total Annual Water Use (gallon)	Annual Water Pump (kWh)	Water Pump Peak Demand (kW)	Total Annual Electric Use (kWh/y)	Total Peak Demand (kW)	Annual Water Use (CCF)
Standard Electric	787	0.111		12,179	99.3	0.014	886.35	0.125	1628.10
Energy Star Electric	563	0.079		6,542	53.4	0.008	616.37	0.087	874.54
Ave. Savings	224	0.032		5,637	46.0	0.006	269.98	0.038	753.56
+/- 90% CI	5.92	0.002		149.1	1.2	0.0003	7.14	0.002	19.93
Standard Gas	80.7	0.011	29.8	12,179	99.3	0.014	180.05	0.025	1628.10
Energy Star Gas	56.9	0.008	20.8	6,542	53.4	0.008	110.27	0.016	874.54
Ave. Savings	23.8	0.003	9	5,637	46.0	0.006	69.78	0.009	753.56
+/- 90% CI	0.63	0.0002	0.24	149.1	1.2	0.0003	1.85	0.0005	19.93
Ave. Savings	83.86	0.0117	6.3	5,637	45.98	0.006	129.84	0.0177	753.56
+/- 90% CI	2.22	0.0006	0.17	149.1	1.22	0.0003	3.43	0.001	19.93

[23] Energy and water use are based on average energy consumption for all non-qualified models from December 2008 and qualified Energy Star® models from July 2009. See CalculatorConsumerClothesWasher.xls available at http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=CW.

Table 3.10 Energy Star® Clotheswasher Ex Ante and Ex Post Savings

Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
2. ES Clotheswashers	194.6	0.075			129.84 ± 3.43	0.0177 ± 0.001	6.3 ± 0.17	5,637 ± 149

3.1.3 Load Impacts for Energy Star® Dishwashers

Load impacts for Energy Star® dishwashers are based on annual energy use for models listed in the Energy Star® database and verification of the TDPUD database consistent with IPMVP Option A (verification of stipulated savings). The US National Appliance Energy Conservation Act (NAECA) standard unit baseline and Energy Star® qualified annual energy and water use and average savings are shown in **Table 3.11**.[24] The ex ante and ex post unit savings are shown in **Table 3.12**. The ex ante and ex post NTGR is 0.80 and the EUL is 13 years. The TDPUD net ex ante savings are 28,304 kWh/yr, 11.2 kW and 367,952 lifecycle kWh based on 150 units. The total net ex post savings are 8,317 ± 220 first-year kWh, 1.24 ± 0.062 kW, 226 ± 6 first-year therm, 73,272 ± 1,938 first-year gallons of water, 108,119 ± 2,860 lifecycle kWh lifecycle kWh, 2,946 ± 78 lifecycle therm, 952,536 ± 25,195 lifecycle gallons of water at the 90% confidence level for 213 units. The ex post savings are approximately 71% less than ex ante savings. Lower electricity savings are small gas and water savings yield a TRC of 0.5. In order to make Energy Star® dishwashers cost effective, the incentive must be reduced to $40 per unit and for units that meet CEE Tier 2 which will increase kWh and therm savings by 20% and water savings by 40% (see **Table 2.6**).

Table 3.11 Annual Energy and Water Use for Dishwashers

Description	Annual Electric Use (kWh/y)	Peak Demand (kW)	Total Annual Gas Use (therm)	Total Annual Water Use (gallon)	Annual Water Pump (kWh)	Water Pump Peak Demand (kW)	Total Annual Electric Use (kWh/y)	Total Peak Demand (kW)	Annual Water Use (CCF)
Standard Electric	368	0.052		1,290	10.5	0.00148	378.52	0.05348	172.45
Energy Star Electric	294	0.041		860	7.0	0.00099	301.02	0.04199	114.97
Ave. Savings	74	0.011		430	3.5	0.00049	77.51	0.01149	57.48
+/- 90% CI	1.96	0.001		11.4	0.1	0.00001	2.05	0.001	1.52
Standard Gas	167	0.024	9.2	1,290	10.5	0.00148	177.52	0.02548	172.45
Energy Star Gas	134	0.019	7.3	860	7.0	0.00099	141.02	0.01999	114.97
Ave. Savings	33	0.005	1.9	430	3.5	0.00049	36.51	0.00549	57.48
+/- 90% CI	0.87	0.0003	0.05	11.4	0.1	0.00001	0.97	0.0003	1.52
Ave. Savings	45.3	0.0068	1.33	430	3.51	0.00049	48.81	0.00729	57.48
+/- 90% CI	1.20	0.0003	0.04	11.4	0.09	0.00002	1.29	0.00036	1.52

[24] Energy and water use are based on the average energy consumption for all non-qualified models from December 2008 and qualified Energy Star® models from July 2009. See CalculatorConsumerDishwasher.xls available at http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=DW.

Table 3.12 Energy Star® Dishwashers Ex Ante and Ex Post Savings

Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
3. Energy Star Dishwasher	235.9	0.093			48.8 ± 1.3	0.007 ± 0.0004	1.3 ± 0.04	430 ± 11

3.1.4 Load Impacts for Energy Star® Refrigerators

Load impacts for Energy Star® refrigerators are based on the difference between the US Federal Standard annual energy use and the US Federal Trade Commission Energy Guide Label annual energy use for 873 Energy Star® models.[25] This approach is consistent with IPMVP Option A (verification of stipulated savings). The US NAECA minimum standard and Energy Star® annual energy use and average savings are shown in **Table 3.13**.[26] The ex ante and ex post unit savings are shown in **Table 3.14**. The ex ante and ex post NTGR is 0.80 and the EUL is 18 years. The TDPUD net ex ante savings are 28,304 kWh/yr, 11.2 kW and 509,472 lifecycle kWh based on 200 units. The total net ex post savings are 23,427 ± 250 first-year kWh, 3.25 ± 0.163 kW, and 421,689 ± 4,505 kWh lifecycle kWh at the 90% confidence level for 242 units. The ex post savings are approximately 17.2% less than ex ante for kWh savings due to 32% lower unit savings. In order to make Energy Star® refrigerators more cost effective, the incentive payment should be revised to pay $50 for CEE Tier 2 and $100 for CEEE Tier 3 which are 25% and 30% above the Federal Standard respectfully (see **Table 2.7**).

Table 3.13 Annual Energy Use for Refrigerators

Description	US Min. Std. Annual Electric Use (kWh/y)	US Min. Federal Std. Peak Demand (kW)	Energy Star® Annual Electric Use (kWh/y)	Energy Star® Peak Demand (kW)	Annual Electric Savings (kWh/y)	Peak Demand Savings (kW)
Top Mount Freezer w/o thru-door ice	529	0.075	423	0.06	106	0.015
Side Mount Freezer w/o thru-door ice	634	0.089	507	0.072	127	0.017
Bottom Mount Freezer w/o thru-door ice	578	0.081	462	0.065	116	0.016
Top Mount Freezer w/ thru-door ice	619	0.087	495	0.07	124	0.017
Side Mount Freezer w/ thru-door ice	666	0.094	533	0.075	133	0.019
Ave. Savings	605	0.085	484	0.068	121	0.017
+/- 90% CI	6.46	0.0043	5.17	0.0034	1.3	0.001

Table 3.14 Energy Star® Refrigerator Ex Ante and Ex Post Savings

Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
4. Energy Star Refrigerators	176.9	0.070			121 ± 1.3	0.017 ± 0.001		

[25] Average energy savings are 121 ± 1.3 kWh/year based on 873 Energy Star® refrigerators with rated volume of 17.0 to 25.3 ft^3 (average 21.2 ± 0.13 ft^3) from ResRefrigeratorQualifyingProductList.xls available at www.cee1.org.

[26] Energy and water use are based on the minimum federal standard and minimum Energy Star® criteria for the configuration. See Consumer_Residential_Refrig_Sav_Calc.xls available at http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=RF.

3.1.5 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 3.15**.[27] Statistical analysis of the refrigerator and freezer data is shown in **Table 3.16**. The ex ante and ex post unit savings are shown in **Table 3.17**. 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% confidence level. The mean refrigerator savings are 1,625 kWh/yr ± 134 kWh/yr and 0.365 kW ± 0.03 kW at the 90% confidence level. The mean freezer savings are 2,009 kWh/yr ± 241 kWh/yr and 0.348 kW ± 0.06 kW at the 90% confidence level. The TDPUD refrigerator & freezer recycling program ex ante savings are 22,607 kWh/yr, 5 kW and 135,642 lifecycle kWh based on 26 units. The ex ante net-to-gross ratio is 0.80, and the ex post NTGR is 0.84 ± 0.09. The ex ante and ex post effective useful lifetime (EUL) is 6 years. The total net ex post savings are 36,735 ± 2,665 first-year kWh, 7.91 ± 0.5 kW, and 220,409 ± 15,987 kWh lifecycle kWh for 26 recycled refrigerators. The ex post savings are approximately 62.5% greater than ex ante for kWh savings and 56.9% greater for kW savings. Differences between ex ante and net ex post savings are primarily due to greater ex post savings per measure.

Table 3.15 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

[27] *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.

Table 3.15 Summary of Field Metering Data for 91 Refrigerators and 16 Freezers

#	*kWh/yr*	*kW*	Make	Model	Size	Style	Defrost	Age
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
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

Table 3.15 Summary of Field Metering Data for 91 Refrigerators and 16 Freezers

#	*kWh/yr*	*kW*	Make	Model	Size	Style	Defrost	Age
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 3.16 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

Table 3.17 Refrigerator Recycling Ex Ante and Ex Post Savings

Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
5. Refrigerator Recycling	1,076.5	0.240			1,682 ± 122	0.362 ± 0.02		

3.1.6 Load Impacts for Building Envelope & Duct Testing

Load impacts for building envelope and duct testing are based on previous field inspections of measures at 3 participant sites, engineering analysis and billing data consistent with IPMVP Option B and D. Field measurements of three participant sites showed average duct leakage reduction of 38.9%, and the average ex post duct leakage reduction for the 2010 TDPUD program is assumed to be 14%.[28] Field measurements of three participant sites showed average infiltration reduction of 0.41 air changes per hour (ACH) or a 48.8% reduction with an average baseline of 0.82 ACH. Infiltration represents approximately 40% of the space heating UEC. Therefore, the ex post infiltration savings are assumed to be 19.5%. The assumed average space heating fan unit energy consumption (UEC) is 419 kWh/year, and the average space heating UEC is 478 therm/year.[29] The ex ante and ex post unit energy savings are shown in **Table 3.18**. TDPUD ex ante savings for building envelope mitigation of 10 kWh/year, 0 kW, and 4 therm/year. TDPUD ex ante savings for duct mitigation are 25 kWh/year, 0.1 kW, and 10 therm/year. The net-to-gross ratio is 0.90 and the EUL is 18 years. The building envelope mitigation program net ex post savings are 221 ± 48.9 first-year kWh, 0.18 ± 0.038 kW, 251 ± 55 first-year therm, 3,985 ± 880 lifecycle kWh, and 4,520 ± 987 lifecycle therm for 3 units. The duct leakage mitigation program net ex post savings are 159 ± 35 first-year kWh, 0.13 ± 0.027 kW, 181 ± 39 first-year therm, 2,867 ± 631 kWh lifecycle kWh, and 3,256 ± 710 lifecycle therm for 3 units. Ex post savings are approximately 3 times greater than ex ante savings due to greater unit savings than what was anticipated.

Table 3.18 Building Envelope and Duct Leakage Mitigation Ex Ante and Ex Post Savings

Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
8. Bldg Envelope Mitigation	10	0.0	11		82 ± 18	0.068 ± 0.014	93 ± 20	
9. Duct Leakage Mitigation	25	0.1	28		59 ± 13	0.049 ± 0.01	67 ± 15	

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 to report for thermally efficient windows. TDPUD needs to define a performance threshold (i.e., minimum overall R-value or maximum u-value) for qualifying windows. For double-pane low-emissivity windows, the minimum should be R-3 or 0.33 Btu/hr-

[28] 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 envelope leakage, occupancy, heating schedule, and vintage of home (i.e., heating system efficiency, building insulation, window type, orientation, thermal mass, etc).

[29] The 478 therm/year space heating UEC is the weighted average for vintages in climate zone 16. 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/.

ft^2-°F including the frame. TDPUD assumed ex ante savings of 160 kWh/year-unit and 0.531 kW/unit, 0.8 NTGR, and 25 year EUL.

3.1.8 Load Impacts for Commercial Lighting

Load impacts for commercial lighting are based on previous EM&V studies, electric power measurements, and lighting logger measurements of fixtures consistent with IPMVP Option B.[30] The average annual hours of operation are 3,135 ± 303 hours per year based on the 2009 TDPUD EM&V study. The gross ex ante and ex post unit savings are shown in **Table 3.19**. The TDPUD assumed gross ex ante site savings per project of 17,700 kWh/yr, 8.7 kW and net ex ante program savings of 169,920 kWh, 83.5 kW and 1,869,120 lifecycle kWh. 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 and ex post effective useful lifetime (EUL) is 11 years. The total net ex post savings are 297,371 ± 8,956 first-year kWh, 146.5 ± 4.91 kW, and 3,271,078 ± 98,521 kWh lifecycle kWh for 14 sites. The ex post savings are approximately 75% greater than the ex ante savings due to more installed measures and greater savings per site than anticipated.

Table 3.19 Load Impacts for Commercial Lighting Projects

Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
11. Commercial Lights	17,700	8.7			22,126 ± 666	10.899 ± 0.365		

3.1.9 Load Impacts for Ground Source Heat Pump

Load impacts for Ground Source Heat Pumps (GHSP) are based on the /TDPUD GHP Monitoring Project Final Report, Davis Energy Group, March 30, 1998. The study monitored 5 GSHP sites in Truckee for 12 months in 1998. Average energy use per GSHP site is 3.64 ± 1.49 kWh/yr-ft^2 based on five monitored sites. The average GSHP heating COP is 3.5. The baseline is an air source heat pump (ASHP) with heating COP of 2.4. The GSHP will be installed at the new 15,000 ft^2 Town of Truckee Corporate Yard building. The GSHP gross energy savings are 25,025 ± 10,244 kWh/yr based on **Equation 10**.

Eq. 10 GSHP Savings = 25,025 kWh/yr = 3.64 kWh/yr-ft^2 x 15,000 ft^2 $\left(\frac{COP_{GSHP}}{COP_{ASHP}} - 1\right)$

Where,

COP_{GSHP} = COP of GSHP = 3.5, and
COP_{ASHP} = COP of GSHP = 2.4.

[30] *Evaluation, Measurement & Verification Report for Truckee Donner Public Utility District 2008 Energy Efficiency Programs.* R., Mowris. E. Jones. 2009. Prepared for Truckee Donner Public Utility District. *Measurement and Verification Report for NCPA SB5X Programs,* prepared for NCPA, prepared by RMA, 2005.

The gross ex ante and ex post unit savings are shown in **Table 3.20**. The ex ante goal is one unit and the study verified the $6,000 check paid to Town of Truckee for the GSHP to be installed at the Corporate Yard in 2011. The ex ante and ex post net-to-gross ratio is 0.8. The ex ante and ex post EUL is 15 years based on the 2005 DEER Update Study.[31] The net ex ante savings are 698 first-year kWh, 0 kW and 10,463 lifecycle kWh. The net ex post savings are 22,523 ± 9,220 first-year kWh, 12.39 ± 5.1 kW, and 337,838 ± 138,294 lifecycle kWh at the 90% confidence level.

Table 3.20 Load Impacts for Ground Source Heat Pump

Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
12. Ground Source HP	775	0.0			25,025 ± 10,244	13.766 ± 5.635		

3.1.10 Load Impacts for Electric Water Heater/Solar

Load impacts for electric water heater/solar 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.[32] Average electric water heater unit energy consumption (UEC) is 3,354 kWh/year.[33] 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 9 water heaters. The TDPUD ex ante unit savings are 57.3 kWh/yr and 0 kW. The baseline energy factor, energy use, and gross energy savings are shown in **Table 3.21**.[34] The program net ex ante savings are 573 kWh/yr, 0 kW and 8,595 lifecycle kWh based on 9 efficient electric water heaters. The ex ante and ex post net-to-gross ratio is 0.80. The ex ante and ex post EUL is 15 years. The total net ex post savings are 1,282 ± 128 first-year kWh, 0.2 ± 0.021 kW, and 19,224 ± 1,922 kWh lifecycle kWh based on 9 units. The ex post savings are approximately 124% greater than ex ante savings due to greater savings per unit.

[31] 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/.

[32] 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.

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

[34] Ibid.

Table 3.21 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

3.1.11 Load Impacts for Low/Moderate Income Energy Assistance

Load impacts low/moderate income energy assistance (Energy Saving Partners) are based on verification inspections at 17 sites, engineering analysis, and the previous EM&V study per IPMVP Option B and C. On-site inspections verified installation of 398 measures compared to 408 measures reported in the TDPUD database (i.e., 97.5% installation rate). An additional 212 measures were installed during the EM&V inspections to motivate customers to participate in the site visits. **Table 3.22** shows the quantities of measures verified at 40 customer sites (17 ESP, 4 RES, and 19 Green Partner sites). The TDPUD database reported 656 measures and 761 measures were verified as installed with an additional 370 measures installed during the EM&V site visits. Customers were offered additional measures during site visits to motivate them to participate. The verified installation rate is 1.16 indicating that 16% more measures are installed compared to what was reported in the database. The reason for the difference is that some measures were given to customers but not reported in the database. Gross ex ante and ex post unit savings are shown in **Table 3.23**. The ex ante and ex post net-to-gross ratio is 0.80. The ex ante EUL is 15 years and the ex post EUL is 9 years. The ex post EUL difference is based on CFL lifetimes which are responsible for 91% of the savings. The TDPUD net ex ante savings are 96,000 kWh/yr, 28.9 kW, 2,447 therms/year, 295,771 gallons/year, 1,440,000 lifecycle kWh, 22,026 lifecycle therm, and 2,661,939 lifecycle gallons of water. The net ex post savings are 117,066 ± 7,203 first-year kWh, 25.2 ± 0.96 kW, 2,273 ± 224 first-year therm, 274,714 ± 27,279 first-year gallons of water, 1,053,592 ± 64,823 lifecycle kWh, 20,458 ± 2,015 lifecycle therm, and 2,472,422 ± 245,511 lifecycle gallons of water.[35] The ex post kWh savings are approximately 22% greater than ex ante savings due to greater ex post unit savings.

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

Table 3.22 Quantity of Installed Measures Verified at 40 Random Sites

#	Energy Survey Measures	Qty. TDPUD Database	Qty. Verified Installed	Qty. Installed during EM&V
1	Door Sweeps	14	7	1
2	Door/Window Weatherstripping (linear feet)	143	151	116
3	1.5 GPM Showerhead	19	9	6
4	Swivel Kitchen Aerator	7	2	0
5	Bath Aerators	16	8	1
6	Water Heater Jacket	8	5	5
7	Pipe Insulation Elbows	7	4	0
8	Pipe Insulation Tees	4	10	0
9	Water Heater Pipe Insulation (linear feet)	38	0	20
10	Water Heater Pipe Insulation Tape (linear feet)	2	1	0
11	Spiral 13W CFL (replace 60W)	82	313	59
12	Spiral 23W CFL (replace 100W)	63	99	55
13	Globe G259/40W (replace 40W)	86	84	24
14	R2014/14W (replace 65W)	31	11	9
15	R30 15W (replace 65W)	62	34	37
16	R30 15W Dimmable (replace 60W)	23	10	18
17	PAR38 23W (replace 90W)	7	1	1
18	PAR38 23W (replace 120W)	34	7	17
19	Toilet Leak Detection Kit	8	5	1
20	Toilet Tank Bank	2	0	0
	Total	656	761	370

Table 3.23 Load Impacts for Low/Moderate Income Energy Assistance (ESP)

Energy Efficiency Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
14. Low Income ESP	600	0.181	35	5,610	836.2 ± 51	0.18 ± 0.007	16.2 ± 1.6	1962 ± 195

3.1.12 Load Impacts for Green Schools

The load impacts for green schools are based on providing all K-8 students at 6 schools throughout the TDPUD electric service area with 1,800 Conservation kits consisting of CFL 60 Watt equivalent spiral 12-packs, low-flow showerhead, 2 faucet aerators, water heater pipe insulation elbow, toilet leak detection kits, 2 LED night lights, shower use timer and conservation education materials. Load impacts are based on previous field inspections and measurements of 211 measures at 4 participant sites and light logger measurements of 10 fixtures consistent with IPMVP Option B. The ex ante and ex post net-to-gross ratio is 0.80. The ex ante EUL is 10 years and the ex post EUL is 9 years. The ex post EUL difference is based on CFL lifetimes which are responsible for 97% of the savings. The embedded energy of water pumping and treatment requires approximately 0.8% more energy or 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. Gross ex ante and ex post unit savings are shown in **Table 3.24**. Ex post quantities and savings are shown in **Table 3.25**. The TDPUD net ex ante savings are 734,331 first-year kWh/yr, 221 kW, 1,360 first-year therm, 7,343,309 lifecycle kWh, and 12,236 lifecycle therm. The net ex post savings are 1,028,699 ± 60,534 first-year kWh/yr, 233 ± 8.7 kW, 1,263 ± 123 first-year therm, 9,258,293 ± 544,805 life-cycle kWh,

and 11,365 ± 1,109 lifecycle therm. The ex post savings are greater than ex ante due to greater unit savings per kit than anticipated.

Table 3.24 Load Impacts for Green Schools

Energy Efficiency Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
15. Green Schools	510	0.154	1		714.4 ± 42	0.162 ± 0.004	0.9 ± 0.1	

Table 3.25 Ex Post Load Impacts for Green Schools Conservation Kits

Measure	Qty	Net Ex Post Savings (kW)	Net Ex Post Savings (kWh)	Net Ex Post Lifecycle Savings (kWh)	EUL	Net Ex Post Savings (therm)	Net Ex Post Lifecycle Savings (therm)	Net Ex Post Savings (gallons)	Net Ex Post Lifecycle Savings (gallons)
CFL 12 Pack	21,600	233	1,028,160	9,253,440	9				
LED Night Light	2,880				9				
Low-Flow Shower	1,440	1	21,082	189,738	9	13,104	117,936	2,913,166	26,218,494
Faucet Aerator	1,440		7,733	69,597	9	4,838	43,542	1,075,630	9,680,670
WH Pipe Insulation	160		539	4,851	9	1,263	11,367		
EE Handouts	160				9				
Total	23,360	234	1,057,536	9,517,626		19,205	172,845	3,988,796	35,899,164

3.1.13 Load Impacts for Residential Energy Survey

Load impacts for residential energy survey (RES) are based on field inspections, interviews with residential customers, and verification of the TDPUD database. On-site inspections verified installation of 51 measures compared to 64 measures reported in the TDPUD database. An additional 43 measures were installed during the EM&V inspections to motivate customers to participate in the site visits. Gross ex ante and ex post site savings are shown in **Table 3.26**. The ex ante NTGR is 0.8 and the ex post NTGR is 0.64 ± 0.09 based on decision maker surveys of 40 participants. The average ex post operating hours are 1,100 ± 65 hours/yr based on participant survey data for 40 customers.[36] The ex ante EUL is 15 years and the ex post EUL is 9 years. The ex post EUL difference is based on CFL lifetimes which are responsible for 89% of the savings. The ex ante savings are 37,354 first-year kWh, 11.3 kW, 613 therm, 77,263 gallons/year of water, 560,306 lifecycle kWh, 5,519 lifecycle therm, and 695,364 lifecycle gallons of water. The total net ex post savings are 24,934 ± 1,540 first-year kWh, 5.4 ± 0.21 kW, 570 ± 56 therm, 71,762 ± 7,064 gallons of water, 224,409 ± 13,859 kWh lifecycle kWh, 5,126 ± 505 lifecycle therm, and 645,857 ± 63,578 lifecycle gallons of water based on 48 units installed. The ex post savings are 33% lower than ex ante due to 52% fewer participants.

[36] 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 3.26 Load Impacts for Residential Energy Survey

Energy Efficiency Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
16. Residential Energy Survey	466.9	0.141	20	2,336	811.7 ± 50	0.174 ± 0.007	18.5 ± 1.8	2,336 ± 230

3.1.14 Load Impacts for Business Green Partners

Load impacts for the Business Green Partners are based on previous field inspections of 645 measures at 12 participant sites and light logger measurements of 347 fixtures consistent with IPMVP Option B. Gross ex ante and ex post unit savings are shown in **Table 3.27**. 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 10 years and the ex post EUL is 3 years. The TDPUD ex ante savings are 10,199 kWh/yr, 2.9 kW and 101,990 lifecycle kWh. The CFL average annual hours of operation are 3,135 ± 303 hours per year based on the 2009 TDPUD EM&V study. Based on 1,469 CFLs installed, the net ex post savings are 79,679 ± 4,679 first-year kWh, 71.9 ± 2.6 kW, and 239,036 ± 14,035 kWh lifecycle kWh at the 90% confidence level. The ex post first-year savings are approximately 7 times greater than ex ante savings due to 7 times more CFLs installed than anticipated.

Table 3.27 Load Impacts for Business Green Partners

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)
17. Business Green Partners	53.1	0.015	10	56.5 ± 3.3	0.051 ± 0.002	3

3.1.15 Load Impacts for Keep Your Cool

Load impacts for the Keep Your Cool program are based on data for 36 commercial customer sites with energy efficiency refrigeration upgrades consistent with IPMVP Option A. Gross ex ante and ex post unit savings are shown in **Table 3.28**. 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 and ex post effective useful lifetime (EUL) is 8 years. The TDPUD ex ante savings are 96,000 kWh/yr, 48 kW and 768,000 lifecycle kWh. The net ex post savings are 346,497 ± 109,281 first-year kWh, 171.8 ± 87.3 kW, and 2,771,978 ± 874,249 kWh lifecycle kWh based on installations at 36 sites. The ex post savings are approximately 260% greater than ex ante savings due to greater savings per site than anticipated.

Table 3.28 Load Impacts for Keep Your Cool

Energy Efficiency Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
18. Keep Your Cool	2,400	1.2			10,026 ± 3,162	4.97 ± 2.53		

3.1.16 Load Impacts for Business LED Pilot

Load impacts for the Business LED Pilot are based on data for 16 commercial sites that received LED lamps and light logger measurements of retail and restaurant sites from previous TPDUD EM&V studies consistent with IPMVP Option B. Gross ex ante and ex post unit savings are shown in **Table 3.29**. The ex ante and ex post net-to-gross ratio is 0.96. The effective useful lifetime (EUL) is 16 years. The TDPUD ex ante savings are 25,498 kWh/yr, 7.7 kW and 407,962 lifecycle kWh. The average annual hours of operation are 3,107 ± 16 hours per year based on the 2009 TDPUD EM&V study. Based on 229 LED lamps installed, the net ex post savings are 21,149 ± 2,300 first-year kWh, 6.6 ± 0.57 kW, and 338,378 ± 36,796 kWh lifecycle kWh at the 90% confidence level. The ex post savings are 16% less than ex ante savings due to fewer lamps installed than anticipated (i.e., 229 versus 1,000 ex ante).

Table 3.29 Load Impacts for Business LED Pilot

Energy Efficiency Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
19. Business LED Pilot	26.6	0.008			96.2 ± 10.5	0.03 ± 0.003		

3.1.17 Load Impacts for LED Business Accent Lighting

Load impacts for the LED Business Accent Lighting are based on data for 3 commercial sites that received LED lamps and light logger measurements of retail and restaurant sites from previous TPDUD EM&V studies consistent with IPMVP Option B. Gross ex ante and ex post unit savings are shown in **Table 3.30**. The ex ante and ex post net-to-gross ratio is 0.96. The effective useful lifetime (EUL) is 16 years. The TDPUD ex ante savings are 15,299 kWh/yr, 4.8 kW and 244,777 lifecycle kWh. The average annual hours of operation are 2,958 ± 37 hours per year based on the 2009 TDPUD EM&V study. Based on 185 LED lamps installed, the net ex post savings are 3,481 ± 379 first-year kWh, 1.24 ± 0.106 kW, and 55,695 ± 6,069 kWh lifecycle kWh at the 90% confidence level. The ex post savings are 77% less than ex ante savings due to fewer lamps installed than anticipated (i.e., 185 versus 700 ex ante).

Table 3.30 Load Impacts for LED Business Accent Lighting

Energy Efficiency Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
20. LED Bus. Accent Lights	22.8	0.007			19.6 ± 2.1	0.007 ± 0.001		

3.1.18 Load Impacts for LED Exit Signs

Load impacts for the LED Exit Signs are based on data for 2 commercial sites that received LED lamps and light logger measurements of retail and restaurant sites from previous TPDUD EM&V studies consistent with IPMVP Option B. Gross ex ante and ex post unit savings are shown in **Table 3.31**. The ex ante and ex post net-to-gross ratio is 0.96. The effective useful lifetime (EUL) is 16 years. The TDPUD ex ante savings are 2,550 kWh/yr, 1.0 kW and 40,796 lifecycle

kWh. The average annual hours of operation are 8,760 hours per year based on the 2009 TDPUD EM&V study. Based on 56 LED exit signs installed, the net ex post savings are 5,887 ± 640 first-year kWh, 0.64 ± 0.059 kW, and 94,188 ± 10,239 kWh lifecycle kWh at the 90% confidence level. The ex post savings are 130% greater than ex ante savings due to greater unit savings per lamp than anticipated.

Table 3.31 Load Impacts for LED Exit Signs

Energy Efficiency Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
21. LED Exit Signs	13.3	0.005			109.5 ± 11.9	0.013 ± 0.001		

3.1.19 Load Impacts for Residential Green Partners

Load impacts for residential green partners (RGP) are based on field inspections, interviews with residential customers, and verification of the TDPUD database. On-site inspections verified installation of 312 measures compared to 184 measures reported in the TDPUD database. An additional 115 measures were installed during the EM&V inspections to motivate customers to participate in site visits. Gross ex ante and ex post unit savings are shown in **Table 3.32**. The ex ante and ex post NTGR is 0.96. The ex ante and ex post EUL is 9 years. The ex ante savings are 254,976 first-year kWh, 76.8 kW, and 2,294,784 lifecycle kWh. The total net ex post savings are 143,866 ± 8,458 first-year kWh, 32.6 ± 1.21 kW, and 1,294,798 ± 76,122 lifecycle kWh based on 3,671 units installed. Differences between ex ante and net ex post savings are due to fewer measures installed (i.e., 3,671 versus 5,000).

Table 3.32 Load Impacts for Residential Green Partners

Energy Efficiency Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
22. Res. Green Partners	53.1	0.016			61.2 ± 3.6	0.014 ± 0.001		

3.1.20 Load Impacts for Neighborhood Block Party

No neighborhood block party events were held in 2010. Non participant customers asked about having neighborhood block parties and BBQ events in 2011.

3.1.21 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 3.33**. The ex ante goal for Energy Star® CFL rebates is 40,000 units and the study verified 53,304 measures from the TDPUD purchase orders. The ex ante and ex post net-to-gross ratios are 0.8. The average ex post operating hours are 1,100 ± 65 hours/yr based on participant survey

data for 40 customers.[37] The ex ante effective useful lifetime is 9 years and the ex post EUL is 9 years per year assuming 10,000 lifecycle operational hours. The total net ex ante savings are 1,869,824 first-year kWh and 563.2 kW and 16,828,416 lifecycle kWh for 40,000 units. The total net ex post savings are 1,418,765 ± 83,457 first-year kWh, 322 ± 23.8 kW, and 12,768,890 ± 751,111 lifecycle kWh for 29,805 units. The ex post savings are approximately 24% less than ex ante savings due to units being credited to other programs.

Table 3.33 Load Impacts for Million CFLs

Energy Efficiency Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
24. Million Energy Star® CFLs	32	0.040			59.5 ± 3.5	0.054 ± 0.002		

3.1.22 Load Impacts for LED Light Swap

Load impacts for the Light Emitting Diode (LED) Light Swap program are based on field inspections of 10 measures at 4 participant sites performed in previous TDPUD EM&V studies consistent with IPMVP Option B. The TDPUD assumed ex ante savings are 24,170 kWh/yr, 7.3 kW and 120,848 lifecycle kWh. Pre- and post-retrofit fixture quantities, hours of operation and savings for the LED holiday lights are shown in **Table 3.34**. 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 5 years and the ex post EUL is 16 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 are 56,329 ± 12,947 first-year kWh, 52.16 ± 11.8 kW, and 901,275 ± 207,167 kWh lifecycle kWh at the 90% confidence level. The ex post savings are approximately 7.5 times greater than ex ante kWh savings. Differences between ex ante and net ex post savings are due to 3.5 times more installed units than anticipated, greater savings (i.e., LED lamps are more efficient than assumed), and longer life than anticipated.

Table 3.34 Load Impacts for LED Light Swap

Energy Efficiency Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
25. LED Light Swap	35.4	0.011			23.9 ± 5.5	0.022 ± 0.005		

[37] 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).

3.1.23 Load Impacts Miscellaneous Water Efficiency

Load impacts for the miscellaneous water efficiency measures are evaluated using field measurements of pre- and post-retrofit flow rates from previous EM&V studies per IPMVP Option A and B.[38] TDPUD purchased 7,384 water efficiency measures including 3,350 showerheads (1.5 gpm), 682 kitchen swivel aerators (1.5 gpm), and 3,352 bath aerators (0.5 gpm). Low-flow showerheads replace standard showerheads with flow rates equal to or greater than 2.5 gpm at a flowing pressure of 80 pounds per square inch gauge (psig).[39] Low-flow showerheads are assumed to reduce water flow by 40% (i.e., 1-1.5/2.5=0.4). Low-flow kitchen swivel aerators replace standard kitchen aerators with flow rates equal to or greater than 2.2 gpm at a flowing pressure of 60 psig. Low-flow kitchen swivel aerators are assumed to reduce water flow by 31.8% (i.e., 1-1.5/2.2=0.318). Low-flow bath aerators replace standard bath aerators with flow rates equal to or greater than 2.2 gpm at a flowing pressure of 60 psig. Low-flow bath aerators are assumed to reduce water flow by 77.3% (i.e., 1-0.5/2.2=0.773). 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.[40] The ex post savings are based on the average 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.). Water efficiency measure applicability factors and load impacts are shown in **Table 3.35**.[41] The gross ex ante and ex post unit savings are shown in **Table 3.36**. Embedded energy for water pumping and treatment is valued at 0.008157374 kWh per gallon.[42] Insufficient time and budget were available to verify how many were installed by TDPUD customers. This study assumes that 30% of water efficiency measures are installed at homes with electric water heaters and 70% are installed at homes with gas water heaters. The ex ante and ex

[38] 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).

[39] EPAct 1992 standard for showerheads and aerators applies to commercial and residential. Showerhead and aerators flow rate standards are defined in American Society of Mechanical Engineers (ASME) A112.18.1/CSA-B125.1-1992/2005. New York, NY: Available online: http://files.asme.org/Catalog/Codes/PrintBook/14122.pdf.

[40] Ibid.

[41]. Energy Efficient Showerhead and Faucet Aerator Metering Study Multifamily Residences: A Measurement and Evaluation Report. October 1994. Prepared by SBW Consulting, Inc. Prepared for Bonneville Power Administration. http://www.bpa.gov/energy/n/reports/evaluation/residential/faucet_aerator.cfm.

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

post NTGR is 0.80. The ex ante and ex post EUL is 10 years. The TDPUD ex ante savings are 203,004 first-year kWh, 17.9 kW, 34,287 first-year therm, 12,355,702 first-year gallons of water, 2,030,037 lifecycle kWh, 342,873 lifecycle therm, and 123,557,022 lifecycle gallons of water. The net ex post savings are 333,646 ± 33,364 first-year kWh, 47 ± 4.7 kW, 31,846 ± 3,185 first-year therm, 11,476,038 ± 1,147,604 first-year gallons of water, 3,336,456 ± 333,646 lifecycle kWh, 318,463 ± 31,846 lifecycle therm, and 114,760,384 ± 11,146,038 lifecycle gallons of water based on 7,384 units installed. The ex post kWh savings are approximately 64% greater than ex ante savings due to electricity savings from water pumping energy savings and therm savings for units that have gas rather than electric water heaters.

Table 3.35 Water Efficiency Measure Applicability Factors and Load Impacts

Measure	Applicability Factor	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallons)	Gross Ex-Post Unit Water Pump Savings (kWh/y)
1.5 gpm Showerhead-Gas DHW	0.7		0.002 ± 0.001	11.4 ± 0.1	1,505 ± 151	12.3 ± 1.2
1.5 gpm Kitchen Aerator-Gas DHW	0.7		0.001 ± 0.0001	5.1 ± 0.5	1,054 ± 10.5	8.6 ± 0.9
0.5 gpm Bath Aerator-Gas DHW	0.7		0.003 ± 0.001	4.6 ± 0.4	2,560 ± 256	20.9 ± 2.1
1.5 gpm Showerhead-Elec DHW	0.3	200± 20	0.03 ± 0.003		1,505 ± 151	12.3 ± 1.2
1.5 gpm Kitchen Aerator-Elec DHW	0.3	90 ± 9	0.014 ± 0.001		1,054 ± 10.5	8.6 ± 0.9
0.5 gpm Bath Aerator-Elec DHW	0.3	80 ± 8	0.013 ± 0.001		2,560 ± 256	20.9 ± 2.1
Average		56.48 ± 5.6	0.008 ± 0.001	5.39 ± 0.5	1,943 ± 194	In Column 3

Table 3.36 Load Impacts for Miscellaneous Water Efficiency

Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gallon/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Water Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
26. Misc. Water Eff.	31.9	0.003	7	3,722	56.46 ± 5.6	0.008 ± 0.001	5.39 ± 0.5	1,943 ± 194

3.2 Verification Inspection Findings

Verification inspections were conducted in 2010 and for the previous EM&V studies in 2008 and 2001 through 2004. Results of the on-site verification inspections were used in the impact evaluation to estimate the overall energy savings. Inspections 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 for the 2008 programs. Electric power measurements were made on a number of fixtures at different sites as shown in **Table 3.37**.

Table 3.37 Field Measurements of Lighting Fixture Average Power (2009 Study)

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 3.38**. 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 3.38 Light Logger Measurements of Lighting Hours of Operation (2009 Study)

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 40 participants and non participant surveys were completed for 40 non participants or individuals who were not contacted by the programs.

3.3.1 Participant Survey Methodology

Participant surveys are used to evaluate retention (i.e., measures still installed), pre-retrofit Watts, hours of operation, and time-of-use. The participant surveys were also used to evaluate net-to-gross ratios (NTGR) for calculating net kW and kWh savings. The NTGR 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 3.39**. The NTGR 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 3.39 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 Findings of the Participant Surveys

Results of the participant surveys are presented in **Table 3.40**. The participant findings indicate that approximately 36% of customers in Truckee say they "would have installed the energy efficiency measures without the program information and incentives."

Table 3.40 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
14. Low-Mod Income Assist/ESP	17	175	600.0	0.181	0.64 ± 0.09
16. Residential Energy Survey	4	48	466.9	0.141	0.64 ± 0.09
22. Residential Green Partners	19	3,671	53.1	0.016	0.64 ± 0.09

3.2 Process Evaluation Results

Process evaluation recommendations are based on process surveys conducted in-person with 40 participants and 40 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**.

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 – 96.5 percent satisfaction rating (i.e., average score of 9.65 ± 0.25 out of 10 points).
   - Courteous and Professional Staff – 97 percent satisfaction rating (i.e., 9.72 ± 0.34 out of 10 points).
   - Increased Understanding of Link between Energy Efficiency, Savings, and Comfort - 82 ± 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.
   - 93 percent of customers are still using the measures installed by the program (i.e., 37 out of 40 surveyed customers were still using all installed measures). One customer complained about the low flow rate of bath aerators and two customers had issues with the CFLs).
   - 93% ± 5% of customers are satisfied with measures offered or installed by the program ((i.e., average score of 9.4 ± 0.5 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.
   - 93 ± 6 percent usefulness rating.
   - 95 ± 4 percent presentation rating.
   - 97 ± 6 percent accuracy rating.
   - 82 ± 8 percent rating of program increasing understanding of the linkage between energy efficiency, bill savings, and comfort.
   - 60 percent of participants indicated that others would benefit from the program.

4. What are the participant demographics?

- 30% of customers have electric water heaters and 70% have gas water heaters.
- Average water temperature set point is 127.3 ± 3.4°F
- Average conditioned floor area is 1,612 ft^2 ± 224 ft^2.
- Average number of occupants is 2.4 ± 0.3.
- 40% owned the home and 60% are tenants.
- 100 percent spoke English well enough to understand and answer the questions.
- Participants had the following primary languages: 82.5% English, 17.5% Spanish.

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

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

- 20% said the program would benefit from "more information about the energy efficiency in Spanish, better advertising, rebates for water efficiency, water metering, improve the survey by having surveyors install energy efficiency measures, more types of CFLs, combine gas/electric, bill inserts."
- 17% wanted "provide more energy efficient lamps such as dimmable CFLs, candelabra, reflectors, and 3-way bulbs 13/23/40W CFL to replace 50/100/150W incandescent."
- 10% said "Excellent program, add low income discount, solar thermal, PV, and solar sun space." "Very satisfied!" "Install CFLs in every fixture." "Do all homes in town!"
- 6% said "promote green/efficient building materials insulation, passive solar, efficient windows, and whole house programs."
- 5% said "CFL takes too long to reach full brightness."

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, 60 percent of interviewed customers shared program information with 18 times as many people. Approximately 20 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 5.3 percent.[43] 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.

[43] Spillover of 5.3 percent is calculated based on 431 people adopting at least one spillover measure based on information shared by a group of 24 participants who adopted 342 measures (i.e., 431 × (1÷ 342) ÷ 24 = 0.053).

1. Is there a continuing need for the program?

The following responses indicate a continuing need for the program.

- 96.5 percent of participants were very satisfied with the program and said they would like the TDPUD to "do all businesses and homes in town!"
- 70 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)? [Multiple answers are provided and sum of percentages is greater than 100%]

- 65% didn't participate due to not knowing about the program (i.e., information costs).
- 10% didn't participate due to not understanding the benefits of energy efficiency.
- 15% didn't participate due to being too busy or not having time to participate (hassle factor).
- 30% didn't participate due to already having installed CFLs, already taken steps to improve home, didn't understanding what programs provided beyond CFLs, 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).

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 on website, via e-mail messages, Facebook, 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 at events, booth at Safeway, or delivered to homes."
- 10% said offer neighborhood block parties or BBQ events to help customers save energy."
- 6% said "compare bill decrease of participants after program with neighbors who didn't participate."
- 5% said they wanted information and lists about eligible dishwashers, clotheswashers, and refrigerators available at local appliance stores like Sears, Czyz's, Home Depot, Lowes, etc." "Send list of qualifying appliances for rebates without having to go to TDPUD 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.

- 90% of non-participants are owners and 10% are renters.
- Average age is 54 ± 6 years.
- 55% of non-participants are male and 45% are female.
- Non-participants had the following primary languages: 100% English.

- Average income of non-participants is $57,000 ± $20,000.

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), make, model number, USDOE FTC energy label rating (kWh/yr), CEE rating (Consortium for Energy Efficiency, www.cee1.orgm Tier 1, 2 or 3), efficiency rating (AFUE, MEF, WF, EF, etc.), 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. Offer incentives based on CEE Tier levels (Tier 2 for dishwashers and Tier 2 and 3 for clotheswashers and refrigerators). Identify products based on CEE Tiers levels through the www.tdpud.org website and work cooperatively with retailers to advertise CEE Tier ratings that exceed Energy Star®.
3. Work with Southwest Gas to develop jointly funded programs and incentives for measures that save gas, electricity, and water such as CEE Tier 2 dishwashers, CEE Tier 2 and 3 clotheswashers, Energy Star® duct sealing, building envelope repair, WaterSense® showerheads and aerators, Energy Star® furnaces, Energy Star® water heaters, Energy Star® solar water heaters, and solar sun spaces or passive solar heating.
4. Develop and implement an internet verification system to ensure that measures are properly installed to increase savings, cost effectiveness, and reduce lost opportunities.
5. Educate customers about comparable CFL and LED replacements in terms of lumens. Offer more types of CFLs (i.e., candelabra, color temperature, reflector, and dimmable, long-life cold-cathode) to increase savings and acceptance.
6. Purchase large quantities of US EPA® Water Sense® 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.

7. Consider incentives for US EPA® Water Sense® (class V) 1.28 gallon per flush toilets.
8. Offer incentives for efficient motor systems such as electronic commutated (EC) motors or brushless permanent magnet (BPM) motors and efficient fans and motor systems.
9. Implement quarterly neighborhood energy efficiency BBQ block party offering CFLs, WaterSense showerheads, aerators, toilets, and comprehensive measures at neighborhood leadership homes such as duct sealing, building envelope repair, insulation, Energy Star® window upgrades, EC motor furnace fans, and Energy Star® programmable thermostats.
10. Implement the California Energy Upgrade program (https://energyupgradeca.org/overview) in TDPUS which includes a $2,000 incentive for saving 20% with 6 prescriptive measures and up to $5000 for saving 50% with custom measures. The 20% prescriptive measures include: 1) building envelope repair to 0.35 ACH, 2) duct sealing to 10%, 3) attic insulation to R60 (with radiant barrier), 4) WaterSense showerheads/aerators, 5) water heater wrap, 5) pipe insulation, and 6) CO/smoke alarm.
11. Rename the duct mitigation program to the Energy Star® ducts (15% reduction with Tier 2 of 10% similar to California Energy Upgrade) and rename the window thermal efficiency program to the Energy Star® windows program.
12. Consider offering incentives for conservation gardens and landscaping to save water using the Patricia S. Sutton TDPUD Conservation Garden as an example.
13. Provide better advertising to increase participation including bill inserts, internet information, handouts or fliers that tell customers about the program, funding source, and free services.
14. Implement a comprehensive whole building performance program consistent with the Energy Upgrade California program (energyupgradeca.org). Offer incentives for passive solar heating and sun spaces with thermal mass, super insulation (attic, wall, floor) with the existing TDPUD building envelope repair and duct sealing programs.
15. Offer incentives for occupancy sensors for commercial lighting and plug loads and offer rebates for Energy Star® LED high-definition television (HDTV) sets.
16. 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.
17. Participants provided the following suggestions to improve the program.
    - "Provide better advertising to increase participation including e-mail, website, bill inserts, and radio advertising to inform customers about incentive programs and free services."
    - "Provide information about energy efficiency incentives and programs in Spanish."
    - "Provide rebates for WaterSense® water efficiency measures, landscaping, and water metering."
    - "Improve the Residential Energy Surveys and ESP surveys by having the surveyors install the measures."
    - "Offer more types of CFLs including dimmable CFLs, candelabra, reflectors, and 3-way bulbs 13/23/40W CFL to replace 50/100/150W incandescent."

- "Work with Southwest Gas to provide electricity and gas energy efficiency incentive programs."
- "Provide more information about dimmable CFLs and offer free dimmable CFLs."
- "Provide lists of eligible dishwashers, clotheswashers, and refrigerators available at local appliance stores like Sears, Czyz's, Home Depot, Lowes, etc. Identify products based on CEE Tiers levels through the www.tdpud.org website and work cooperatively with retailers to advertise CEE Tier ratings that exceed Energy Star®. 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 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), make, model number, USDOE FTC energy label rating (kWh/yr), CEE rating (Consortium for Energy Efficiency, www.cee1.orgm Tier 1, 2 or 3), efficiency rating (AFUE, MEF, WF, EF, etc.), 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.

3.2.3.3 Recommendations for Building Envelope and Duct Sealing

Provide Energy Star® building envelope and Energy Star® 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 0.35 ACH for building envelope infiltration and 15% for 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. Educate customers about comparable CFL and LED replacements in terms of lumens. 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), 3-way 13/23/40W, and fully-dimmable CFLs, and candelabra, to increase savings, acceptance and persistence of CFL savings.

3.2.3.5 Recommendations for Low-Flow Showerheads

Some customers complained that TDPUD low-flow showerheads didn't provide enough flow. Purchase WaterSense® qualified showerheads and offer customers at least three different types of WaterSense® pressure-compensating showerheads (including hand-held) to maintain consistent flow rates of 1.5 gpm, 1.75 gpm, and 2.0 gpm @ 30 to 60 psig flowing pressure to improve customer satisfaction and retention.

3.2.3.6 Recommendations for Low-Flow Aerators

Some customers complained that the TDPUD low-flow aerators didn't provide enough flow. WaterSense® qualified aerators and offer customers at least three different types of aerator flow rates of 0.5 gpm, 1.0 gpm, and 1.5 gpm @ 30 to 60 psig flowing pressure to improve customer satisfaction and retention.

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 2011.

1. Improve the Green Schools program by continuing to give away large numbers of bulk purchased CFLs, showerheads, and aerators, etc. Require online verification from each participant where students compete for additional cash prizes by verifying installation of all measures and receive a grade for reporting the installations on the www.tdpud.org website or website provided by Truckee High School Bright Schools/Envirolution environment club. This survey should include more information about all TDPUD programs to motivate customers to participate in other TDPUD programs. The energy education program should also be expanded to other students especially for Earth Day.
2. Increase attic insulation to R-60 with radiant barriers 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. Provide incentives for

crawl space sealing and radiant barriers to save heating energy. Work with SIGBA to provide workshops for builders on advanced high performance super insulated buildings.

4. Develop a super insulated home program to go beyond California Energy Upgrade with a goal of zero net energy.
5. Work with Southwest Gas to develop jointly funded programs and incentives for measures that save gas, electricity, and water such as CEE Tier 2 dishwashers, CEE Tier 2 and 3 clotheswashers, Energy Star® duct sealing, building envelope repair, WaterSense® showerheads and aerators, Energy Star® furnaces, Energy Star® water heaters, Energy Star® solar water heaters, and solar sun spaces or passive solar heating.
6. Offer incentives for occupancy sensors for commercial lighting and plug loads and offer rebates for Energy Star® LED 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.
7. Educate customers about comparable CFL and LED replacements in terms of lumens. 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), 3-way 13/23/40W, and fully-dimmable CFLs, and candelabra, to increase savings, acceptance and persistence of CFL savings.
8. Purchase large quantities of US EPA® Water Sense® 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.
9. Consider incentives for US EPA® Water Sense® (class V) 1.28 gallon per flush toilets.
10. 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.
11. Offer incentives for efficient motor systems such as electronic commutated (EC) motors or brushless permanent magnet (BPM) motors and efficient fans and motor systems.
12. Implement the California Energy Upgrade program (https://energyupgradeca.org/overview) in TDPUS which includes a $2,000 incentive for saving 20% with 6 prescriptive measures and up to $5000 for saving 50% with custom measures. The 20% prescriptive measures include: 1) building envelope repair to 0.35 ACH, 2) duct sealing to 10%, 3) attic insulation to R60 (with radiant barrier), 4) WaterSense showerheads/aerators, 5) water heater wrap, 5) pipe insulation, and 6) CO/smoke alarm.
13. Implement quarterly neighborhood energy efficiency BBQ block party offering CFLs, WaterSense showerheads, aerators, toilets, and comprehensive measures at neighborhood leadership homes such as duct sealing, building envelope repair, insulation, Energy Star® window upgrades, EC motor furnace fans, and Energy Star® programmable thermostats.

Appendix A: Participant and Non Participant Decision-Maker Survey

Interview Instructions for Decision-Maker Survey

1. Purpose

The purpose of the Decision-Maker Survey is to obtain sufficient information to improve the program, 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 Saver or Residential Energy Survey or Green Partners energy efficiency measures. 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. 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.
2. **Non-participants** must be a residential customer in the TDPUD service area that was unaware of the program or decided not to allow program measures to be installed at their home (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) Own 3) Lease; 4) Male or Female; or 5) Located outside TDPUD.

4. 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).

5. 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 ESP, Residential Energy Survey, and Green Partners Programs. The programs provided free Energy Surveys and no-cost energy efficiency measures for your home. Funding for the program is from TDPUD. 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 ESP, Residential Energy Survey, and Green Partners Programs that were funded by public benefits from TDPUD customers in 2010. You didn't participate in the program, but your feedback will help us evaluate and improve the program. The program provided a free Energy Survey and no-cost energy efficiency measures for your home. Funding for the program is from TDPUD. Would you mind spending 10 minutes to answer a few questions?

TDPUD PARTICIPANT SURVEY #_____

Customer Name:_____ Date: _____

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

Participant Survey (If Residential Green Partners Skip to Q8)

1. Do you remember TDPUD providing an *Energy Survey* and no-cost energy efficiency measures for your home?

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

2. How would you rate the surveyor 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 surveyor at your home?
   ___ 1 hr ___2 hrs ___3 hrs ___4 hrs ___>4 hrs **98** Don't Know **99** Refused to Answer

5. Did you receive *Energy Survey* from TDPUD ? ___ **1** (Yes) ___ **2** (No, ***Skip to Q8***) **98** DK **99** Refused

   If yes, how would you rate the *Energy Survey* 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 Survey* 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 Survey* 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. (**Skip here for Green Partners Program**) Did you receive the *Energy Survey*, efficiency measures or rebates?

   ___ **1** (Yes) ___ **2** (No) **98** DK **99** Refused

   If yes, how satisfied were you with the *Energy Survey* advice on a scale from 1 to 10?
   ___ Efficiency Measures (**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 link 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 is 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 not installed (i.e., check TDPUD database to verify installation of CFLs, etc.)?
    ___ **1** (Yes) ___ **2** (No) **98** Don't Know **99** Refused to Answer

    Please list measures not installed? _____

TDPUD PARTICIPANT SURVEY (cont'd) #_____

14. Have you shared information with any of your neighbors about the benefits of screw-in CFLs, efficient showerheads/aerators, door sweeps, weatherstripping, pipe insulation, water heater jacket, or other measures from the *Energy Survey*?
    ___ **1** (Yes) ___ **2** (No) **98** Don't Know **99** Refused to Answer

    With how many other neighbors 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 neighbors or friends that would benefit from this program (name/address)? _____

    _____

16. How many refrigerators do you have? _____ Refrigerator _____Freezer **98** Don't Know **99** Refused

17. Do you have an electric water heater? ___ **1** (Yes) ___ Gallons ___ **2** (No) **98** Don't Know **99** Refused

18. (Optional) Measure water heater set point temperature (run water for 5 minutes in sink near tank) _____ (F)

19. Did you receive Energy Survey measures to install at your home?
    ___ **1** (Yes) ___ **2** (No) **98** Don't Know **99** Refused to Answer

20. Please verify the quantity of TDPUD energy and water efficiency measures installed.

#	Energy Survey Measures	Qty. TDPUD Database	Qty. Verified Installed	Qty. Installed during EM&V
1	Door Sweeps			
2	Door/Window Weatherstripping (feet)			
3	1.5 GPM Showerhead			
4	Swivel Kitchen Aerator			
5	Bath Aerators			
6	Water Heater Jacket			
7	Pipe Insulation Elbows			
8	Pipe Insulation Tees			
9	Water Heater Pipe Insulation (linear feet)			
10	Water Heater Pipe Insul. Tape (feet)			
11	Spiral 13W CFL (replace 60W)			
12	Spiral 23W CFL (replace 100W)			
13	Globe G259/40W (replace 40W)			
14	R2014/14W (replace 65W)			
15	R30 15W (replace 65W)			
16	R30 15W Dimmable (replace 60W)			
17	PAR38 23W (replace 90W)			
18	PAR38 23W (replace 120W)			
19	Toilet Leak Detection Kit			
20	Toilet Tank Bank			

21. Please provide the following demographic information?
    _____Language ____# Occupants Own Lease _____ Floor Area **99** Refused

22. 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). _____

DECISION-MAKER SURVEY #_____

Customer Name: _____ Date: _____

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 survey regarding the TDPUD energy efficiency programs. Would you mind spending 5 minutes to answer a few questions to help us evaluate the Energy Saver , Residential Energy Survey and Residential Green Partner Programs."

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 Wattage bulbs did you replace with CFLs? ___ **1** (60 W) ___ **2** (75 W) ___ **3** (100W) **98 DK 99** Refused

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? _____ (Month/Year)

   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 or other measures? (**Circle One**) **1** Before **2** After (**Go to Q.7**) **98** DK **99** Refused to Answer

6. Did you install CFL(s) or other measures 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

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

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 likely and 10 very likely. ___ Response (**0-10**) **98** DK **99** Refused

   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**]. Find the explanation. Do not 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: _____

DECISION-MAKER SURVEY (Continued) #_____

9. What role did the Utility Program play in your decision to install the CFLs or other measures? [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

Say: Here are some statements that may be more or less applicable for your home 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. Utility Program was nice but it was unnecessary to install CFL(s) or other measures.

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

11. Utility Program was a critical factor to install CFL(s) or other measures

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

12. We would not have installed the CFL(s) or other measures 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: _____

13. If you hadn't received free CFLs [or other measures] from TDPUD would you have installed the same 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 #_____

Customer Name: _____ Date: _____

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

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) and other energy efficiency measures to customers like you. CFLs use 75% less energy than incandescent lamps. Would you mind spending 5 minutes to answer a few questions?

1. Would you have participated in the TDPUD Energy Efficiency Programs 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 Energy Saver, Residential Energy Survey, or Green Partner Programs?
   (Read list – Multiple answers are okay.)

   1 Didn't know about CFLs or the survey 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 ___TDPUD Customer ___ **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). _____

   _____