Evaluation, Measurement & Verification Report for Truckee Donner Public Utility District 2012 Energy Efficiency Programs

DRAFT REPORT

Prepared for

Truckee Donner Public Utility District

Truckee, California

Prepared by

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Verified®, Incorporated

Truckee, California

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1. Executive Summary

This report provides the Evaluation, Measurement, and Verification (EM&V) findings for the 2012 Truckee Donner Public Utility District (TDPUD) energy efficiency programs. TDPUD operates on a calendar-year budget. This study was conducted by Verified, Incorporated, with public benefits funds under the auspices of the Northern California Power Agency (NCPA), California Municipal Utilities Association (CMUA), and the California Energy Commission (CEC). The study is available for download at www.calmac.org. TDPUD implemented 29 energy efficiency programs or measures in 2012 as shown in **Table 1.1**. The programs provided educational information, incentives, and free energy efficiency measures to residential and commercial customers. TDPUD accomplished 50,630 measures or 15.9% more than the ex ante estimate.

Table 1.1 Ex Ante and Ex Post Energy Efficiency Programs or Measures

Description	Ex Ante Qty.	Ex Post Qty.
Total Installed Measures	**43,689**	**50,630**
1. Residential CFLs	100	113
2. Clothes Washers Energy Star	180	190
3. Dishwashers Energy Star	170	167
4. Refrigerator/Freezers Energy Star	200	203
5. Refrigerator Recycling	130	142
6. Building Envelope Testing	9	9
7. Duct System Testing	11	11
8. Building Envelope Mitigation	9	9
9. Duct System Mitigation	9	9
10. Window Thermal Efficiency		
11. Commercial Lighting Projects	38	38
12. Commercial Projects Other (TTUSD)	4	4
13. EE Electric Water Heater	6	6
14. Low-Mod. Income Assist/ESP	120	133
15. Green Schools Program/Kits		
16. Residential Energy Survey (RES)	140	153
17. Business Green Partners	1200	1,274
18. Keep Your Cool	5	5
19. Business LED Pilot	550	585
20. LED Business Accent Lighting	25	100
21. LED Exit Sign Direct Install	1	1
22. Residential Green Partners	3300	3,676
23. Neighborhood Block Party	25	29
24. Million CFLs	30000	34,732
25. LED Light Swap	644	1,983
26. Misc. Water Efficiency	5500	5,745
27. Toilet Rebates and Exchange	594	594
28. Customer Water Leak Repair	25	25
29. TDPUD Bldg. LED EE Lighting Project	694	694

TDPUD achieved 14.9% greater lifecycle electricity savings with ex post savings of 27,224,345 kWh versus ex ante goal of 23,700,782 kWh. TDPUD exceeded the ex ante E3 Calculator Total Resource Cost (TRC) test goal by 10.7% with an ex post TRC of 2.48 and the ex ante TRC of 2.24 as shown in **Table 1.2**.[1] The ex post TRC is greater than the ex ante TRC due to 15.9% 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 1,596 measures at 12 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 4,236 fixtures at 41 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)	2,473,273	2,768,287
Net Demand Savings (kW)	818	1,005
Net Lifecycle Electricity Savings (kWh)	23,700,782	27,224,345
Net Annual Therm Savings (therm/yr)	19,557	20,729
Net Lifecycle Therm Savings (therm)	197,075	208,294
Net Annual Water Savings (gallon/yr)[2]	16,889,992	17,339,473
Net Lifecycle Water Savings (gallon)	177,423,110	181,907,569
Total Resource Cost (TRC) Test – E3	**2.24**	**2.48**
TRC Test Costs	$1,040,787	$1,064,785
TRC Test Benefits	$2,326,934	$2,640,630
TRC Test Net Benefits	$1,286,147	$1,575,844
Participant Test	**0.72**	**0.73**
Participant Test Costs	$773,027	$790,112
Participant Test Benefits	$559,622	$576,708
Participant Test Net Benefits	($213,404)	($213,404)

The ex ante first-year savings are summarized in **Table 1.3**. The first-year net ex ante program savings are 2,473,273 kWh per year, 818 kW per year, 19,557 therms per year, and 16,889,992 gallons of water per year.

[1] Energy and Environmental Economics (E3), Inc. 2011. EE Reporting Tool 2011 (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.

[2] 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)
1. Residential CFLs	59.5	0.014			0.69	4,106	0.9	0	0
2. Energy Star Clothes Washers	205.3	0.175	6.3	8,050	0.68	25,127	21.4	771	985,262
3. Energy Star Dishwashers	64.3	0.105	1.3	514	0.69	7,545	12.3	156	60,335
4. Energy Star Refrigerators	127.7	0.022			0.70	17,878	3.1	0	0
5. Refrigerator Recycling	1,151.0	0.248			0.85	127,190	27.4	0	0
6. Building Envelope Testing					0.80	0	0.0	0	0
7. Duct System Testing					0.74	0	0.0	0	0
8. Building Envelope Mitigation	71.4	0.059	41.8		0.80	514	0.4	301	0
9. Duct System Mitigation	96.7	0.080	56.6		0.74	644	0.5	377	0
10. Window Thermal Efficiency	160.0	0.531	10.9		0.96	0	0.0	0	0
11. Commercial Lighting Projects	4,988.4	1.008			0.85	161,124	32.5	0	0
12. Commercial Other (TTUSD)	36,739.8	16.992			0.97	142,550	65.9	0	0
13. EE Electric/Solar Water Heat	32.0	0.005			0.79	152	0.0	0	0
14. Low-Mod Income Assist/ESP	314.4	0.233	25.4	4,475	0.84	31,694	23.5	2,557	451,103
15. Green Schools Program/Kits	7.5	0.003			0.80	0	0.0	0	0
16. Residential Energy Survey	969.1	0.796	30.6	7,053	0.64	86,834	71.3	2,745	631,905
17. Business Green Partners	165.1	0.046			0.85	168,434	47.3	0	0
18. Keep Your Cool	20,557.8	1.745			0.95	97,649	8.3	0	0
19. Business LED Pilot	226.0	0.046			0.85	105,661	21.3	0	0
20. LED Business Accent Lights	68.5	0.016			0.85	1,456	0.3	0	0
21. LED Exit Sign Direct Install	109.5	0.013			0.85	93	0.0	0	0
22. Residential Green Partners	63.6	0.058			0.64	134,390	121.9	0	0
23. Neighborhood Block Party	422.7	0.093	18.3	4,064	0.69	7,291	1.6	315	70,104
24. Million CFLs	59.5	0.014			0.69	1,231,650	279.5	0	0
25. LED Light Swap	23.9	0.089			0.91	14,023	51.9	0	0
26. Misc. Water Efficiency	3.9	0.002	2.9	1,469	0.77	16,696	8.5	12,335	6,219,405
27. WaterSense Toilets	26.0	0.004		3,178	0.81	12,488	1.8	0	1,529,089
28. Customer Water Leak Repair	1,731.6	0.198		360,664	0.77	33,333	3.8	0	6,942,790
29. TDPUD Building EE Project	64.5	0.018			1.00	44,750	12.7	0	0
Total						2,473,273	818.4	19,557	16,889,992

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 2,768,287 ± 90,909 kWh per year, 1005 ± 52 kW per year, 20,729 ± 1,671 therms per year, and 17,339,473 ± 1,784,795 gallons (23,181 ± 2,386 CCF) of water per year at the 90 percent confidence level. The net first-year realization rates are 1.12 ± 0.04 for kWh, 1.23 ± 0.06 for kW, 1.06 ± 0.09 for therms, and 1.03 ± 0.11 for gallons of 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	0.014			0.69	4,639	1.1	0	0
2. Clothes Washers	205.3	0.175	6.3	8,050	0.68	26,523	22.6	814	1,039,999
3. Dishwashers	64.3	0.105	1.3	514	0.69	7,412	12.1	153	59,270
4. Refrigerator/Freezers	127.7	0.022			0.70	18,147	3.1	0	0
5. Refrigerator Recycling	1,151.0	0.248			0.85	138,931	29.9	0	0
6. Building Envelope Testing					0.80	0	0.0	0	0
7. Duct System Testing					0.74	0	0.0	0	0
8. Building Envelope Mitigation	71.4	0.059	41.8		0.80	514	0.4	301	0
9. Duct System Mitigation	96.7	0.080	56.6		0.74	644	0.5	377	0
10. Window Thermal Efficiency	160.0	0.531	10.9		0.96	0	0.0	0	0
11. Commercial Light Projects	4,988.4	1.008			0.89	168,707	34.1	0	0
12. Commercial Other (TTUSD)	36,739.8	16.992			0.97	142,550	65.9	0	0
13. EE Elec/Solar Water Heat	32.0	0.005			0.79	152	0.0	0	0
14. Low-Mod Income Asst/ESP	314.4	0.233	25.4	4,475	0.84	35,128	26.1	2,834	499,972
15. Green Schools Program/Kits	7.5	0.003			0.80	0	0.0	0	0
16. Residential Energy Survey	969.1	0.796	30.6	7,053	0.64	94,898	77.9	3,000	690,582
17. Business Green Partners	165.1	0.046			0.85	178,821	50.2	0	0
18. Keep Your Cool	20,557.8	1.745			0.95	97,649	8.3	0	0
19. Business LED Pilot	226.0	0.046			0.85	112,385	22.7	0	0
20. LED Business Accent Lights	68.5	0.016			0.85	5,824	1.3	0	0
21. LED Exit Sign Direct Install	109.5	0.013			0.85	93	0.011	0	0
22. Residential Green Partners	63.6	0.058			0.64	149,702	135.8	0	0
23. Neighborhood Block Party	422.7	0.093	18.3	4,064	0.69	8,458	1.9	366	81,321
24. Million CFLs	59.5	0.014			0.69	1,425,922	323.5	0	0
25. LED Light Swap	23.9	0.089			0.91	43,178	159.9	0	0
26. Misc. Water Efficiency	3.9	0.002	2.9	1,469	0.77	17,440	8.9	12,884	6,496,451
27. WaterSense Toilets	26.0	0.004		3,178	0.81	12,488	1.8	0	1,529,089
28. Water Leak Repair	1,731.6	0.198		360,664	0.77	33,333	3.8	0	6,942,790
29. TDPUD Building EE Project	64.5	0.018			1.00	44,750	12.7	0	0
Total						2,768,287	1,004.6	20,729	17,339,473
90% Confidence Interval						90,909	52	1,671	1,784,795
Realization Rate						1.12 ± 0.04	1.23 ± 0.06	1.06 ± 0.09	1.03 ± 0.11

The lifecycle electricity and water savings are summarized in **Table 1.5**. The net ex-ante lifecycle program savings are 23,700,782 kWh, 197,075 therms, and 177,423,110 gallons of water. The net ex-post lifecycle program savings are 27,224,345 ± 816,603 kWh, 208,294 ± 16,641 therms, and 181,907,569 ± 17,872,114 gallons of water (243,192 ± 23,893 CCF). The net lifecycle realization rates are 1.15 ± 0.03 for kWh, 1.06 ± 0.08 for therms, and 1.03 ± 0.10 for gallons of 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	36,950			9	41,753		
2. Energy Star Clothes Washers	12	301,527	9,253	11,823,144	12	318,278	9,768	12,479,985
3. Energy Star Dishwashers	11	82,991	1,716	663,684	11	81,527	1,686	651,972
4. Energy Star Refrigerators	14	250,297			14	254,051		
5. Refrigerator Recycling	5	635,951			5	694,654		
6. Building Envelope Testing	5				5	0		
7. Duct System Testing	5				5	0		
8. Building Envelope Mitigation	18	9,248	5,416		18	9,248	5,416	
9. Duct System Mitigation	18	11,590	6,788		18	11,590	6,788	
10. Window Thermal Efficiency	20				20	0		
11. Commercial Lighting Projects	11	1,772,368			15	2,530,601		
12. Commercial Other (TTUSD)	15	2,138,253			15	2,138,253		
13. EE Electric/Solar Water Heat	15	2,275			15	2,275		
14. Low-Mod Income Assist/ESP	9	285,250	23,010	4,059,924	9	316,153	25,503	4,499,749
15. Green Schools Program/Kits	5				5	0		
16. Residential Energy Survey	9	781,509	24,707	5,687,144	9	854,078	27,001	6,215,236
17. Business Green Partners	3	505,302			3	536,462		
18. Keep Your Cool	8	781,196			8	781,196		
19. Business LED Pilot	16	1,690,581			16	1,798,163		
20. LED Business Accent Lights	16	23,294			16	93,177		
21. LED Exit Sign Direct Install	16	1,489			16	1,489		
22. Residential Green Partners	9	1,209,511			9	1,347,322		
23. Neighborhood Block Party	9	65,619	2,838	630,940	9	76,118	3,292	731,890
24. Million CFLs	9	11,084,850			9	12,833,300		
25. LED Light Swap	16	224,361			16	690,850		
26. Misc. Water Efficiency	10	166,958	123,346	62,194,051	10	174,396	128,840	64,964,513
27. WaterSense Toilets	15	187,325		22,936,328	15	187,325		22,936,328
28. Customer Water Leak Repair	10	333,328		69,427,896	10	333,328		69,427,896
29. TDPUD Building EE Project	25	1,118,758			25	1,118,758		
Total		23,700,782	197,075	177,423,110		27,224,345	208,294	181,907,569
90% Confidence Interval						816,603	16,641	17,872,114
Realization Rate						1.15 ± 0.03	1.06 ± 0.08	1.03 ± 0.10

The energy impact reporting for 2012 programs is provided in **Table 1.6**.

Table 1.6 Energy and Water Impact Reporting for 2012 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	2012	3,314	2,768	1.110	0.896	26,055	20,729	29,604	23,181
2	2013	3,314	2,768	1.110	0.896	26,055	20,729	29,604	23,181
3	2014	3,314	2,768	1.110	0.896	26,055	20,729	29,604	23,181
4	2015	3,116	2,589	1.054	0.845	26,055	20,729	29,604	23,181
5	2016	3,116	2,589	1.054	0.845	26,055	20,729	29,604	23,181
6	2017	2,966	2,451	1.022	0.816	26,055	20,729	29,604	23,181
7	2018	2,966	2,451	1.022	0.816	26,055	20,729	29,604	23,181
8	2019	2,966	2,451	1.022	0.816	26,055	20,729	29,604	23,181
9	2020	2,863	2,353	1.013	0.807	26,055	20,729	29,604	23,181
10	2021	678	634	0.275	0.241	18,265	14,529	27,430	21,481
11	2022	613	583	0.259	0.228	2,246	1,645	4,578	3,514
12	2023	413	576	0.203	0.216	2,020	1,492	4,461	3,435
13	2024	376	549	0.171	0.194	886	678	2,524	2,044
14	2025	376	549	0.171	0.194	886	678	2,524	2,044
15	2026	350	531	0.167	0.190	886	678	2,524	2,044
16	2027	188	207	0.097	0.089	886	678	0	0
17	2028	46	46	0.014	0.014	886	678	0	0
18	2029	46	46	0.014	0.014	886	678	0	0
19	2030	45	45	0.013	0.013	0	0	0	0
20	2031	45	45	0.013	0.013	0	0	0	0
21	2032	45	45	0.013	0.013	0	0	0	0
22	2033	45	45	0.013	0.013	0	0	0	0
23	2034	45	45	0.013	0.013	0	0	0	0
24	2035	45	45	0.013	0.013	0	0	0	0
25	2036	45	45	0.013	0.013	0	0	0	0
Total		31,334	27,224			262,338	208,294	310,477	243,192

** 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. 1 CCF = 748 gallons.
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	1,984	1,005	2,768,287	27,224,345	20,829	14,729	0.04	0.05	2.48
24. Million CFLs	1,294	324	1,425,922	12,833,300	0	6,851	0.01	0.01	7.03
20. LED Business Accent	1	1	5,824	93,177	0	52	0.02	0.02	6.48
28. Water Leak Repair	4	4	33,333	333,328	0	181	0.02	0.02	5.18
17. Business Green Partner	50	50	178,821	536,462	0	297	0.02	0.02	4.40
19. Business LED Pilot	23	23	112,385	1,798,163	0	997	0.03	0.03	4.32
1. Residential CFLs	4	1	4,639	41,753	0	22	0.02	0.02	4.18
26. Misc. Water Efficiency	9	9	17,440	174,396	12,884	93	0.23	0.23	4.07
22. Res. Green Partners	136	136	149,702	1,347,322	0	719	0.03	0.03	3.48
5. Refrigerator Recycling	30	30	138,931	694,654	0	377	0.03	0.03	3.11
12. Commercial (TTUSD)	66	66	142,550	2,138,253	0	1,199	0.04	0.06	2.99
23. Neighborhood Block Pty	7	2	8,458	76,118	329	41	0.05	0.05	2.95
16. Res. Energy Survey	78	78	94,898	854,078	2,700	456	0.05	0.05	2.45
6-9. Bldg/Duct Test/Repair	1	1	1,158	20,838	1,220	13	0.55	0.55	2.03
2. E Star Clotheswashers	23	23	26,523	318,278	977	176	0.10	0.10	1.71
25. LED Light Swap	160	160	43,178	690,850	0	369	0.08	0.08	1.48
18. Keep Your Cool	8	8	97,649	781,196	0	412	0.09	0.09	1.15
29. TDPUD Bldg LED Lights	13	13	44,750	1,118,758	0	620	0.15	0.15	1.11
14. Low-Mod Income/ESP	26	26	35,128	316,153	2,550	169	0.17	0.17	1.09
4. Energy Star Refrigerators	3	3	18,147	254,051	0	138	0.12	0.12	1.00
11. Commercial Lighting	34	34	168,707	2,530,601	0	1,402	0.06	0.15	0.95
21. LED Exit Sign	0	0	93	1,489	0	1	0.20	0.20	0.71
3. Energy Star Dishwashers	12	12	7,412	81,527	169	45	0.28	0.28	0.54
13. EE Elec Water Heater	0	0	152	2,275	0	1	0.29	0.29	0.40
27. WaterSense Toilet	2	2	12,488	187,325	0	100	0.46	0.46	0.26
10. Window Efficiency									
15. Green Schools Program									

The TDPUD E3 energy efficiency portfolio total utility resource cost is $0.05/kWh and the net lifecycle green house gas (GHG) reductions are 14,729 tons. TDPUD energy efficiency (EE) portfolio realized a 2.48 TRC which is 10.7% greater than anticipated due to installing 15.9% more measures through innovative community-based programs. The top ten programs have an average TRC of 4.5. The Million CFL program realized a TRC of 7.03 by purchasing CFLs in large quantities at low cost and installing CFLs through multiple programs. The Water Leak Repair and Miscellaneous Water Efficiency programs realized a TRC of 5.18 and 4.07 respectfully due to electricity savings from water pumping and therm savings from units installed at sites with gas water heaters. The LED Business Accent, Business LED Pilot, and Business Green Partners programs realized a TRC of 6.5, 4.32, and 4.40 respectfully by buying LED lamps and CFLs in bulk and distributing them directly to commercial customers. The Commercial (TTUSD) program realized a TRC of 2.99 with comprehensive lighting, pump, and HVAC retrofit projects. The Neighborhood Block Party program realized a TRC of 2.95 by providing free energy efficient CFLs directly to customers who attended the neighborhood events. The Refrigerator Recycling program realized a TRC of 3.11 by using a local appliance chain store to recycle units. Residential Green Partners realized a TRC of 3.48. The LED Light Swap program realized a TRC of 1.48. The Keep Your Cool program realized a TRC of 1.15 by installing 264 commercial refrigeration measures including LED refrigeration case lights, door gaskets, floating-head pressure controls, anti-sweat heater controls, efficient evaporator fan motors (electronically commutated motors - ECMs), and ECM fan controllers. The TDPUD LED Lighting Project realized a TRC of 1.11 by installing advanced LED lighting throughout the

building. The LED fixtures use 42% less power and provide 18% more illuminance than pre-existing fixtures and 85% more illuminance than the IESNA recommendation. The Energy Star® Clotheswasher program realized a TRC of 1.71 due to the combination of kWh, therm, and water savings. Savings were evaluated using the US EPA database (http://www.energystar.gov/). Low-Moderate Income Assistance/Energy Saving Partners realized a TRC of 1.09 and Commercial Lighting realized a TRC of 0.95. TDPUD offered a wide range of innovative and successful programs for residential and commercial customers 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. TDPUD partnered with several local organizations to implement projects including: Sierra Watershed Education Partnership, Sierra Green Building Association, 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 95.1 percent of participants are satisfied with the program based on 7,682 survey responses to 35 questions from 178 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 9.51 ± 0.02 out of 10 points. Participants indicated that they would like to see improved programs to better serve TDPUD customers. Non-participant survey results indicate 67 percent would have participated if they had known about the program with 25% declining due to already having compact fluorescent lamps installed, and 7% 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 following process evaluation recommendations are provided to improve program services, procedures, and cost effectiveness.

- TDPUD is implementing an internet-tracking system (www.energy-orbit.com) to track program accomplishments. The tracking database will help customers understand energy efficiency and renewable energy by providing information about energy savings, apply for rebates online, and provide feedback regarding the rebate process and programs. The database can be used to provide interim information about program energy savings and help document and verify installed measures for EM&V reporting.
- Provide better advertising to increase participation including bill inserts, internet information, handouts or fliers that tell customers about the programs and free services.
- The Million CFLs program has a TRC of 7.03. The program provides CFLs and LEDs for residential and commercial customers. TDPUD continues to evaluate CFLs and LED lamps to find better quality products with longer life.
- TDPUD has redesigned the appliance rebate program for 2013. For refrigerators, TDPUD is offering a $75 rebate for CEE Tier 1, $100 for CEE Tier 2 which is 25% more efficient than Federal Standards, and $125 for CEE Tier 3 which is 30% more efficient than Federal

Standards. For dishwashers, TDPUD is offering a $75 rebate for CEE Tier 1 which is 14% better than Federal Standards. For clotheswashers, TDPUD is offering a $75 rebate for CEE Tier 1 which is 59% more efficient than Federal Standards, $150 for CEE Tier 2 which is 75% more efficient, and $175 for CEE Tier 3 which is 90% better. TDPUD helps customers identify qualifying products through the www.tdpud.org website link to www.cee1.org. TDPUD is working cooperatively with retailers to advertise CEE Tier 2 or better products that exceed Energy Star®. These program improvements will motivate customers to purchase more efficient appliances and make the Energy Star® programs more cost effective.

- The TDPUD refrigerator and freezer recycling program realized a TRC of 3.11 by recycling 142 units in 2012 which is a 490% increase from 2011. Increased participation is due to TDPUD hiring a local appliance retailer to recycle refrigerators and freezers year round. Using a local retailer increased the number of units recycled and improved the local economy.
- The building envelope and duct mitigation program realized a TRC of 2.03. This program should provide rebates for achieving minimum leakage reduction targets. The duct leakage target should be 15% measured in cubic feet per minute (cfm) or 15% total duct leakage as a percentage of total system airflow. The building envelope sealing target should be 15% CFM50 reduction in air leakage or no less than 0.3 Air Changes per Hour (ACH).[1] Information and incentives should be provided to commercial customers to optimize minimum outdoor air damper settings to save cooling and heating energy.
- 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 and duct mitigation programs. Consider at least one pilot demonstration sun space project in 2013 at the Senior Center where billing data for one unit with a temporary plastic sun space enclosure reduced electric resistance heating bills by 50%.
- TDPUD should implement a thermally efficient window program for its office building and encourage at least five customers per year to install thermally efficient low-emissivity windows. This will help customers understand the importance of saving electricity and natural gas by reducing window heat loss in winter and heat gain in summer. Installing low-emissivity windows at the TDPUD offices will reduce energy use to achieve the Energy Star® BEP rating. The Energy Star® window qualification criteria maximum u-value is 0.32 Btu/hr-ft^2-°F and 0.4 solar heat gain coefficient (SHGC) including the frame.[3] TDPUD should adopt the Energy Star® window criteria for incentive programs. The SHGC will be effective in reducing residential and commercial cooling loads in summer when solar gains and outdoor temperatures peak on south facing exposures.
- The Commercial Lighting program will benefit from the revised application process where customers enter pre- and post-retrofit fixtures, quantities, Watts, and hours of operation. This will streamline the rebate application process and provide better tracking information for EM&V purposes.

[3] http://www.energystar.gov/ia/partners/prod_development/archives/downloads/windows_doors/WindowsDoorsSkylightsProgRequirements7Apr09.pdf

- TDPUD should encourage at least one customer per year to install solar thermal water heaters to help customers understand the importance of saving electricity and natural gas by heating water with solar power consistent with the California Solar Initiative (CSI) Thermal Program (see http://www.gosolarcalifornia.org/solarwater/). The CSI-Thermal Program offers cash rebates of up to $1,875 for solar water heating systems on single-family homes. Multifamily and Commercial properties qualify for rebates of up to $500,000. The California CSI program encourages customers to "save money on gas or electricity bills by harnessing the heat of the sun!"
- TDPUD should continue to require energy auditors who perform Low/Moderate Income Energy Assistance and Residential Energy Surveys to install the measures. This will include using ladders to install CFL lamps in ceiling fixtures. Many low income elderly or disabled customers cannot climb ladders. Installing the measures will improve cost effectiveness and help low income customers save energy and money.
- The Business Green Partners program has a TRC of 4.4 and is very popular with small commercial business customers. TDPUD should continue to offer this innovative program to help small local businesses save energy and be successful. This program generates high customer satisfaction ratings with 92% of participants indicating they were very satisfied with the overall energy efficiency services received from TDPUD.
- The Commercial Refrigeration Retrofit program has a TRC of 1.15 and is very popular with small commercial business customers. TDPUD should continue to offer this innovative program to help small local businesses save refrigeration energy. This program generates high customer satisfaction ratings with 90% of participants indicating they were very satisfied with the overall energy efficiency services received from TDPUD. The Commercial Refrigeration Retrofit program needs to require pre and post-retrofit measurements of motors to correctly estimate kW savings which are currently estimated using engineering equations. Motor electric power cannot be accurately estimated using engineering equations due to unknown voltage, current, and phase angles.
- The LED Business Accent Lighting program has a TRC of 6.4 and Business LED Pilot program has a TRC of 4.3. These programs are very popular with small commercial business customers. TDPUD should continue to offer these innovative programs to help small local businesses save energy. The programs generate high customer satisfaction ratings with 92% of participants indicating they were very satisfied with the overall energy efficiency services received from TDPUD. The custom delivery approach should be expanded in 2013.
- The Residential Green Partners program has a TRC of 3.5 and distributes information and free energy and water-saving measures to residential customers. This innovative program invites customers to visit the TDPUD Conservation office and select various CFLs 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. This innovative program provides customers with excellent information about energy and water efficiency measures.
- The Neighborhood Block Party program provides neighborhood energy efficiency BBQ block parties offering CFLs, WaterSense® showerheads, and aerators. The program should consider offering additional comprehensive measures at neighborhood leadership homes such

as duct sealing, building envelope repair, leak repair, insulation, Energy Star® window upgrades, and Energy Star® residential climate control thermostats. This innovative program should be expanded to reach more customers.

- The Miscellaneous Water Efficiency program has a TRC of 4.1. This innovative program provided 5,745 water efficiency measures to customers. The 2010 EM&V study received comments from some customers who complained that the low-flow showerheads and aerators didn't provide enough flow. TDPUD purchased aerators and WaterSense® showerheads in 2011 and 2012 and this greatly improved customer satisfaction. This cost effective water efficiency program should be continued. WaterSense® 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 offering incentives for water conservation gardens and landscaping to save water using the Patricia S. Sutton TDPUD Conservation Garden as an example.
- The Water Efficient Toilets program had a TRC of 0.26. In order to make the program more cost effective, TDPUD should reduce incentives for water efficient toilets from $100 per toilet to $20 per toilet. The program should require WaterSense® toilets with maximum water use of 1.28 gallons per flush (gpf) compared to the current US standard of 1.6 gpf (http://www.epa.gov/WaterSense/products/toilets.html). WaterSense® toilets flush 4 times better than standard toilets and save approximately 3,178 gallons per year of water and 26 kWh/yr of electricity used to pump water. Customers were very satisfied with the Water Efficient toilet program giving it an overall satisfaction rating of 96% +/- 1.6%.
- The Customer Water Leak Repair program has high customer satisfaction and TRC test of 5.2. Water supply leaks represent 10 to 50% of the total water supplied by municipal utilities. The TDPUD energy and water efficiency departments should be recognized for excellence in program design and implementation for this innovative program.
- The TDPUD Building LED Lighting Project had a TRC of 1.11. This innovative project demonstrates significant energy savings and improved lighting efficacy compared to T8 fluorescent lamps. The TDPUD LED project will also help customers understand the value of comprehensive LED lighting retrofits compared to standard T8 fluorescent and High Intensity Discharge (HID) lamps.
- 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 checklist information. **Section 3** describes the EM&V objectives, including baseline information, energy efficiency measure information, measurement and verification approach, and the evaluation approach. **Section 3** 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 4** 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 4** also includes measure recommendations to increase savings, achieve greater persistence, and improve customer satisfaction. **Appendix A** provides the CEC EM&V Checklist. **Appendix B** provides the participant decision-maker survey instrument for the TDPUD programs. **Appendix C** provides the Light Logger Metering Equipment Protocols.

2. EM&V Checklist Information

This section provides information required in the CEC EM&V checklist (**Appendix A**).

2.1 Contextual Reporting

☒ Clearly state savings values and compare to the associated ex ante savings.

Table 2.1 provides a comparison of the EM&V study savings values compared to the associated ex ante savings. The EM&V study found net peak demand savings of 896 ± 49 KW, net annual savings of 2,734,763 ± 90,819 kWh per year, net lifecycle savings of 26,687,974 ± 806,216 kWh, and net lifecycle green house gas savings of 14,441 ± 436 tons. With respect to the ex ante savings for TDPUD, the EM&V study net ex post savings represent 110% of net ex ante peak kW, 111% of annual net ex ante kWh, 113% of net ex ante lifecycle kWh, and 113% of the net ex ante GHG savings.

☒ What portion of the portfolio is covered? Describe the programs or savings not evaluated?

The EM&V study covers 100% of the TDPUD program portfolio.

☒ Assess risk or uncertainly in selecting the components of the portfolio to evaluate.

The uncertainties associated with selecting the components of the portfolio to evaluate are unknown. The uncertainties associated with the EM&V study are 6% of the net savings at the 90 percent confidence level. The EM&V study evaluated the uncertainty based on the mean and standard deviation for 9,981 measures included in EM&V studies of similar programs since 2008. The uncertainty is approximately 6% for kW savings, 3.7% for first year kWh savings, and 3.4% for lifecycle kWh savings.

Table 2.1 EM&V Savings Compared to Ex Ante Savings

Description	Ex Ante	EM&V Study	%
Net Peak kW Savings	818	896	110%
Net Annual kWh Savings	2,473,273	2,734,763	111%
Net Lifecycle kWh Savings	23,700,782	26,687,974	113%
Net Lifecycle GHG Savings (tons)	12,827	14,441	113%
Utility Incentive Cost ($)	$559,622	$576,408	103%
Utility Marketing, EM&V, and Administrative Cost ($)	$294,901	$294,901	100%
Total Utility Cost ($)	$854,523	$871,309	102%
TRC	2.24	2.44	109%

2.2 Overview and Documentation of Evaluation Effort

☒ Clearly identify what is being evaluated in the study (part of a program; an entire program; the entire portfolio).

The EM&V study performed site visits and measurements at 14 of the largest non-residential customer sites in 2012 per IPMVP options A and B. The study performed engineering and statistical analyses of all other non-residential and residential programs per IPMVP options A based on EM&V studies conducted over the previous 5 years. The EM&V study performed on-site inspections to verify the measures and installed light loggers to measure hours of operation. The study also conducted surveys with decision maker to evaluate net-to-gross ratios (i.e., free riders) and customer satisfaction and obtain customer feedback and suggestions to improve the program (see **Appendix B**).

☒ Include an assessment of EUL and lifecycle savings.

The EM&V lifecycle savings are generally based an average effective useful lifetime (EUL) values provided in the Energy Environmental Economics (E3) calculator and based on the DEER.[4] The EM&V study found the following gross lifecycle savings of 34,525,923 +/- 1,042,993 and 19,225 ± 582 tons of greenhouse gas (GHG) emissions. The ex ante gross lifecycle savings are 31,334,429 kWh and 17,103 tons of GHG emissions.

☒ Provide documentation of all engineering and billing analysis algorithms, assumptions, survey instruments and explanation of methods.

Documentation of all engineering algorithms, assumptions, survey instruments, and methods are provided in **Section 3** and **Appendix D**.

☒ Describe the methodology in sufficient detail that another evaluator could replicate the study and achieve similar results.

The methodology is described in **Section 3** and **Appendix D**.

☒ Include all data collection instruments in an appendix.

Data collection instruments are provided in **Appendix B**.

[4] Ibid.

☒ Describe metering equipment and protocols in an appendix.

Light logger metering equipment and protocols are provided in **Appendix C**.

2.3 Gross Savings

☒ Review the program's choice of baseline.

The TDPUD program choice of baselines are from previous EM&V studies of similar programs, the E3 calculator, manufacturers' data, engineering analyses, spreadsheets, and time-series data logger measurements.

☒ Characterize the population of participants.

The population of TDPUD participants by program application is shown in **Table 2.2**. Approximately 13,282 customers participated in the 2012 programs. The EM&V non-residential participant average floor area is 60,375 +/- 42,826 square feet. The building types included: hotel, hospitality, restaurants, retail, office, elementary schools, and high schools. Average non-residential occupancy is 50 +/- 32. The end use categories include HVAC, refrigeration, VFD pumps, lighting (lamps, fixtures, sensors), and computing (PC network power management). Residential end use categories include HVAC, appliances, refrigerator/freezer recycling, lighting, water heating, toilets, and water.

Table 2.2 Population of TDPUD Participants by Measure

Program	Participant Applications
1. Residential CFLs	11
2. Clothes Washers Energy Star	190
3. Dishwashers Energy Star	167
4. Refrigerator/Freezers Energy Star	203
5. Refrigerator Recycling	133
6. Building Envelope Testing	9
7. Duct System Testing	11
8. Building Envelope Mitigation	9
9. Duct System Mitigation	9
10. Window Thermal Efficiency	0
11. Commercial Lighting Projects	38
12. Commercial Projects Other (TTUSD)	4
13. EE Electric Water Heater	6
14. Low-Mod. Income Assist/ESP	133
15. Green Schools Program/Kits	0
16. Residential Energy Survey (RES)	153
17. Business Green Partners	28
18. Keep Your Cool	5
19. Business LED Pilot	28
20. LED Business Accent Lighting	1
21. LED Exit Sign Direct Install	1
22. Residential Green Partners	408
23. Neighborhood Block Party	29
24. Million CFLs	7697
25. LED Light Swap	726
26. Misc. Water Efficiency	2873
27. WaterSense Toilet Rebates and Exchange	384
28. Customer Water Leak Repair	25
29. TDPUD Bldg. LED EE Lighting Project	1
Total	13,282

☒ Discuss the sampling approach and sample design.

The sampling approach for gross savings involved selecting a random sample of sites or measures from the program population. Samples were selected to obtain a reasonable level of precision and accuracy at the 90% confidence level. The sample design was based on statistical survey sampling methods.[5] Sampling methods were used to analyze 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.[6] 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 sample size was 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.

☒ State the sampling precision targets and achieved precision.

The sampling precision targets are +/- 10%. The EM&V study achieved precision of+/- 9% at the 90% +/- 10% confidence level based on average savings per measure and standard deviations for 9,981 measures (see **Table 3.2)**.

☒ Present ex post gross savings.

The EM&V study found the following ex post gross savings for the program 1,219 kW, 3,675,602 kWh per year, 27,629 therm/yr, 30,413 CCF/yr, lifecycle savings of 33,525,923 kWh, 277,397 therms, 318,554 CCF of water, and 19,255 tons of greenhouse gas (GHG) emissions. Ex post gross savings do not include the NTGR.

☒ Expand the results to the program population. If not, state why not; and clearly indicate where ex ante savings are being passed through.

The EM&V results are expanded to the program population since all programs were evaluated over the previous 5 years.

☒ Explain any differences between ex ante and ex post savings.

With respect to the ex ante savings for TDPUD, the EM&V study net ex post savings represent 110% of net ex ante peak kW, 111% of annual net ex ante kWh, 113% of net ex ante lifecycle kWh, and 113% of the net ex ante GHG savings. The ex post savings are greater due to installing 12.7% more measures.

[5] 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.

[6] 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.

2.4 Net Savings

☒ Include a quantitative assessment of net-to-gross. If not, clearly indicate the source of the assumed net-to-gross value.

The quantitative assessment of the net-to-gross ratio (NTGR) is provided in **Section 3**. The EM&V study weighted average NTGR is 0.75 for approximately 100% of the total energy savings based on surveys of 211 program participants. The ex ante assumed net to gross ratio is 0.75. Net to gross ratios are used to determine the portion of the total energy savings (gross savings) that is attributable to the utility energy efficiency program. For a complete discussion on rationale and approaches used to establish the program NTGR, please refer to the Model Energy Efficiency Program Impact Evaluation Guide - November 2007, published by the National Action Plan for Energy Efficiency Leadership Group.

☒ Discuss the sampling approach and sample design.

The sampling approach for net savings involved selecting a random sample of representative participants from the program population. Sampling methods were used to analyze data and extrapolate average survey responses (i.e., net-to-gross ratios) to the population of all program participants and to evaluate the statistical precision of the results. Customers in similar programs 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. Samples were selected to obtain a reasonable level of precision and accuracy at the 90% confidence level.

☒ If a self-report method is used, does the approach account for free-ridership?

The EM&V study used a self-report method including interviews with participants. Non participant surveys were not conducted due to time and budget limitations. The survey results indicate free ridership ranges from 0 to 36% with an average of 25% who indicated that they would have installed energy efficiency measures without the rebates. The total gross savings are reduced by 25% to account for free-ridership.

2.5 EM&V Summary and Conclusions

☒ Provide clear recommendations for improving program processes to achieve measurable and cost-effective energy savings.

Most survey participants (i.e., 75%) said they would not have installed energy efficient measures without incentives and information from TDPUD. These customers did not have sufficient capital or motivation to invest in improving the energy efficiency of their lighting systems without the incentives. To overcome these market barriers, the TDPUD efficiency programs should be continued and expanded to save energy and peak demand and reduce carbon dioxide emissions.

☒ Assess the reliability of the verified savings and areas of uncertainty

The EM&V study evaluated the reliability and uncertainty of the verified savings based on the mean and standard deviation for 9,981 measures. The uncertainty is approximately 6.0% for kW savings, 3.7% for first year kWh, 8.5% for therms, and 10.6% for water.

3. Required EM&V Objectives and Components

This section discusses how the EM&V study meets the objectives listed in **Table 3.1** including baseline information, energy efficiency measure information, measurement and verification approach, and the evaluation approach.

Table 3.1 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.

3.1 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 3.2**.

Table 3.2 Existing Baseline Studies

Study	Description
1	*Evaluation Measurement and Verification Report for the Truckee Donner Public Utility District 2011 Energy Efficiency Programs*, Prepared by Verified, Inc., April 2012.
2	*Evaluation Measurement and Verification Report for the Truckee Donner Public Utility District 2010 Energy Efficiency Programs*, Prepared by Verified, Inc., February 2011.
3	*Evaluation Measurement and Verification Report for the Truckee Donner Public Utility District 2008 Energy Efficiency Programs*, Prepared by Robert Mowris & Associates, February 2009.
4	*Evaluation Measurement and Verification Report for the Small Nonresidential Energy Fitness Program #179*, Prepared by Robert Mowris & Associates, April 30 2004.
5	*Measurement & Verification Summary Report for NCPA SB5X Programs* prepared for NCPA and the California Energy Commission, 2005.
6	*Measurement and Verification Report for NCPA SB5X Commercial and Industrial Lighting Programs*, prepared for NCPA, prepared by RMA, 2005.
7	*Measurement and Verification Report for NCPA SB5X Refrigerator Recycling Programs*, prepared for NCPA, prepared by RMA, 2005.
8	*Measurement and Verification Report for NCPA SB5X Residential Compact Fluorescent Lamp Programs*, prepared for NCPA, prepared by RMA, 2005.
9	*Measurement and Verification Report for NCPA SB5X Miscellaneous Programs*, prepared for NCPA, prepared by Robert Mowris & Associates, 2005.
10	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/.
11	*Database for Energy Efficiency Resources (DEER). Summary of the EUL-RUL Analysis for the April 2008 Update to DEER EUL/RUL (Effective/Remaining Useful Life) Values (Updated 10 October 2008) and EUL/RUL Summary Documentation (Posted April 2008). Prepared by KEMA, Inc.* *http://www.deeresources.com/deer2008exante/downloads/EUL_Summary_10-1-08.xls*
12	*DEER2008 unit energy consumption values from the* Measure Inspection and Summary viewer tool (MISer Version 1.10.25) and Database for Energy Efficiency Resources (DEER Version: DEER2008.2.2). See http://www.deeresources.com/.
13	E3: Energy and Environmental Economics, Inc. 2011. E3 Calculator. Energy and Environmental Economics, Inc.: San Francisco, Calif. 94104. Available online: http://www.ethree.com/cpuc_cee_tools.html.
14	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.
15	*California Statewide Residential Appliance Saturation Survey.* Study 300-00-004, prepared for California Energy Commission, prepared by KEMA-XENERGY Inc. Oakland, California, June 2004.
16	*USEPA FTC Databases (http://www.energystar.gov/) and Refrigerator and Freezer Energy Rating Databases (http://www.kouba-cavallo.com/refmods.htm).*

3.2 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 3.3**.

Table 3.3 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	59.5	0.014			9	0.69	100
2. Energy Star Clothes Washers	Unit	205.3	0.175	6.3	8,050	12	0.68	180
3. Energy Star Dishwashers	Unit	64.3	0.105	1.3	514	11	0.69	170
4. Energy Star Refrigerators	Unit	127.7	0.022			14	0.70	200
5. Refrigerator Recycling	Unit	1,151.0	0.248			5	0.85	130
6. Building Envelope Testing	Unit					5	0.80	8
7. Duct System Testing	Unit					5	0.74	10
8. Building Envelope Mitigation	Unit	71.4	0.059	41.8		18	0.80	8
9. Duct System Mitigation	Unit	96.7	0.080	56.6		18	0.74	8
10. Window Thermal Efficiency	Unit	160.0	0.531	10.9		20	0.96	
11. Commercial Lighting Projects	Site	4,988.4	1.008			11	0.85	38
12. Commercial Other (TTUSD)	Unit	36,739.8	16.992			15	0.97	4
13. EE Electric/Solar Water Heat	Unit	32.0	0.005			15	0.79	5
14. Low-Mod Income Assist/ESP	Site	314.4	0.233	25.4	4,475	9	0.84	120
15. Green Schools Program/Kits	Kit	7.5	0.003			5	0.80	
16. Residential Energy Survey	Site	969.1	0.796	30.6	7,053	9	0.64	140
17. Business Green Partners	Unit	165.1	0.046			3	0.85	1200
18. Keep Your Cool	Site	20,557.8	1.745			8	0.95	5
19. Business LED Pilot	Site	226.0	0.046			16	0.85	550
20. LED Business Accent Lights	Unit	68.5	0.016			16	0.85	25
21. LED Exit Sign Direct Install	Unit	109.5	0.013			16	0.85	1
22. Residential Green Partners	Unit	63.6	0.058			9	0.64	3300
23. Neighborhood Block Party	Site	422.7	0.093	18.3	4,064	9	0.69	25
24. Million CFLs	Unit	59.5	0.014			9	0.69	30000
25. LED Light Swap	Unit	23.9	0.089			16	0.91	600
26. Misc. Water Efficiency	Unit	3.9	0.002	2.9	1,469	10	0.77	5500
27. WaterSense Toilets	Unit	26.0	0.004		3,178	15	0.81	550
28. Customer Water Leak Repair	Site	1,731.6	0.198		360,664	10	0.77	25
29. TDPUD Building EE Project	Site	64.5	0.018			25	1.00	694

The intended ex ante net annual energy and peak demand savings for the TDPUD programs are 2,588,929 kWh per year, 891 kW per year, 24,389 therms per year, and 33,436,981 gallons of water per year. The net ex-ante lifecycle program savings are 24,301,504 kWh, 248,136 therms, and 338,144,167 gallons of water. These savings were is to be accomplished through the installation of 49,384 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 2.1 based on the E3 EE Reporting Tool.

3.2.1 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) lamps. The rebate of $2 per CFL 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. TDPUD assumed average ex ante savings of 59.5 kWh/yr and 0.014 kW for the Residential CFL, Residential Green Partners and Million CFL programs based on the 2011 EM&V study. Ex ante deemed savings for other CFL measures included in the TDPUD programs are shown in **Table 3.4**.

Table 3.4 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	59.5	0.014	1,102.1	n/a	n/a	9.0	0.8
2	Spiral 13/60 (Million CFL)	Unit	59.5	0.014	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 23/120 **	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 3.5**. Energy Star® qualified clotheswashers use 26 to 63 percent less energy and 37 to 58% less water than the federal minimum standard for energy consumption.

Table 3.5 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 3.6**.

Table 3.6 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. Compact dishwashers hold fewer than eight place settings.

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

The Energy Star® and CEE efficiency levels for refrigerators are shown in **Table 3.7**.

Table 3.7 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 3.8**. Energy Star® qualified clothes washers save 70 to 250 kWh/yr compared to regular clothes washers (http://www.energystar.gov). The pumping and treatment electricity associated with water savings increases the electricity savings by 23 to 97 kWh/yr. 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, 2) upright freezers with manual defrost, and 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. TDPUD assumed average ex ante savings of 205.3 kWh/yr and 0.175 kW for Energy Star® clotheswashers, 64.3 kWh/yr and 0.105 kW for Energy Star® dishwashers, and 127.7 kWh/yr and 0.022 kW for Energy Star® refrigerators based on the 2011 EM&V study.

Table 3.8 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	0.159	NA	62.0	n/a	12	0.76
3b	Energy Star® Dishwasher	Unit	0.105	NA	30.7	n/a	11	0.80
3c	Energy Star® Refrigerator	Unit	0.021	NA	121.0	n/a	14	0.75

3. Refrigerator and Freezer Recycling

The Refrigerator and Freezer Recycling Program works with the local Sears® Hometown Store, to remove and recycle existing units. Customers may receive a cash rebate for allowing Sears® to remove and recycle their first, second, third, or fourth refrigerator or freezer. Once approved, Sears® makes 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.[7] TDPUD assumed annual ex ante energy savings of 1,151 kWh/yr and 0.248 kW based on the 2011 EM&V study.

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 and $250 for building or duct mitigation. 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 forced air unit (FAU) and supply/return ducts to 15% (or

[7] 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/.

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 71.4 kWh/year, 0.059 kW, and 41.8 therm/year and for duct mitigation 96.7 kWh/year, 0.080 kW, and 56.6 therm/year based on the 2011 EM&V study.

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 maximum should be R-3 or u-value of 0.32 Btu/hr-ft^2-°F and 0.4 SHGC. TDPUD assumed ex ante savings of 160 kWh/year-unit and 0.531 kW/unit based on the 2011 EM&V study.

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. There are approximately 1,000 to 1,500 all-electric homes in Truckee.

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 3.9**. TDPUD assumed average gross ex ante savings per project of 4,988.4 kWh/year and 1.008 kW based on EM&V site visits and light logger measurements at 13 sites in the 2012 program.

Table 3.9 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 3.10**.

Table 3.10 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. Commercial Other (TTUSD)

The Commercial Other Tahoe Truckee Unified School District (TTUSD) Program provided incentives for the purchase and installation of 335 energy efficiency measures within the following 4 projects: 1) variable frequency drives (VFD) on air handler units (AHU), 2) VFD pumps, 3) personal computer (PC) power controller software, and 4) energy management, maintenance and lighting measures. The EM&V study performed time series pre- and post-measurements of electricity usage for the VFD pumps and the PC power controllers. TDPUD assumed an annual ex ante savings per project of 36,739.8 kWh/year and peak demand savings 16.992 kW based on EM&V site visits and time-series electric power measurements.

9. Energy Efficient Water Heaters (Electric, Solar, and Geothermal Heat Pump)

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 0.93 or higher. Electric water heaters 60 gallons and larger must have an Energy Factor of 0.91 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.[8] Average electric water heater unit energy consumption (UEC) is 3,354 kWh/year.[9] The incremental costs for electric resistance storage water heaters for a 0.02 EF improvement in are approximately $70 to $80 per unit. Savings for an efficient electric water heater with 0.93 EF are 32 kW compared to baseline units with 0.88 EF. 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 ex-ante unit savings of 32 kWh/yr and 0.005 kW. The ex ante effective useful lifetime is 15 years.

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, Sierra Green Building Association, and Sierra Energy Pros to qualify customers and perform the residential energy surveys. TDPUD assumed average ex ante site savings of 314.4 kWh/year, 0.233 kW, 24.4 therm/year, and 4,475 gallons/year based on the 2011 EM&V study. The ex ante effective useful lifetime is 9 years.

11. Green Schools Conservation Kits

The Green Schools Program continued in 2012. Previous programs provided K-8 students at 6 schools throughout the TDPUD electric service area with CFLs, LEDs, low-flow showerheads,

[8] 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.

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

and a water efficient garden hose nozzle. The conservation kits were 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. This year's shows distributed water-saving native seeds which were not evaluated. Previous EM&V studies found average ex post garden nozzle kit savings of 7.5 kWh/year, 0.003 kW, and 1,560 gallons/year. The effective useful lifetime is 5 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 and Sierra Energy Pros. TDPUD assumed average ex ante site savings of 969.1 kWh/year, 0.796 kW, 30.6 therm/year, and 7,053 gallons/year based on the 2011 EM&V study. The ex ante effective useful lifetime is 9 years.

13. Business Green Partners

The Business Green Partners program provides free energy efficiency 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. Other TDPUD programs provide energy and water efficiency measures such as 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 165.1 kWh/year and 0.046 kW based on the 2011 EM&V study. The ex ante effective useful lifetime is 3 years.

14. Commercial Refrigeration Retrofit Program

The Commercial Refrigeration Retrofit 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 2012 through KYC include: new refrigeration gaskets, cooler case strip curtains, automatic door closers for walk-in coolers, electronically-commutated refrigeration motors, anti-sweat controllers, and LED case lighting. Truckee businesses must be TDPUD electric customers in order to participate. TDPUD assumed average ex ante site savings of 20,557.8 kWh/year and 1.745 kW based on the 2011 EM&V study and engineering analyses and measurements from 2012. 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 226 kWh/year and 0.046 kW based on the 2011 EM&V study. The ex ante effective useful lifetime is 16 years.

16. 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 68.5 kWh/year and 0.016 kW based on the 2011 EM&V study. The ex ante effective useful lifetime is 16 years.

17. 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 109.5 kWh/year and 0.013 kW based on the 2011 EM&V study. The assumed ex ante effective useful lifetime is 16 years. The estimated energy savings for three different LED exit signs are shown in **Table 3.11**.

Table 3.11 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	0.85
2l	Incand. to LED Exit - 2 socket	Unit	0.038	8,760	333	n/a	16	0.85
2m	Fluorescent to LED Exit	Unit	0.0125	8,760	109.5	n/a	16	0.85

18. 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 through the Million CFL program. 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/65 Watt replacements, both dimmable and non-dimmable, 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 63.6 kWh/year and 0.058 kW based on the 2011 EM&V study. The ex ante effective useful lifetime is 9 years.

19. 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 a different Truckee neighborhood(s) 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 422.7 kWh/year and 0.093 kW based on the 2011 EM&V study. The effective useful life is 9 years.

20. 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, etc., 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 0.014 kW based on the 2011 EM&V study.

21. LED Light Swap

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 bill stuffer, radio spots, newspaper notices, and word-of-mouth. TDPUD had already 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 (www.superbrightleds.com/cgi-bin/store/commerce.cgi?product=MR16) to replace 10W incandescent E27 G12 lamps (www.buylighting.com/G12-Colored-Globes-s/310.htm). TDPUD assumed ex ante unit savings of 23.9 kWh/year and 0.089 kW based on the 2011 EM&V study. The EUL is 16 years.

22. 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) handed directly to customers at events and in the office. 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).[10] 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). The program goal was to provide customers with 5,900 miscellaneous water efficiency measures, and

[10] 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.

the program provided customers with 6,445 measures. TDPUD assumed ex ante unit savings of 3.9 kWh/year, 0.002 kW, 2.9 therm/year, and 1,436 gallons/year based on the 2011 EM&V study. The effective useful life is 10 years.

23. Water Efficient Toilets

The Water Efficient Toilet program provided $100 incentives to customers who purchased a 1.6 or less gallon per flush (gpf) toilet or exchanged an old inefficient toilet for a WaterSense® toilet through a local plumbing distributor. Ultra water efficient toilets use 1.28 gallons per flush (gpf) or 20% less water than standard toilets which use 1.6 gpf (www.epa.gov/WaterSense/pubs/toilets.html). Toilets account for nearly 30 percent of residential indoor water consumption. Toilets are also a major source of wasted water due to leaking flush flapper valves and/or inefficiency. The TDPUD Water Leak Repair program provided incentives to repair leaking toilets and referred customers to the Water Efficient Toilet program to replace inefficient leaking toilets with 1.6 or less gpf toilets. The WaterSense® Toilets program is sponsored by the U.S. Environmental Protection Agency (EPA) to help customers identify high performance, water-efficient toilets that reduce water use in the home and help preserve water resources. The program goal was to provide incentives for 550 toilets and the program provided incentives for 701 1.6 or less GPF toilets. TDPUD assumed ex ante unit savings of 26 kWh/year, 0.004 kW, and 3,178 gallons/year based on the 2011 EM&V study. The effective useful life is 15 years.

24. Water Leak Repair

The Water Leak Repair program provided incentives of up to $100 per customer for repairing water leaks at their site that were identified by the new electronic water metering system. Customers received a letter from TDPUD indicating the presence of a potential water leak due to increased or unusually high water usage based on electronic billing data. The program goal was to have 100 participants and 89 customers participated in the program and received incentives. TDPUD assumed average ex ante unit savings of 1731.6 kWh/yr, 0.198 kW, and 360,664 gallons/year per customer based on the 2011 EM&V study. The effective useful life is 11 years.

25. TDPUD Building LED Lighting Project

The TDPUD Building LED Lighting program demonstrated new LED lighting measures. TDPUD assumed average gross ex ante measure savings of 64.5 kWh/yr and 0.018 kW based on pre- and post-installation electric power and light logger measurements of hours of operation from the 2012 EM&V study. Pre- and post-measurements of approximately 20 fixtures indicated that the LED lighting improved illuminance (i.e., footcandles) compared to pre-existing fluorescent lighting fixtures. The effective useful life is 25 years.

3.3 Measurement and Verification Approach

The measurement and verification approach is based on the *International Performance Measurement & Verification Protocols* (IPMVP) defined **Table 3.12**.[11] 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 3.12 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.

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

Where,

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

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

Savings will be adjusted based on the proportion of measures, $\hat{p}_i$ **,** found properly installed during verification inspections using **Equation 2**.

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

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.[12]

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 $= \sqrt{\frac{\sum_{j=1}^{n}(y_j - \bar{y})^2}{n(n-1)}}$

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

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 $\hat{Y}$ = Program Savings $= \sum_{i=1}^{m}(N_{p_i} \times \hat{p}_i \bar{y}_i)$

Where,

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

[12] 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 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.

3.4 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.).

3.5 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 3.13**. 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 2012 programs were evaluated using previous EM&V studies.

Table 3.13 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 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 and Refrigerator and Freezer Energy Rating Databases (http://www.kouba-cavallo.com/refmods.htm).
6-9. Building Envelope & Ducts	Energy and peak demand savings based on previous EM&V studies, leakage reduction and DEER UECs..
10. Window Thermal Efficiency	Energy and peak demand savings based on EM&V site visits and previous EM&V studies.
11. Commercial Lighting Projects	Energy and peak demand savings based on EM&V site visits, measurements, and engineering analyses.
12. Commercial Other (TTUSD)	Energy and peak demand savings based on EM&V site visits, measurements, and engineering analyses.
13. EE Electric 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 visits.
15. Green Schools Efficient Garden Nozzle	Energy and peak demand savings based on EM&V measurements.
16. Residential Energy Survey	Energy and peak demand savings based on previous EM&V studies, customer surveys, and site visits.
17. Business Green Partners	Energy and peak demand savings based on previous EM&V studies, customer surveys, and site visits.
18. Keep Your Cool	Energy and peak demand savings based on previous EM&V studies, customer surveys, and site visits.
19. Business LED Pilot	Energy and peak demand savings based on previous EM&V studies, customer surveys, and site visits.
20. LED Business Accent Lights	Energy and peak demand savings based on previous EM&V studies.
21. LED Exit Sign Direct Install	Energy and peak demand savings based on previous EM&V studies.
22. Residential Green Partners	Energy and peak demand savings based on previous EM&V studies, customer surveys, and site visits.
23. Neighborhood Block Party	Energy and peak demand savings based on previous EM&V studies, customer surveys, and site visits.
24. Million CFLs	Energy and peak demand savings based on previous EM&V studies, customer surveys, and site visits.
25. LED Light Swap	Energy and peak demand savings based on previous EM&V studies and measurements.
26. Miscellaneous Water Efficiency	Energy and peak demand savings based on previous EM&V studies, customer surveys, and site visits.
27. WaterSense® Toilets	Energy and peak demand savings based on previous EM&V studies, customer surveys, and site visits.
28. Customer Water Leak Repair	Energy and peak demand savings based on previous EM&V studies and customer surveys.
29. TDPUD Building LED Lighting Project	Energy and peak demand savings based on EM&V site visits, measurements, and engineering analyses.

Field measurement equipment tolerances are shown in **Table 3.14**.

Table 3.14 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%
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%

3.6 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.[13] 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.[14] 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."

For small populations, the sample size is corrected using the finite population correction (FPC) equation as follows using **Equation 9**.

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

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 from 2008 through 2012 are shown in **Table 3.15**. 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.

[13] 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.

[14] 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.

Table 3.15 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	100	N/A	113	120	0.39	0.059
2. Clothes Washers	180	N/A	190	11	0.04	0.022
3. Dishwashers	170	N/A	167	14	0.12	0.053
4. Refrigerator/Freezers	200	N/A	203	16	0.08	0.031
5. Refrigerator Recycling	130	N/A	142	13	0.04	0.019
6. Building Envelope Testing	8	N/A	9	8	N/A	N/A
7. Duct System Testing	10	N/A	11	12	N/A	N/A
8. Building Envelope Mitigation	8	N/A	9	8	0.17	0.100
9. Duct System Mitigation	8	N/A	9	12	0.21	0.100
10. Window Thermal Efficiency		N/A		N/A	N/A	N/A
11. Commercial Projects (2012)	38	N/A	38	12	0.04	0.01
12. Commercial Other (TTUSD) (2012)	4	N/A	4	2	0.40	0.04
13. EE Electric Water Heater	5	N/A	6	2	0.09	0.100
14. Low-Mod. Income Assist/ESP	120	10	133	12	0.21	0.100
15. Green Schools Program/Kits		N/A		10	0.19	0.100
16. Residential Energy Survey	140	4	153	4	0.12	0.100
17. Business Green Partners	1200	N/A	1,274	916	0.40	0.022
18. Keep Your Cool	5	N/A	5	7	0.45	0.282
19. Business LED Pilot	550	N/A	585	7	0.16	0.100
20. LED Bus. Accent Lighting	25	N/A	25	N/A	0.07	0.049
21. LED Exit Sign Direct Install	1	N/A	1	4	0.12	0.100
22. Residential Green Partners	3300	40	3,676	120	0.37	0.055
23. Neighborhood Block Party	25	N/A	29	160	0.77	0.100
24. Million CFLs	30000	200	34,732	608	0.88	0.059
25. LED Light Swap	600	N/A	644	10	0.19	0.100
26. Misc. Water Efficiency	5500	19	5,745	19	0.27	0.100
27. WaterSense Toilets	550		594	10	0.11	0.059
28. Customer Water Leak Repair	25		25	10	0.48	0.249
29. TDPUD Building LED Lighting Project	694		694	1	0.06	0.100
Participant Surveys	N/A	10	N/A	14	0.02	0.002
Non-Participant Surveys	N/A	N/A	N/A	N/A	N/A	N/A

3.7 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 14 participants were asked process questions (40 non-participant surveys were completed for the 2011 study). 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.

3.7.1 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 14 participant surveys for 2012 and inspecting 1,596 measures at a random sample of 14 participant sites. Participants indicated that measures were properly installed as indicated by the rating of 9.5 ± 0.02 on a scale of 1 to 10 for quality of work performed by installers. Light loggers were installed at 6 sites in the 2012 EM&V study and 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. Forty-one (41) were successfully downloaded to monitor hours of operation on 3,914 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 3,914 measures at a random sample of 176 participant sites (1,274 in 2012 and 2,828 previously). The EM&V study inspected the following measures (in 2009, 2010, 2011, and 2012): commercial lighting (T8, T5, LED, occupancy sensors), PC Network controllers, commercial refrigeration (EC motors/controllers, LED lamps, door gaskets), CFLs and LEDs (spiral, globes, reflectors, parabolic reflectors, dimmable), door sweeps, weather stripping, water heater insulation, pipe insulation/elbow/tees, insulation tape, toilet leak detection kits, and WaterSense® toilets, showerheads, and aerators, 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) for 18 programs over a period of four years. The 2012 study conducted participant surveys of commercial lighting projects (0.96), commercial projects (TTUSD) (0.97), and TDPUD LED programs (1.0). The 2011 study conducted participant surveys and developed specific NTGRs for the following program measures: Residential CFLs (0.69), Energy Star® Clotheswashers (0.68), Energy Star® Dishwashers (0.69), Energy Star® Refrigerator/Freezers (0.70), Refrigerator Recycling (0.85), Building Envelope Mitigation (0.80), Duct Mitigation (0.74), Commercial Lighting (0.85), Electric/Solar Water Heater (0.79), Business Green Partners (0.85), Keep Your Cool (0.95), Business LED Pilot (0.85), WaterSense Toilets (0.81), and Customer Leak Repair (0.77). The 2009 EM&V study evaluated NTGRs for the following programs: 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), 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 WaterSense 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.[15]

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 90% confidence level.

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

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, LEDs)?

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 50,636 measures to approximately 13,282 customers and overall participant satisfaction with the program was 95.1 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 67 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 (based on 2011 non-participant study).

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, efficient commercial lighting, Energy Star® appliances, refrigerator recycling, efficient windows, attic insulation, infiltration reduction, duct sealing, , or other measures and educates customers on the value of these and other measures. Based on process survey responses, 50 percent of interviewed customers shared program information with 16 times as many people. Approximately 23 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 0.5 percent. [16] Programs that link technologies with educational measures can have multiplier effects as high as 10-25 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 lamps, hardwired T-8 or T5 fluorescent fixtures, commercial refrigeration, WaterSense® or Energy Star® products, weatherization, leak repair, or other energy or water efficiency measures offered by the programs?
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?

3.7.2 List of Tasks Undertaken by the Study

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

Task 1. Prepare EM&V Plan

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

Task 2. Market Assessments or Baseline Analyses

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

Task 3. Develop Survey Instruments

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

Task 4. Phone or In-person Surveys

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

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

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

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

The 2009, 2010, 2011, and 2012 EM&V studies installed metering and monitoring equipment to measure load impacts. Metering equipment included data loggers to

[16] Spillover of 0.5 percent is calculated based on 309 people adopting at least one spillover measure based on information shared by a group of 83 participants who adopted 777 measures (i.e., 309 × (1÷ 777) ÷ 83 = 0.005).

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.

3.7.3 How Study met the California Energy Efficiency Objectives

The study met the following objectives California energy efficiency objectives.

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

  The study met this objective by performing 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 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 study evaluated program theory and approach.

- **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 to assess the continuing need for the program and how the program influenced customer awareness of energy efficiency, bill savings, and increased comfort.

4. EM&V Findings

This section provides load impact results for programs and measures. This section also provides the process evaluation results and recommendations regarding what works, what doesn't work, and the continuing need for the program. Also provided are recommendations to increase savings, achieve greater persistence, and improve customer satisfaction.

4.1 Load Impact Results

TDPUD implemented 29 energy efficiency programs or measures in 2012 as shown in **Table 4.1**. The programs provided information, incentives, and free energy efficiency measures to customers. TDPUD accomplished 50,630 measures or 15.9% more than the ex ante estimate.

Table 4.1 Ex Ante and Ex Post Energy Efficiency Programs or Measures

Description	Ex Ante Qty.	Ex Post Qty.
Total Installed Measures	43,689	50,630
1. Residential CFLs	100	113
2. Clothes Washers Energy Star	180	190
3. Dishwashers Energy Star	170	167
4. Refrigerator/Freezers Energy Star	200	203
5. Refrigerator Recycling	130	142
6. Building Envelope Testing	9	9
7. Duct System Testing	11	11
8. Building Envelope Mitigation	9	9
9. Duct System Mitigation	9	9
10. Window Thermal Efficiency		
11. Commercial Lighting Projects	38	38
12. Commercial Projects Other (TTUSD)	4	4
13. EE Electric Water Heater	6	6
14. Low-Mod. Income Assist/ESP	120	133
15. Green Schools Program/Kits		
16. Residential Energy Survey (RES)	140	153
17. Business Green Partners	1200	1,274
18. Keep Your Cool	5	5
19. Business LED Pilot	550	585
20. LED Business Accent Lighting	25	100
21. LED Exit Sign Direct Install	1	1
22. Residential Green Partners	3300	3,676
23. Neighborhood Block Party	25	29
24. Million CFLs	30000	34,732
25. LED Light Swap	644	1,983
26. Misc. Water Efficiency	5500	5,745
27. Toilet Rebates and Exchange	594	594
28. Customer Water Leak Repair	25	25
29. TDPUD Bldg. LED EE Lighting Project	694	694

TDPUD achieved 14.9% greater lifecycle electricity savings with ex post savings of 27,224,345 kWh versus ex ante goal of 23,700,782 kWh. TDPUD exceeded the ex ante E3 Calculator Total Resource Cost (TRC) test goal by 10.7% with an ex post TRC of 2.48 and the ex ante TRC of 2.24 as shown in **Table 4.2**.[17] The ex post TRC is greater than the ex ante TRC due to 15.9% 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 1,596 measures at 12 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 4,236 fixtures at 41 sites and pre and post-retrofit utility billing data from 65 sites.

Table 4.2 Ex Ante Goals and Ex Post E3 Cost Effectiveness

Description	Ex Ante Goal	Ex Post Accomplishment
Net Annual Electricity Savings (kWh/yr)	2,473,273	2,768,287
Net Demand Savings (kW)	818	1,005
Net Lifecycle Electricity Savings (kWh)	23,700,782	27,224,345
Net Annual Therm Savings (therm/yr)	19,557	20,729
Net Lifecycle Therm Savings (therm)	197,075	208,294
Net Annual Water Savings (gallon/yr)[18]	16,889,992	17,339,473
Net Lifecycle Water Savings (gallon)	177,423,110	181,907,569
Total Resource Cost (TRC) Test – E3	**2.24**	**2.48**
TRC Test Costs	$1,040,787	$1,064,785
TRC Test Benefits	$2,326,934	$2,640,630
TRC Test Net Benefits	$1,286,147	$1,575,844
Participant Test	**0.72**	**0.73**
Participant Test Costs	$773,027	$790,112
Participant Test Benefits	$559,622	$576,708
Participant Test Net Benefits	($213,404)	($213,404)

The ex ante first-year savings are summarized in **Table 4.3**. The first-year net ex ante program savings are 2,473,273 kWh per year, 818 kW per year, 19,557 therms per year, and 16,889,992 gallons of water per year.

[17] Energy and Environmental Economics (E3), Inc. 2011. EE Reporting Tool 2011 (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.

[18] 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 4.3 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	59.5	0.014			0.69	4,106	0.9	0	0
2. Energy Star Clothes Washers	205.3	0.175	6.3	8,050	0.68	25,127	21.4	771	985,262
3. Energy Star Dishwashers	64.3	0.105	1.3	514	0.69	7,545	12.3	156	60,335
4. Energy Star Refrigerators	127.7	0.022			0.70	17,878	3.1	0	0
5. Refrigerator Recycling	1,151.0	0.248			0.85	127,190	27.4	0	0
6. Building Envelope Testing					0.80	0	0.0	0	0
7. Duct System Testing					0.74	0	0.0	0	0
8. Building Envelope Mitigation	71.4	0.059	41.8		0.80	514	0.4	301	0
9. Duct System Mitigation	96.7	0.080	56.6		0.74	644	0.5	377	0
10. Window Thermal Efficiency	160.0	0.531	10.9		0.96	0	0.0	0	0
11. Commercial Lighting Projects	4,988.4	1.008			0.85	161,124	32.5	0	0
12. Commercial Other (TTUSD)	36,739.8	16.992			0.97	142,550	65.9	0	0
13. EE Electric/Solar Water Heat	32.0	0.005			0.79	152	0.0	0	0
14. Low-Mod Income Assist/ESP	314.4	0.233	25.4	4,475	0.84	31,694	23.5	2,557	451,103
15. Green Schools Program/Kits	7.5	0.003			0.80	0	0.0	0	0
16. Residential Energy Survey	969.1	0.796	30.6	7,053	0.64	86,834	71.3	2,745	631,905
17. Business Green Partners	165.1	0.046			0.85	168,434	47.3	0	0
18. Keep Your Cool	20,557.8	1.745			0.95	97,649	8.3	0	0
19. Business LED Pilot	226.0	0.046			0.85	105,661	21.3	0	0
20. LED Business Accent Lights	68.5	0.016			0.85	1,456	0.3	0	0
21. LED Exit Sign Direct Install	109.5	0.013			0.85	93	0.0	0	0
22. Residential Green Partners	63.6	0.058			0.64	134,390	121.9	0	0
23. Neighborhood Block Party	422.7	0.093	18.3	4,064	0.69	7,291	1.6	315	70,104
24. Million CFLs	59.5	0.014			0.69	1,231,650	279.5	0	0
25. LED Light Swap	23.9	0.089			0.91	14,023	51.9	0	0
26. Misc. Water Efficiency	3.9	0.002	2.9	1,469	0.77	16,696	8.5	12,335	6,219,405
27. WaterSense Toilets	26.0	0.004		3,178	0.81	12,488	1.8	0	1,529,089
28. Customer Water Leak Repair	1,731.6	0.198		360,664	0.77	33,333	3.8	0	6,942,790
29. TDPUD Building EE Project	64.5	0.018			1.00	44,750	12.7	0	0
Total						2,473,273	818.4	19,557	16,889,992

The EM&V ex post first-year savings are summarized in **Table 4.4**. The EM&V study found first-year net ex post program savings of 2,768,287 ± 90,909 kWh per year, 1005 ± 52 kW per year, 20,729 ± 1,671 therms per year, and 17,339,473 ± 1,784,795 gallons (23,181 ± 2,386 CCF) of water per year at the 90 percent confidence level. The net first-year realization rates are 1.12 ± 0.04 for kWh, 1.23 ± 0.06 for kW, 1.06 ± 0.09 for therms, and 1.03 ± 0.11 for gallons of water.

Table 4.4 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	0.014			0.69	4,639	1.1	0	0
2. Clothes Washers	205.3	0.175	6.3	8,050	0.68	26,523	22.6	814	1,039,999
3. Dishwashers	64.3	0.105	1.3	514	0.69	7,412	12.1	153	59,270
4. Refrigerator/Freezers	127.7	0.022			0.70	18,147	3.1	0	0
5. Refrigerator Recycling	1,151.0	0.248			0.85	138,931	29.9	0	0
6. Building Envelope Testing					0.80	0	0.0	0	0
7. Duct System Testing					0.74	0	0.0	0	0
8. Building Envelope Mitigation	71.4	0.059	41.8		0.80	514	0.4	301	0
9. Duct System Mitigation	96.7	0.080	56.6		0.74	644	0.5	377	0
10. Window Thermal Efficiency	160.0	0.531	10.9		0.96	0	0.0	0	0
11. Commercial Light Projects	4,988.4	1.008			0.89	168,707	34.1	0	0
12. Commercial Other (TTUSD)	36,739.8	16.992			0.97	142,550	65.9	0	0
13. EE Elec/Solar Water Heat	32.0	0.005			0.79	152	0.0	0	0
14. Low-Mod Income Asst/ESP	314.4	0.233	25.4	4,475	0.84	35,128	26.1	2,834	499,972
15. Green Schools Program/Kits	7.5	0.003			0.80	0	0.0	0	0
16. Residential Energy Survey	969.1	0.796	30.6	7,053	0.64	94,898	77.9	3,000	690,582
17. Business Green Partners	165.1	0.046			0.85	178,821	50.2	0	0
18. Keep Your Cool	20,557.8	1.745			0.95	97,649	8.3	0	0
19. Business LED Pilot	226.0	0.046			0.85	112,385	22.7	0	0
20. LED Business Accent Lights	68.5	0.016			0.85	5,824	1.3	0	0
21. LED Exit Sign Direct Install	109.5	0.013			0.85	93	0.011	0	0
22. Residential Green Partners	63.6	0.058			0.64	149,702	135.8	0	0
23. Neighborhood Block Party	422.7	0.093	18.3	4,064	0.69	8,458	1.9	366	81,321
24. Million CFLs	59.5	0.014			0.69	1,425,922	323.5	0	0
25. LED Light Swap	23.9	0.089			0.91	43,178	159.9	0	0
26. Misc. Water Efficiency	3.9	0.002	2.9	1,469	0.77	17,440	8.9	12,884	6,496,451
27. WaterSense Toilets	26.0	0.004		3,178	0.81	12,488	1.8	0	1,529,089
28. Water Leak Repair	1,731.6	0.198		360,664	0.77	33,333	3.8	0	6,942,790
29. TDPUD Building EE Project	64.5	0.018			1.00	44,750	12.7	0	0
Total						2,768,287	1,004.6	20,729	17,339,473
90% Confidence Interval						90,909	52	1,671	1,784,795
Realization Rate						1.12 ± 0.04	1.23 ± 0.06	1.06 ± 0.09	1.03 ± 0.11

The lifecycle electricity and water savings are summarized in **Table 4.5**. The net ex-ante lifecycle program savings are 23,700,782 kWh, 197,075 therms, and 177,423,110 gallons of water. The net ex-post lifecycle program savings are 27,224,345 ± 816,603 kWh, 208,294 ± 16,641 therms, and 181,907,569 ± 17,872,114 gallons of water (243,192 ± 23,893 CCF). The net lifecycle realization rates are 1.15 ± 0.03 for kWh, 1.06 ± 0.08 for therms, and 1.03 ± 0.10 for gallons of water.

Table 4.5 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	36,950			9	41,753		
2. Energy Star Clothes Washers	12	301,527	9,253	11,823,144	12	318,278	9,768	12,479,985
3. Energy Star Dishwashers	11	82,991	1,716	663,684	11	81,527	1,686	651,972
4. Energy Star Refrigerators	14	250,297			14	254,051		
5. Refrigerator Recycling	5	635,951			5	694,654		
6. Building Envelope Testing	5				5	0		
7. Duct System Testing	5				5	0		
8. Building Envelope Mitigation	18	9,248	5,416		18	9,248	5,416	
9. Duct System Mitigation	18	11,590	6,788		18	11,590	6,788	
10. Window Thermal Efficiency	20				20	0		
11. Commercial Lighting Projects	11	1,772,368			15	2,530,601		
12. Commercial Other (TTUSD)	15	2,138,253			15	2,138,253		
13. EE Electric/Solar Water Heat	15	2,275			15	2,275		
14. Low-Mod Income Assist/ESP	9	285,250	23,010	4,059,924	9	316,153	25,503	4,499,749
15. Green Schools Program/Kits	5				5	0		
16. Residential Energy Survey	9	781,509	24,707	5,687,144	9	854,078	27,001	6,215,236
17. Business Green Partners	3	505,302			3	536,462		
18. Keep Your Cool	8	781,196			8	781,196		
19. Business LED Pilot	16	1,690,581			16	1,798,163		
20. LED Business Accent Lights	16	23,294			16	93,177		
21. LED Exit Sign Direct Install	16	1,489			16	1,489		
22. Residential Green Partners	9	1,209,511			9	1,347,322		
23. Neighborhood Block Party	9	65,619	2,838	630,940	9	76,118	3,292	731,890
24. Million CFLs	9	11,084,850			9	12,833,300		
25. LED Light Swap	16	224,361			16	690,850		
26. Misc. Water Efficiency	10	166,958	123,346	62,194,051	10	174,396	128,840	64,964,513
27. WaterSense Toilets	15	187,325		22,936,328	15	187,325		22,936,328
28. Customer Water Leak Repair	10	333,328		69,427,896	10	333,328		69,427,896
29. TDPUD Building EE Project	25	1,118,758			25	1,118,758		
Total		23,700,782	197,075	177,423,110		27,224,345	208,294	181,907,569
90% Confidence Interval						816,603	16,641	17,872,114
Realization Rate						1.15 ± 0.03	1.06 ± 0.08	1.03 ± 0.10

The energy impact reporting for 2012 programs is provided in **Table 4.6**.

Table 4.6 Energy and Water Impact Reporting for 2012 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	2012	3,314	2,768	1.110	0.896	26,055	20,729	29,604	23,181
2	2013	3,314	2,768	1.110	0.896	26,055	20,729	29,604	23,181
3	2014	3,314	2,768	1.110	0.896	26,055	20,729	29,604	23,181
4	2015	3,116	2,589	1.054	0.845	26,055	20,729	29,604	23,181
5	2016	3,116	2,589	1.054	0.845	26,055	20,729	29,604	23,181
6	2017	2,966	2,451	1.022	0.816	26,055	20,729	29,604	23,181
7	2018	2,966	2,451	1.022	0.816	26,055	20,729	29,604	23,181
8	2019	2,966	2,451	1.022	0.816	26,055	20,729	29,604	23,181
9	2020	2,863	2,353	1.013	0.807	26,055	20,729	29,604	23,181
10	2021	678	634	0.275	0.241	18,265	14,529	27,430	21,481
11	2022	613	583	0.259	0.228	2,246	1,645	4,578	3,514
12	2023	413	576	0.203	0.216	2,020	1,492	4,461	3,435
13	2024	376	549	0.171	0.194	886	678	2,524	2,044
14	2025	376	549	0.171	0.194	886	678	2,524	2,044
15	2026	350	531	0.167	0.190	886	678	2,524	2,044
16	2027	188	207	0.097	0.089	886	678	0	0
17	2028	46	46	0.014	0.014	886	678	0	0
18	2029	46	46	0.014	0.014	886	678	0	0
19	2030	45	45	0.013	0.013	0	0	0	0
20	2031	45	45	0.013	0.013	0	0	0	0
21	2032	45	45	0.013	0.013	0	0	0	0
22	2033	45	45	0.013	0.013	0	0	0	0
23	2034	45	45	0.013	0.013	0	0	0	0
24	2035	45	45	0.013	0.013	0	0	0	0
25	2036	45	45	0.013	0.013	0	0	0	0
Total		31,334	27,224			262,338	208,294	310,477	243,192

** 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. 1 CCF = 748 gallons.
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 4.7**.

Table 4.7 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	1,984	1,005	2,768,287	27,224,345	20,829	14,729	0.04	0.05	2.48
24. Million CFLs	1,294	324	1,425,922	12,833,300	0	6,851	0.01	0.01	7.03
20. LED Business Accent	1	1	5,824	93,177	0	52	0.02	0.02	6.48
28. Water Leak Repair	4	4	33,333	333,328	0	181	0.02	0.02	5.18
17. Business Green Partner	50	50	178,821	536,462	0	297	0.02	0.02	4.40
19. Business LED Pilot	23	23	112,385	1,798,163	0	997	0.03	0.03	4.32
1. Residential CFLs	4	1	4,639	41,753	0	22	0.02	0.02	4.18
26. Misc. Water Efficiency	9	9	17,440	174,396	12,884	93	0.23	0.23	4.07
22. Res. Green Partners	136	136	149,702	1,347,322	0	719	0.03	0.03	3.48
5. Refrigerator Recycling	30	30	138,931	694,654	0	377	0.03	0.03	3.11
12. Commercial (TTUSD)	66	66	142,550	2,138,253	0	1,199	0.04	0.06	2.99
23. Neighborhood Block Pty	7	2	8,458	76,118	329	41	0.05	0.05	2.95
16. Res. Energy Survey	78	78	94,898	854,078	2,700	456	0.05	0.05	2.45
6-9. Bldg/Duct Test/Repair	1	1	1,158	20,838	1,220	13	0.55	0.55	2.03
2. E Star Clotheswashers	23	23	26,523	318,278	977	176	0.10	0.10	1.71
25. LED Light Swap	160	160	43,178	690,850	0	369	0.08	0.08	1.48
18. Keep Your Cool	8	8	97,649	781,196	0	412	0.09	0.09	1.15
29. TDPUD Bldg LED Lights	13	13	44,750	1,118,758	0	620	0.15	0.15	1.11
14. Low-Mod Income/ESP	26	26	35,128	316,153	2,550	169	0.17	0.17	1.09
4. Energy Star Refrigerators	3	3	18,147	254,051	0	138	0.12	0.12	1.00
11. Commercial Lighting	34	34	168,707	2,530,601	0	1,402	0.06	0.15	0.95
21. LED Exit Sign	0	0	93	1,489	0	1	0.20	0.20	0.71
3. Energy Star Dishwashers	12	12	7,412	81,527	169	45	0.28	0.28	0.54
13. EE Elec Water Heater	0	0	152	2,275	0	1	0.29	0.29	0.40
27. WaterSense Toilet	2	2	12,488	187,325	0	100	0.46	0.46	0.26
10. Window Efficiency									
15. Green Schools Program									

The TDPUD E3 energy efficiency portfolio total utility resource cost is $0.05/kWh and the net lifecycle green house gas (GHG) reductions are 14,729 tons. TDPUD energy efficiency (EE) portfolio realized a 2.48 TRC which is 10.7% greater than anticipated due to installing 15.9% more measures through innovative community-based programs. The top ten programs have an average TRC of 4.5. The Million CFL program realized a TRC of 7.03 by purchasing CFLs in large quantities at low cost and installing CFLs through multiple programs. The Water Leak Repair and Miscellaneous Water Efficiency programs realized a TRC of 5.18 and 4.07 respectfully due to electricity savings from water pumping and therm savings from units installed at sites with gas water heaters. The LED Business Accent, Business LED Pilot, and Business Green Partners programs realized a TRC of 6.5, 4.32, and 4.40 respectfully by buying LED lamps and CFLs in bulk and distributing them directly to commercial customers. The Commercial (TTUSD) program realized a TRC of 2.99 with comprehensive lighting, pump, and HVAC retrofit projects. The Neighborhood Block Party program realized a TRC of 2.95 by providing free energy efficient CFLs directly to customers who attended the neighborhood events. The Refrigerator Recycling program realized a TRC of 3.11 by using a local appliance chain store to recycle units. Residential Green Partners realized a TRC of 3.48. The LED Light Swap program realized a TRC of 1.48. The Keep Your Cool program realized a TRC of 1.15 by installing 264 commercial refrigeration measures including LED refrigeration case lights, door gaskets, floating-head pressure controls, anti-sweat heater controls, efficient evaporator fan motors (electronically commutated motors - ECMs), and ECM fan controllers. The TDPUD LED Lighting Project realized a TRC of 1.11 by installing advanced LED lighting throughout the

building. The LED fixtures use 42% less power and provide 18% more illuminance than pre-existing fixtures and 85% more illuminance than the IESNA recommendation. The Energy Star® Clotheswasher program realized a TRC of 1.71 due to the combination of kWh, therm, and water savings. Savings were evaluated using the US EPA database (http://www.energystar.gov/). Low-Moderate Income Assistance/Energy Saving Partners realized a TRC of 1.09 and Commercial Lighting realized a TRC of 0.95. TDPUD offered a wide range of innovative and successful programs for residential and commercial customers 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. TDPUD partnered with several local organizations to implement projects including: Sierra Watershed Education Partnership, Sierra Green Building Association, 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.

4.1.1 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 CFLs and LEDs. The ex ante and ex post unit savings are shown in **Table 4.8**. The ex ante goal for Energy Star® CFL rebates is 500 units and the study verified 282 measures from the TDPUD rebate applications and by interviewing customers. The ex ante and ex post NTGR are 0.69 ± 0.07 based on decision maker surveys indicating 31% 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.[19] The ex ante and ex post effective useful lifetime (EUL) is 9 years assuming 10,000 lifecycle operational hours. The total ex ante savings are 4,106 first-year kWh and 0.9 kW and 39,950 lifecycle kWh based on 100 customer rebates. The total net ex post savings are 4,639 ± 396 first-year kWh, 1.1 ± 0.23 kW, and 41,753 ± 3,560 kWh lifecycle kWh at the 90% confidence level for 113 customer rebates. The ex post savings are approximately 13% more than ex ante for kWh and kW savings due to more units. The CFL net to gross ratio should decline over time as more CFLs are given away through the million CFLs program and more customers become aware of the advantages of CFLs in terms of energy savings, cost effectiveness, and longer life compared to incandescent lamps. The TRC is 4.18.

[19] 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).

Table 4.8 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	59.5	0.014			59.5 ± 3.5	0.014 ± 0.002		

4.1.2 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 4.9**.[20] The ex ante and ex post unit savings are shown in **Table 4.10**. The ex ante and NTGR is 0.68 and ex post NTGR is 0.68 +/- 0.08 based on decision maker surveys conducted with 11 participants. This indicates 32% of participants were free riders and would have purchased Energy Star clotheswashers without rebates. The ex ante and ex post EUL is 12 years The TDPUD net ex ante savings are 25,127 kWh/yr, 21.4 kW and 301,527 lifecycle kWh based on 180 units. The total net ex post savings are 26,523 ± 866 first-year kWh, 22.6 ± 0.74 kW, 814 ± 27 first-year therm, 1,039,999 ± 30,526 first-year gallons of water, 318,278 ± 10392 lifecycle kWh, 9,768 ± 319 lifecycle therm, and 12,479,985 ± 366,307 lifecycle gallons at the 90% confidence level for 190 units. The ex post kWh and kW savings are approximately 6% greater than ex ante savings due to 10 more units. The electricity, natural gas, and water savings increase the TRC to 1.71.

Table 4.9 Standard and Energy Star® Clotheswasher Annual Energy and Water Use

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 CW	281.8	0.240	22.8	13,558	110.6	0.094	392.4	0.334	18.12
Energy Star CW	142.2	0.121	16.5	5,508	44.9	0.038	187.1	0.159	7.36
Ave. Savings	139.6	0.119	6.3	8,050	65.7	0.056	205.3	0.175	10.76
+/- 90% CI	3.62	0.003	0.14	161	1.3	0.001	4.92	0.004	0.21

Table 4.10 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. Energy Star® CW	205.3	0.175			205.3 ± 4.56	0.175 ± 0.004	6.3 ± 0.14	8,050 ± 161

[20] Energy and water use are based on average energy consumption for non-qualified models and qualified Energy Star® models from October 2011. See CalculatorConsumerClothesWasher.xls available at http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=CW.

4.1.3 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 4.11**.[21] The ex ante and ex post unit savings are shown in **Table 4.12**. The ex ante and ex post NTGR is 0.69 and the EUL is 11 years. The TDPUD net ex ante savings are 7,545 kWh/yr, 12.3 kW and 82,991 lifecycle kWh based on 170 units. The total net ex post savings are 7,412 ± 564 first-year kWh, 12.1 ± 1.0 kW, 153 ± 5 first-year therm, 59,270 ± 3,302 first-year gallons of water, 81,527 ± 6,209 lifecycle kWh lifecycle kWh, 1,686 ± 55 lifecycle therm, 651,972 ± 36,317 lifecycle gallons of water at the 90% confidence level for 167 units. The ex post savings are approximately 1.8% less than ex ante savings due to fewer units. The $100 per unit rebate and low electricity savings yield a TRC of 0.4. In order to make Energy Star® dishwashers cost effective, the incentive should be reduced to $40 per unit which will increase kWh and therm savings by 20% and water savings by 40% (see **Table 4.6**). The TRC is 0.54.

Table 4.11 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 DW	355.5	0.551	3.6	1,398	11.4	0.02	366.9	0.569	1.87
Energy Star® DW	295.7	0.458	2.3	884	7.2	0.01	302.9	0.470	1.18
Ave. Savings	59.8	0.093	1.3	514	4.2	0.01	64.3	0.105	0.69
+/- 90% CI	3.33	0.005	0.07	19.8	0.2	0.00	3.4	0.005	0.03

Table 4.12 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	64.3	0.105			64.3 ± 3.4	0.105 ± 0.005	1.3 ± 0.07	514 ± 20

4.1.4 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.[22] This approach is consistent with IPMVP Option A (verification of stipulated savings). The US NAECA minimum standard and Energy Star®

[21] 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.

[22] 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.

annual energy use and average savings are shown in **Table 4.13**.[23] The ex ante and ex post unit savings are shown in **Table 4.14**. The ex ante and ex post NTGR is 0.70 (based on 2011 decision maker survey responses) and the EUL is 14 years. The TDPUD net ex ante savings are 18,147 kWh/yr, 3.1 kW and 255,297 lifecycle kWh based on 200 units. The total net ex post savings are 18,147 ± 802 first-year kWh, 3.1 ± 0.2 kW, and 254,051 ± 11,226 kWh lifecycle kWh at the 90% confidence level for 203 units. The ex post savings are approximately 1.5% greater than ex ante for kWh savings due to 5% more units and slightly greater unit savings. The $100 per unit rebate and moderate electricity savings yield a TRC of 1.0. In order to make Energy Star® refrigerators more cost effective, the incentive payment should be revised to pay $50 for Energy Star, $100 for CEE Tier 2, and $150 for CEE Tier 3 which are 25% and 30% above the Federal Standard respectfully (see **Table 4.7**).

Table 4.13 Annual Energy Use for Refrigerators

Description	Qty.	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 Freezer w/o thru-door ice	67	490.9	0.084	385.9	0.066	105.0	0.018
Bottom Freezer w/o thru-door ice	62	580.3	0.099	457.3	0.078	123.0	0.021
Side Freezer w/ thru-door ice	45	713.7	0.122	553.9	0.095	159.8	0.027
Bottom Freezer w/o thru-door ice	27	694.1	0.119	543.1	0.093	151.0	0.026
Refrig. Only - Single Door	1	457.4	0.078	365.0	0.062	92.4	0.016
Average		593.6	0.101	465.9	0.080	127.7	0.022
+/- 90% CI		10.7	0.002	8.7	0.001	4.0	0.001

Table 4.14 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	127.7	0.022			127.7 ± 4.0	0.022 ± 0.001		

4.1.5 Load Impacts for Refrigerator & Freezer Recycling

Load impacts for refrigerator recycling are based on mean annual electricity use from the US Department of Energy (DOE) database and the Refrigerator and Freezer Energy Rating Database from http://www.kouba-cavallo.com/refmods.htm. These databases provide annual energy use based on make and model per IPMVP Option B. Estimated savings for each participating unit are provided in **Table 4.15**. The ex ante and ex post unit savings are shown in **Table 4.16**. The ex ante and ex post NTGR is 0.85 ± 0.05 based on 2011 interviews with 13 participants. The ex ante and ex post EUL is 5 years. The net ex ante savings are 127,190 kWh/yr, 27.4 kW and 635,951 lifecycle kWh based on 130 units. The total net ex post savings are 138,931 ± 15,052 first-year kWh, 29.9 ± 3.24 kW, and 694,654 ± 75,260 kWh lifecycle kWh at the 90% confidence level for 142 units. The ex post kWh and kW savings are 9.2% greater than ex ante due to more measures.

[23] Energy use 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.

Table 4.15 Summary of Mean Electricity Use for Recycled Refrigerators and Freezers

#	kWh/yr	kW	Make	Model	Size	Style	Defrost	Age
1	854	0.184	Whirlpool	ED25PB*B*B*0	25.02	SBS	Auto	1994
2	965	0.208	Sears	2537603712	20	TF	Auto	1985
3	942	0.203	Montgomery Ward	HMG289606A	28	TF	Auto	1992
4	1,179	0.254	Frigidaire	FPE-19V3JWO	19.1	TF	Auto	1982
5	774	0.167	Hotpoint	CSX22BC	21.7	TF	Auto	1992
6	1,179	0.254	Amana	SR119B-L	19	TF	Auto	1982
7	957	0.206	GE	TFF24DMB	24	SBS	Auto	1992
8	1,764	0.380	JCPenny	86706224	21.8	TF	Auto	1979
9	1,142	0.246	Kenmore	106.8602	n/a	SBS	Auto	1990
10	1,336	0.288	Kenmore	8611460	19.1	TF	Auto	1981
11	1,956	0.421	MagicChef	RC24CACAI	25	TF	Auto	1979
12	1,484	0.320	Signature	HMG227303H	22	SBS	Auto	1990
13	880	0.190	GE	TFF24RVD	23.5	SBS	Auto	1993
14	854	0.184	GE	TFFADWP	22	SBS	Auto	1994
15	1,308	0.282	GE	TFG24RVD	25	UF	Manual	1979
16	1,308	0.282	Hotpoint	CSF20EBC	19.6	UF	Manual	1979
17	1,388	0.299	GE	TFF24RCM	23.5	TF	Auto	1985
18	921	0.198	Kenmore	106.862068	22	UF	Manual	1980
19	1,098	0.237	Amana	SR25N-AG	25	BF	Auto	1990
20	751	0.162	Amana	SX25JL	25	TF	Manual	1995
21	1,154	0.249	Kenmore	106.8620G82	22.2	TF	Auto	1985
22	751	0.162	Whirlpool	FD25DQXVDO2	25	TF	Manual	1995
23	1,533	0.330	Hotpoint	CSX24DHR	23.5	SBS	Auto	1980
24	1,147	0.247	Whirlpool	FD25SMXLU10	25	TF	Auto	1985
Mean	1,151	0.248			22.9			1987
90% CI	106	0.023						
Std. Dev.	316.6	0.068						
Cv	0.28	0.28						

Table 4.16 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	1,151	0.248			1,151 ± 22	0.248 ± 0.023		

4.1.6 Load Impacts for Building Envelope & Duct Testing

Load impacts for building envelope and duct testing are based on 2012 field inspections of measures at 3 participant sites and engineering analysis consistent with IPMVP Option B. Field measurements of three participant sites showed average duct leakage reduction of 22%, and the average ex post duct leakage reduction for the 2011 TDPUD program is 14%.[24] Field measurements of three participant sites showed average infiltration reduction of 17%. Infiltration represents approximately 40% of the space heating UEC. Therefore, the ex post infiltration savings are assumed to be 6.8%. The weighted average unit energy consumption (UEC) values

[24] 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).

are 602 therm/yr for space heating and 244 kWh/yr for heating ventilation in climate zone 16.[25] The ex ante and ex post unit energy savings are shown in **Table 4.17**. The net-to-gross ratio is 0.80 for building envelope mitigation and 0.74 for duct repair. The EUL is 18 years. The ex ante savings for building envelope mitigation are 514 kWh/year, 0.4 kW, 301 therm/year, 9,248 lifecycle kWh, and 5,416 lifecycle therms for 9 units. The ex ante savings for duct mitigation are 644 kWh/year, 0.5 kW, 377 therm/year, and 11,590 lifecycle kWh, and 6,788 lifecycle therms for 9 units. The building envelope mitigation program net ex post savings are 514 ± 64 first-year kWh, 0.4 ± 0.05 kW, 301 ± 38 first-year therm, 9,248 ± 1,156 lifecycle kWh, and 5,416 ± 677 lifecycle therm for 9 units. The duct leakage mitigation program net ex post savings are 644 ± 87 first-year kWh, 0.5 ± 0.07 kW, 377 ± 51 first-year therm, 11,590 ± 1,566 kWh lifecycle kWh, and 6,788 ± 917 lifecycle therms for 9 units. The TRC is 2.03.

Table 4.17 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	71.4	0.059	41.8		71.4 ± 7.1	0.059 ± 0.006	41.8 ± 4	
9. Duct Leakage Mitigation	96.7	0.080	56.6		96.7 ± 9.7	0.080 ± 0.008	56.6 ± 6	

4.1.7 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 maximum should be u-value of 0.32 Btu/hr-ft^2-°F and 0.4 solar heat gain coefficient (SHGC) including the frame. TDPUD assumed ex ante unit savings of 160 kWh/year, 0.531 kW, 10.9 therm/year, 0.96 NTGR, and 20 year EUL. TDPUD should encourage at least 1 to 10 customers to install thermally efficient windows to help customers understand the importance of saving electricity and natural gas by reducing heat loss in winter and heat gain in summer. This is especially important for commercial sites that use heating and electric cooling such as the TDPUD district offices, local retail stores, offices, and the hospital..

4.1.8 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.[26]

[25] Measure Inspection and Summary viewer tool (MISer Version 1.10.25) and Database for Energy Efficiency Resources (DEER Version: DEER2008.2.2). See http://www.deeresources.com/.

[26] *Evaluation, Measurement & Verification Report for Truckee Donner Public Utility District 2011 Energy Efficiency Programs*. R., Mowris. E. Jones. 2012. *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 commercial lighting projects are summarized in **Table 4.18**. The ex post ex ante and ex post unit savings are shown in **Table 4.19**. The TDPUD assumed gross ex ante site savings per project of 4,988 kWh/yr, 1.009 kW and net ex ante program savings of 161,124 kWh, 32.5 kW and 1,772,368 lifecycle kWh based on 38 projects. The ex ante net-to-gross ratio is 0.85. The ex post NTGR is 0.89 ± 0.03 based on 2012 decision maker survey results. The ex ante EUL is 11 years. The ex post effective useful lifetime (EUL) is 15 years based on 78% of projects having LED lamps which increased the EUL. The total net ex post savings are 168,707 ± 8,427 first-year kWh, 34.1 ± 1.01 kW, and 2,530,601 ± 126,412 kWh lifecycle kWh based on 38 projects. The ex post kWh savings are approximately 43% greater due to greater EUL and kW savings are 4.7% greater due to the greater ex post NTGR. The TRC is 0.95.

Table 4.18 Summary of Commercial Lighting Projects

#	Existing Fixture	Existing Watt/Fix	Existing Qty.	New Fixture	New Watt/Fix	Ex Post Qty.	Ex Ante Hrs/yr	Ex Ante kW Savings	Ex Ante kWh/y Savings	Ex Post Hrs/yr	Ex Post kW Savings	Ex Post kWh/y Savings
1	T12 3Lx4ft	115	56	T8 3Lx4ft	87	56	3,688	1.568	5,783	3,688	1.568	5,783
2	T12 4Lx4ft	162	17	T8 4Lx4ft	118	17	2,600	0.748	1,945	2,600	0.748	1,945
	T12 2Lx4ft	75	8	T8 2Lx4ft	61	8	2,600	0.112	291	2,600	0.112	291
3	T12 2Lx4ft	75	18	T8 2Lx4ft	61	18	2,080	0.252	524	2,080	0.252	524
	T12HO 2Lx2ft	90	3	T8 2Lx2ft	30	3	2,080	0.18	374	2,080	0.18	374
4	T12 2Lx4ft	75	7	T8 2Lx4ft	61	7	2,080	0.098	204	2,080	0.098	204
	T12HO 2Lx2ft	90	2	T8 2Lx2ft	30	2	2,080	0.12	250	2,080	0.12	250
5	T12 2Lx4ft	75	28	T8 2Lx4ft	61	28	2,773	0.392	1,087	2,773	0.392	1,087
	T12 8Lx4ft	308	6	T8 8Lx4ft	216	6	2,773	0.552	1,531	2,773	0.552	1,531
	60W Inc.	60	4	7W LED	7	4	2,773	0.212	588	2,773	0.212	588
	Exit 25W	25	3	Exit LED 3W	3	3	8,760	0.066	578	8,760	0.066	578
6	T12 Fixture	374	12	LED Fixture	144	12	8,760	2.76	24,178	8,760	2.76	24,178
7	T12 2Lx4ft	75	2	T8 2Lx4ft	61	2	2,080	0.028	58	2,080	0.028	58
8	T12 2Lx4ft	75	22	T8 2Lx4ft	61	22	2,080	0.308	641	2,080	0.308	641
9	T12 3Lx4ft	115	32	T8 3Lx4ft	87	32	2,080	0.896	1,864	2,080	0.896	1,864
10	T8 2Lx4ft	61	30	T8 2Lx4ft LED	46	30	2,080	0.45	936	2,080	0.45	936
11	T12 3Lx4ft	120	65	T8 3Lx4ft LED	54	65	8,760	4.29	37,580	8,760	4.29	37,580
12	T12 3Lx4ft	120	45	T8 3Lx4ft LED	54	45	8,760	2.97	26,017	8,760	2.97	26,017
13	T12ES 2Lx4ft	68	12	T8 2Lx4ft LED	36	12	2,548	0.384	978	2,548	0.384	978
14	T12 2Lx4ft	75	9	T8 2Lx4ft	61	9	3,838	0.126	484	3,838	0.126	484
	T12 3Lx4ft	115	61	T8 3Lx4ft	87	61	3,838	1.708	6,555	3,838	1.708	6,555
	T12 4Lx4ft	164	1	T8 4Lx4ft	118	1	3,838	0.046	177	3,838	0.046	177
	T12U 3Lx2ft	115	4	T8U 3Lx2ft	89	4	3,838	0.104	399	3,838	0.104	399
	Exit 25W	25	6	Exit LED 3W	3	6	8,760	0.132	1,156	8,760	0.132	1,156
15	100W HID	126	3	28W LED	28	3	2,080	0.294	612	2,080	0.294	612
16	35W MR16	35	4	6W LED	6	4	3,068	0.116	356	3,068	0.116	356
17	70W HPS	70	12	28W LED	28	12	4,380	0.504	2,208	4,380	0.504	2,208
18	70W HPS	70	11	28W LED	28	11	4,380	0.462	2,024	4,380	0.462	2,024
19	T12 2Lx4ft	75	96	T8 2Lx4ft	61	96	5,460	1.344	7,338	5,460	1.344	7,338
	T12 2Lx2ft	56	4	T8 2Lx2ft	31	4	5,460	0.1	546	5,460	0.1	546
	100W HPS	138	3	42W LED	42	3	5,460	0.288	1,572	5,460	0.288	1,572
20	T12 2Lx4ft	75	2	T8 2Lx4ft	61	2	5,460	0.028	153	5,460	0.028	153
	100W HPS	138	1	42W LED	42	1	5,460	0.096	524	5,460	0.096	524
21	T12 2Lx4ft	75	4	T8 2Lx4ft	61	4	5,460	0.056	306	5,460	0.056	306
	100W HPS	138	1	42W LED	42	1	5,460	0.096	524	5,460	0.096	524
22	T12 2Lx4ft	75	4	T8 2Lx4ft	61	4	5,460	0.056	306	5,460	0.056	306
23	T12 2Lx4ft	75	4	T8 2Lx4ft	61	4	5,460	0.056	306	5,460	0.056	306
	100W HPS	138	1	42W LED	42	1	5,460	0.096	524	5,460	0.096	524
24	T12 2Lx4ft	75	2	T8 2Lx4ft	61	2	5,460	0.028	153	5,460	0.028	153
	100W HPS	138	1	42W LED	42	1	5,460	0.096	524	5,460	0.096	524
25	T12 2Lx4ft	75	12	T8 2Lx4ft	61	12	5,460	0.168	917	5,460	0.168	917
26	T12 4Lx4ft	112	27	T8 4Lx4ft LED	72	27	2,503	1.08	2,703	2,503	1.08	2,703
	26W CFL	26	7	13W LED	13	7	2,503	0.091	228	2,503	0.091	228
	27W CFL	27	36	13W CFL	13	36	2,503	0.504	1,262	2,503	0.504	1,262

Table 4.18 Summary of Commercial Lighting Projects

#	Existing Fixture	Existing Watt/Fix	Existing Qty.	New Fixture	New Watt/Fix	Ex Post Qty.	Ex Ante Hrs/yr	Ex Ante kW Savings	Ex Ante kWh/y Savings	Ex Post Hrs/yr	Ex Post kW Savings	Ex Post kWh/y Savings
	38W CFL	38	16	26W CFL	26	16	2,503	0.192	481	2,503	0.192	481
27	T8 3Lx4ft	116	27	T8 3Lx4ft LED	54	27	1,536	1.674	2,571	1,536	1.674	2,571
	T8 2Lx4ft	78	11	T8 2Lx4ft LED	36	11	4,320	0.462	1,996	4,320	0.462	1,996
	T8 2Lx4ft	61	16	T8 2Lx4ft LED	36	16	4,320	0.4	1,728	4,320	0.4	1,728
28	T8 4Lx4ft	154	4	T8 4Lx4ft LED	72	4	4,380	0.328	1,437	4,380	0.328	1,437
	T8 2Lx4ft	78	2	T8 2Lx4ft LED	36	2	4,380	0.084	368	4,380	0.084	368
29	T8 2Lx4ft	154	4	T8 2Lx4ft LED	72	4	3,600	0.328	1,181	3,600	0.328	1,181
30	T8 2Lx4ft	78	35	T8 2Lx4ft LED	36	35	3,600	1.47	5,292	3,600	1.47	5,292
31	T8 2Lx4ft	78	25	T8 2Lx4ft LED	36	25	2,548	1.05	2,675	2,548	1.05	2,675
32	T12 2Lx8ft	131	22	T8 4Lx4ft	111	22	5,400	0.44	2,376	5,400	0.44	2,376
33	T12 2Lx8ft	131	64	T8 4Lx4ft	111	64	3,600	1.28	4,608	3,600	1.28	4,608
34	150W HPS	188	10	30W LED	30	10	4,380	1.58	6,920	4,380	1.58	6,920
35	100W HPS	138	3	52W LED	52	3	4,380	0.258	1,130	4,380	0.258	1,130
36	T12 2Lx8ft	125	24	T8 2Lx8ft	108	24	2,106	0.408	859	2,106	0.408	859
37	T8 2Lx4ft	61	102	T8 2Lx4ft LED	36	102	4,368	2.55	11,138	4,368	2.55	11,138
38	T8 2Lx4ft	61	69	T8 2Lx4ft LED	36	69	4,368	1.725	7,535	4,368	1.725	7,535
	Total		1122			1122		38.290	189,558		38.290	189,558
	Average Site							1.008	4,988.4		1.008	4,988.4
	90% CI							0.027	221.8		0.027	221.8

Table 4.19 Commercial Lighting Projects Ex Ante and Ex Post Site 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)
11. Commercial Lights	4,988.4	1.008			4,988.4 ± 221.8	1.008 ± 0.027		

4.1.9 Load Impacts for Commercial Projects Other (TTUSD)

Load impacts for commercial projects other (TTUSD) are based on pre- and post-EM&V time-series electric power measurements, and lighting logger measurements of fixtures consistent with IPMVP Option B.[27] The commercial project savings are summarized in **Table 4.20**. The ex post ex ante and ex post unit savings are shown in **Table 4.21**. The TDPUD assumed gross ex ante site savings per project of 9,185 kWh/yr, 4.248 kW and net ex ante program savings of 142,550 kWh, 65.9 kW and 2,138,253 lifecycle kWh based on 4 projects. The ex ante and ex post NTGR is 0.97 ± 0.03 based on 2012 decision maker survey results. The ex ante and ex post EUL is 15 years. The total net ex post savings are 142,550 ± 706 first-year kWh, 65.9 ± 0.30 kW, and 2,138,253 ± 10,594 kWh lifecycle kWh based on 4 projects. The ex post kWh savings are the same as ex ante savings based on EM&V pre- and post-measurements of savings. The TRC is 2.99. For commercial buildings, TDPUD should motivate customers to optimize minimum outdoor airflow per ASHRAE 62.1 without wasting energy due to incorrect damper positions. Closed dampers generally provide 15 to 30% outdoor air and many dampers are set 10 to 30% open due to building operators not understanding the difference between volumetric airflow and geometric position (i.e., percent open).

[27] Ibid.

Table 4.20 Summary of Commercial Projects Other (TTUSD)

#	Existing Fixture	Existing Watt/Fix	Existing Qty.	New Fixture	New Watt/Fix	Ex Post Qty.	Ex Ante Hrs/yr	Ex Ante kW Savings	Ex Ante kWh/y Savings	Ex Post Hrs/yr	Ex Post kW Savings	Ex Post kWh/y Savings
1	35 Hp Gym AHU 1	22,223	1	VFD (50% savings)	11,112	1	2,400	11.112	13,334	2,400	11.112	13,334
	35 Hp Gym AHU 2	22,223	1	VFD (95% savings)	1,056	1	2,400	21.11	48,136	2,400	21.112	48,136
2	7.5 Hp Const. Spd Pump	4,606	1	1.12 VFD EC Pump	1,122	1	5,760	3.484	20,068	5,760	3.484	20,068
3	No Controller	48.6	218	PC Power Controller	49	218	4,632	0.000	9,165	3,767	0.000	9,165
4	7.5 Hp Boiler Burner Motor	4,762.1	1	Controller 30% savings	3,333	1	5,712	1.429	8,160	5,712	1.429	8,160
	20 Hp Boiler Loop Pump	12,699.0	1	Controller 30% savings	8,889	1	5,712	3.810	21,761	5,712	3.810	21,761
	Standard schedule	13,810.2	1	Adjst schedule occupied hrs	13,120	1	1,870	0.691	1,291	1,870	0.691	1,291
	In room heater motors	317.5	24	Adjust schedule	0	24	1,870	7.619	712	1,870	7.619	712
	Fire Dampers Stuck	7,460.7	1	Correct Detectors	4,849	1	1,870	2.611	4,883	1,870	2.611	4,883
	2-Hr Warm-up Reduction	13,810.2	1	Adjust schedule	11,324	1	1,870	2.486	4,649	1,870	2.486	4,649
	100W Incand.	87.0	29	13W CFL	0	29	240	2.523	606	240	2.523	606
	AHU #3 Mech Room	2,222.3	1	Schedule shut down	0	1	857	2.222	1,904	857	2.222	1,904
	Library Lights on 3:30PM to 9PM	61.0	25	Schedule off 3:30PM to 9PM	0	25	990	1.525	1,510	990	1.525	1,510
	Lighting Retro Mechanical Room	44.0	28	4' 4L T12-T8	0	28	416	1.232	513	416	1.232	513
	AHU 1A and 1B	22,223.3	1	VFD from 100% to 50%	17,779	1	1,680	4.445	7,467	1,680	4.445	7,467
	AHU 1A OA Dampers Brkn	11,111.6	1	Repaired Dampers	9,445	1	1,680	1.667	2,800	1,680	1.667	2,800
	Total		335			335		67.967	146,957		67.967	146,959
	Average Site							4.248	9,185		4.248	9,185
	90% CI							0.075	176.6		0.075	176.6

Table 4.21 Commercial Projects Other (TTUSD Ex Ante and Ex Post Site 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)
12. Commercial Other	9,185	4.248			9,185 ± 176.6	4.248 ± 0.075		

4.1.10 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 Options A and B. 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.[28] Average electric water heater

[28] 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.

unit energy consumption (UEC) is 3,354 kWh per year.[29] 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 six electric water heaters. The TDPUD ex ante unit savings are 178 kWh and 0.024 kW. The baseline energy factor, energy use, and gross ex ante energy savings are shown in **Table 4.22**.[30] The ex ante and ex post NTGR values are 0.79. The ex ante and ex post EUL is 15 years. The program net ex ante savings are 152 kWh/yr, 0.025 kW and 2,275 lifecycle kWh based on 6 units. The total net ex post savings are 152 ± 15 first-year kWh, 0.025 ± 0.03 kW, and 2,275 ± 228 kWh lifecycle kWh based on 6 units. The ex post savings are the same as ex ante savings. The TRC is 0.40. TDPUD should encourage at least 1 to 10 customers to install solar thermal water heaters to help customers understand the importance of saving electricity and natural gas by heating water with solar power consistent with the California Solar Initiative (CSI) Thermal Program (see http://www.gosolarcalifornia.org/solarwater/). The CSI-Thermal Program offers cash rebates of up to $1,875 for solar water heating systems on single-family homes. Multifamily and Commercial properties qualify for rebates of up to $500,000. The California CSI encourages customers to "save money on gas or electricity bills by harnessing the heat of the sun!"

Table 4.22 Electric and/or Solar Water Heater Ex Ante and Ex Post Unit Savings

Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-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)
13. Electric/Solar Water Htr	32	0.005			32 ± 3.2	0.005 ± 0.001		

4.1.11 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. The study verified installation of 535 measures as reported in the TDPUD database. Gross ex ante and ex post unit savings are shown in **Table 4.23**. The ex ante net-to-gross ratio is 0.64. The ex post net-to-gross ratio is 0.84 +/- 0.09. The ex ante and ex post EUL is 15 years. The TDPUD net ex ante savings are 35,123 kWh/yr, 26.1 kW, 2,834 therms/year, 499,972 gallons/year, 285,250 lifecycle kWh, 23,010 lifecycle therm, and 4,069,924 lifecycle gallons of water based on 120 sites. The net ex post savings are 35128 ± 5,647 first-year kWh, 26.1 ± 4.01 kW, 2,834 ± 337 first-year therm, 499,972 ± 85,937 first-year gallons of water, 316,153 ± 50,824 lifecycle kWh, 25,503 ± 3,036 lifecycle therm, and 4,499,749 ± 773,438 lifecycle gallons of water based on 133 sites.[31] The ex post kWh and kW savings are approximately 11% greater than ex ante savings due to more 5 participants.

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

[30] Ibid.

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

Table 4.23 Low/Moderate Income Energy Assistance (ESP) Ex Ante and Ex Post Savings

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	314.4	0.233	25.4	4,475	314.4 ± 42	0.233 ± 0.030	25.4 ± 2.5	4,475 ± 646

4.1.12 Load Impacts for Green Schools

The Green Schools program did not have any load impacts in 2012.

4.1.13 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. Gross ex ante and ex post unit savings are shown in **Table 4.24**. RES energy savings are different than ESP due to different household characteristics and quantities of measures installed. The ex ante and 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.[32] The ex ante and ex post EUL is 9 years. The ex ante savings are 86,834 first-year kWh, 71.3 kW, 2,745 therm, 631,905 gallons/year of water, 781,509 lifecycle kWh, 24,707 lifecycle therm, and 5,687,144 lifecycle gallons of water based on 140 participants. The total net ex post savings are 94,898 ± 10,505 first-year kWh, 77.9 ± 8.01 kW, 3,000 ± 419 therm, 690,582 ± 104,059 gallons of water, 854,078 ± 94.546 kWh lifecycle kWh, 27,001 ± 3,775 lifecycle therm, and 6,215,236 ± 936,533 lifecycle gallons of water based on 153 participants. The ex post savings are 9.3% greater than ex ante due to more participants.

Table 4.24 Residential Energy Survey Ex Ante and Ex Post Unit Savings

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	969.1	0.796	30.6	7,053	969.1 ± 69	0.796 ± 0.052	30.6 ± 2.7	7,053 ± 680

4.1.14 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 4.25**. The ex ante

[32] 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).

and ex post net-to-gross ratios are 0.85 based on participant surveys. The ex ante and ex post effective useful lifetime (EUL) is 3 years. The TDPUD ex ante savings are 168,434 kWh/yr, 47.3 kW and 505,302 lifecycle kWh based on 1,200 units. The average annual hours of operation are 3,135 ± 303 hours per year based on the 2009 TDPUD EM&V study. The net ex post savings are 178,821 ± 21,038 first-year kWh, 50.2 ± 5.91 kW, and 536,462 ± 63,113 kWh lifecycle kWh based on 1,274 units. The ex post kWh savings are approximately 6% greater than ex ante savings due to more measures being installed than anticipated.

Table 4.25 Business Green Partners Ex Ante and Ex Post Unit Savings

Energy Efficiency Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Ex Ante Effective Useful Life (yrs)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Ex Post Effective Useful Life (yrs)
17. Business Green Partners	165.1	0.046	3	165.1 ± 16.5	0.046 ± 0.005	3

4.1.15 Load Impacts for Commercial Refrigeration Retrofit

Load impacts for the Commercial Refrigeration Retrofit program are based on data for 5 commercial customer sites with energy efficiency refrigeration upgrades consistent with IPMVP Option A. The average gross ex ante and ex post site savings are shown in **Table 4.26**. The ex ante and ex post net-to-gross ratio is 0.95 based on surveys conducted with seven participants in 2011. The ex ante and ex post effective useful lifetime (EUL) is 8 years. The TDPUD ex ante savings are 97,649 kWh/yr, 8.3 kW and 781,509 lifecycle kWh based on 5 sites. The net ex post savings are 97,649 ± 19,936 first-year kWh, 8.3 ± 1.7 kW, and 781,196 ± 159,491 kWh lifecycle kWh based on installations at 5 sites. The Commercial Refrigeration program TRC is 1.2.

Table 4.26 Keep Your Cool Ex Ante and Ex Post Unit Savings

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	20,558	1.745			20,558 ± 3,987	1.745 ± 0.339		

4.1.16 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 4.27**. The ex ante and ex post net-to-gross ratio is 0.85. The effective useful lifetime (EUL) is 16 years. The TDPUD ex ante savings are 105,661 kWh/yr, 21.3 kW and 1,308,320 lifecycle kWh based on 550 units. The average annual hours of operation are 3,107 ± 16 hours per year based on the 2009 TDPUD EM&V study. The net ex post savings are 112,385 ± 10,571 first-year kWh, 22.7 ± 2.46 kW, and 1,798,163 ± 169,135 kWh lifecycle kWh based on 585 installed units. The ex post kWh and kW savings are 6.4% greater due to more lamps installed than anticipated. The Business LED Pilot has a TRC of 4.3 with very high customer satisfaction. The custom delivery approach should be expanded.

Table 4.27 Business LED Pilot Ex Ante and Ex Post Unit Savings

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	226	0.046			2267 ± 18.1	0.046 ± 0.004		

4.1.17 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 4.28**. The ex ante and ex post net-to-gross ratio is 0.85. The effective useful lifetime (EUL) is 16 years. The TDPUD ex ante savings are 1,456 kWh/yr, 0.3 kW and 23,294 lifecycle kWh based on 25 units. The average annual hours of operation are 2,958 ± 37 hours per year based on the 2009 TDPUD EM&V study. The net ex post savings are 5,824 ± 685 first-year kWh, 1.2 ± 0.16 kW, and 93,177 ± 10.962 kWh lifecycle kWh based on 100 installed units. The ex post kWh and kW savings are 300% greater than ex ante savings due to four times more units installed and three times greater savings per lamp.

Table 4.28 LED Business Accent Lighting Ex Ante and Ex Post Unit Savings

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	68.5	0.016			68.5 ± 6.9	0.016 ± 0.002		

4.1.18 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 4.29**. 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 93 kWh/yr, 0.01 kW and 1,489 lifecycle kWh based on 1 unit. The average annual hours of operation are 8,760 hours per year based on the 2009 TDPUD EM&V study. The net ex post savings are 93 ± 11 first-year kWh, 0.01 ± 0.001 kW, and 1,489 ± 174 kWh lifecycle kWh based on 1 units.

Table 4.29 LED Exit Signs Ex Ante and Ex Post Unit Savings

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	109.5	0.013			109.5 ± 10.9	0.013 ± 0.001		

4.1.19 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. Gross ex ante and ex post unit savings are shown in **Table 4.30**. The ex ante and ex post NTGR is 0.64. The ex ante and ex post EUL is 9 years. The ex ante savings are 134,390 first-year kWh, 121.9 kW, and 1,209,511 lifecycle kWh based on 3,300 units. The total net ex post savings are 149,702 ± 12,866 first-year kWh, 135.8 ± 7.35 kW, and 1,347,322 ± 115,794 lifecycle kWh based on 3,676 units installed. The ex post kWh and kW savings are 11.4% greater due to more units installed.

Table 4.30 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	63.6	0.058			63.6 ± 3.5	0.058 ± 0.002		

4.1.20 Load Impacts for Neighborhood Block Party

Load impacts for the Neighborhood Block Party are based on interviews with residential customers and verification of the TDPUD database. Gross ex ante and ex post unit savings are shown in **Table 4.31**. The ex ante and ex post NTGR is 0.69. The ex ante and ex post EUL is 9 years. The ex ante savings are 7,291 first-year kWh, 1.6 kW, 315 first-year therms, 70,104 first-year gallons of water, 65,619 lifecycle kWh, 2,838 lifecycle therms, and 630,940 lifecycle gallons of water based on 25 units. The total net ex post savings are 8,458 ± 1,066 first-year kWh, 1.9 ± 0.93 kW, 366 ± 27 therms, 81,321 ± 6,043 gallons of water, 76,118 ± 9,591 lifecycle kWh, 3,292 ± 245 lifecycle therms, and 731,890 ± 54,390 lifecycle gallons of water based on 29 units installed. The ex post kWh and kW savings are 16% greater than ex ante savings due to more units installed. The Neighborhood Block Party program has high customer satisfaction and should be expanded to reach more customers.

Table 4.31 Neighborhood Block Party Ex Ante and Ex Post Unit Savings

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)
23. Neighborhood Block Party	422.7	0.093	18.3	4,064	422.7 ± 36.7	0.093 ± 0.032	18.3 ± 0.94	4,064 ± 208

4.1.21 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 4.32**. The ex ante goal for Energy Star® CFL measures is 30,000 units and the study verified 38,813 measures from the TDPUD purchase orders. The ex ante and ex post net-to-gross ratios are 0.69 based on participant decision maker surveys. The average ex post operating hours

are 1,100 ± 65 hours/yr based on participant survey data for 40 customers.[33] 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 1,231,650 first-year kWh and 279.5 kW and 11,084,850 lifecycle kWh for 30,000 units. The total net ex post savings are 1,425,702 ± 121,562 first-year kWh, 323.5 ± 69.46 kW, and 12,833,300 ± 1,094,058 lifecycle kWh for 34,732 units. The ex post savings are 15.8% greater than ex ante savings due to more units being installed than anticipated. The Million CFLs program has a TRC of 7.03 and represents approximately 48% of total energy efficiency program savings. The Million CFLs program should provide more educational information to help customers understand the types of CFLs and LEDs that are available for their home or business in terms of lumens and Watts (i.e., LEDs for holiday lights, standard bulbs, MR16s, and T8s).

Table 4.32 Million CFLs Ex Ante and Ex Post Unit Savings

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	59.5	0.014			59.5 ± 3.5	0.014 ± 0.002		

4.1.22 Load Impacts for LED Holiday Light Swap

Load impacts for the Light Emitting Diode (LED) Holiday 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 ex ante and ex post unit savings are shown in **Table 4.33**. The ex ante and ex post NTGR values are 0.91 ± 0.01 based on 2011 participant surveys. The ex ante and 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). The ex ante savings are 14,023 kWh/yr, 51.9 kW and 224,361 lifecycle kWh based on 644 units. The net ex post savings are 43,178 ± 4,745 first-year kWh, 159.9 ± 17.57 kW, and 690,850 ± 75,918 kWh lifecycle kWh based on 1983 units. The ex post savings are 209% greater than ex ante due to three times more units being installed. The LED Light Swap program can be improved by tracking participants in a database (i.e., customer name, number of strings, Watts per string received, and distributed).

Table 4.33 LED Light Swap Ex Ante and Ex Post Unit Savings

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	23.9	0.089			23.9 ± 2.4	0.089 ± 0.009		

[33] 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).

4.1.23 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.[34] TDPUD distributed 5,745 water efficiency measures including showerheads (1.5 gpm), kitchen swivel aerators (1.5 gpm), bath aerators (0.5 gpm), and garden nozzles (2.1 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).[35] 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). Efficient garden nozzles save 45% (i.e., 1-1.73/3.83=0.45). Pre- and post-retrofit measurements of showerhead and aerator flow rates (gpm) and flowing pressure (psi) were made with flow meters as per ASME A112.18.1/CSA B125.1-2011. 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.[36] 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.).[37] The gross ex ante and ex post unit savings are shown in **Table 4.34**. Embedded energy for water pumping and treatment is valued at 0.008157374 kWh per gallon and the embedded energy for water pumping only is 0.0048008025.[38] The study assumes that 30% of water efficiency measures are installed at homes with electric water heaters and 70% are

[34] 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).

[35] 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.

[36] Ibid.

[37]. 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.

[38] 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.

installed at homes with gas water heaters. The ex ante and ex post NTGR is 0.77. The ex ante and ex post EUL is 10 years. The TDPUD ex ante savings are 16,696 first-year kWh, 8.5 kW, 12,335 first-year therm, 6,219,405 first-year gallons of water, 166,958 lifecycle kWh, 123,346 lifecycle therm, and 62,194,051 lifecycle gallons of water based on 5,500 units. The net ex post savings are 17,440 ± 3,713 first-year kWh, 8.9 ± 0.45 kW, 12,884 ± 2,109 first-year therm, 6,496,451 ± 536,861 first-year gallons of water, 174,396 ± 37,134 lifecycle kWh, 128,840 ± 21,092 lifecycle therm, and 64,964,513 ± 5,368,611 lifecycle gallons of water based on 5,745 units installed. The ex post savings are 4.5% greater than ex ante savings due to more units being installed.

Table 4.34 Miscellaneous Water Efficiency Ex Ante and Ex Post Unit Savings

Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-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.	6.5	0.002	2.9	1,469	6.5 ± 0.6	0.002 ± 0.0001	2.9 ± 0.37	1,469 ± 93

4.1.24 Load Impacts for Water Efficient Toilet Rebate and Exchange

Load impacts for the Water Efficient Toilet Rebate and Exchange program are based on the rated water use per flush and 5.1 flushes per day (see http://www.epa.gov/WaterSense/product_search.html). The pre-existing toilet water use is based on 3.4 gallons per flush (gpf) and 1.6 gpf for toilets from 1994 through 2010.[39] The embedded energy of water pumping and treatment is 0.008157374 kWh per gallon based on TDPUD total 2007 electricity usage for water pumping and water treatment or 19,202,459 kWh per year and total water use of 2.354 billion gallons. Annual water and energy use for each toilet that received a rebate is based on the difference between the rated gallons per flush of the pre-existing toilet and the rated gallons per flush for the specific make and model listed in the WaterSense® database consistent with IPMVP Option B. The ex ante and ex post unit savings are shown in **Table 4.35**. The ex ante and ex post net-to-gross ratio is 0.81 ± 0.07 based on surveys with 10 participants. The ex ante and ex post effective useful lifetime (EUL) is 10 years. The ex ante savings are 11,563 kWh/yr, 1.6 kW and 173,449 lifecycle kWh based on 594 units. The net ex post savings are 12,488 ± 914 first-year kWh, 1.8 ± 0.13 kW, 1,529,089 ± 111,933 first-year gallons, 187,325 ± 13,712 lifecycle kWh, and 22,936,328 ± 1,678,999 lifecycle gallons of water based on 594 units. The ex ante and ex post savings are the same based on actual units and savings based on previous EM&V studies. The Water Efficient Toilet Rebate and Exchange programs have a TRC of 0.26 due to the E3 calculator not including the avoided costs of water savings. Reducing the rebate to $20 per water efficient toilet will make the program cost effective.

[39] Peter W. Mayer and William B, DeOreo. Residential End Uses of Water. Aquacraft, Inc. Water Engineering and Management. American Water Works Association. 1998. p. 94.

Table 4.35 WaterSense® Toilets Ex Ante and Ex Post Unit Savings

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)
27. WaterSense® Toilets	26	0.004		1,943	26 ± 1.5	0.004 ± 0.0002		3,178 ± 188

4.1.25 Load Impacts for Water Leak Repair

Load impacts for the Customer Water Leak Repair program are based on the measured water leak rate reported by the TDPUD water department which identifies leaks based on electronic metering and historical water use for each customer consistent with IPMVP Option D. The embedded energy of water pumping requires approximately 0.00480080 kWh per gallon based on total 2007 electricity usage for water pumping and total water use of 2.354 billion gallons. The leaks are generally caused by leaking underground shut-off valves, leaking fittings, or leaking toilet flapper valves that would not be obvious to customers. Before the program was established residential customers did not have water meters and billing was based on a flat rate per site. The Customer Leak Repair program was established after electronic meters were installed. The TDPUD water department provides customers with a letter indicating the magnitude of the leak and when the leak was identified. Based on 2011 program data, the average time to repair leaks is 155 +/- 27 days and the average cost of repairs is $844 +/- $184 per site. The ex ante and ex post unit savings are shown in **Table 4.36**. The ex ante and ex post net-to-gross ratio is 0.77 ± 0.14 based on surveys with 10 participants. The ex ante and ex post effective useful lifetime (EUL) is 10 years since leaks often occur again at the same site. The ex ante savings are 33,333 first-year kWh, 3.8 kW, 6,942,790 first-year gallons, 333,328 lifecycle kWh, and 69,427,896 lifecycle gallons based on 10 customer sites. The net ex post savings are 33,333 ± 10,792 first-year kWh, 3.8 ± 1.23 kW, 6,942,790 ± 2,248,025 first-year gallons, 333,328 ± 107,924 lifecycle kWh, and 69,427,896 ± 22,480,250 lifecycle gallons of water based on 25 customer sites. The ex ante and ex post savings are the same based on previous EM&V studies.[40] The Customer Leak Repair program has a TRC of 5.18 and very high customer satisfaction. This innovative program should be widely publicized to acknowledge excellence in program design and implementation by the TDPUD energy and water efficiency departments. Water supply leaks represent 10 to 50% of the total water supplied by municipal utilities (see http://www.corrosion-club.com/waterfigures.htm). The total water supply loss due to leaks in California is estimated at 81 billion gallons per year (US EPA). The typical large municipal city water leak rate is 17.2% (F. van der Leeden et al.: "The Water Encyclopedia", Second Edition, Lewis Publishers, 1990). The estimated leak rate in London is 50% (Marq de Villiers: "Water", Stoddart Publishing Co., 1999).

[40] The TDPUD water department did not provide an ex ante estimate of savings for the Customer Leak Repair program so the EM&V ex post savings are used for ex ante savings.

Table 4.36 Customer Leak Repair Ex Ante and Ex Post Unit Savings

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)
28. Customer Leak Repair	1732	0.198		360,684	1732 ± 432	0.198 ± 0.049		360,684 ± 89,921

4.1.26 Load Impacts for TDPUD Building LED Lighting Project

Load impacts for the TDPUD Building LED Lighting Project are based on detailed site visits and measurements of pre- and post-lighting fixtures and hours of operation using lighting loggers. The project included 694 LED lighting fixtures shown in **Table 4.37**. The pre- and post-measurements of power and illuminance (footcandles) are provided in **Table 4.38**. The ex ante and ex post savings are shown in **Table 4.39**. The average pre-retrofit lighting level is 34.4 footcandles and the average post-retrofit lighting level is 40.7 footcandles.[41] The IESNA average recommended lighting level is 22 footcandles.[42] Average pre-retrofit power is 69.1 W/fixture, and average post-retrofit power is 40 W/fixture. The LED fixtures provide 18% more illuminance than the T8 fixtures, and 85% more illuminance than the IESNA recommendation using 42% less power. The ex ante and ex post net-to-gross ratio is 1.0. The ex ante and ex post effective useful lifetime (EUL) is 25 years. The ex ante savings are 44,750 first-year kWh, 12.7 kW, and 1,118,758 lifecycle kWh. The net ex post savings are 44,750 ± 3,948 first-year kWh, 12.7 ± 0.94 kW, and 1,118,758 ± 98,706 lifecycle kWh. The ex ante and ex post savings are the same based on pre- and post-measurements from the 2012 EM&V study. The TRC is 1.1. The TDPUD Building LED Project is an excellent demonstration of cost effective high performance commercial lighting. Additional measures should be considered in 2013 to reduce total site energy intensity and qualify the TDPUD building for the 75 Energy Star rating.

Table 4.37 Summary of TDPUD LED Lighting Project

#	Existing Fixture	Existing Watt/Fix	Existing Qty.	New Fixture	New Watt/Fix	Ex Post Qty.	Ex Ante Hrs/yr	Ex Ante kW Savings	Ex Ante kWh/y Savings	Ex Post Hrs/yr	Ex Post kW Savings	Ex Post kWh/y Savings
1	T8 2Lx4ft	59	2	T8 2Lx4ft LED	36	2	8760	0.046	403.0	8760	0.046	403.0
2	T8 2Lx4ft	59	4	T8 2Lx4ft LED	36	4	3120	0.092	287.0	3120	0.092	287.0
3	T8 2Lx4ft	59	1	T8 2Lx4ft LED	36	1	8760	0.023	201.5	8760	0.023	201.5
4	T8 2Lx4ft	59	3	T8 2Lx4ft LED	36	3	6938	0.069	478.7	6938	0.069	478.7
5	26W CFL	26	1	P38 LED	18	1	6938	0.008	55.5	6938	0.008	55.5
6	T8 2Lx4ft	59	5	T8 2Lx4ft LED	36	5	494	0.115	56.8	494	0.115	56.8
7	T8 2Lx4ft	59	1	T8 2Lx4ft LED	36	1	260	0.023	6.0	260	0.023	6.0
8	T8 2Lx4ft	59	3	T8 2Lx4ft LED	36	3	8760	0.069	604.4	8760	0.069	604.4
9	T8 3Lx4ft	86	7	T8 3Lx4ft LED	54	7	5135	0.224	1150.2	5135	0.224	1150.2
10	26W CFL	26	9	P38 LED	18	9	4100	0.072	295.2	4100	0.072	295.2
11	23W CFL	23	4	P38 LED	18	4	4100	0.020	82.0	4100	0.020	82.0
12	T8 2Lx4ft	59	1	T8 2Lx4ft LED	36	1	8760	0.023	201.5	8760	0.023	201.5
13	T8 2Lx4ft	59	3	T8 2Lx4ft LED	36	3	4467	0.069	308.2	4467	0.069	308.2
14	T8 2Lx4ft	59	2	None	0	0	8760	0.118	1033.7	8760	0.118	1033.7

[41] Footcandle (fc) is a unit of illuminance equal to 1 lumen per square foot or 10.76 lux. Measurements are at surface of the work area typically 3 feet from the floor.

[42] IESNA, Illuminating Engineering Society of North America, Lighting Handbook, Reference Application, 8th Edition, NY, Chapter 11, page 460, Figure 11-1, 1993.

Table 4.37 Summary of TDPUD LED Lighting Project

#	Existing Fixture	Existing Watt/Fix	Existing Qty.	New Fixture	New Watt/Fix	Ex Post Qty.	Ex Ante Hrs/yr	Ex Ante kW Savings	Ex Ante kWh/y Savings	Ex Post Hrs/yr	Ex Post kW Savings	Ex Post kWh/y Savings
15	T8 2Lx4ft	59	2	T8 2Lx4ft LED	36	2	2469	0.046	113.6	2469	0.046	113.6
16	T8 2Lx4ft	59	23	T8 2Lx4ft LED	36	10	2469	0.997	2461.6	2469	0.997	2461.6
17	23W CFL	23	2	P38 LED	18	2	2469	0.016	39.5	2469	0.016	39.5
18	T8 U-tube	32	1	P38 LED	18	1	2469	0.014	34.6	2469	0.014	34.6
19	N			P38 LED	72	2	2469	-0.144	-355.5	2469	-0.144	-355.5
20	N/A			MR16 LED	21	1	2469	-0.021	-51.8	2469	-0.021	-51.8
21	N/A			LED cabinet	0	1	2469	0.000	0.0	2469	0.000	0.0
22	T8 2Lx4ft	59	2	T8 2Lx4ft LED	36	2	8760	0.046	403.0	8760	0.046	403.0
23	T8 2Lx4ft	59	7	T8 2Lx4ft LED	36	7	1248	0.161	200.9	1248	0.161	200.9
24	T8 2Lx4ft	59	1	T8 2Lx4ft LED	36	1	1248	0.023	28.7	1248	0.023	28.7
25	T8 2Lx4ft	59	1	T8 3Lx4ft LED	54	1	8760	0.005	43.8	8760	0.005	43.8
26	T8 3Lx4ft	86	4	T8 3Lx4ft LED	54	4	1918	0.128	245.5	1918	0.128	245.5
27	T8 2Lx4ft	59	2	T8 2Lx4ft LED	36	2	520	0.046	23.9	520	0.046	23.9
28	17W Lamp	17	2		0	0	1918	0.034	65.2	1918	0.034	65.2
29	T8 1Lx4ft	30	11	T8 1Lx4ft LED	18	11	1918	0.132	253.2	1918	0.132	253.2
30	26W CFL	26	22	P38 LED	18	20	1918	0.212	406.6	1918	0.212	406.6
31	T8 2Lx4ft	59	1	T8 2Lx4ft LED	36	1	8760	0.023	201.5	8760	0.023	201.5
32	T8 2Lx4ft	59	5	T8 2Lx4ft LED	36	5	520	0.115	59.8	520	0.115	59.8
33	T8 2Lx4ft	59	1	T8 2Lx4ft LED	36	1	8760	0.023	201.5	8760	0.023	201.5
34	T8 2Lx4ft	59	1	T8 2Lx4ft LED	36	1	2080	0.023	47.8	2080	0.023	47.8
35	T8 2Lx4ft	59	2	T8 2Lx4ft LED	36	2	2080	0.046	95.7	2080	0.046	95.7
36	T8 2Lx4ft	59	1	T8 2Lx4ft LED	36	1	520	0.023	12.0	520	0.023	12.0
37	T8 2Lx4ft	59	4	T8 2Lx4ft LED	36	4	520	0.092	47.8	520	0.092	47.8
38	T8 4Lx4ft	112	1	T8 4Lx4ft LED	72	1	8760	0.040	350.4	8760	0.040	350.4
39	T8 2Lx4ft	59	3	T8 2Lx4ft LED	36	3	2080	0.069	143.5	2080	0.069	143.5
40	T8 2Lx4ft	59	1	T8 2Lx4ft LED	36	1	2080	0.023	47.8	2080	0.023	47.8
41	T8 2Lx4ft	59	2	T8 2Lx4ft LED	36	2	8760	0.046	403.0	8760	0.046	403.0
42	T8 2Lx4ft	59	1	T8 2Lx4ft LED	36	1	8760	0.023	201.5	8760	0.023	201.5
43	T8 2Lx4ft	59	2	T8 2Lx4ft LED	36	2	2080	0.046	95.7	2080	0.046	95.7
44	T8 2Lx4ft	59	1	T8 2Lx4ft LED	36	1	8760	0.023	201.5	8760	0.023	201.5
45	T8 2Lx4ft	59	1	T8 2Lx4ft LED	36	1	2080	0.023	47.8	2080	0.023	47.8
46	T8 2Lx4ft	59	1	T8 2Lx4ft LED	36	1	8760	0.023	201.5	8760	0.023	201.5
47	T8 2Lx4ft	59	9	T8 2Lx4ft LED	36	9	1040	0.207	215.3	1040	0.207	215.3
48	T8 2Lx4ft	59	2	T8 2Lx4ft LED	36	2	8760	0.046	403.0	8760	0.046	403.0
49	T8 2Lx4ft	59	19	T8 2Lx4ft LED	36	19	2469	0.437	1079.0	2469	0.437	1079.0
50	T8 2Lx4ft	59	6	T8 2Lx4ft LED	36	6	8760	0.138	1208.9	8760	0.138	1208.9
51	T8 2Lx4ft	59	5	T8 2Lx4ft LED	36	4	2080	0.151	314.1	2080	0.151	314.1
52	T8 2Lx4ft	59	0	T8 1Lx4ft LED	18	1	520	-0.018	-9.4	520	-0.018	-9.4
53	T8 2Lx4ft	59	1	T8 2Lx4ft LED	36	1	0	0.023	0.0	0	0.023	0.0
54	T8 2Lx4ft	59	2	T8 2Lx4ft LED	36	2	520	0.046	23.9	520	0.046	23.9
55	T8 2Lx4ft	59	10	T8 2Lx4ft LED	36	10	8760	0.230	2014.8	8760	0.230	2014.8
56	T8 2Lx4ft	59	50	T8 2Lx4ft LED	36	50	3221	1.150	3704.2	3221	1.150	3704.2
57	T8 2Lx4ft	59	1	T8 2Lx4ft LED	36	1	8760	0.023	201.5	8760	0.023	201.5
58	T8 2Lx4ft	59	5	T8 2Lx4ft LED	36	5	2469	0.115	283.9	2469	0.115	283.9
59	T8 2Lx4ft	59	3	T8 2Lx4ft LED	36	3	4467	0.069	308.2	4467	0.069	308.2
60	T8 2Lx4ft	59	1	T8 2Lx4ft LED	36	1	520	0.023	12.0	520	0.023	12.0
61	T8 2Lx4ft	59	10	T8 2Lx4ft LED	36	2	2469	0.518	1278.9	2469	0.518	1278.9
62	T8 1Lx4ft	30	0	T8 1Lx4ft LED	18	8	2469	-0.144	-355.5	2469	-0.144	-355.5
63	T8 2Lx4ft	59	1	None	0	0	8760	0.059	516.8	0	0.059	516.8
64	T8 4Lx4ft	112	1	T8 4Lx4ft LED	72	1	2080	0.040	83.2	2080	0.040	83.2
65	T8 2Lx4ft	59	1	T8 2Lx4ft LED	36	0	8760	0.059	516.8	0	0.059	516.8
66	T8 1Lx4ft	30	3	T8 1Lx4ft LED	18	4	2762	0.033	146.6	2377	0.033	146.6
67	T8 2Lx4ft	59	1	T8 2Lx4ft LED	36	1	8760	0.023	201.5	8760	0.023	201.5
68	T8 1Lx4ft	30	6	T8 1Lx4ft LED	18	6	2519	0.138	358.4	2469	0.138	358.4
69	85W Inc.	85	4	P38 LED	18	4	2519	0.268	678.7	2469	0.268	678.7
70	T8 4Lx4ft	112	6	T8 4Lx4ft LED	72	6	2377	0.456	1083.9	2377	0.456	1083.9
71	T8 4Lx4ft	112	2	T8 4Lx4ft LED	72	2	1040	0.080	83.2	1040	0.080	83.2
72	T8 2Lx4ft	59	2	T8 2Lx4ft LED	36	2	0	0.046	0.0	0	0.046	0.0
73	T8 2Lx4ft	59	18	T8 2Lx4ft LED	36	6	2348	0.846	1986.4	2348	0.846	1986.4
74	T8 1Lx4ft	30	1	T8 1Lx4ft LED	18	1	8760	0.023	201.5	8760	0.023	201.5

Table 4.37 Summary of TDPUD LED Lighting Project

#	Existing Fixture	Existing Watt/Fix	Existing Qty.	New Fixture	New Watt/Fix	Ex Post Qty.	Ex Ante Hrs/yr	Ex Ante kW Savings	Ex Ante kWh/y Savings	Ex Post Hrs/yr	Ex Post kW Savings	Ex Post kWh/y Savings
75	T8 2Lx8ft	112	11	T8 3Lx4ft LED	75	13	2348	0.257	603.4	2348	0.257	603.4
76	N/A	0		T8 3Lx4ft LED	75	2	8760	-0.150	-1314.0	8760	-0.150	-1314.0
77	N/A	0		P38 LED	18	19	2348	-0.342	-803.0	2348	-0.342	-803.0
78	N/A	0		P38 LED	18	1	8760	-0.018	-157.7	8760	-0.018	-157.7
79	T12 2Lx4ft	88	2	T8 2Lx4ft LED	36	2	2348	0.103	242.3	2348	0.103	242.3
80	400W HPS	465	4	LED Array	75	4	4100	1.560	6396.0	4100	1.560	6396.0
81	400W HPS	465	5	LED Array	145	5	4100	1.600	6560.0	4100	1.600	6560.0
82	400W HPS	465	4	LED Array	145	4	4100	1.280	5248.0	4100	1.280	5248.0
	Total							12.7	44,750		12.7	44,750

Table 4.38 TDPUD LED Project Pre- and Post-Measurements (fc = footcandles)

Pre-Fixture	Pre-Watts	Pre-Retrofit (fc)	Post Fixture	Post-Watts	Post-Retrofit (fc)	IESNA (fc)
T8 3Lx4'	90	40	LED 3Lx4'	51	38	15
T8 3Lx4'	90	52	LED 3Lx4'	51	42	15
T8 5Lx4'	126	40	LED 5Lx4'	85	45	30
CFL R30	23	18	LED R30	11	59	30
T8 2Lx4'	60	34	LED 2Lx4'	34	40	30
T8 3Lx4'	64	35	LED 3Lx4'	34	32	30
T8 3Lx4'	90	54	LED 3Lx4'	51	55	30
T8 2Lx4'	60	26	LED 2Lx4'	34	23	15
T8 2Lx4'	60	25	LED 2Lx4'	34	33	15
CFL R30	23	16	LED R30	11	58	15
T8 2Lx8'	111	36	LED 4Lx4'	68	40	30
T8 2Lx4'	60	10	LED 2Lx4'	34	16	15
T8 2Lx4'	60	46	LED 2Lx4'	34	45	15
T8 2Lx4'	60	40	LED 2Lx4'	34	37	30
T8 2Lx4'	60	44	LED 2Lx4'	34	48	15
Average	69.1	34.4		40.0	40.7	22.0

Table 4.39 TDPUD Building LED Lighting Project Ex Ante and Ex Post Unit Savings

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)
29. TDPUD Bldg. LED Project	44,750	12.7			44,750 ± 3,948	12.7 ± 0.94		

4.2 Verification Inspection Findings

Verification inspections were conducted in 2012 and for the previous EM&V studies in 2011, 2010, 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 three sites and duct leakage was checked at three sites for the 2010 programs and all sites passed inspections. On-site inspections and survey responses were used to evaluate pre- and post-retrofit lighting fixture wattages. A total of 2,035 measures were inspected for 2012 programs, 1,131 measures were inspected for the 2010 programs and 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 4.40**.

Table 4.40 Field Measurements of Lighting Fixture Average Power (2012 and 2010)

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		
T8 4 ft linear LED		18	36	54	72
T8 2 ft linear LED		9	18	27	36
HID HPS Highbay (Rated/Actual W)		150/188	250/295	400/465	
LED Highbay (dark sky compliant)		36	75	145	
100W PAR38		100			
LED PAR38		18			
Incandescent Exit Sign		25/40			
CFL Exit Sign		12/20			
LED Exit Sign		3/6			
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 6 sites in the 2012 study and 30 sites in 2011 study to measure hours of operation. These were left at the sites for a period of up to eight weeks. Data loggers at two (2) sites were tampered with by the occupants and the data was lost. Fifty two (52) data loggers were successfully downloaded to monitor hours of operation on 2,989 fixtures. Lighting hours of operation are based on data from 52 light loggers as shown in **Table 4.41**. The average EM&V ex post hours of operation are 3,554 ± 456 hours per year which compares favorably to the ex ante assumption of 3,409 hours per year.

Table 4.41 Light Logger Measurements of Lighting Hours of Operation (2012, 2009)

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	8.9	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	4.7	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	6.5	2374
18	Office	CFL - Green Partner	56.1	13.46	4914
22	Retail	T8 - Commercial Lighting	52.1	12.5	4564
24	Hospitality	CFL - Green Partner	100	24	8760
28	Retail	CFL - Green Partner	51.2	12.29	4485
30	Hospitality	CFL - Green Partner	100	24	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
41	Office	Comm Lighting	28.6	6.86	2503
42	Office	Comm Lighting	22.9	5.49	2003
43	Office	Comm Lighting	17.6	4.22	1541
44	Storage	Comm Lighting	60.9	14.62	5337
45	Storage	Comm Lighting	60.9	14.62	5337
46	Retail	Comm Lighting	31.7	7.60	2773
47	Retail	Comm Lighting	10.6	2.55	930
48	Retail	Comm Lighting	43.8	10.51	3838
49	Retail	Comm Lighting	42.1	10.10	3688
50	Retail	Comm Lighting	28.0	6.71	2450
51	Office	TDPUD LED	27.1	6.51	2377
52	Office	TDPUD LED	28.2	6.77	2469
	Average	EM&V Ex Post	38.2	9.2	3554 ± 456
		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.

4.3 Participant Survey Results

This study uses participant surveys to estimate the net-to-gross ratios for kWh and kW savings. In 2012, participant surveys were completed for 12 commercial customers representing 17.5% of total savings. In 2011, participant surveys were completed for 167 participants. In 2011, non

participant surveys were completed for 10 customers who were not contacted by programs in 2011. In 2010, non participant surveys were completed for 40 customers who were not contacted by programs in 2010.

4.3.1 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 4.42**. 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 4.42 Net-to-Gross Ratio Participant Survey Questions and Scoring

#	Question	Answer	Score
1	Are you using the energy efficiency measures you purchased or received from the program (i.e., 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) or Did salesperson explain benefits of Energy Star®?	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 energy efficiency upgrade BEFORE or AFTER you heard about the 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 Energy Star® or Utility Program information 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 Energy Star® information or Utility Program rebates were a critical factor to install the energy efficiency upgrades.	0 to 10	0=0, 10=1
11	I would not have purchased or installed the Energy Star® appliances or measures without the Utility Program rebates or information.	0 to 10	0=0, 10=1
12	The Energy Star® information or Utility Program was nice but unnecessary to have energy efficient appliances or measures installed.	0 to 10	0=1, 10=0
13	If you had not received the [Energy Star® information, rebate or service] from the Utility, when would you have purchased or installed the Energy Star® appliance or energy efficiency 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

4.3.2 Findings of the Participant Surveys (NTGR)

Results of the participant surveys regarding the net to gross ratio (NTGR) are presented in **Table 4.43**. The participant findings indicate that approximately 25% of customers in Truckee say they

"would have installed the energy efficiency measures without the program information and incentives." This indicates that TDPUD has been successful in motivating 25% of their customers to make energy efficient purchasing decisions while 75% of customers lack sufficient information or economic resources to make energy efficient purchasing decisions without information and/or incentives from TDPUD.

Table 4.43 Findings of Participant Surveys for TDPUD Programs (NTGR)

TDPUD Program	Sample Size	Units Installed	NTGR	+/- 90% CI
1. Residential CFLs (2010/11)	10	282	0.69	0.07
2. Energy Star® Clotheswashers (2010/11)	11	224	0.68	0.08
3. Energy Star® Dishwasher (2010/11)	14	177	0.69	0.07
4. Energy Star® Refrigerator/Freezer (2010/11)	19	209	0.7	0.06
5. Refrigerator Recycling (2010/11)	13	24	0.85	0.05
8. Bldg Envelope Mitigation (2010/11)	8	4	0.8	0.08
9. Duct Mitigation (2010/11)	11	11	0.74	0.08
11. Commercial Lighting 2012	13	1,596	0.89	0.03
11. Commercial Lighting (2010/11)	15	1,909	0.85	0.03
13. Elec/Solar Water Heater (2011)	2	2	0.79	0
14. Low-Mod Income Assist/ESP (2009)	17	175	0.64	0.09
16. Residential Energy Survey (2009)	4	48	0.64	0.09
17. Business Green Partners (2010/11)	10	10	0.85	0.03
18. Keep Your Cool (2010/11)	7	15	0.95	0.02
19. Business LED Pilot (2011)	10	10	0.85	0.03
20. LED Business Accent (2011)	10	10	0.85	0.03
22. Residential Green partners (2009)	19	3,671	0.64	0.09
27.WaterSense® Toilets (2011)	10	821	0.81	0.07
28. Customer Leak Repair (2011)	10	89	0.77	0.14
29. TDPUD Bldg. LED Lighting (2012)	1	694	1.00	0
Total	214	9,981	0.75	0.07

4.2 Process Evaluation Results

Process evaluation recommendations are based on process surveys conducted in-person with 167 participants and 10 non participants or individuals who were not contacted by the programs in 2011 and 40 non participants who were not contacted by the programs in 2010. 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**.

4.2.1 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 – 95.1 percent satisfaction rating (i.e., average score of 9.51 ± 0.25 out of 10 points).
- Presentation of information – 92 percent satisfaction rating (i.e., 9.2 ± 0.24 out of 10 points).
- Increased Understanding of Link between Energy Efficiency, Savings, and Comfort - 88 ± 2 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.

- 94 percent of customers are still using the measures installed by the program (i.e., 169 out of 179 surveyed customers were still using all installed measures).
- 94% ± 2% of customers are satisfied with measures offered or installed by the program (i.e., average score of 9.4 ± 0.2 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.

- 92 ± 2 percent presentation rating.
- 93.3 ± 2.4 percent accuracy rating.
- 88.1 ± 2.4 percent rating of program increasing understanding of the linkage between energy efficiency, bill savings, and comfort.
- 45 percent of participants indicated that others would benefit from the program.

4. What are the participant demographics?

- 25.6% of customers have electric water heaters and 74.4% have gas water heaters.
- Average water temperature set point is 127.3 ± 3.4°F.
- Average conditioned floor area is 2,141 ft^2 ± 10.5 ft^2.
- Average number of occupants is 3.02 ± 0.03.
- 75% owned the home or business and 25% are tenants.
- 100 percent spoke English well enough to understand and answer the questions.
- Participants had the following primary languages: 97% English, 3% Spanish.

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

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

- 42% said "great program, very satisfied with program and measures, program influenced me to buy more Energy Star® appliances, would not have bought efficient refrigerator without program, happy with TDPUD, using 50% less electricity than last year, excellent program, very satisfied, installed CFLs in every fixture, hope you can reach every home and business in Truckee, liked mailer about program and wouldn't have replaced 3 toilets without it, TDPUD engineer was really great on time and informative, really liked the LED Holiday lighting."
- 27% said the program would benefit from "online rebate applications, better advertising on community bulletin boards, website, or email, add rebates for solar water heating, improve surveys by having surveyors install energy efficiency measures, provide more types of CFLs/LEDs, combined gas/electric, bill inserts, found out online from manufacturer, tdpud.org and blog, didn't see utility bill insert, paperwork could be better, Energy Star® appliances were hard to find, please provide better information."
- 17% wanted "TDPUD to offer more energy efficient LED lamps and increase the rebate for LED lamps to $5/lamp."
- 10% said "without program owners would have never changed to LED and just continued to re-lamp old fixtures" and "extremely happy with LED lighting."
- 2% said "continue rebates for leak repair and follow up with customer to let them know leaks are fixed based on lower water meter readings."
- 7% want "TDPUD to provide a list of qualified contractors who are available to provide the following services: water leak repair, duct repair, building envelope repair, solar water heating, solar electric, and other measures."
- 3% (42% of Keep Your Cool participants) said they would like "more LED refrigerator lamps and replacement refrigerator/freezer gaskets."

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, 45 percent of interviewed customers shared program information with 16 times as many people. Approximately 23 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 0.5 percent.[43] Programs that link technologies with educational measures can have multiplier effects as high as 10-25 percent including the sharing of program information to a population that is several times larger than the participant population.

4.2.2 Non-Participant Survey Results

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

1. Is there a continuing need for the program?

[43] Spillover of 0.5 percent is calculated based on 309 people adopting at least one spillover measure based on information shared by a group of 83 participants who adopted 777 measures (i.e., 309 × (1÷ 777) ÷ 83 = 0.005).

The following responses indicate a continuing need for the program.

- 95 percent of participants were very satisfied with the program and said they would like the TDPUD to "do all businesses and homes in town!"
- 67 percent of non-participants would have participated if they knew the programs provided rebates, information and free compact fluorescent lamps, LED lamps, LED holiday lights, WaterSense® 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%]

- 58% didn't participate due to not knowing about the program (i.e., information costs).
- 4% didn't participate due to not understanding the benefits of energy efficiency.
- 2% didn't participate due to not owning the building.
- 8% didn't participate due to being too busy or not having time to participate (hassle factor).
- 28% 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.

- 47% suggested better advertising and information would help. Typical responses include: "Increase advertising and promotion on website, e-mail messages, social network sites, local newspapers and radio, especially to new homeowners and low income families." "Include advertising with electric bill and on website." "Please have more events to distribute free CFLs, LEDs, and other measures to families and local businesses."
- 18% said they wanted "more variety of free CFLs and LEDs."
- 6% said "offer neighborhood block parties or events to help customers save energy."
- 12% said "compare bill decrease of participants after program with neighbors who didn't participate."
- 5% said they "needed information and online lists providing qualifying Energy Star® appliances available at local appliance stores."
- 12% said they "appreciates the amount of information on utility bill about programs, TDPUD is doing a good job, but their home or businesses are already efficient."

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 53.9 ± 5.5 years.
- 57% of non-participants are male and 43% are female.
- Non-participants had the following primary languages: 100% English.
- Average income range of non-participants is $34,000 to $64,000.

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

4.2.3 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.

4.2.3.1 Recommendations for Database

TDPUD is implementing an internet-tracking system (www.energy-orbit.com) to track program accomplishments. The tracking database will help customers understand apply for rebates online, and provide feedback regarding the rebate process and programs. The database can be used to help document and verify installed measures for EM&V reporting. The online database can include the following information for each measure: name, address, phone number, e-mail address, account number, incentives paid, date paid, date installed, pre-existing measure, measure description (from pull-down list or entered), make, model, serial, 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.), pre/post duct leakage, pre/post building envelope leakage, and pre/post Watts or efficiency units.

4.2.3.2 Recommendations for Million CFLs and LED Lamps

The Million CFLs program has a TRC of 7.03 and the Residential CFLs program has a TRC of 4.18. The Million CFL program represents approximately 48% of total energy efficiency program savings. The Million CFLs program provides educational information to help customers understand the types of CFLs and LEDs that are available for their home or business in terms of lumens and Watts (i.e., LEDs for holiday lights, standard bulbs, MR16s, and T8s). TDPUD continues to evaluate CFLs and LED lamps to find better quality products with longer life. The LED Holiday Light Swap program has a TRC of 1.5 and should be continued.

4.2.3.3 Recommendations for Energy Star® Appliances

TDPUD is offering appliance incentives based on CEE Tier levels and helps customers identify qualifying products through the www.tdpud.org website link to www.cee1.org. TDPUD is working cooperatively with retailers to advertise CEE Tier 2 or better products that exceed Energy Star®. TDPUD has redesigned the appliance rebate program for 2013. For refrigerators, TDPUD is offering a $75 rebate for CEE Tier 1, $100 for CEE Tier 2 which is 25% more efficient than Federal Standards, and $125 for CEE Tier 3 which is 30% more efficient than Federal Standards. For dishwashers, TDPUD is offering a $75 rebate for CEE Tier 1 which is 14% better than Federal Standards. For clotheswashers, TDPUD is offering a $75 rebate for CEE Tier 1 which is 59% more efficient than Federal Standards, $150 for CEE Tier 2 which is 75% more efficient, and $175 for CEE Tier 3 which is 90% better. These recommendations will

motivate customers to purchase more efficient appliances and make the Energy Star® programs more cost effective.

4.2.3.4 Recommendations for Refrigerator & Freezer Recycling

The TDPUD refrigerator and freezer recycling program realized a TRC of 3.11 by recycling 142 units in 2012 which is a 490% increase from 2011. Increased participation is due to TDPUD hiring a local appliance retailer to recycle refrigerators and freezers year round. Using a local retailer increased the number of units recycled and improved the local economy.

4.2.3.5 Recommendations for Building Envelope and Duct Mitigation

The building envelope and duct mitigation programs realized a TRC of 2.03. This program should provide rebates for contractors who achieve target leakage reduction values. The duct leakage target should be 15% measured in cubic feet per minute (cfm) or 15% total duct leakage as a percentage of total system airflow. The building envelope sealing target should be 20% CFM50 reduction in air leakage or no less than 0.3 Air Changes per Hour (ACH).[44] The program should require pre and post leakage measurements to qualify for incentives and minimum thresholds for leakage reduction of at least 20% for building envelope and 10% for duct leakage. Provide information about benefits such as reduced energy bills, improved comfort, and better indoor air quality. Require technician training and certification (score of 75 on a technical challenge test) to participate in the TDPUD program. Require the following data for each job submitted for incentives. 1) make, model, serial number of furnace (and air conditioner if present), 2) pre-test and post-test duct or building envelope leakage in cubic feet per minute (cfm), 3) duct or building envelope leakage in terms of percentage of total system airflow for ducts and air changes per hour for building envelope, 4) repairs performed to reduce duct leakage (i.e., sealed boots, ducts, FAU, plenum, repaired or replaced ducts) or building envelope (i.e., repaired or installed weather stripping and door sweeps, caulked floor joints, sealed electrical and plumbing penetrations, repaired chimney flue damper, etc.).

4.2.3.6 Recommendations for Thermally Efficient Windows

TDPUD should implement a thermally efficient window program for its office building and encourage at least five customers per year to install thermally efficient low-emissivity windows. This will help customers understand the importance of saving electricity and natural gas by reducing window heat loss in winter and heat gain in summer. Installing low-emissivity windows at the TDPUD offices will reduce energy use to achieve the Energy Star® BEP rating. The Energy Star® window qualification criteria maximum u-value is 0.32 Btu/hr-ft^2-°F and less than or equal to 0.4 SHGC. TDPUD should adopt the Energy Star® window criteria for incentive

[44] For duct leakage the leakage measurements should be provided in terms of percentage of total system airflow based on 18.5 cfm per thousand British thermal units per hour (kBtuh) of heating capacity. For building envelope repair the leakage should be in terms of air changes per hour (ACH) for building envelope where ACH=[CFM50 x 0.055 x 2 x 60] / [floor area x ceiling height]),

programs. The SHGC will be effective in reducing residential and commercial cooling loads in summer when solar gains and outdoor temperatures peak on south facing exposures.

4.2.3.7 Recommendations for Commercial Lighting

The Commercial Lighting program will benefit from an online application process so customers can enter the pre- and post-retrofit fixtures, quantities, Watts, and hours of operation. This will streamline the rebate application process and provide better tracking information for EM&V purposes.

4.2.3.8 Recommendations for Ground Source Heat Pumps

TDPUD should encourage at least one customer per year to install ground source heat pumps to provide enough local business to keep this energy efficiency measure viable.

4.2.3.9 Recommendations for Electric/Solar Water Heaters

TDPUD should encourage at least one customer per year to install solar thermal water heaters to help customers understand the importance of saving electricity and natural gas by heating water with solar power consistent with the California Solar Initiative (CSI) Thermal Program (see http://www.gosolarcalifornia.org/solarwater/). The CSI-Thermal Program offers cash rebates of up to $1,875 for solar water heating systems on single-family homes. Multifamily and Commercial properties qualify for rebates of up to $500,000. The California CSI program encourages customers to “save money on gas or electricity bills by harnessing the heat of the sun!”

4.2.3.10 Recommendations for Energy Assistance and Residential Energy Survey

TDPUD should require energy auditors who perform low/moderate income energy assistance and residential energy surveys to install the measures. This will include using ladders to install CFLs lamps in ceiling fixtures. Many low income elderly or disabled customers cannot climb ladders. Installing the measures will improve cost effectiveness and help low income customers save energy and money. TDPUD should provide 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). TDPUD should provide 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).

4.2.3.11 Recommendations for Green Schools

The Green Schools program was not evaluated in 2012, but has been successful in the past and should continue to be implemented

4.2.3.12 Recommendations for Business Green Partners

The Business Green Partners program has a TRC of 4.4 and is very popular with small commercial business customers. TDPUD should continue to offer this innovative program to help small local businesses save energy and be successful. This program generates high customer satisfaction ratings with 92% of participants indicating they were very satisfied with the overall energy efficiency services received from TDPUD.

4.2.3.13 Recommendations for Commercial Refrigeration

The Commercial Refrigeration program has a TRC of 1.15 and is very popular with small commercial business customers. TDPUD should continue to offer this innovative program to help small local businesses save refrigeration energy. This program generates high customer satisfaction ratings with 90% of participants indicating they were very satisfied with the overall energy efficiency services received from TDPUD. The Commercial Refrigeration program needs to require pre and post-retrofit measurements of motors to correctly estimate kW savings which are currently estimated using engineering equations. Motor electric power cannot be accurately estimated using engineering equations due to unknown voltage, current, and phase angles.

4.2.3.14 Recommendations for Business LED Pilot and Accent Lighting

The Business LED Accent Lighting program has a TRC of 6.5 and Business LED Pilot program has a TRC of 4.3. These programs are very popular with small commercial business customers. TDPUD should continue to offer these innovative programs to help small local businesses save energy. The programs generate high customer satisfaction ratings with 92% of participants indicating they were very satisfied with the overall energy efficiency services received from TDPUD. The custom delivery approach should be expanded in 2012.

4.2.3.15 Recommendations for Residential Green Partners

The Residential Green Partners program has a TRC of 3.5 and distributes information and free energy and water-saving measures to residential customers. This innovative program invites customers to visit the TDPUD Conservation office and select various CFLs 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 the TDPUD residential CFL $2/bulb lighting rebate program. This innovative program provides customers with excellent information about energy and water efficiency measures.

4.2.3.16 Recommendations for Neighborhood Block Party

The Neighborhood Block Party program provides neighborhood energy efficiency BBQ block parties offering CFLs, LEDs, WaterSense showerheads, and aerators. The program should offer additional measures such as toilets, and comprehensive measures at neighborhood leadership

homes such as duct sealing, building envelope repair, insulation, Energy Star® window upgrades, EFC, and Energy Star® residential climate control thermostats. This innovative program should be expanded to reach more customers.

4.2.3.17 Recommendations for Miscellaneous Water Efficiency

The Miscellaneous Water Efficiency program has a TRC of 4.1. This innovative program provided 5,745 water efficiency measures to customers. The 2010 EM&V study received comments from some customers who complained that the low-flow showerheads and aerators didn't provide enough flow. TDPUD purchased WaterSense® showerheads and aerators in 2011 and this greatly improved customer satisfaction in 2011. This cost effective water efficiency program should be continued. WaterSense® 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 offering incentives for water conservation gardens and landscaping to save water using the Patricia S. Sutton TDPUD Conservation Garden as an example.

4.2.3.18 Recommendations for WaterSense® Toilets

The WaterSense® Toilets program had a TRC of 0.26. In order to make the program more cost effective, TDPUD should reduce incentives for Water Sense® toilets from $100 per toilet to $20 per toilet. WaterSense® toilets flush 4 times better than standard toilets and save approximately 3,178 gallons per year of water and 26 kWh/yr of electricity used to pump water. Customers were very satisfied with the WaterSense® toilet program giving it an overall satisfaction rating of 96% +/- 1.6%.

4.2.3.19 Recommendations for Customer Leak Repair

The Customer Leak Repair program has high customer satisfaction and TRC test of 5.2. Water supply leaks represent 10 to 50% of the total water supplied by municipal utilities. The TDPUD energy and water efficiency departments should be recognized for excellence in program design and implementation for this innovative program.

4.2.3.20 Recommendations for TDPUD Building LED Lighting Project

The TDPUD Building LED Lighting Project had a TRC of 1.11. This innovative project demonstrates significant energy savings and improved lighting efficacy compared to T8 fluorescent lamps. The TDPUD LED project will also help customers understand the value of comprehensive LED lighting retrofits compared to standard T8 fluorescent and High Intensity Discharge (HID) lamps. Conservation Program staff should continue improving efficiency to reduce site energy intensity and qualify for the Energy Star rating of 75.

Appendix A: CEC EM&V Check List

Contextual Reporting

- ☐ Clearly state savings values and compare to the associated SB 1037 annual report.
- ☐ What portion of the portfolio is covered? Describe the programs or savings not evaluated?
- ☐ Assess risk or uncertainly in selecting the components of the portfolio to evaluate.

Overview and Documentation of Specific Evaluation Effort

- ☐ Clearly identify what is being evaluated in the study (part of a program; an entire program; the entire portfolio).
- ☐ Include an assessment of EUL and lifecycle savings.
- ☐ Provide documentation of all engineering and billing analysis algorithms, assumptions, survey instruments and explanation of methods.
- ☐ Describe the methodology in sufficient detail that another evaluator could replicate the study and achieve similar results.
- ☐ Include all data collection instruments in an appendix.
- ☐ Describe metering equipment and protocols in an appendix.

Gross Savings

- ☐ Review the program's choice of baseline.
- ☐ Characterize the population of participants.
- ☐ Discuss the sampling approach and sample design.
- ☐ State the sampling precision targets and achieved precision.
- ☐ Present ex post savings.
- ☐ Expand the results to the program population. If not, state why not and clearly indicate where ex ante savings are being passed through.
- ☐ Explain any differences between ex ante and ex post savings.

Net Savings

- ☐ Include a quantitative assessment of net-to-gross. If not, clearly indicate the source of the assumed net-to-gross value.
- ☐ Discuss the sampling approach and sample design.
- ☐ If a self-report method is used, does the approach account for free-ridership?

EM&V Summary and Conclusions

- ☐ Provide clear recommendations for improving program processes to achieve measurable and cost-effective energy savings.
- ☐ Assess the reliability of the verified savings and areas of uncertainty.

Appendix B: 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 Energy Efficiency Programs. The programs provided free energy efficiency measures (CFLs, LED lamps, showerheads, etc.), Energy Surveys, and rebates for energy efficient lighting, leak repair, building envelope and duct testing/repair, refrigerator/freezer recycling, Energy Star® appliances and equipment, and WaterSense® toilets and showerheads. 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 2011 TDPUD Energy Efficiency Programs. You didn't participate in the programs, but your feedback will help us evaluate and improve the program. The programs provided free energy efficiency measures (CFLs, LED lamps, showerheads, etc.), Energy Surveys, and rebates for energy efficient lighting, leak repair, building envelope and duct testing/repair, refrigerator/freezer recycling, Energy Star® appliances and equipment, and WaterSense® toilets and showerheads. 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

1. Do you remember TDPUD providing energy efficiency measures or rebates for your home or business?

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

2. If yes, how satisfied were you with the TDPUD energy efficiency measures or rebates on a scale of 1 to 10?
   ___ Response (**1 is low and 10 is high**) **98** Don't Know **99** Refused to Answer

For non- CFL or LED Programs Skip to Question 10

3. Did you install any CFL or LED lamps?
   ___ **1** (Yes) ___ **2** (No) **98** Don't Know **99** Refused to Answer

4. If you installed CFL or LED lamps, what Wattage lamps did you replace?

   ___ **1** (60 W) ___ **2** (75 W) ___ **3** (100W) **98 DK 99** Refused

5. How many hours per day do you use the CFLs or LEDs?

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

6. Are CFLs or LEDs on from 2 to 6PM during weekdays?
   ___ **1** (Yes) ___ **2** (No) **98** Don't Know **99** Refused to Answer

7. How do you rate CFL or LED light output compared to previous lamps on a scale of 1 to 10?
   ___ Response (**1 is low and 10 is high**) **98** Don't Know **99** Refused to Answer

8. How do you rate CFL or LED color compared to previous lamps on a scale of 1 to 10?
   ___ Response (**1 is low and 10 is high**) **98** Don't Know **99** Refused to Answer

9. For LED PAR or MR 16 lamps, how do you rate beam spread compared to previous on a scale of 1 to 10?
   ___ Response (**1 is low and 10 is high**) **98** Don't Know **99** Refused to Answer

Skip to Question 10 for non-Lighting Programs

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

11. How would you rate the TDPUD program in terms of accuracy of information on a scale of 1 to 10?
    ___ Response (**1 is low and 10 is high**) **98** Don't Know **99** Refused to Answer

12. How would you rate the overall energy efficiency services you received from TDPUD on a scale of 1 to 10?
    ___ **1** (Yes) ___ **2** (No) **98** Don't Know **99** Refused to Answer

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

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

15. 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? _____

TDPUD PARTICIPANT SURVEY (cont'd) #_____

16. Were there any measures not installed (i.e., check TDPUD database to verify installation of measures)?
___ **1** (Yes) ___ **2** (No) **98** Don't Know **99** Refused to Answer

Please list measures not installed? _____

17. Have you shared information with any of your friends or associates about the benefits of measures from Rebate Program?
___ **1** (Yes) ___ **2** (No) **98** Don't Know **99** Refused to Answer

With how many other people have you shared this information in the last 12 months? _____

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

18. Do you know any other friends or associates that would benefit from this program (name/address)? _____

_____

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

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

21. Did you receive energy efficiency measures from TDPUD to install at your home or business?
___ **1** (Yes) ___ **2** (No) **98** Don't Know **99** Refused to Answer

22. 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 WaterSense® Showerhead			
4	WaterSense® Swivel Kitchen Aerator			
5	WaterSense® 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			

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

24. 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 some questions to help us evaluate the programs?"

Begin Survey

1. Are you using the energy efficiency measures [or Energy Star® appliances] that you purchased (with a rebate) or received from the Utility program? If they say "no," then say -
   ___ **1** (Yes) ___ **2** (No) **98** Don't Know **99** Refused to Answer
2. Where did you buy the appliance? _____ Store or Website **98** Don't Know **99** Refused
3. Did the salesperson (or website) explain the benefits of Energy Efficiency or Energy Star® products?
   ___ **1** (Yes) ___ **2** (No) **98** Don't Know **99** Refused to Answer
4. When did you first learn about the Utility program (or Energy Star® products)? _____ (Month/Year)

   1 Didn't know there was a program (or didn't know about Energy Star®) (**Go to Q.6**)
5. Keeping that in mind, did you understand the value of the Utility program (or Energy Star®) BEFORE or AFTER you installed or purchased the measures? (**Circle One**)
   1 Before **2** After (**Go to Q.7**) **98** DK **99** Refused to Answer
6. Did you install or purchase the measures BEFORE or AFTER you were aware of the Utility program (or aware of Energy Star®)? (**Circle One**) **1** Before **2** After **98** Don't Know **99** Refused to Answer
7. If Energy Star information (or rebates) had not been available, how likely is it you would have done exactly the same thing on a scale of 0 to 10 with 0 being not at all likely and 10 being very likely? ___ Response (**0-10**) **98** Don't Know **99** Refused
8. On a scale of 0 to 10, with 0 being no influence and 10 being very influential, how much influence did Energy Star (or the rebate) have on your decision to install the measures? 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 information or rebates (or Energy Star®) play in your decision to install the 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 incentives were a critical factor to purchase or install the energy efficiency measures
___ Response (**0-10**) **98** Don't Know **99** Refused to Answer

11. We would not have purchased or installed the energy efficiency measures without the Utility incentives .
___ Response (**0-10**) **98** Don't Know **99** Refused to Answer

12. The Utility incentives were nice but unnecessary to install or purchase the energy efficiency measures.
___ 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 question 12 about "the Utility incentives being 'nice' but unnecessary," I interpreted that to mean that the Utility incentives were unimportant to your decision. Then, you answered question 10 about "the Utility incentives 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 had not received Utility rebates or information (such as Energy Star®) from the utility, when would you have purchased or installed the same or similar energy efficiency 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 the 2011 TDPUD Energy Efficiency Programs. You didn't participate in the program, but your feedback will help us evaluate and improve the program. The program provided incentives for energy efficiency measures and free Compact Fluorescent Lamps (CFL), LED lamps, WaterSense® showerheads, and other energy efficiency measures to customers like you. The energy efficiency measures use 20 to 75% less energy than standard products. 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 incentives and free energy efficiency measures for customers like you to save 20 to 75% on your energy 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 TDPUD energy efficiency programs? (Read list – Multiple answers are okay.)

   1 Didn't know about free CFLs, incentives, or the survey programs (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). _____

   _____

Appendix C: Light Logger Metering Equipment Protocols

The lighting logger metering equipment protocol requires determination of how many unique lighting areas or fixture groups are in the building. At least one lighting logger is installed in each unique lighting area or fixture group. A representative fixture is selected for the area to install a lighting logger. Lighting loggers are identified with a custom sticker identifying the logger number, building, location, and fixture. This data is entered into the Lighting Logger tracking database. Approximately 1 to 5 lighting loggers are installed per site. A maximum of 5 lighting loggers are installed at sites with more than one unique area and different lighting usage patterns. A return visit is scheduled with on-site personnel to collect the loggers from 2 to 8 weeks after installation (longer if there are holidays during the installed period). Refer to the installation instructions provided by Dent Instruments regarding installation of the lighting loggers. The following installation protocol is required to ensure proper installation of light logger metering equipment.

1. Identify the unique lighting area or fixture group. Find a fixture within the group that has hours of operation representative of the unique lighting area. The selected fixture must have the same control strategy as the entire group of fixtures.
2. If the fixture has a wall switch, turn it off and on. This is done to confirm the selected lights are controlled by a switch. Lights that do not turn off with the switch are security fixtures that operate 24 hours and security fixtures are not selected for light logger installation.
3. Identify ambient light sources. Do not install loggers on fixtures that may be subject to "false" recordings due to ambient light triggering the logger. Be sure to consider the ambient light exposure throughout the day. The sun may not be a problem at the time of installation, but could have a negative effect during a different period of the day.
4. Visually inspect the fixture. If necessary, open the fixture. Take care not to damage the lens or fixture. If there appears to be any previous damage or problem with the fixture notify the site personnel so they are aware of any pre-existing conditions.
5. Make sure the pre-printed identification sticker on the logger is marked to indicate the site, to identify site name, location in building, date and time, and number of fixtures controlled.
6. Adjust lighting level threshold (sensitivity) on lighting logger by holding it about 2 feet from the lamp. Using a small flat screwdriver, slowly adjust the sensitivity of the logger so that the display reads "on" only when the fixture is on. This is done by setting the sensitivity low and slowly adjusting it until the logger is triggered. Turn the sensitivity approximately ¼ turn past that point.
7. Test the logger operation by turning off the fixture and checking that the logger reads "off". Turn it back on and check the display for "on". If you cannot operate the fixture control (e.g., an occupancy sensor controls the light), then you can remove one of the lamps to disable the light depending on the wiring scheme of the ballast.
8. When the logger is properly installed, before closing the fixture, press the reset button on the logger to delete all previous data. Only a trained EM&V engineer is allowed to reset the logger using a computer after data has been collected.
9. Place lighting logger in fixture. Loggers can be placed in many fixtures using the magnetic strip attached to the logger. Double-sided tape may need to be used with other types of fixtures to hold the logger in the fixture. Take care with reflective fixtures not to diminish the reflective qualities. Many fixtures have lens covers that need to be opened to install the loggers. For these

types of fixtures, the loggers are placed so that the light sensor is looking at the lamp. Too much heat can damage the logger. As a guide, if you can hold your hand there for a minute then the logger should be okay.

10. After the logger has been placed in the fixture confirm the logger display shows “ON” when the lights are on.
11. In the EM&V tracking database record the logger serial number, site name, location in building, date and time, and number of fixtures controlled. Describe the location of the logger so someone else can find it and so it identifies the area usage type. Identify the space type where the logger has been placed and what percentage of the building the logger represents. Account for as much of the building as possible. Also note any special conditions such as occupancy sensors, daylight area, only used at night, etc.
12. Place a colored sticker on the outside of the fixture frame so it can be identified as someone walks up to it.
13. Make sure someone at the site knows where the lighting loggers have been placed and will keep an eye out until you return to remove them. Write their name on the Installation Form.