Evaluation, Measurement & Verification Report for Truckee Donner Public Utility District 2011 Energy Efficiency Programs

FINAL 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 2011 Truckee Donner Public Utility District (TDPUD) energy efficiency programs. This study was conducted by Verified, Incorporated, with public benefits funds under the auspices of the Northern California Power Agency (NCPA) and the California Energy Commission. The study is available for download at www.calmac.org. TDPUD implemented 29 energy efficiency programs in 2011 as shown in **Table 1.1**. The programs provided educational information, incentives, and free energy efficiency measures to residential and commercial customers. The program ex ante goal was to install 52,482 energy efficiency measures and TDPUD accomplished 60,619 installed measures and this is 15.5.7% greater than the ex ante goal.

Table 1.1 Ex Ante Goals and Ex Post Accomplishments

Description	Ex Ante Goal	Ex Post Accomplishment
Total Installed Measures	**52,482**	**60,619**
1. Residential CFLs	500	282
2. Clothes Washers	200	224
3. Dishwashers	150	177
4. Refrigerator/Freezers	200	209
5. Refrigerator Recycling	25	24
6. Building Envelope Testing	20	6
7. Duct System Testing	20	13
8. Building Envelope Mitigation	10	4
9. Duct System Mitigation	10	11
10. Window Thermal Efficiency		
11. Commercial Projects	15	23
12. Ground Source Heat Pumps	1	
13. EE Electric Water Heating/Solar	10	2
14. Low-Mod. Income Assist/ESP	200	94
15. Green Schools Program/Kits	1,800	1,800
16. Residential Energy Survey (RES)	200	280
17. Business Green Partners	3,000	2,602
18. Keep Your Cool	50	15
19. Business LED Pilot	1,000	1,139
20. LED Business Accent Lighting	500	271
21. LED Exit Sign Direct Install	70	10
22. Residential Green Partners	7,000	5,220
23. Neighborhood Block Party	200	202
24. Million CFLs	30,000	38,813
25. LED Light Swap	750	1,842
26. Misc. Water Efficiency	5,900	6,445
27. WaterSense Toilet Rebates and Exchange	550	821
28. Customer Water Leak Repair	100	89
29. TDPUD Building EE Project	1	1

TDPUD achieved 23.8% greater lifecycle electricity savings with ex post savings of 30,698,936 kWh versus ex ante goal of 24,792,482 kWh. TDPUD exceeded the ex ante E3 Calculator Total Resource Cost (TRC) test goal by 34.8% with an ex post TRC of 2.82 and the ex ante TRC of 2.1 as shown in **Table 1.2**.[1] The ex post TRC is greater than the ex ante TRC due to 15.5% more measures and lower measure costs due to purchasing measures in bulk and innovative programs. Ex post accomplishments were verified by checking the tracking database, randomly inspecting 2,626 measures at 162 participant sites, and conducting surveys of participants, non-participants, and non-contacts. The EM&V ex post savings are based on site inspections, engineering analysis, and previous evaluation studies of TDPUD programs including light logger data from 2,640 fixtures at 29 sites and pre and post-retrofit utility billing data from 65 sites.

Table 1.2 Ex Ante Goals and Ex Post E3 Cost Effectiveness

Description	Ex Ante Goal	Ex Post Accomplishment
Net Annual Electricity Savings (kWh/yr)	2,736,331	3,390,914
Net Demand Savings (kW)	1,024	1,173
Net Lifecycle Electricity Savings (kWh)	24,792,482	30,698,936
Net Annual Therm Savings (therm/yr)	25,670	30,624
Net Lifecycle Therm Savings (therm)	259,662	307,318
Net Annual Water Savings (gallon/yr)[2]	33,721,682	37,023,564
Net Lifecycle Water Savings (gallon)	340,706,479	370,069,486
Total Resource Cost (TRC) Test – E3	**2.10**	**2.82**
TRC Test Costs	$1,046,443	$967,836
TRC Test Benefits	$2,197,191	$2,733,063
TRC Test Net Benefits	$1,150,748	$1,765,227
Participant Test	**1.00**	**1.00**
Participant Test Costs	$671,276	$580,138
Participant Test Benefits	$671,276	$580,138
Participant Test Net Benefits	$0	$0

The ex ante first-year savings are summarized in **Table 1.3**. The first-year net ex ante program savings are 2,736,331 kWh per year, 1,024 kW per year, 25,670 therms per year, and 33,721,682 gallons of water per year.

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

Energy Efficiency Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm)	Gross Ex-Ante Unit Savings (gal/yr)	Net-to-Gross Ratio	Net Ex Ante Program Savings (kWh/y)	Net Ex Ante Program Savings (kW)	Net Ex Ante Program Savings (therm)	Net Ex Ante Program Savings (galyr)
1. Residential CFLs	59.5	0.014	0.0	0	0.75	22,164	5.0	0	0
2. Energy Star Clothes Washers	62.0	0.159	0.0	0	0.76	9,424	24.2	0	0
3. Energy Star Dishwashers	30.7	0.105	0.0	0	0.80	3,684	12.6	0	0
4. Energy Star Refrigerators	121.0	0.021	0.0	0	0.75	18,239	3.2	0	0
5. Refrigerator Recycling	926.0	0.195	0.0	0	0.85	19,678	4.1	0	0

[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)
6. Building Envelope Testing			0.0	0	0.82	0	0.0	0	0
7. Duct System Testing			0.0	0	0.77	0	0.0	0	0
8. Building Envelope Mitigation	82.0	0.068	41.8	0	0.82	676	0.6	345	0
9. Duct System Mitigation	59.0	0.049	56.6	0	0.77	454	0.4	436	0
10. Window Thermal Efficiency	160.0	0.531	10.9	0	0.96				0
11. Commercial Lighting Projects	15,032.6	3.335	0.0	0	0.88	198,211	44.0	0	0
12. Ground Source Heat Pumps	25,025.0	13.766	0.0	0	0.90	22,523	12.4	0	0
13. EE Electric/Solar Water Heat	178.0	0.024	0.0	0	0.79	1,406	0.2	0	0
14. Low-Mod Income Assist/ESP	424.6	0.302	16.2	1,962	0.64	54,348	38.6	2,078	251,167
15. Green Schools Program/Kits	0.0	0.000	0.0	0	0.80	0	0.0	0	0
16. Residential Energy Survey	686.6	0.523	18.5	2,336	0.64	87,886	67.0	2,373	299,008
17. Business Green Partners	56.5	0.051	0.0	0	0.85	144,075	130.1	0	0
18. Keep Your Cool	10,026.0	4.970	0.0	0	0.95	476,233	236.1	0	0
19. Business LED Pilot	96.2	0.030	0.0	0	0.85	81,770	25.5	0	0
20. LED Business Accent Lights	19.6	0.007	0.0	0	0.85	8,330	3.0	0	0
21. LED Exit Sign Direct Install	109.5	0.013	0.0	0	0.85	6,515	0.7	0	0
22. Residential Green Partners	61.2	0.014	0.0	0	0.64	274,330	62.2	0	0
23. Neighborhood Block Party	59.5	0.054	9.4	2,084	0.69	8,211	7.5	1,294	287,577
24. Million CFLs	59.5	0.014	0.0	0	0.69	1,231,650	279.5	0	0
25. LED Light Swap	23.9	0.089	0.0	0	0.91	16,331	60.5	0	0
26. Misc. Water Efficiency	6.5	0.001	3.7	934	0.77	29,364	3.6	16,679	4,245,361
27. WaterSense Toilet s	26.0	0.004	0.0	1,943	0.81	11,563	1.6	0	865,482
28. Customer Water Leak Repair	0.0	0.000	0.0	360,689	0.77	0	0.0	0	27,773,087
29. TDPUD Building EE Project	10,900.0	2.418	2900.0	0	0.85	9,265	2.1	2,465	0
Total						2,736,331	1,024	25,670	33,721,682

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 3,390,914 ± 207,115 kWh per year, 1,173 ± 47 kW per year, 30,624 ± 1,758 therms per year, and 37,023,564 ± 6,942,551 gallons (49,493 ± 9,281 CCF) of water per year at the 90 percent confidence level. The net first-year realization rates are 1.24 ± 0.08 for kWh, 1.15 ± 0.05 for kW, 1.19 ± 0.07 for therms, and 1.10 ± 0.21 for water.

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

Energy Efficiency Measure	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm)	Gross Ex-Post Unit Savings (gal)	Net-to-Gross Ratio	Net Ex Post Program Savings (kWh/y)	Net Ex Post Program Savings (kW)	Net Ex Post Program Savings (therm)	Net Ex Post Program Savings (gal)
1. Residential CFLs	59.5	0.014		0	0.69	11,577.5	2.6		0
2. Clothes Washers	205.3	0.175	6.3	8,050	0.68	31,269.5	26.7	960	1,226,189
3. Dishwashers	64.3	0.105	1.3	514	0.69	7,855.3	12.8	162	62,824
4. Refrigerator/Freezers	127.7	0.022		0	0.70	18,682.9	3.2		0
5. Refrigerator Recycling	1,151.0	0.248		0	0.85	23,481.3	5.1		0
6. Building Envelope Testing				0	0.80				0
7. Duct System Testing				0	0.74				0
8. Building Envelope Mitigation	71.4	0.059	41.8	0	0.80	228.3	0.2	134	0
9. Duct System Mitigation	96.7	0.080	56.6	0	0.74	787.0	0.7	461	0
10. Window Thermal Efficiency	160.0	0.531	10.9	0	0.96	0.0	0.0		0
11. Commercial Light Projects	15,032.6	3.335		0	0.85	293,887.8	65.2		0
12. Ground Source Heat Pumps	25,025.0	13.766		0	0.90	0.0	0.0		0
13. EE Elec/Solar Water Heat	1,652.0	0.233		0	0.79	2,610.2	0.4		0
14. Low-Mod Income Asst/ESP	424.6	0.302	25.4	6,461	0.84	33,526.1	23.8	2,003	510,196
15. Green Schools Program/Kits	7.5	0.003		1,560	0.80	10,763.8	4.3		2,245,968

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)
16. Residential Energy Survey	686.6	0.523	27.4	6,801	0.64	123,040.2	93.8	4,913	1,218,785
17. Business Green Partners	165.1	0.046		0	0.85	365,221.0	102.5		0
18. Keep Your Cool	14,153.3	1.264		0	0.95	201,684.5	18.0		0
19. Business LED Pilot	180.7	0.042		0	0.85	174,944.9	40.7		0
20. LED Business Accent Lights	68.5	0.016		0	0.85	15,781.8	3.6		0
21. LED Exit Sign Direct Install	109.5	0.013		0	0.85	930.8	0.1		0
22. Residential Green Partners	63.6	0.058		0	0.64	212,580.8	192.9		0
23. Neighborhood Block Party	367.5	0.321	9.4	2,084	0.69	51,217.5	44.8	1,307	290,453
24. Million CFLs	59.5	0.014		0	0.69	1,593,467.7	361.5		0
25. LED Light Swap	23.9	0.089		0	0.91	40,108.0	148.5		0
26. Misc. Water Efficiency	6.5	0.001	3.7	934	0.77	32,076.8	3.9	18,220	4,637,518
27. WaterSense Toilet s	26.0	0.004		3,178	0.81	17,260.9	2.4		2,113,584
28. Water Leak Repair	1,731.6	0.198		360,689	0.77	118,664.7	13.5		24,718,047
29. TDPUD Building EE Project	10,900.0	2.418	2,900.0	0	0.85	9,265.0	2.1	2,465	0
Total						3,390,914	1,173	30,624	37,023,564
90% Confidence Interval						207,115	47	1,758	6,942,551
Realization Rate						1.31 ± 0.08	1.32 ± 0.05	1.26 ± 0.07	1.10 ± 0.21

The lifecycle electricity and water savings are summarized in **Table 1.5**. The net ex-ante lifecycle program savings are 24,792,482 kWh, 259,662 therms, and 340,706,479 gallons of water. The net ex-post lifecycle program savings are 30,698,936 ± 1,711,965 kWh, 307,318 ± 17,431 therms, and 370,069,486 ± 69,401,997 gallons of water (494,711 ± 92,777 CCF). The net lifecycle realization rates are 1.24 ± 0.07 for kWh, 1.18 ± 0.07 for therms, and 1.09 ± 0.21 for water.

Table 1.5 Lifecycle Electricity, Natural Gas, and Water Savings

Energy Efficiency Measure	Ex Ante Effective Useful Life (EUL)	Net Ex-Ante Lifecycle Program Savings (kWh)	Net Ex-Ante Lifecycle Program Savings (therm)	Net Ex-Ante Lifecycle Program Savings (gal)	Ex Post EUL	Net Ex-Post Lifecycle Program Savings (kWh)	Net Ex-Post Lifecycle Program Savings (therm)	Net Ex-Post Lifecycle Program Savings (gal)
1. Residential CFLs	9	199,474	0	0	9	104,198		
2. Clothes Washers	12	113,088	0	0	12	375,233	11,515	14,714,268
3. Dishwashers	11	40,524	0	0	11	86,409	1,787	691,060
4. Refrigerator/Freezers	14	255,348	0	0	14	261,560		
5. Refrigerator Recycling	5	98,388	0	0	5	117,406		
6. Building Envelope Testing	5	0	0	0	5			
7. Duct System Testing	5	0	0	0	5			
8. Building Envelope Mitigation	18	12,170	6,202	0	18	4,110	2,407	
9. Duct System Mitigation	18	8,177	7,848	0	18	14,166	8,296	
10. Window Thermal Efficiency	20			0	20	0		
11. Commercial Projects	11	2,180,326	0	0	11	3,232,766		
12. Ground Source Heat Pumps	15	337,838	0	0	15	0		
13. EE Electric/Solar Water Heat	15	21,093	0	0	15	39,152		
14. Low-Mod Income Assist/ESP	9	489,134	18,705	2,260,500	9	301,734	18,025	4,591,767
15. Green Schools Program/Kits	5	0	0	0	5	53,819		11,229,840
16. Residential Energy Survey	9	790,973	21,360	2,691,072	9	1,107,362	44,217	10,969,068
17. Business Green Partners	3	432,225	0	0	3	1,095,663		
18. Keep Your Cool	8	3,809,866	0	0	8	1,613,476		
19. Business LED Pilot	16	1,308,320	0	0	16	2,799,118		
20. LED Business Accent Lighting	16	133,280	0	0	16	252,509		
21. LED Exit Sign Direct Install	16	104,244	0	0	16	14,892		
22. Residential Green Partners	9	2,468,969	0	0	9	1,913,227		

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)
23. Neighborhood Block Party	9	73,899	11,642	2,588,194	9	460,957	11,759	2,614,076
24. Million CFLs	9	11,084,850	0	0	9	14,341,209		
25. LED Light Swap	16	261,290	0	0	16	641,727		
26. Misc. Water Efficiency	10	293,643	166,790	42,453,614	10	320,768	182,197	46,375,177
27. WaterSense Toilet s	15	173,449	0	12,982,230	15	258,913		31,703,759
28. Water Leak Repair	10	0	0	277,730,869	10	1,186,647		247,180,473
29. TDPUD Building EE Project	11	101,915	27,115	0	11	101,915	27,115	0
Total		24,792,482	259,662	340,706,479		30,698,936	307,318	370,069,486
90% Confidence Interval						1,711,965	17,431	69,401,997
Realization Rate						1.26 ± 0.07	1.24 ± 0.07	1.09 ± 0.21

The required energy impact reporting for 2011 programs is provided in **Table 1.6**.

Table 1.6 Required Energy and Water Impact Reporting for 2011 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	3,661	3,391	1.3	1.2	34,376	30,624	58,722	49,493
2	2013	3,661	3,391	1.3	1.2	34,376	30,624	58,722	49,493
3	2014	3,661	3,391	1.3	1.2	34,376	30,624	58,722	49,493
4	2015	3,492	3,026	1.2	1.1	34,376	30,624	58,722	49,493
5	2016	3,492	3,026	1.2	1.1	34,376	30,624	58,722	49,493
6	2017	3,469	2,991	1.2	1.1	34,376	30,624	58,722	46,491
7	2018	3,469	2,991	1.2	1.1	34,376	30,624	58,722	46,491
8	2019	3,469	2,991	1.2	1.1	34,376	30,624	58,722	46,491
9	2020	2,967	2,790	0.9	1.0	34,376	30,624	58,722	46,491
10	2021	490	764	0.2	0.3	25,545	22,401	57,016	43,791
11	2022	452	614	0.2	0.3	3,884	4,182	1,428	4,549
12	2023	211	303	0.2	0.2	984	1,554	1,428	4,465
13	2024	198	271	0.1	0.2	984	595	1,428	2,825
14	2025	198	271	0.1	0.2	984	595	1,428	2,825
15	2026	174	253	0.1	0.2	984	595	1,428	2,825
16	2027	133	233	0.1	0.2	984	595	0	0
17	2028	1	1	0.0	0.0	984	595	0	0
18	2029	1	1	0.0	0.0	984	595	0	0
19	2030	0	0	0.0	0.0	0	0	0	0
20	2031	0	0	0.0	0.0	0	0	0	0
Total		33,200	30,699			345,698	307,318	592,658	494,711

** 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	2,266	1,173	3,390,914	30,698,936	30,732	16,553	0.04	0.04	2.82
20. LED Business Accent	4	4	15,782	252,509		140	0.01	0.01	11.4
1. Residential CFLs:	11	3	11,578	104,198		56	0.01	0.01	11.0
24. Million CFLs (R&D, EE)	1,446	362	1,593,468	14,341,209		7,656	0.01	0.01	9.9
13. EE Elec/Solar Wtr Heat			2,610	39,152		21	0.02	0.02	7.2
28. Water Leak Repair	14	14	118,665	1,186,647		643	0.02	0.02	6.3
26. Misc. Water Efficiency	4	4	32,077	320,768	18,220	172	0.14	0.14	5.1
19. Business LED Pilot	41	41	174,945	2,799,118		1,551	0.04	0.04	3.8
11. Commercial Lighting	65	65	293,888	3,232,766		1,792	0.04	0.04	3.4
23. Neighborhood EE Block	45	45	51,217	460,957	1,176	246	0.04	0.04	3.1
5. Refrig./Freezer Recycling	5	5	23,481	117,406		64	0.03	0.03	2.6
22. Res. Green Partners	193	193	212,581	1,913,227		1,021	0.04	0.04	2.3
6-9. Bldg. Duct Test/Repair	1	1	1,015	18,276	1,070	11	0.52	0.52	2.1
17. Business Green Partner	103	103	365,221	1,095,663		607	0.04	0.04	2.1
16. Res. Energy Survey	94	94	123,040	1,107,362	4,422	591	0.07	0.07	2.0
2. Clothes Washers E. Star	27	27	31,269	375,233	1,152	207	0.1	0.1	1.6
21. LED Exit Direct Install			931	14,892		8	0.1	0.1	1.3
18. Keep Your Cool	18	18	201,684	1,613,476		851	0.08	0.08	1.2
29. TDPUD Bldg EE Project	2	2	9,265	101,915	2,712	56	0.35	0.35	1.2
4. Refrig/Freezers E. Star	3	3	18,683	261,560		142	0.13	0.13	0.9
25. LED Holiday Light Swap	149	149	40,108	641,727		343	0.12	0.12	0.9
14. Low-Mod Income/ESP	24	24	33,526	301,734	1,802	161	0.22	0.22	0.7
3. Dishwashers Energy Star	13	13	7,855	86,409	179	48	0.32	0.32	0.4
15. Green Schools Program	4	4	10,764	53,819		29	0.39	0.39	0.2
27. WaterSense Toilet	2	2	17,261	258,913		139	0.68	0.68	0.2
10. Window Thermal Eff.									0
12. Ground Source HP									0

The TDPUD energy efficiency portfolio utility cost is $0.04/kWh and the net lifecycle green house gas (GHG) reductions are 16,553 tons. TDPUD programs realized a 2.82 TRC which is 34.8% greater than anticipated due to installing 22.7% more measures through innovative community-based programs. The top ten programs have an average TRC of 6.4. The Residential and Million CFL programs realized a TRC of 11.0 and 9.9 respectfully by purchasing CFLs in large quantities at low cost and installing CFLs through multiple programs. The Energy Efficient Electric and Solar Water Heater program realized a TRC of 7.2 by providing incentives for efficient electric water heaters and solar preheat tanks. The water leak repair and miscellaneous water efficiency programs realized a TRC of 6.3 and 5.1 respectfully due to electricity savings from water pumping and therm savings from units installed at sites with gas water heaters. The LED Business Accent and Business LED Pilot programs realized a TRC of 11.4 and 3.8 respectfully by buying LED lamps in bulk and distributing them directly to commercial customers. The Commercial Lighting program realized a TRC of 3.4 and 48% greater savings by providing incentives for comprehensive lighting retrofit projects including the LED technology demonstration project at Office Boss. The Neighborhood Energy Efficiency Block Party program realized a TRC of 3.1 by providing free energy efficient CFLs directly to customers who attended the neighborhood events. The Refrigerator Recycling program realized a TRC of 2.6 and 19% greater savings than anticipated due to recycling more units. The energy usage of each unit was obtained from the USEPA (http://www.energystar.gov/) and Refrigerator and Freezer Energy Rating Databases (http://www.kouba-cavallo.com/refmods.htm). These databases provide annual energy use based on make and model per IPMVP Option B. Residential Green

Partners realized a TRC of 2.3. The Keep Your Cool program realized a TRC of 1.2 by installing 596 commercial refrigeration measures including LED refrigeration case lights, door closers, strip curtains, anti-sweat heater controls, efficient evaporator fan motors (electronically commutated motors - ECMs), and efficient fan controllers. The TDPUD Building EE Project realized a TRC of 1.2 by installing energy efficient HVAC operation and maintenance (O&M) measures, boiler controls, garage door insulation, and lighting controls. The TDPUD building received a commercial building energy performance (BEP) benchmark rating of 14. The TDPUD BEP rating indicates that the energy intensity needs to be reduced by 55% to qualify for the Energy Star rating of 75 (current site energy intensity is 91 kBtu/ft^2 and EPA Energy Star performance requires site energy intensity of 41 kBtu/ft^2). The Energy Star® Clotheswasher program realized a TRC of 1.6 due to the combination of kWh, therm, and water savings. Savings for all units were evaluated individually using the US EPA database (http://www.energystar.gov/). The LED Holiday Light Swap program realized a TRC of 0.9. Low-Moderate Income Assistance/Energy Saving Partners realized a TRC of 0.7. 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. Two programs did not realize any participation: Window Thermal Efficiency and Ground Source Heat Pumps. The Green Schools program realized a TRC of 0.2 by distributing water-efficient garden nozzles to all K-8 students throughout the TDPUD service area (6 schools). The water-efficient nozzles were distributed at school assemblies by the Truckee High School Bright Schools/Envirolution club. TDPUD partnered with several local organizations to implement projects including: Sierra Watershed Education Partnership, Truckee High School Bright Schools/Envirolution Club, Sierra Business Council, 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 93.6 percent of participants are satisfied with the program based on 5,845 survey responses to 35 questions from 167 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 9.36 ± 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.

- Implement an internet-tracking system to help customers understand energy efficiency and renewable energy, apply for rebates online, and provide feedback (i.e., reviews of products and programs). The database should also be used document and verify installed measures for EM&V purposes.
- Provide better advertising to increase participation including bill inserts, internet information, handouts or fliers that tell customers about the programs and free services.
- Offer incentives based on CEE Tier levels (Tier 2 for dishwashers and Tier 2 and 3 for clotheswashers and refrigerators). Identify products based on CEE Tiers levels through the www.tdpud.org website and work cooperatively with retailers to advertise CEE Tier ratings that exceed Energy Star®.
- 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). Some customers complained that CFLs and LEDs were not bright enough, and some complained about LEDs burning out quickly. TDPUD should continue to evaluate CFLs and LED lamps to find better quality products with high quality light output and longer life.
- TDPUD offers a $100 rebate to customers who purchase Energy Star® qualified appliances regardless of efficiency. For refrigerators, TDPUD should offer a $50 rebate for CEE Tier 2 which is 25% more efficient than Federal Standards and $100 for CEE Tier 2 which is 30% more efficient than Federal Standards. For dishwashers, TDPUD should offer a $50 rebate for CEE Tier 1 which is 14% better than Federal Standards and $100 for CEE Tier 2 which is 17% more efficient than Federal Standards. For clotheswashers, TDPUD should offer a $50 rebate for CEE Tier 1 which is 59% more efficient than Federal Standards, $100 for CEE Tier 2 which is 75% more efficient, and $150 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.
- The TDPUD refrigerator and freezer recycling program only recycled 24 units in 2011 due to using a contractor who only picked up and recycled units during the summer months. TDPUD should hire a local appliance retailer to recycle refrigerators and freezers year round since this program is very cost effective with a TRC of 3.1. Using a local retailer will significantly increase the number of units recycled and improve the local economy.
- The building envelope and duct mitigation programs 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]
- 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 rand duct mitigation programs. Consider at least one pilot demonstration sun space project in 2011 at the Senior Center where billing data for one unit with a temporary plastic sun space enclosure reduced the heating bill by 50%.
- 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 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.
- TDPUD should encourage at least one to five customers 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 encourage surveyors who perform Low/Moderate Income Energy Assistance and Residential Energy Surveys to install the measures. This will include using ladders to install CFLs and LED 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 Green Schools program TRC is 0.2 because the E3 calculator only values energy savings and does not currently include avoided costs for water savings. In addition to providing efficient garden nozzles, the Green Schools program should provide each student with at least one LED or CFL lamp and one efficient showerhead and aerator to teach students how to measure fluid mechanics (volumetric flow rates at various flowing pressure), electric power (voltage, current, and Watts), and thermal heat energy (specific heat, temperature, and British thermal units – Btu). This will encourage more students to appreciate and understand science, electric power, and energy and water efficiency.
- The Business Green Partners program has a TRC of 2.1 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 Keep Your Cool program has a TRC of 1.2 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 Keep Your Cool 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 Business LED Accent Lighting program has a TRC of 11.4, Business LED Pilot program has a TRC of 3.8, and LED Exit Sign program has a TRC of 1.3. 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 and installation approach should be expanded in 2012.
- The Residential Green Partners program has a TRC of 2.3 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, LEDs, 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 5.1. This innovative program provided 5,900 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.
- The WaterSense® Toilets program had a TRC of 0.2. 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%.
- The Customer Leak Repair program has high customer satisfaction and TRC test of 6.3. 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 EE Project had a TRC of 1.2. The project should be continued to reduce site energy intensity by 55% and qualify for the Energy Star rating of 75.

- Based on findings from this and other studies, most residential and commercial customers do not have sufficient capital or motivation to invest in improving the energy efficiency of their homes and businesses. To overcome these market barriers, TDPUD energy efficiency programs should be continued and expanded to save energy, water, and peak demand and reduce carbon dioxide emissions.

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

Section 2 describes the EM&V objectives, including baseline information, energy efficiency measure information, measurement and verification approach, and the evaluation approach. **Section 2** also includes equations used to develop energy and peak demand savings, sample design, methods used to verify proper installation of measures, and methods used to perform field measurements. **Section 3** provides EM&V study findings including load impact results and process evaluation results regarding what works, what doesn't work, and recommendations to improve the program's services and procedures. **Section 3** also includes measure recommendations to increase savings, achieve greater persistence, and improve customer satisfaction. **Appendix A** provides the participant and non participant decision-maker survey instrument for the TDPUD programs.

2. Required EM&V Objectives and Components

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

Table 2.1 Components of an EM&V Plan

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

2.1 Baseline Information

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

Table 2.2 Existing Baseline Studies

Study	Description
1	*Evaluation Measurement and Verification Report for the Truckee Donner Public Utility District 2010 Energy Efficiency Programs*, Prepared by Verified, Inc., February 2011.
2	*Evaluation Measurement and Verification Report for the Truckee Donner Public Utility District 2008 Energy Efficiency Programs*, Prepared by Robert Mowris & Associates, February 2009.
3	*Evaluation Measurement and Verification Report for the Small Nonresidential Energy Fitness Program #179*, Prepared by Robert Mowris & Associates, April 30 2004.
4	*Measurement & Verification Summary Report for NCPA SB5X Programs* prepared for NCPA and the California Energy Commission, 2005.
5	*Measurement and Verification Report for NCPA SB5X Commercial and Industrial Lighting Programs,* prepared for NCPA, prepared by RMA, 2005.
6	*Measurement and Verification Report for NCPA SB5X Refrigerator Recycling Programs,* prepared for NCPA, prepared by RMA, 2005.
7	*Measurement and Verification Report for NCPA SB5X Residential Compact Fluorescent Lamp Programs,* prepared for NCPA, prepared by RMA, 2005.
8	*Measurement and Verification Report for NCPA SB5X Miscellaneous Programs,* prepared for NCPA, prepared by Robert Mowris & Associates, 2005.
9	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/.
10	*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*
11	*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/.
12	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.
13	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.
14	*California Statewide Residential Appliance Saturation Survey.* Study 300-00-004, prepared for California Energy Commission, prepared by KEMA-XENERGY Inc. Oakland, California, June 2004.
15	*USEPA FTC Databases (http://www.energystar.gov/) and Refrigerator and Freezer Energy Rating Databases (http://www.kouba-cavallo.com/refmods.htm).*

2.2 Energy Efficiency Measure Information

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

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

Measure	Unit	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm)	Gross Ex-Ante Unit Savings (gal/yr)	EUL	NTG Ratio	Unit Goals
1. Residential CFLs	Unit	59.5	0.014			9	0.75	500
2. Energy Star Clothes Washers	Unit	62.0	0.159	0.0	0	12	0.76	200
3. Energy Star Dishwashers	Unit	30.7	0.105	0.0	0	11	0.80	150
4. Energy Star Refrigerators	Unit	121.0	0.021			14	0.75	200
5. Refrigerator Recycling	Unit	926.0	0.195			5	0.85	25
6. Building Envelope Testing	Unit					5	0.82	20
7. Duct System Testing	Unit					5	0.77	20
8. Building Envelope Mitigation	Unit	82.0	0.068	41.8		18	0.82	10
9. Duct System Mitigation	Unit	59.0	0.049	56.6		18	0.77	10
10. Window Thermal Efficiency	Unit	160.0	0.531	10.9		20	0.96	
11. Commercial Lighting Projects	Site	15,032.6	3.335			11	0.88	15
12. Ground Source Heat Pumps	Unit	25,025.0	13.766			15	0.90	1
13. EE Electric/Solar Water Heat	Unit	178.0	0.024			15	0.79	10
14. Low-Mod Income Assist/ESP	Site	424.6	0.302	16.2	1,962	9	0.64	200
15. Green Schools Program	Kit	0.0	0.000		0	5	0.80	1,800
16. Residential Energy Survey	Site	686.6	0.523	18.5	2,336	9	0.64	200
17. Business Green Partners	Unit	56.5	0.051			3	0.85	100
18. Keep Your Cool	Site	10,026.0	4.970			8	0.95	50
19. Business LED Pilot	Site	96.2	0.030			16	0.85	1,000
20. LED Business Accent Lights	Unit	19.6	0.007			16	0.85	500
21. LED Exit Sign Direct Install	Unit	109.5	0.013			16	0.85	70
22. Residential Green Partners	Unit	61.2	0.014			9	0.64	7,000
23. Neighborhood Block Party	Site	59.5	0.054	9.4	2,084	9	0.69	2
24. Million CFLs	Unit	59.5	0.014			9	0.69	30,000
25. LED Light Swap	Unit	23.9	0.089			16	0.91	750
26. Misc. Water Efficiency	Unit	6.5	0.001	3.7	934	10	0.77	5,900
27. WaterSense Toilet s	Unit	26.0	0.004		1,943	15	0.81	550
28. Customer Water Leak Repair	Site	0.0	0.000		360,689	10	0.77	100
29. TDPUD Building EE Project	Site	10,900.0	2.418			11	0.85	1

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.

2.2.1 Description of Energy Efficiency Measures

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

1. Residential Compact Fluorescent Lamps (CFL)

The Residential CFL program provides rebates to TDPUD residential customers to replace existing incandescent and halogen lamps with compact fluorescent lamps (CFL) or light emitting diode (LED) lamps. The rebate of $2 per CFL or LED is a credit on the customer's bill. Multi-family customers must purchase and install at least 5 CFLs and single-family customers must purchase and install at least 10 CFLs to receive the $2 per bulb rebate. Compact fluorescent lamps are designed to replace standard incandescent lamps. They are approximately four times more efficient than incandescent lamps. Screw-in modular lamps have reusable ballasts that typically last for four lamp lives. Commercial applications for compact fluorescent lamps include general lighting, accent and specialty lighting, decorative and portable lighting, utility lighting, and exterior illumination. As with all fluorescent lamps, CFLs emit light when low-pressure mercury vapor is energized inside the lamp, which produces ultraviolet (UV) radiation. The UV radiation is absorbed by a phosphor coating on the inner surface of the lamp, which converts the radiation into light. Ballasts provide initial voltage for starting lamps and regulate lamp current during operation. CFL ballasts are electronic. Incandescent lamps typically use 15 to 250W or more and can be replaced with CFLs using 4 to 65W. Compact fluorescent lamp fixtures replace standard incandescent lamp fixtures. They use pin type lamps instead of screw-in lamps so they typically last longer than screw-in lamps. Otherwise they are comparable to screw-in CFLs in terms of first-year savings. The "Residential CFL" average ex ante savings are 10.6 kWh/yr and 0.003 kW, and the "Million CFL" average ex ante savings are 59.5 kWh/yr and 0.018 kW. Ex ante deemed savings for other CFL measures included in the TDPUD programs are shown in **Table 2.4**.

Table 2.4 Ex Ante Savings for CFLs

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

2. Energy Star® Clothewashers, Dishwashers, and Refrigerators

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

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

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

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

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

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

Table 2.6 Energy Star and CEE Tier Efficiency Levels for Dishwashers

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

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

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

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

Table 2.7 Energy Star and CEE Tier Efficiency Levels for Refrigerators

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

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

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

Ex ante savings for TDPUD Energy Star® appliances are shown in **Table 2.8**. Energy Star® qualified clothes washers save 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, upright freezers with manual defrost, 3) chest freezers with manual defrost only. Energy Star® compact refrigerators and freezers use at least 20% less energy than required by current federal standards. Compacts are models with volumes less than 7.75 cubic feet. The average ex ante savings are 62 kWh/yr and 0.159 kW for Energy Star® clotheswashers, 30.7 kWh/yr and 0.105 kW for Energy Star® dishwashers, and 121 kWh/yr and 0.021 kW for Energy Star® refrigerators.

Table 2.8 Ex Ante Savings for Energy Star® Appliances

#	Description	Units	Demand Savings per unit kW	Annual Hours of Operation per unit	Savings per unit kWh	Savings per unit therm	EUL	Ex Ante NTGR
3a	Energy Star® Clothes Washer	Unit	0.159	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 recycling contractor JACO Environmental, to remove and recycle existing units. Customers may receive a cash rebate for allowing TDPUD to remove and recycle their first, second, third or fourth refrigerator or freezer. Once approved, TDPUD will have the refrigerator/freezer recycling company make an appointment with the customer to pick up the old refrigerators and/or freezers from their home or business. Qualifying customers receive a $30 rebate for each refrigerator or freezer being removed and recycled. In addition to recycling refrigerant, foam, plastic, metals, and other

components are also recycled. The effective useful lifetime for refrigerator and freezer recycling is 6 years.[3] TDPUD assumed annual ex ante energy savings of 926 kWh/yr and 0.195 kW.

4. Building Envelope and Duct System Mitigation

The Building Envelope and Duct System Mitigation program provides rebates for pressurization testing and sealing of the building envelope (i.e., floors, walls and ceiling) and/or duct system. A leakage test and the building envelope and/or distribution system mitigation must be completed and documented to receive rebates. The testing rebate is $75 per home or business receiving a duct test or blower door test to measure the air leakage. Building envelope repair involves pressurization testing of the building to 50 Pascal and then sealing leaks in the building shell to reduce total building leakage from 0.5 to 1.0 or more air changes per hour (ACH) to less than 0.3 ACH. Building leakage is tested using a blower door. Duct test and seal involves sealing the forced air unit (FAU) and supply/return ducts to 15% (or less) of the measured total system air flow at 25 Pascal pressure (supply and return). Duct testing is performed using duct pressurization equipment and duct sealing is performed using UL-rated metal or mastic tape or UL-rated mastic sealant. The assumed baseline is 29% duct leakage going to 15% for a 14% reduction or 60 cfm/ton. TDPUD assumed ex ante savings for building envelope mitigation of 82 kWh/year, 0.066 kW, and 41.6 therm/year and for duct mitigation 59 kWh/year, 0.049 kW, and 56.6 therm/year.

5. Window Thermal Efficiency

The Thermally Efficient Windows program provides rebates for double or triple-pane low-emissivity windows with vinyl or wood clad frames (aluminum framed windows do not qualify unless they have documented thermal break built into the aluminum frame which increases its r-value to level similar to vinyl and wood-framed windows). Customers who install qualifying windows and window frames will receive a cash rebate. In order to qualify, the existing windows being replaced must be single-pane windows and the customer must be currently using a permanent electric space heating system as their primary source of heating. The incentive is $5 per square feet of thermally-efficient windows and frames. TDPUD should define a minimum R-value or u-value for qualifying windows. For double-pane low-emissivity windows, the minimum should be R-3 or 0.33 Btu/hr-ft^2-°F. TDPUD assumed ex ante savings of 160 kWh/year-unit and 0.531 kW/unit.

6. Attic and Wall Insulation

Attic insulation involves installing R-38 or greater blown-in insulation into uninsulated attics or attics with existing insulation less than R-11. Wall insulation involves installing R-11 (3.5 inch wall studs) or R19 (6.5 inch wall studs) into uninsulated walls. TDPUD did not implement any attic or wall insulation rebates in 2010.

[3] 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/.

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

The Commercial Lighting Projects program provides incentives to TDPUD commercial customers to replace their existing inefficient lamps and/or lighting systems with energy efficient lamps or lighting systems. Commercial customers receive a rebate equal to 1/3 the cost of qualifying lighting measures/fixtures purchased and installed up to a maximum rebate of $10,000 per customer applicant. The rebate applies to both the capital purchase of lighting measures as well as the labor cost to install the energy efficient lamps and lighting fixtures. Standard lamp/fixtures must be replaced with T8, T5, or T2 lamps with electronic ballasts as well as induction, LED or other more energy-efficient lighting options. T-8 lamps with electronic ballasts replace 1½-inch diameter T-12 fluorescent lamps and standard magnetic ballasts. High efficiency components use tri-phosphor 1-inch diameter T-8 lamps (32 W), and electronic ballasts. The average ex ante savings are 121 kWh/yr and 0.0436 kW (based on two lamp fixtures). The ex ante savings for T-8 lamps with electronic ballasts are shown in **Table 2.9**. TDPUD assumed average gross ex ante savings per project of 15,032.6 kWh/year and 3.335 kW.

Table 2.9 Ex Ante Savings T-8 Lamps with Electronic Ballasts

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

Delamping three-lamp to two-lamp fixtures saves 37 percent on lighting and often provides adequate illumination. TDPUD assumed average ex ante savings for delamping of 256 kWh/year and 0.094 kW. The ex ante savings for delamping are shown in **Table 2.10**.

Table 2.10 Ex Ante Savings for Delamping

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

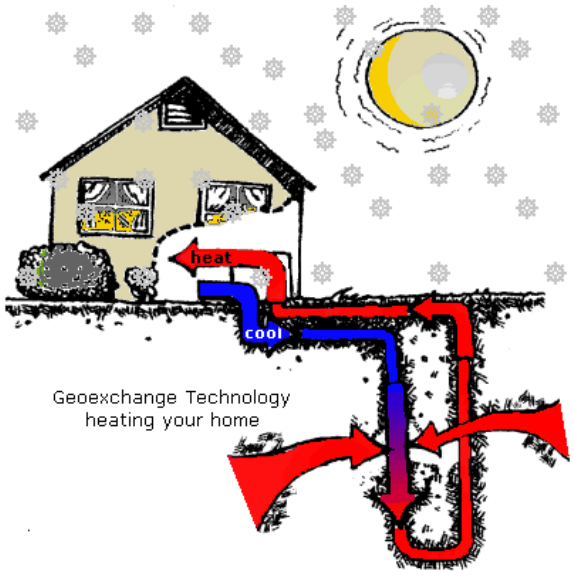
Occupancy sensors are used to automatically turn on and off lights depending upon occupancy conditions. They can be wall mounted or ceiling mounted, passive infrared (PIR) or ultrasonic. Occupancy sensors are reliable, market tested products, but require proper installation and calibration. Understanding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

8. Ground Source Heat Pump

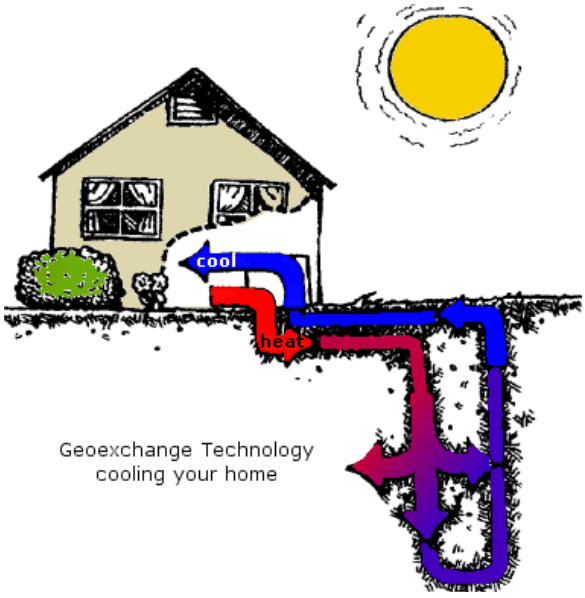
The Ground Source Heat Pump Program provides rebates for the purchase and installation of a new ground source heat pump system. The rebate of $200 per ton per unit is a rebate check mailed directly to the customer. Ground source heat pumps exchange heat with the ground instead of the outdoor air. The temperature of the ground remains relatively constant throughout the year, even though the outdoor air temperature may fluctuate greatly with the change of seasons. At a depth of approximately six feet, for example, the temperature of soil in most of the world's regions remains stable between 45 and 70 degrees Fahrenheit (°F). This is why well water drawn from below ground tastes cool even on the hottest summer days. In winter, it is much easier to capture heat from the soil at a moderate 50°F temperature than from the atmosphere when the air temperature is below freezing. This is also why GSHP systems can provide warm air through a home's ventilation system, even when the outdoor air temperature is extremely cold. Conversely, in summer, the relatively cool ground can absorb the home's waste heat more readily than the hot outdoor air. Comparing the GSHP to a conventional heating, ventilating and air conditioning (HVAC) system with gas heating will increase electricity use for heating and yield negative electricity savings. An EM&V study of ground source heat pumps performed for Redding Electric Utility found savings of -1,355 kWh/year and 2.1 kW and 546 therms/year (savings are negative based on gas baseline).[4] The GSHP savings are positive with an electric space heating baseline. TDPUD assumed an electric space heating baseline and annual ex ante savings of 24.025 kWh/year and peak demand savings 13.766 kW.

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

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



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



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 .93 or higher. Electric water heaters 60 gallons and larger must have an Energy Factor of .91 or higher. Qualifying solar and geothermal heat pump water heaters must displace electric water heaters. The 2004 Federal Standards are 0.9304 EF for 30 gallon units, 0.9172 EF for 40 gallon units, and

0.904 EF for 50 gallon units.[5] Average electric water heater unit energy consumption (UEC) is 3,354 kWh/year.[6] The incremental costs for electric resistance storage water heaters for a 0.02 EF improvement in are approximately $70 to $80 per unit. Savings are 180.3 kWh/yr going from 0.88 EF to 0.93 EF with a UEC of 3,354 kWh/year. TDPUD assumed annual savings of 143.2 kWh/yr and peak demand savings 0.025 kW. Savings for solar water heaters are 50 to 70% or 1,677 to 2,348 kWh/yr at a cost of $6,000 (assuming two four feet by ten feet solar panels, at least 100 gallons of storage, pumps, and controls) with a simple payback of 16 years. Geothermal heat pump water heaters can save 20 to 30% with an installed cost of $10,000 and a simple payback of 64 years. TDPUD assumed average ex ante unit savings of 178 kWh/year and 0.024 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 and the Sierra Green Building Association to qualify customers and perform the residential energy surveys. TDPUD assumed average ex ante site savings of 424.6 kWh/year, 0.302 kW, 16.2 therm/year, and 1,962 gallons/year. The ex ante effective useful lifetime is 9 years.

11. Green Schools Conservation Kits

The Green Schools Program consisted of providing all K-8 students at 6 schools throughout the TDPUD electric service area with a water efficient garden hose nozzle. The garden nozzle kits are prepared by the Sierra Watershed Education Partnership and given away at school assemblies by the Truckee High School Bright Schools/Envirolution environment club during community Trashion Fashion shows. TDPUD assumed average ex ante kit savings of 0 kWh/year, 0 kW, and 0 therm/year. The effective useful lifetime is 5 years.

[5] 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.

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

12. Residential Energy Survey

The Residential Energy Survey (RES) program provides free energy audits surveys and conservation measures for any TDPUD residential electric customer. RES is a component of the District's Energy Savings Program (ESP), but with no income-qualifying guidelines or direct financial assistance. The same measures are given away during the on-site energy audit performed by auditors from the Sierra Green Building Association. TDPUD assumed average ex ante site savings of 686.6 kWh/year, 0.523 kW, 18.5 therm/year, and 2,336 gallons/year. The ex ante effective useful lifetime is 9 years.

13. Business Green Partners

The Business Green Partners program provides free energy and water-saving measures to retail, restaurant, hospitality and other TDPUD business customers. A "Green Partner" label is provided to participating customer/partners to show that the business meets minimum program requirements. This program is heavily dependent on direct contact with the owners and managers of these businesses. Participating customers/demonstration sites show how efficient lighting works. TDPUD works with restaurants to install energy efficient lighting, dishwashing (machines and pre-rinse spray valves), refrigeration, and HVAC. TDPUD also works with hotels, motels, and resorts and other businesses to implement energy efficient lighting, controls, HVAC, water heating, pool/spa, restaurant, renewable energy, and green building technologies. TDPUD assumed average ex ante savings of 56.5 kWh/year and 0.051 kW. The ex ante effective useful lifetime is 3 years.

14. Keep Your Cool

Keep Your Cool program provides direct-install energy efficiency measures for display refrigeration systems at commercial convenience, grocery, and other Truckee-area stores using commercial-grade refrigeration equipment. The measures that we're installed in 2010 through KYC include: new refrigeration gaskets, cooler case strip curtains, automatic door closers for walk-in coolers, and electronically-commutated refrigeration motors. The KYC program will continue in 2012 with the same plus some new refrigeration energy-efficiency measures. Truckee businesses must be TDPUD electric customers in order to participate. TDPUD assumed average ex ante site savings of 10,026 kWh/year and 4.97 kW. The ex ante effective useful lifetime is 8 years.

15. Business LED Pilot

The Business LED Pilot program involves working with Truckee business customers on trying out a multitude of different LED lights, both screw-in and plug-in. TDPUD so far has provided business with LED R & PAR 20, 30, and 38 lamps and MR-16s, both dimmable and non-dimmable. The purpose of the program is to educate and demonstrate the LED lighting technology to the community and to see what lamps and applications work best to replace less energy-efficient lighting technologies. TDPUD assumed average ex ante savings of 96.2 kWh/year and 0.030 kW. 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 19.6 kWh/year and 0.007 kW. 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 0.0125 kW. The assumed ex ante effective useful lifetime is 16 years. The estimated energy savings for three different LED exit signs are shown in **Table 2.11**.

Table 2.11 Ex Ante Savings for LED Exit Signs

#	Description	Units	Demand Savings per unit kW	Annual Hours of Operation per unit	Savings per unit kWh	Savings per unit therm	EUL	Ex Ante NTGR
2k	Incand. to LED Exit – 1 socket	Unit	0.039	8,760	342	n/a	16	0.85
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. 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 61.2 kWh/year and 0.014 kW. 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 two Truckee neighborhoods each year and provide local service providers an opportunity to exhibit and share information about their community services. TDPUD has its own exhibit which includes a table full of the give-a-way energy and water efficiency measures including the offer for a free home energy survey on the spot. TDPUD assumed ex ante unit savings of 59.5 kWh/year and 0.054 kW. 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.

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 radio spots, newspaper notices, and word-of-mouth. TDPUD has also developed an LED Christmas Light demonstration project in downtown. TDPUD worked with the Town of Truckee to provide LED lights for the Train Depot and annual holiday tree/Bud Fish tree. LED holiday lights use 0.021 Watts per bulb and a 20 feet string of 60 LED bulbs uses 2.1 Watts. Traditional C7 incandescent holiday light strings use 5 Watts per bulb and a 20 feet string of 40 use 200 Watts and M5 incandescent mini lights use 0.5 Watts per bulb so a

20 feet string of 100 use 50 Watts. LED savings compared to C7 incandescent are 197.9 Watts per 20 feet string, and LED savings compared to M5 mini incandescent are 47.9 Watts. LEDs last 50,000 to 100,000 hours and the limited heat output makes for safer illumination of indoor trees. Town of Truckee installed 800 1.9W E27-X8_G LED G12 (1.5 inch diameter) lamps (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. 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). 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).[7] 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 the program provided customers with 6,445 measures. TDPUD assumed ex ante unit savings of 6.5 kWh/year, 0.001 kW, 3.7 therm/year, and 934 gallons/year. The effective useful life is 10 years.

23. WaterSense® Toilets

The WaterSense® Toilet program provided $100 incentives to customers who purchased a WaterSense® toilet or exchanged an old inefficient toilet for a WaterSense® toilet through a local plumbing distributor. WaterSense® 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 WaterSense® program to replace inefficient leaking toilets with WaterSense® 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 WaterSense® toilets. TDPUD assumed ex ante unit savings of 26 kWh/year, 0.004 kW, and 1,943 gallons/year. The effective useful life is 15 years.

[7] 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.

24. Water Leak Repair

The Water Leak Repair program provided incentives of $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 360,689 gallons/year per customer. No ex ante electricity savings were assumed from pumping energy savings. The effective useful life is 11 years.

25. TDPUD Building Energy Efficient Lighting Project

The TDPUD Building Energy Efficient (EE) Lighting program provided incentives for building energy efficiency measures including HVAC operation and maintenance (O&M) measures, boiler controls, garage door insulation, and lighting occupancy sensors in the warehouse, garage, and O&M offices. O&M measures included isolating a non-operating boiler, automatic stack damper on boiler 2, and adjusting gas pressure for increased combustion efficiency. The TDPUD building received a commercial building energy performance (BEP) benchmark rating of 14. The TDPUD BEP rating of 14 indicates that the energy intensity needs to be reduced by 55% to qualify for the Energy Star rating of 75 (current site energy intensity is 91 kBtu/ft^2 and EPA Energy Star performance requires site energy intensity of 41 kBtu/ft^2). The incentives of $14,053 paid for labor and equipment costs. TDPUD assumed average gross ex ante savings of 10,900 kWh/yr, 2.418 kW, and 2,900 therms/yr based on the TDPUD Building Energy Use Assessment and Improvement Study prepared by Enovity, Inc. of Rancho Cordova, CA.[8] The effective useful life is 11 years.

2.3 Measurement and Verification Approach

The measurement and verification approach is based on the *International Performance Measurement & Verification Protocols* (IPMVP) defined **Table 2.12**.[9] 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.

[8] Enovity, Inc., 2009. Building Energy Use Assessment and Improvement Study for Truckee Donner Public Utility District. Prepared by Enovity, Inc., Rancho Cordova, CA. December 2009.

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

Table 2.12 IPMVP M&V Options

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

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**.

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

Where,

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

$n_{verified}$ = 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.[10]

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.

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

Eq. 7 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.

[10] 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.

2.4 Cost Effectiveness Approach

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

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

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

2.5 Measure Verification Approach

The measure verification approach relies on previous EM&V studies, TDPUD customer site visits and surveys, billing data, field measurements, light logger data, and on-site surveys. A description of the verification approach for each measure is provided in **Table 2.13**. IPMVP Options A, B, C, and D were used to evaluate energy and peak demand savings for the program. Measurements were short-term, and some, but not all parameters were stipulated, as long as the total impact of possible stipulation errors was not significant to the resultant savings. Due to budget constraints some 2011 programs were evaluated using previous EM&V studies.

Table 2.13 Verification Approach for TDPUD Measures

Measure	Measurement and Verification Approach
1. Compact Fluorescent Lamps	Energy and peak demand savings based on previous EM&V studies, customer surveys, and site verification.
2-4. Energy Star Appliances	Energy and peak demand savings based on 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 and previous EM&V studies.
12. Ground Source Heat Pumps	Energy and peak demand savings based on previous EM&V studies.
13. EE Electric and Solar Water Heaters	Energy and peak demand savings based on previous EM&V studies.
14. Low/Moderate Income ESP	Energy and peak demand savings based on previous EM&V studies, customer surveys, and site visits.
15. Green Schools Efficient Garden Nozzle	Energy and peak demand savings based on EM&V measurements.

Table 2.13 Verification Approach for TDPUD Measures

Measure	Measurement and Verification Approach
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 EE Project	Energy and peak demand savings based on previous EM&V studies, customer surveys, and on-site visit.

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

Table 2.14 Field Measurement Equipment Tolerances

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

2.6 Sampling Design Approach

The statistical sample design approach for the load impact and process evaluations involved selecting a random sample of customers from the program population. Samples were selected to obtain a reasonable level of precision and accuracy at the 90% confidence level. The proposed sample design was based on statistical survey sampling methods.[11] Sampling methods were used

[11] 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*

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.[12] 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 in 2011 are shown in **Table 2.15**. The sample size is based on relative savings per measure assuming a coefficient of variation (Cv) of 0.5 and relative precision of 0.1 to 0.2 to achieve 80 to 90% confidence.

Table 2.15 Statistical Sample Size for TDPUD Measures

Measure Description	Ex Ante Units	Proposed EM&V Sample	Ex Post Installed Units	EM&V Units Inspected	Ex Post Coefficient of Variation (Cv)	Ex Post Relative Precision (r)
1. Residential CFLs	500	N/A	282	120	0.39	0.059
2. Clothes Washers	200	N/A	224	11	0.04	0.022
3. Dishwashers	150	N/A	177	14	0.12	0.053
4. Refrigerator/Freezers	200	N/A	209	16	0.08	0.031
5. Refrigerator Recycling	25	N/A	24	13	0.04	0.019

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.

[12] 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 2.15 Statistical Sample Size for TDPUD Measures

Measure Description	Ex Ante Units	Proposed EM&V Sample	Ex Post Installed Units	EM&V Units Inspected	Ex Post Coefficient of Variation (Cv)	Ex Post Relative Precision (r)
6. Building Envelope Testing	20	N/A	6	8	N/A	N/A
7. Duct System Testing	20	N/A	13	12	N/A	N/A
8. Building Envelope Mitigation	10	N/A	4	8	0.17	0.100
9. Duct System Mitigation	10	N/A	11	12	0.21	0.100
10. Window Thermal Efficiency		N/A		N/A	N/A	N/A
11. Commercial Projects	15	N/A	23	23	0.09	0.030
12. Ground Source Heat Pumps	1	N/A		N/A	N/A	N/A
13. EE Electric Water Heat/Solar	10	N/A	2	2	0.09	0.100
14. Low-Mod. Income Assist/ESP	200	10	94	12	0.21	0.100
15. Green Schools Program/Kits	1,800	N/A	1,800	10	0.19	0.100
16. Residential Energy Survey	200	4	280	4	0.12	0.100
17. Business Green Partners	3,000	N/A	2,602	916	0.40	0.022
18. Keep Your Cool	50	N/A	15	7	0.45	0.282
19. Business LED Pilot	1,000	N/A	1139	7	0.16	0.100
20. LED Bus. Accent Lighting	500	N/A	271	N/A	0.07	0.049
21. LED Exit Sign Direct Install	70	N/A	10	4	0.12	0.100
22. Residential Green Partners	7,000	40	5,220	120	0.37	0.055
23. Neighborhood Block Party	200	N/A	202	160	0.77	0.100
24. Million CFLs	30,000	200	38,813	608	0.88	0.059
25. LED Light Swap	750	N/A	1,842	10	0.19	0.100
26. Misc. Water Efficiency	5,900	19	6,445	19	0.27	0.100
27. WaterSense Toilet s	550		821	10	0.11	0.059
28. Customer Water Leak Repair	100		89	10	0.48	0.249
29. TDPUD Building EE Project	1		1	1	0.06	0.100
Participant Surveys	N/A	40	N/A	167	0.02	0.002
Non-Participant Surveys	N/A	40	N/A	40	N/A	N/A

2.7 Process Evaluation Approach

The evaluation approach used process surveys to measure participant satisfaction, and obtain suggestions to improve the program's services and procedures. Process surveys, on-site inspections, and field measurements were used to guide the overall process evaluation in terms of investigating operational characteristics of the program and developing specific recommendations to help make the program more cost effective, efficient and operationally effective. The process evaluation examined how to install a comprehensive package of measures for each customer within the constraints of the program. Interview questions assessed how the program influenced awareness of linkages between efficiency improvements and bill savings and increased comfort for customers. A sample of 40 participants and 40 non-participants were asked process questions. The participant and non-participant surveys are provided in the **Appendices**. Participants were asked why and how they decided to participate in the program. Non-participants were asked why they chose not to participate. This was done to identify reasons why program marketing efforts were not successful with some customers as well as to identify additional hard-to-reach market barriers (i.e., incentives or other inducements to achieve greater participation). The process survey evaluation includes a summary of what works, what doesn't work, and the level of need for the program. The evaluation identified the rejection rate/acceptance rate and size of the rejecter pool. This information was used to define if there were issues to be addressed. On-going feedback was provided based on installation quality.

The process evaluation used surveys to measure participant satisfaction, and obtain suggestions to improve the program's services and procedures. Process surveys, on-site inspections, and field

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

2.7.1 List of Questions Answered by the Study

The following questions are answered by the study.

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

   The study answered this question by conducting 167 participant surveys and inspecting 2,626 measures at a random sample of 162 participant sites. Participants indicated that measures were properly installed as indicated by the rating of 9.3 ± 0.25 on a scale of 1 to 10 regarding the quality of work performed by installers. Light loggers were previously installed at 30 sites in the 2009 EM&V study to measure hours of operation. These were left at the sites for a period of up to four weeks and then rotated to other sites. Twenty-eight (28) were successfully downloaded to monitor hours of operation on 2,640 fixtures. In the 2009 EM&V study, billing analysis for 65 sites provided additional verification that measures were installed properly. These efforts provided useful information in developing best practices recommendations to ensure measures are installed properly (see **Section 3.2.3**).

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

   The study answered this question by performing on-site inspections of 2,626 measures at a random sample of 162 participant sites. The EM&V study inspected the following measures (in 2009, 2010, and 2011): 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 2011 study conducted participant surveys and developed specific NTGRs for the following programs: 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.[13]

5. Are the total program savings estimates accurate?

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

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

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

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

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 60,619 measures to approximately 6,000 customers and overall participant satisfaction with the program was 93.6 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.

9. Are there measurable program multiplier effects?

Program multiplier effects questions are used to measure program participants sharing information learned from the program with non-participants, and if sharing of information is acted upon in a way that results in the installation of similar measures within a non-participant population. For example, the TDPUD programs provide free compact fluorescent lamps, water saving showerheads, and aerators. The TDPUD programs also provide rebates for CFLs, LEDs, efficient commercial lighting, Energy Star® appliances, refrigerator recycling, efficient windows, attic insulation, infiltration reduction, duct sealing, showerheads, aerators, or other measures and educates customers on the value of these and other measures. Based on process survey responses, 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. [14] Programs that link technologies with educational measures can have multiplier effects as high as 10-25 percent including the sharing of program information

[14] 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., $309 \times (1 \div 777) \div 83 = 0.005$).

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?

2.7.2 List of Tasks Undertaken by the Study

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

Task 1. Prepare EM&V Plan

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

Task 2. Market Assessments or Baseline Analyses

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

Task 3. Develop Survey Instruments

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

Task 4. Phone or In-person Surveys

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

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

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

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

The 2009, 2010, and 2011 EM&V studies installed metering and monitoring equipment to measure load impacts. Metering equipment included data loggers to measure temperature, electric power, motor operation, and light loggers to measure hours of operation. In addition spot measurements of performance were made to verify proper installation of measures and savings according to IPMVP Options A, B, C, and D. Lighting loggers were left in place for 1 to 4 weeks to develop a basis for annual extrapolation (length of time depended on type of business and permission of customers).

Task 7. Analyze Survey Data

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

Task 8. Provide Feedback to Implementer

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

Task 9. Prepare Draft and Final Reports

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

2.7.3 How Study will meet CPUC EEPM Objectives

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

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

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

- **Measure cost-effectiveness.**

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

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

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

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

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

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

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

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

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

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

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

3. EM&V Findings

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

3.1 Load Impact Results

TDPUD implemented 29 energy efficiency programs in 2010 as shown in **Table 3.1**. The program ex ante goal was to install 52,482 energy efficiency measures and TDPUD accomplished 60,619 installed measures and this is 15.5.7% greater than the ex ante goal.

Table 3.1 Ex Ante Goals and Ex Post Accomplishments

Description	Ex Ante Goal	Ex Post Accomplishment
Total Installed Measures	**52,482**	**60,619**
1. Residential CFLs	500	282
2. Clothes Washers	200	224
3. Dishwashers	150	177
4. Refrigerator/Freezers	200	209
5. Refrigerator Recycling	25	24
6. Building Envelope Testing	20	6
7. Duct System Testing	20	13
8. Building Envelope Mitigation	10	4
9. Duct System Mitigation	10	11
10. Window Thermal Efficiency		
11. Commercial Projects	15	23
12. Ground Source Heat Pumps	1	
13. EE Electric Water Heating/Solar	10	2
14. Low-Mod. Income Assist/ESP	200	94
15. Green Schools Program/Kits	1,800	1,800
16. Residential Energy Survey (RES)	200	280
17. Business Green Partners	3,000	2,602
18. Keep Your Cool	50	15
19. Business LED Pilot	1,000	1,139
20. LED Business Accent Lighting	500	271
21. LED Exit Sign Direct Install	70	10
22. Residential Green Partners	7,000	5,220
23. Neighborhood Block Party	200	202
24. Million CFLs	30,000	38,813
25. LED Light Swap	750	1,842
26. Misc. Water Efficiency	5,900	6,445
27. WaterSense Toilet Rebates and Exchange	550	821
28. Customer Water Leak Repair	100	89
29. TDPUD Building EE Project	1	1

TDPUD achieved 23.8% greater lifecycle electricity savings with ex post savings of 30,698,936 kWh versus ex ante goal of 24,792,482 kWh. TDPUD exceeded the ex ante E3 Calculator Total Resource Cost (TRC) test goal by 34.8% with an ex post TRC of 2.82 and the ex ante TRC of 2.1 as shown in **Table 3.2**.[15] The ex post TRC is greater than the ex ante TRC due to 15.5% more measures and lower measure costs due to purchasing measures in bulk and innovative programs. Ex post accomplishments were verified by checking the tracking database, randomly inspecting 2626 measures at 162 participant sites, and conducting surveys of participants, non-participants, and non-contacts. The EM&V ex post savings are based on site inspections, engineering analysis, and previous evaluation studies of TDPUD programs including light logger data from 2,640 fixtures at 29 sites and pre and post-retrofit utility billing data from 65 sites.

Table 3.2 Ex Ante Goals and Ex Post E3 Cost Effectiveness

Description	Ex Ante Goal	Ex Post Accomplishment
Net Annual Electricity Savings (kWh/yr)	2,736,331	3,390,914
Net Demand Savings (kW)	1,024	1,173
Net Lifecycle Electricity Savings (kWh)	24,792,482	30,698,936
Net Annual Therm Savings (therm/yr)	25,670	30,624
Net Lifecycle Therm Savings (therm)	259,662	307,318
Net Annual Water Savings (gallon/yr)[16]	33,721,682	37,023,564
Net Lifecycle Water Savings (gallon)	340,706,479	370,069,486
Total Resource Cost (TRC) Test – E3	**2.10**	**2.82**
TRC Test Costs	$1,046,443	$967,836
TRC Test Benefits	$2,197,191	$2,733,063
TRC Test Net Benefits	$1,150,748	$1,765,227
Participant Test	**1.00**	**1.00**
Participant Test Costs	$671,276	$580,138
Participant Test Benefits	$671,276	$580,138
Participant Test Net Benefits	$0	$0

The ex ante first-year savings are summarized in **Table 3.3**. The first-year net ex ante program savings are 2,736,331 kWh per year, 1,024 kW per year, 25,670 therms per year, and 33,721,682 gallons of water per year.

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

Energy Efficiency Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm)	Gross Ex-Ante Unit Savings (gal/yr)	Net-to-Gross Ratio	Net Ex Ante Program Savings (kWh/y)	Net Ex Ante Program Savings (kW)	Net Ex Ante Program Savings (therm)	Net Ex Ante Program Savings (galyr)
1. Residential CFLs	59.5	0.014	0.0	0	0.75	22,164	5.0	0	0
2. Energy Star Clothes Washers	62.0	0.159	0.0	0	0.76	9,424	24.2	0	0
3. Energy Star Dishwashers	30.7	0.105	0.0	0	0.80	3,684	12.6	0	0
4. Energy Star Refrigerators	121.0	0.021	0.0	0	0.75	18,239	3.2	0	0
5. Refrigerator Recycling	926.0	0.195	0.0	0	0.85	19,678	4.1	0	0

[15] 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.

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

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

Energy Efficiency Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm)	Gross Ex-Ante Unit Savings (gal/yr)	Net-to-Gross Ratio	Net Ex Ante Program Savings (kWh/y)	Net Ex Ante Program Savings (kW)	Net Ex Ante Program Savings (therm)	Net Ex Ante Program Savings (galyr)
6. Building Envelope Testing			0.0	0	0.82	0	0.0	0	0
7. Duct System Testing			0.0	0	0.77	0	0.0	0	0
8. Building Envelope Mitigation	82.0	0.068	41.8	0	0.82	676	0.6	345	0
9. Duct System Mitigation	59.0	0.049	56.6	0	0.77	454	0.4	436	0
10. Window Thermal Efficiency	160.0	0.531	10.9	0	0.96				0
11. Commercial Lighting Projects	15,032.6	3.335	0.0	0	0.88	198,211	44.0	0	0
12. Ground Source Heat Pumps	25,025.0	13.766	0.0	0	0.90	22,523	12.4	0	0
13. EE Electric/Solar Water Heat	178.0	0.024	0.0	0	0.79	1,406	0.2	0	0
14. Low-Mod Income Assist/ESP	424.6	0.302	16.2	1,962	0.64	54,348	38.6	2,078	251,167
15. Green Schools Program/Kits	0.0	0.000	0.0	0	0.80	0	0.0	0	0
16. Residential Energy Survey	686.6	0.523	18.5	2,336	0.64	87,886	67.0	2,373	299,008
17. Business Green Partners	56.5	0.051	0.0	0	0.85	144,075	130.1	0	0
18. Keep Your Cool	10,026.0	4.970	0.0	0	0.95	476,233	236.1	0	0
19. Business LED Pilot	96.2	0.030	0.0	0	0.85	81,770	25.5	0	0
20. LED Business Accent Lights	19.6	0.007	0.0	0	0.85	8,330	3.0	0	0
21. LED Exit Sign Direct Install	109.5	0.013	0.0	0	0.85	6,515	0.7	0	0
22. Residential Green Partners	61.2	0.014	0.0	0	0.64	274,330	62.2	0	0
23. Neighborhood Block Party	59.5	0.054	9.4	2,084	0.69	8,211	7.5	1,294	287,577
24. Million CFLs	59.5	0.014	0.0	0	0.69	1,231,650	279.5	0	0
25. LED Light Swap	23.9	0.089	0.0	0	0.91	16,331	60.5	0	0
26. Misc. Water Efficiency	6.5	0.001	3.7	934	0.77	29,364	3.6	16,679	4,245,361
27. WaterSense Toilet s	26.0	0.004	0.0	1,943	0.81	11,563	1.6	0	865,482
28. Customer Water Leak Repair	0.0	0.000	0.0	360,689	0.77	0	0.0	0	27,773,087
29. TDPUD Building EE Project	10,900.0	2.418	2900.0	0	0.85	9,265	2.1	2,465	0
Total						2,736,331	1,024	25,670	33,721,682

The EM&V ex post first-year savings are summarized in **Table 3.4**. The EM&V study found first-year net ex post program savings of 3,390,914 ± 207,115 kWh per year, 1,173 ± 47 kW per year, 30,624 ± 1,758 therms per year, and 37,023,564 ± 6,942,551 gallons (49,493 ± 9,281 CCF) of water per year at the 90 percent confidence level. The net first-year realization rates are 1.24 ± 0.08 for kWh, 1.15 ± 0.05 for kW, 1.19 ± 0.07 for therms, and 1.10 ± 0.21 for water.

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

Energy Efficiency Measure	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm)	Gross Ex-Post Unit Savings (gal)	Net-to-Gross Ratio	Net Ex Post Program Savings (kWh/y)	Net Ex Post Program Savings (kW)	Net Ex Post Program Savings (therm)	Net Ex Post Program Savings (gal)
1. Residential CFLs	59.5	0.014		0	0.69	11,577.5	2.6		0
2. Clothes Washers	205.3	0.175	6.3	8,050	0.68	31,269.5	26.7	960	1,226,189
3. Dishwashers	64.3	0.105	1.3	514	0.69	7,855.3	12.8	162	62,824
4. Refrigerator/Freezers	127.7	0.022		0	0.70	18,682.9	3.2		0
5. Refrigerator Recycling	1,151.0	0.248		0	0.85	23,481.3	5.1		0
6. Building Envelope Testing				0	0.80				0
7. Duct System Testing				0	0.74				0
8. Building Envelope Mitigation	71.4	0.059	41.8	0	0.80	228.3	0.2	134	0
9. Duct System Mitigation	96.7	0.080	56.6	0	0.74	787.0	0.7	461	0
10. Window Thermal Efficiency	160.0	0.531	10.9	0	0.96	0.0	0.0		0
11. Commercial Light Projects	15,032.6	3.335		0	0.85	293,887.8	65.2		0
12. Ground Source Heat Pumps	25,025.0	13.766		0	0.90	0.0	0.0		0
13. EE Elec/Solar Water Heat	1,652.0	0.233		0	0.79	2,610.2	0.4		0
14. Low-Mod Income Asst/ESP	424.6	0.302	25.4	6,461	0.84	33,526.1	23.8	2,003	510,196
15. Green Schools Program/Kits	7.5	0.003		4,050	0.80	10,763.8	4.3		2,245,968

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

Energy Efficiency Measure	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm)	Gross Ex-Post Unit Savings (gal)	Net-to-Gross Ratio	Net Ex Post Program Savings (kWh/y)	Net Ex Post Program Savings (kW)	Net Ex Post Program Savings (therm)	Net Ex Post Program Savings (gal)
16. Residential Energy Survey	686.6	0.523	27.4	6,801	0.64	123,040.2	93.8	4,913	1,218,785
17. Business Green Partners	165.1	0.046		0	0.85	365,221.0	102.5		0
18. Keep Your Cool	14,153.3	1.264		0	0.95	201,684.5	18.0		0
19. Business LED Pilot	180.7	0.042		0	0.85	174,944.9	40.7		0
20. LED Business Accent Lights	68.5	0.016		0	0.85	15,781.8	3.6		0
21. LED Exit Sign Direct Install	109.5	0.013		0	0.85	930.8	0.1		0
22. Residential Green Partners	63.6	0.058		0	0.64	212,580.8	192.9		0
23. Neighborhood Block Party	367.5	0.321	9.4	2,084	0.69	51,217.5	44.8	1,307	290,453
24. Million CFLs	59.5	0.014		0	0.69	1,593,467.7	361.5		0
25. LED Light Swap	23.9	0.089		0	0.91	40,108.0	148.5		0
26. Misc. Water Efficiency	6.5	0.001	3.7	934	0.77	32,076.8	3.9	18,220	4,637,518
27. WaterSense Toilet s	26.0	0.004		3,178	0.81	17,260.9	2.4		2,113,584
28. Water Leak Repair	1,731.6	0.198		360,689	0.77	118,664.7	13.5		24,718,047
29. TDPUD Building EE Project	10,900.0	2.418	2,900.0	0	0.85	9,265.0	2.1	2,465	0
Total						3,390,914	1,173	30,624	37,023,564
90% Confidence Interval						207,115	47	1,758	6,942,551
Realization Rate						1.31 ± 0.08	1.32 ± 0.05	1.26 ± 0.07	1.10 ± 0.21

The lifecycle electricity and water savings are summarized in **Table 3.5**. The net ex-ante lifecycle program savings are 24,792,482 kWh, 259,662 therms, and 340,706,479 gallons of water. The net ex-post lifecycle program savings are 30,698,936 ± 1,711,965 kWh, 307,318 ± 17,431 therms, and 370,069,486 ± 69,401,997 gallons of water (494,711 ± 92,777 CCF). The net lifecycle realization rates are 1.24 ± 0.07 for kWh, 1.18 ± 0.07 for therms, and 1.09 ± 0.21 for water.

Table 3.5 Lifecycle Electricity, Natural Gas, and Water Savings

Energy Efficiency Measure	Ex Ante Effective Useful Life (EUL)	Net Ex-Ante Lifecycle Program Savings (kWh)	Net Ex-Ante Lifecycle Program Savings (therm)	Net Ex-Ante Lifecycle Program Savings (gal)	Ex Post EUL	Net Ex-Post Lifecycle Program Savings (kWh)	Net Ex-Post Lifecycle Program Savings (therm)	Net Ex-Post Lifecycle Program Savings (gal)
1. Residential CFLs	9	199,474	0	0	9	104,198		14,714,268
2. Clothes Washers	12	113,088	0	0	12	375,233	11,515	691,060
3. Dishwashers	11	40,524	0	0	11	86,409	1,787	
4. Refrigerator/Freezers	14	255,348	0	0	14	261,560		
5. Refrigerator Recycling	5	98,388	0	0	5	117,406		
6. Building Envelope Testing	5	0	0	0	5			
7. Duct System Testing	5	0	0	0	5			
8. Building Envelope Mitigation	18	12,170	6,202	0	18	4,110	2,407	
9. Duct System Mitigation	18	8,177	7,848	0	18	14,166	8,296	
10. Window Thermal Efficiency	20			0	20	0		
11. Commercial Projects	11	2,180,326	0	0	11	3,232,766		
12. Ground Source Heat Pumps	15	337,838	0	0	15	0		
13. EE Electric/Solar Water Heat	15	21,093	0	0	15	39,152		4,591,767
14. Low-Mod Income Assist/ESP	9	489,134	18,705	2,260,500	9	301,734	18,025	11,229,840
15. Green Schools Program/Kits	5	0	0	0	5	53,819		10,969,068
16. Residential Energy Survey	9	790,973	21,360	2,691,072	9	1,107,362	44,217	
17. Business Green Partners	3	432,225	0	0	3	1,095,663		
18. Keep Your Cool	8	3,809,866	0	0	8	1,613,476		
19. Business LED Pilot	16	1,308,320	0	0	16	2,799,118		
20. LED Business Accent Lighting	16	133,280	0	0	16	252,509		
21. LED Exit Sign Direct Install	16	104,244	0	0	16	14,892		
22. Residential Green Partners	9	2,468,969	0	0	9	1,913,227		2,614,076

Table 3.5 Lifecycle Electricity, Natural Gas, and Water Savings

Energy Efficiency Measure	Ex Ante Effective Useful Life (EUL)	Net Ex-Ante Lifecycle Program Savings (kWh)	Net Ex-Ante Lifecycle Program Savings (therm)	Net Ex-Ante Lifecycle Program Savings (gal)	Ex Post EUL	Net Ex-Post Lifecycle Program Savings (kWh)	Net Ex-Post Lifecycle Program Savings (therm)	Net Ex-Post Lifecycle Program Savings (gal)
23. Neighborhood Block Party	9	73,899	11,642	2,588,194	9	460,957	11,759	
24. Million CFLs	9	11,084,850	0	0	9	14,341,209		
25. LED Light Swap	16	261,290	0	0	16	641,727		46,375,177
26. Misc. Water Efficiency	10	293,643	166,790	42,453,614	10	320,768	182,197	31,703,759
27. WaterSense Toilet s	15	173,449	0	12,982,230	15	258,913		247,180,473
28. Water Leak Repair	10	0	0	277,730,869	10	1,186,647		0
29. TDPUD Building EE Project	11	101,915	27,115	0	11	101,915	27,115	370,069,486
Total		24,792,482	259,662	340,706,479		30,698,936	307,318	69,401,997
90% Confidence Interval						1,711,965	17,431	1.09 ± 0.21
Realization Rate						1.26 ± 0.07	1.24 ± 0.07	14,714,268

The required energy impact reporting for 2011 programs is provided in **Table 3.6**.

Table 3.6 Required Energy and Water Impact Reporting for 2011 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	3,661	3,391	1.3	1.2	34,376	30,624	58,722	49,493
2	2013	3,661	3,391	1.3	1.2	34,376	30,624	58,722	49,493
3	2014	3,661	3,391	1.3	1.2	34,376	30,624	58,722	49,493
4	2015	3,492	3,026	1.2	1.1	34,376	30,624	58,722	49,493
5	2016	3,492	3,026	1.2	1.1	34,376	30,624	58,722	49,493
6	2017	3,469	2,991	1.2	1.1	34,376	30,624	58,722	46,491
7	2018	3,469	2,991	1.2	1.1	34,376	30,624	58,722	46,491
8	2019	3,469	2,991	1.2	1.1	34,376	30,624	58,722	46,491
9	2020	2,967	2,790	0.9	1.0	34,376	30,624	58,722	46,491
10	2021	490	764	0.2	0.3	25,545	22,401	57,016	43,791
11	2022	452	614	0.2	0.3	3,884	4,182	1,428	4,549
12	2023	211	303	0.2	0.2	984	1,554	1,428	4,465
13	2024	198	271	0.1	0.2	984	595	1,428	2,825
14	2025	198	271	0.1	0.2	984	595	1,428	2,825
15	2026	174	253	0.1	0.2	984	595	1,428	2,825
16	2027	133	233	0.1	0.2	984	595	0	0
17	2028	1	1	0.0	0.0	984	595	0	0
18	2029	1	1	0.0	0.0	984	595	0	0
19	2030	0	0	0.0	0.0	0	0	0	0
20	2031	0	0	0.0	0.0	0	0	0	0
Total		33,200	30,699			345,698	307,318	592,658	494,711

** 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 3.7**.

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

	Net Demand Savings (kW)	Net Coincident Peak Savings (kW)	Net Annual Energy Savings (kWh)	Net Lifecycle Energy Savings (kWh)	Net Lifecycle Gas Savings (MMBtu)	Net Lifecycle GHG Reduction (Tons)	Utility Cost ($/kWh)	Total Resource ($/kWh)	Ex Post TRC
TOTAL EE PORTFOLIO	2,266	1,173	3,390,914	30,698,936	30,732	16,553	0.04	0.04	2.82
20. LED Business Accent	4	4	15,782	252,509		140	0.01	0.01	11.4
1. Residential CFLs:	11	3	11,578	104,198		56	0.01	0.01	11.0
24. Million CFLs (R&D, EE)	1,446	362	1,593,468	14,341,209		7,656	0.01	0.01	9.9
13. EE Elec/Solar Wtr Heat			2,610	39,152		21	0.02	0.02	7.2
28. Water Leak Repair	14	14	118,665	1,186,647		643	0.02	0.02	6.3
26. Misc. Water Efficiency	4	4	32,077	320,768	18,220	172	0.14	0.14	5.1
19. Business LED Pilot	41	41	174,945	2,799,118		1,551	0.04	0.04	3.8
11. Commercial Lighting	65	65	293,888	3,232,766		1,792	0.04	0.04	3.4
23. Neighborhood EE Block	45	45	51,217	460,957	1,176	246	0.04	0.04	3.1
5. Refrig./Freezer Recycling	5	5	23,481	117,406		64	0.03	0.03	2.6
22. Res. Green Partners	193	193	212,581	1,913,227		1,021	0.04	0.04	2.3
6-9. Bldg. Duct Test/Repair	1	1	1,015	18,276	1,070	11	0.52	0.52	2.1
17. Business Green Partner	103	103	365,221	1,095,663		607	0.04	0.04	2.1
16. Res. Energy Survey	94	94	123,040	1,107,362	4,422	591	0.07	0.07	2.0
2. Clothes Washers E. Star	27	27	31,269	375,233	1,152	207	0.1	0.1	1.6
21. LED Exit Direct Install			931	14,892		8	0.1	0.1	1.3
18. Keep Your Cool	18	18	201,684	1,613,476		851	0.08	0.08	1.2
29. TDPUD Bldg EE Project	2	2	9,265	101,915	2,712	56	0.35	0.35	1.2
4. Refrig/Freezers E. Star	3	3	18,683	261,560		142	0.13	0.13	0.9
25. LED Holiday Light Swap	149	149	40,108	641,727		343	0.12	0.12	0.9
14. Low-Mod Income/ESP	24	24	33,526	301,734	1,802	161	0.22	0.22	0.7
3. Dishwashers Energy Star	13	13	7,855	86,409	179	48	0.32	0.32	0.4
15. Green Schools Program	4	4	10,764	53,819		29	0.39	0.39	0.2
27. WaterSense Toilet	2	2	17,261	258,913		139	0.68	0.68	0.2
10. Window Thermal Eff.									0
12. Ground Source HP									0

The TDPUD energy efficiency portfolio utility cost is $0.04/kWh and the net lifecycle green house gas (GHG) reductions are 16,553 tons. TDPUD programs realized a 2.82 TRC which is 34.8% greater than anticipated due to installing 15.5% more measures through innovative community-based programs. The top ten programs have an average TRC of 6.4. The Residential and Million CFL programs realized a TRC of 11.0 and 9.9 respectfully by purchasing CFLs in large quantities at low cost and installing CFLs through multiple programs. The Energy Efficient Electric and Solar Water Heater program realized a TRC of 7.2 by providing incentives for efficient electric water heaters and solar preheat tanks. The water leak repair and miscellaneous water efficiency programs realized a TRC of 6.3 and 5.1 respectfully due to electricity savings from water pumping and therm savings from units installed at sites with gas water heaters. The LED Business Accent and Business LED Pilot programs realized a TRC of 11.4 and 3.8 respectfully by buying LED lamps in bulk and distributing them directly to commercial customers. The Commercial Lighting program realized a TRC of 3.4 and 48% greater savings by providing incentives for comprehensive lighting retrofit projects including the LED technology demonstration project at Office Boss. The Neighborhood Energy Efficiency Block Party program realized a TRC of 3.1 by providing free energy efficient CFLs directly to customers who attended the neighborhood events. The Refrigerator Recycling program realized a TRC of 2.6 and 19% greater savings than anticipated due to recycling more units. The energy usage of each unit was obtained from the USEPA (http://www.energystar.gov/) and Refrigerator and Freezer Energy Rating Databases (http://www.kouba-cavallo.com/refmods.htm). These databases provide annual energy use based on make and model per IPMVP Option B. Residential Green

Partners realized a TRC of 2.3. The Keep Your Cool program realized a TRC of 1.2 by installing 596 commercial refrigeration measures including LED refrigeration case lights, door closers, strip curtains, anti-sweat heater controls, efficient evaporator fan motors (electronically commutated motors - ECMs), and efficient fan controllers. The TDPUD Building EE Project realized a TRC of 1.2 by installing energy efficient HVAC operation and maintenance (O&M) measures, boiler controls, garage door insulation, and lighting controls. The TDPUD building received a commercial building energy performance (BEP) benchmark rating of 14. The TDPUD BEP rating indicates that the energy intensity needs to be reduced by 55% to qualify for the Energy Star rating of 75 (current site energy intensity is 91 kBtu/ft^2 and EPA Energy Star performance requires site energy intensity of 41 kBtu/ft^2). The Energy Star® Clotheswasher program realized a TRC of 1.6 due to the combination of kWh, therm, and water savings. Savings for all units were evaluated individually using the US EPA database (http://www.energystar.gov/). The LED Holiday Light Swap program realized a TRC of 0.9. Low-Moderate Income Assistance/Energy Saving Partners realized a TRC of 0.7. 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. Two programs did not realize any participation: Window Thermal Efficiency and Ground Source Heat Pumps. The Green Schools program realized a TRC of 0.2 by distributing water-efficient garden nozzles to all K-8 students throughout the TDPUD service area (6 schools). The water-efficient nozzles were distributed at school assemblies by the Truckee High School Bright Schools/Envirolution Club. TDPUD partnered with several local organizations to implement projects including: Sierra Watershed Education Partnership, Truckee High School Bright Schools/Envirolution Club, Sierra Business Council, 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.

3.1.1 Load Impacts for Residential Lighting

Load impacts for residential lighting are based on field inspections of Energy Star® CFLs, interviews with 40 TDPUD residential customers, and verification of rebates paid to TDPUD customers. Residential lighting rebates were issued for the following CFLs: 1) Spiral 13W CFL (replace 60W), 2) Spiral 23W CFL (replace 100W), 3) Globe G259/40W (replace 40W), 4) R2014/14W (replace 65W), 5) R30 15W (replace 65W), 6) R30 15W Dimmable (replace 60W), 7) PAR38 23W (replace 90W or 120W). The ex ante and ex post unit savings are shown in **Table 3.8**. The ex ante goal for Energy Star® CFL rebates is 500 units and the study verified 282 measures from the TDPUD rebate applications and by interviewing customers. The ex ante net-to-gross ratio is 0.8. The ex post NTGR is 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.[17] The ex ante effective useful

[17] 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

lifetime is 9 years and the ex post EUL is 9 years per year assuming 10,000 lifecycle operational hours. The total ex ante savings are 21,164 first-year kWh and 5.0 kW and 199,474 lifecycle kWh. The total net ex post savings are 11,578 ± 681 first-year kWh, 2.6 ± 0.39 kW, and 104,198 ± 6,129 kWh lifecycle kWh at the 90% confidence level. The ex post savings are approximately 48% less than ex ante for kWh and kW savings. Differences between ex ante and net ex post savings are due to lower participation (i.e., fewer CFLs) and lower net to gross ratios based on survey responses. 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.

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

Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
1. Residential CFLs	59.5	0.014			59.5 ± 3.5	0.014 ± 0.002		

3.1.2 Load Impacts for Energy Star® Clotheswashers

Load impacts for Energy Star® clotheswashers are based on annual energy use for models listed in the Energy Star® database and verification of the TDPUD database consistent with IPMVP Option A (verification of stipulated savings). The US National Appliance Energy Conservation Act (NAECA) standard unit baseline and Energy Star® qualified annual energy and water use and average savings are shown in **Table 3.9**.[18] The ex ante and ex post unit savings are shown in **Table 3.10**. The ex ante NTGR is 0.76 and the EUL is 10 years. The 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 TDPUD net ex ante savings are 9,424 kWh/yr, 24.2 kW and 113,088 lifecycle kWh based on 200 units. The total net ex post savings are 31,270 ± 694 first-year kWh, 26.7 ± 0.59 kW, 960 ± 21 first-year therm, 1,226,189 ± 24,472 first-year gallons of water, 375,233 ± 8,331 lifecycle kWh, 11,515 ± 256 lifecycle therm, and 14,714,268 ± 293,662 lifecycle gallons at the 90% confidence level for 224 units. The ex post kWh savings are approximately 232% greater than ex ante and the ex post kW savings are 10% greater. The electricity, natural gas, and water savings increase the TRC to 1.6.

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).

[18] 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.

Table 3.9 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 3.10 Energy Star® Clotheswasher Ex Ante and Ex Post Savings

Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
2. Energy Star® CW	62.0	0.159			205.3 ± 4.56	0.175 ± 0.004	6.3 ± 0.14	8,050 ± 161

3.1.3 Load Impacts for Energy Star® Dishwashers

Load impacts for Energy Star® dishwashers are based on annual energy use for models listed in the Energy Star® database and verification of the TDPUD database consistent with IPMVP Option A (verification of stipulated savings). The US National Appliance Energy Conservation Act (NAECA) standard unit baseline and Energy Star® qualified annual energy and water use and average savings are shown in **Table 3.11**.[19] The ex ante and ex post unit savings are shown in **Table 3.12**. The ex ante and ex post NTGR is 0.80 and the EUL is 11 years. The TDPUD net ex ante savings are 3,684 kWh/yr, 12.6 kW and 40,524 lifecycle kWh based on 150 units. The total net ex post savings are 7,855 ± 413 first-year kWh, 12.8 ± 0.73 kW, 162 ± 4 first-year therm, 62,824 ± 2,415 first-year gallons of water, 85,409 ± 4,541 lifecycle kWh lifecycle kWh, 1,787 ± 40 lifecycle therm, 691,060 ± 26,560 lifecycle gallons of water at the 90% confidence level for 177 units. The ex post savings are approximately 113% more than ex ante savings. 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 for units that meet CEE Tier 2 which will increase kWh and therm savings by 20% and water savings by 40% (see **Table 2.6**).

Table 3.11 Annual Energy and Water Use for Dishwashers

Description	Annual Electric Use (kWh/y)	Peak Demand (kW)	Total Annual Gas Use (therm)	Total Annual Water Use (gallon)	Annual Water Pump (kWh)	Water Pump Peak Demand (kW)	Total Annual Electric Use (kWh/y)	Total Peak Demand (kW)	Annual Water Use (CCF)
Standard 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	0.099	0.69
+/- 90% CI	3.33	0.005	0.07	19.8	0.2	0.00	3.4	0.005	0.03

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

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

Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
3. Energy Star Dishwasher	30.7	0.105			64.3 ± 3.4	0.099 ± 0.005	1.3 ± 0.07	514 ± 20

3.1.4 Load Impacts for Energy Star® Refrigerators

Load impacts for Energy Star® refrigerators are based on the difference between the US Federal Standard annual energy use and the US Federal Trade Commission Energy Guide Label annual energy use for 873 Energy Star® models.[20] This approach is consistent with IPMVP Option A (verification of stipulated savings). The US NAECA minimum standard and Energy Star® annual energy use and average savings are shown in **Table 3.13**.[21] The ex ante and ex post unit savings are shown in **Table 3.14**. The ex ante and ex post NTGR is 0.75 and the EUL is 14 years. The TDPUD net ex ante savings are 18,239 kWh/yr, 3.2 kW and 255,348 lifecycle kWh based on 200 units. The total net ex post savings are 18,683 ± 578 first-year kWh, 3.2 ± 0.15 kW, and 261,560 ± 8,090 kWh lifecycle kWh at the 90% confidence level for 209 units. The ex post savings are approximately 2.4% 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 0.9. 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 2.7**).

Table 3.13 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

[20] 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.

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

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

Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
4. Energy Star Refrigerators	121.0	0.021			127.7 ± 4.0	0.022 ± 0.001		

3.1.5 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 3.15**. The ex ante and ex post unit savings are shown in **Table 3.16**. The ex ante NTGR is 0.75 and the ex post NTGR is 0.85 ± 0.05 based on interviews with 13 participants. The ex ante and ex post EUL is 5 years. The net ex ante savings are 19,678 kWh/yr, 4.1 kW and 98,388 lifecycle kWh based on 25 units. The total net ex post savings are 23,481 ± 2,162 first-year kWh, 5.1 ± 0.47 kW, and 117,406 ± 10,812 kWh lifecycle kWh at the 90% confidence level for 24 units. The ex post kWh savings are 19.3% greater and the ex post kW savings are 22% greater than the ex ante savings. Differences between net ex post and ex ante are due to greater ex post savings per measure and greater NTGR.

Table 3.15 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 3.16 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	926	0.195			1,151 ± 22	0.248 ± 0.023		

3.1.6 Load Impacts for Building Envelope & Duct Testing

Load impacts for building envelope and duct testing are based on field inspections of measures at 3 participant sites 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%.[22] 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 unit energy consumption (UEC) values are 602 therm/year for space heating and 244 kWh/yr for heating ventilation in climate zone 16.[23] The ex ante and ex post unit energy savings are shown in **Table 3.17**. The net-to-gross ratio is 0.92 for building envelope mitigation and 0.77 for duct repair. The EUL is 18 years. The ex ante savings for building envelope mitigation are 676 kWh/year, 0.6 kW, 345 therm/year, 12,170 lifecycle kWh, and 6,202 lifecycle therms for 10 units. The ex ante savings for duct mitigation are 454 kWh/year, 0.4 kW, 436 therm/year, and 8,177 lifecycle kWh, and 7,848 lifecycle therms for 10 units. The building envelope mitigation program net ex post savings are 228 ± 23 first-year kWh, 0.2 ± 0.02 kW, 134 ± 13 first-year therm, 4,110 ± 411 lifecycle kWh, and 2,407 ± 241 lifecycle therm for 4 units. The duct leakage mitigation program net ex post savings are 787 ± 79 first-year kWh, 0.7 ± 0.07 kW, 461 ± 46 first-year therm, 14,166 ± 1,417 kWh lifecycle kWh, and 8,296 ± 830 lifecycle therms for 11 units. Ex post savings for building envelope mitigation are approximately 67% less due to fewer measures, and ex post savings for duct repair are 73% greater due to greater unit savings than anticipated.

Table 3.17 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	82	0.068	41.8		71.4 ± 7.1	0.059 ± 0.006	41.8 ± 4	
9. Duct Leakage Mitigation	59	0.049	56.6		96.7 ± 9.7	0.080 ± 0.008	56.6 ± 6	

[22] 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).

[23] 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/.

3.1.7 Load Impacts for Thermally Efficient Windows

No thermally efficient window rebate applications were received by TDPUD. Therefore, there are no load impacts to report for thermally efficient windows. TDPUD needs to define a performance threshold (i.e., minimum overall R-value or maximum u-value) for qualifying windows. For double-pane low-emissivity windows, the minimum should be R-3 or 0.33 Btu/hr-ft^2-°F 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.

3.1.8 Load Impacts for Commercial Lighting

Load impacts for commercial lighting are based on previous EM&V studies, electric power measurements, and lighting logger measurements of fixtures consistent with IPMVP Option B.[24] The commercial lighting projects are summarized in **Table 3.18**. The ex post ex ante and ex post unit savings are shown in **Table 3.19**. The TDPUD assumed gross ex ante site savings per project of 15,032 kWh/yr, 3.335 kW and net ex ante program savings of 198,211 kWh, 44 kW and 2,180,326 lifecycle kWh based on 14 projects. The ex ante net-to-gross ratio is 0.88. The ex post NTGR is 0.85 ± 0.03 based on decision maker surveys of 23 participants. The ex ante and ex post effective useful lifetime (EUL) is 11 years. The total net ex post savings are 293,888 ± 8,852 first-year kWh, 65.2 ± 1.96 kW, and 3,232,766 ± 97,367 kWh lifecycle kWh based on 23 projects. The ex post savings are approximately 48% greater than the ex ante savings due to more projects and more measures.

Table 3.18 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	400W HID	458	15	T5HO 4Lx4ft	234	15	4,477	3.36	15,043	4,477	3.36	15,043
2	T12 4Lx4ft	189	3	T8 4Lx4ft	108	3	5,475	0.24	1,330	5,475	0.24	1,330
3	T12 2Lx8ft	141	10	T8 2Lx8ft	111	10	6,188	0.30	1,856	6,188	0.30	1,856
4	R38 Inc	120	24	18W LED	18	24	3,120	2.45	7,638	3,120	2.45	7,638
5	T12 1Lx4ft	57	4	LED Refrig	6	4	8,760	0.20	1,787	8,760	0.20	1,787
6	HID Park	462	14	147W LED	147	14	4,380	4.26	18,672	4,380	4.26	18,672
	T12 4Lx4ft	189	8	T8 3Lx4ft	90	8	4,368	0.79	3,459	4,368	0.79	3,459
7	T12 4Lx4ft	189	4	T8 3Lx4ft	90	4	3,640	0.40	1,441	3,640	0.40	1,441
8	T24 T8.	33	112	LED Demo	13	112	3,120	2.17	6,780	3,120	2.17	6,780
9	R38 120W	120	139	18W LED	18	139	8,760	16.46	144,225	8,760	16.46	144,225
10	T12 4Lx8ft	246	0	T8 4Lx8ft	219	0	3,822	-1.31	-5,022	3,822	-1.31	-5,022
	T12 4Lx4ft	189	8	T8 4Lx4ft	108	8	3,822	0.65	2,477	3,822	0.65	2,477
	T12 2Lx4ft	96	13	T8 2Lx4ft	61	13	3,822	1.07	4,070	3,822	1.07	4,070
	T12 1Lx4ft	57	5	T8 1Lx4ft	39	5	3,822	-0.03	-103	3,822	-0.03	-103

[24] *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.

Table 3.18 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
	T12 1Lx3ft	42	2	T8 1Lx3ft	26	2	3,822	0.03	122	3,822	0.03	122
	T12 1Lx2ft	28	0	T8 1Lx2ft	20	0	3,822	-0.12	-459	3,822	-0.12	-459
11	T12 2Lx4ft	96	11	T8 2Lx4ft	61	0	1,095	0.39	422	1,095	0.39	422
12	T12 4Lx4ft	189	46	T8 4Lx4ft	108	46	3,174	5.35	16,968	3,174	5.35	16,968
	T12 2Lx4ft	96	27	T8 2Lx4ft	61	27	2,920	0.15	444	2,920	0.15	444
13	R38 120W	120	78	LED 18W	18	78	3,120	7.96	24,823	3,120	7.96	24,823
	HID Park	368	12	35.5W LED	36	12	4,380	3.99	17,476	4,380	3.99	17,476
14	T12HO 4L	351	8	T5HO 5Lx4ft	234	8	2,500	0.94	2,340	2,500	0.94	2,340
15	T12HO 4L	377	12	T5HO 5Lx4ft	234	0	3,195	1.72	5,483	3,195	1.72	5,483
	60W Inc	60	16	12WLED	12	0	3,195	0.77	2,454	3,195	0.77	2,454
16	MH/T12	196	309	T8 sensors	176	0	1,691	6.09	10,299	1,691	6.09	10,299
17	T12 3Lx4ft	143	7	T8 3Lx4ft	90	0	3,100	0.37	1,150	3,100	0.37	1,150
18	HID Park	368	24	LED 35.5W	36	24	4,380	7.98	34,952	4,380	7.98	34,952
19	T12 4Lx4ft	189	21	T8 4Lx4ft	108	0	2,080	1.70	3,538	2,080	1.70	3,538
20	50W Inc.	50	75	7W CFL	7	0	2,080	3.23	6,708	2,080	3.23	6,708
21	400W HID	458	8	T5HO 4Lx4ft	216	6	2,500	2.37	5,920	2,500	2.37	5,920
	T12 4Lx4ft	189	8	T5HO 4Lx4ft	216	8	2,500	-0.22	-540	2,500	-0.22	-540
	400W HID	458	6	T5HO 4Lx4ft	216	5	2,500	1.67	4,170	2,500	1.67	4,170
22	T12 2Lx4ft	96	1	T8 2Lx4ft	61	1	4,368	0.04	153	4,368	0.04	153
	T12 3Lx4ft	189	15	T8 4Lx4ft	108	15	4,368	1.22	5,307	4,368	1.22	5,307
23	T12 2Lx4ft	96	2	T8 2x4 LED	48	2	3,822	0.10	367	3,822	0.10	367
	Average							3.335	15,033		3.335	15,033
	90% CI										0.100	452.8

Table 3.19 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	15,032	3.335			15,032 ± 452.8	3.335 ± 0.100		

3.1.9 Load Impacts for Ground Source Heat Pump

Load impacts for Ground Source Heat Pumps (GHSP) are based on the /TDPUD GHP Monitoring Project Final Report, Davis Energy Group, March 30, 1998. The study monitored 5 GSHP sites in Truckee for 12 months in 1998. Average energy use per GSHP site is 3.64 ± 1.49 kWh/yr-ft^2 based on five monitored sites. The average GSHP heating COP is 3.5. The baseline is an air source heat pump (ASHP) with heating COP of 2.4. A GSHP was installed at the 15,000 ft^2 Town of Truckee Corporate Yard building in 2011. The GSHP gross ex ante energy savings are 25,025 ± 10,244 kWh/yr based on **Equation 10**.

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

Where,

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

The gross ex ante and ex post unit savings are shown in **Table 3.20**. The ex ante goal is one unit. The study verified the $6,000 check paid to Town of Truckee in 2010 for the GSHP installed at

the Corporate Yard in 2011. The ex ante and ex post net-to-gross ratio is 0.8. The ex ante and ex post EUL is 15 years based on the 2005 DEER Update Study.[25] The net ex ante savings are 22,523 first-year kWh, 12.4 kW, and 337,838 lifecycle kWh at the 90% confidence level. The ex post savings are zero since no additional GSHP units were installed in 2011.

Table 3.20 Ground Source Heat Pump 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)
12. Ground Source HP	25,025	13.76			25,025 ± 10,244	13.766 ± 5.635		

3.1.10 Load Impacts for Electric Water Heater/Solar

Load impacts for electric water heater/solar are based on the difference between average annual energy use for standard efficiency water heaters and energy efficient water heaters consistent with IPMVP Option A (verification of stipulated savings). The 2004 Federal Standards are 0.9304 EF for 30 gallon units, 0.9172 EF for 40 gallon units, and 0.904 EF for 50 gallon units.[26] Average electric water heater unit energy consumption (UEC) is 3,354 kWh per year.[27] 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 one electric water heater and one solar water heater. 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 3.21**.[28] 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 1,406 kWh/yr, 0.2 kW and 21,093 lifecycle kWh based on 10 units. The total net ex post savings are 2,619 ± 261 first-year kWh, 0.4 ± 0.04 kW, and 39,152 ± 3,915 kWh lifecycle kWh based on 2 units. The ex post savings are approximately 85.6% greater than ex ante savings due to greater savings from the solar water heater. 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 program encourages customers to "save money on gas or electricity bills by harnessing the heat of the sun!"

[25] 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/.

[26] 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.

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

[28] Ibid.

Table 3.21 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	178	0.024			1,652 ± 165	0.302 ± 0.023		

3.1.11 Load Impacts for Low/Moderate Income Energy Assistance

Load impacts low/moderate income energy assistance (Energy Saving Partners) are based on verification inspections at 17 sites, engineering analysis, and the previous EM&V study per IPMVP Option B and C. 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 3.22**. 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 54,348 kWh/yr, 38.6 kW, 2,078 therms/year, 251,167 gallons/year, 489,134 lifecycle kWh, 18,705 lifecycle therm, and 2,260,500 lifecycle gallons of water based on 200 sites. The net ex post savings are 33,526 ± 3,353 first-year kWh, 23.8 ± 2.38 kW, 2,003 ± 200 first-year therm, 510,196 ± 51,020 first-year gallons of water, 301,724 ± 30,173 lifecycle kWh, 18,025 ± 1,802 lifecycle therm, and 4,591,767 ± 459,177 lifecycle gallons of water based on 94 sites.[29] The ex post kWh savings are approximately 38% less than ex ante savings due to 53% fewer participants.

Table 3.22 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	424.6	0.302	16.2	1,962	424.6 ± 42	0.302 ± 0.030	25.4 ± 2.5	6,461 ± 646

3.1.12 Load Impacts for Green Schools

The load impacts for green schools are based on providing all K-8 students at 6 schools throughout the TDPUD electric service area with 1,800 Conservation kits consisting of a water efficient garden nozzle and conservation education materials. Load impacts are based on field measurements of the water efficient garden nozzle and standard garden nozzles consistent with IPMVP Option B as shown in **Table 3.23**. The annual energy use for standard and water efficient garden nozzles is shown in **Table 3.24**. The ex ante and ex post net-to-gross ratio is 0.80. The ex ante and ex post EUL is 5 years. The embedded energy of water pumping requires approximately 0.00480080 kWh per gallon based on total 2007 electricity usage for water pumping. Gross ex ante and ex post unit savings are shown in **Table 3.25**. The net ex ante savings were assumed to be zero since TDPUD had never implemented an efficient garden nozzle program previously and the nozzle manufacturer did not provide estimated water or energy savings. The net ex post savings are 10,763 ± 1,076 first-year kWh/yr, 4.3 ± 0.43 kW, 2,245,968 ± 224,597 first-year

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

gallons, 53,819 ± 5,382 life-cycle kWh, and 11,229,840 ± 1,122,984 lifecycle gallons based on 1,800 units. The TRC is 0.2 because the E3 calculator only values energy savings and does not currently include avoided costs for water savings. In addition to providing efficient garden nozzles, the Green Schools program should provide each student with at least one LED or CFL lamp and one efficient showerhead and aerator to teach students how to measure fluid mechanics (volumetric flow rates at various flowing pressure), electric power (voltage, current, and Watts), and thermal heat energy (specific heat, temperature, and British thermal units – Btu). This will encourage more students to appreciate and understand science, electric power, and energy and water efficiency.

Table 3.23 Efficient Garden Nozzle Water Savings

#	Flow (gpm)	Flowing Pressure (psig)	Daily Use (minutes)	Annual Days of Use per Year	Gallons per year
Standard Garden Nozzle #1	4	10	10	90	3,600
Standard Garden Nozzle #2	4	12	10	90	3,600
Standard Garden Nozzle #3	3.5	23	10	90	3,150
Average Standard	3.83	15	10	90	3,450
Efficient Garden Nozzle	2.10	41	10	90	1,890
Savings	1.73		10	90	1,560

Table 3.24 Annual Energy and Water Use for Standard and Efficient Garden Nozzles

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 Garden Nozzle				3,450	16.6	0.006	16.6	0.006	4.61
Efficient Garden Nozzle				1,890	9.1	0.003	9.1	0.003	2.53
Ave. Savings				1,560	7.5	0.003	7.5	0.003	2.09
+/- 90% CI				28.1	0.13	0.000	0.1	0.000	0.04

Table 3.25 Green Schools 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)
15. Green Schools					7.5 ± 0.7	0.003 ± 0.00		1,560 ± 156

3.1.13 Load Impacts for Residential Energy Survey

Load impacts for residential energy survey (RES) are based on field inspections, interviews with residential customers, and verification of the TDPUD database. Gross ex ante and ex post unit savings are shown in **Table 3.26**. The ex ante NTGR is 0.8 and the ex post NTGR is 0.64 ± 0.09 based on decision maker surveys of 40 participants. The average ex post operating hours are 1,100 ± 65 hours/yr based on participant survey data for 40 customers.[30] The ex ante and ex post

[30] 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.,

EUL is 9 years. The ex ante savings are 87,886 first-year kWh, 67 kW, 2,373 therm, 299,008 gallons/year of water, 790,973 lifecycle kWh, 21,360 lifecycle therm, and 2,691,072 lifecycle gallons of water based on 200 participants. The total net ex post savings are 123,040 ± 12,304 first-year kWh, 93.8 ± 9.38 kW, 4,913 ± 491 therm, 1,218,785 ± 121,879 gallons of water, 1,107,362 ± 110,736 kWh lifecycle kWh, 44,217 ± 4,422 lifecycle therm, and 10,969,058 ± 1,096,907 lifecycle gallons of water based on 280 participants. The ex post savings are 40% greater than ex ante due to 40% more participants.

Table 3.26 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	686.6	0.523	18.5	2,336	686.6 ± 69	0.523 ± 0.052	27.4 ± 2.7	6,801 ± 680

3.1.14 Load Impacts for Business Green Partners

Load impacts for the Business Green Partners are based on previous field inspections of 645 measures at 12 participant sites and light logger measurements of 347 fixtures consistent with IPMVP Option B. Gross ex ante and ex post unit savings are shown in **Table 3.27**. The ex ante 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 144,075 kWh/yr, 130.1 kW and 432,225 lifecycle kWh based on 3,000 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 365,221 ± 36,522 first-year kWh, 102.5 ± 10.3 kW, and 1,095,663 ± 109,566 kWh lifecycle kWh based on 2,602 units. The ex post kWh savings are approximately 154% greater than ex ante savings due to three times greater savings per unit.

Table 3.27 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	56.5	0.051	3	165.1 ± 16.5	0.046 ± 0.005	3

3.1.15 Load Impacts for Keep Your Cool

Load impacts for the Keep Your Cool program are based on data for 15 commercial customer sites with energy efficiency refrigeration upgrades consistent with IPMVP Option A. Detailed pre- and post-retrofit field measurements were made at Site 15 to evaluate the savings for converting two evaporator fan coils with eight (8) permanent split capacitance (PSC) motors operating at high speed 8,760 hours per year to electronically commutated (EC) motors and an efficient controller installed at a refrigerated warehouse as shown in **Table 3.28**. The electric

Los Gatos, CA, Prepared by Robert Mowris & Associates, Olympic Valley, CA, June 12, 2008, Available online: www.calmac.org).

power was measured before and after the efficient refrigeration measures were installed. The efficient controller operates the EC motors operate at high speed to provide airflow across the evaporator when the refrigeration system is operating and low speed to circulate air in the warehouse and prevent stratification when the refrigeration system is off. The EC motors use 46% less power than the PSC motors on high speed and 84% less power on low speed. For Keep Your Cool Site 15 the total measured kWh savings are 77% and the total kW savings are 65%. The average gross ex ante and ex post site savings are shown in **Table 3.29**. The ex ante and ex post net-to-gross ratio is 0.95 based on surveys conducted with seven participants. The ex ante and ex post effective useful lifetime (EUL) is 8 years. The TDPUD ex ante savings are 476,233 kWh/yr, 236.1 kW and 3,809,866 lifecycle kWh based on 50 sites. The net ex post savings are 201,684 ± 56,819 first-year kWh, 18 ± 4.83 kW, and 1,613,476 ± 454,549 kWh lifecycle kWh based on installations at 15 sites. The Keep Your Cool program TRC is 1.2. The ex post kWh savings are approximately 58% less than ex ante savings due to 70% fewer sites than anticipated and 41% greater kWh savings per site. The kW savings are 92% less than ex ante savings due to 70% fewer sites and 75% less kW savings per site. The Keep Your Cool 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.

Table 3.28 Keep Your Cool Site 15 Detailed Pre- and Post-Retrofit Field Measurements

Description	Refrig. High Speed Fan kW	Low Speed Fan kW	Refrig. Load High Speed Fan (Btu)	Refrig. Load Low Speed Fan (Btu)	High Speed Fan (hr/yr)	Low Speed Fan (hr/yr)	Refrig. kWh	Refrig. kW	Fan kWh	Total kWh	Total kW
Existing Refrig.	24.2	0	82,450	0	8,760	0	3,151	1.12	26,460	29,612	4.14
Efficient Refrig.	13.1	3.8	44,847	12,906	1,411	7,349	1,104	0.39	5,793	6,897	1.45
Savings							2,048	0.73	20,667	22,715	2.69

Table 3.29 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	10,026	4.970			14,153 ± 3,987	1.264 ± 0.339		

3.1.16 Load Impacts for Business LED Pilot

Load impacts for the Business LED Pilot are based on data for 16 commercial sites that received LED lamps and light logger measurements of retail and restaurant sites from previous TPDUD EM&V studies consistent with IPMVP Option B. Gross ex ante and ex post unit savings are shown in **Table 3.30**. 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 81,770 kWh/yr, 25.5 kW and 1,308,320 lifecycle kWh based on 1,000 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 174,945 ± 17,494 first-year kWh, 40.7 ± 4.07 kW, and 2,799,118 ± 279,912 kWh lifecycle kWh based on 1,139 installed units. The ex post kWh savings are 114% greater and the kW savings are 59.5% greater than ex ante savings due to greater savings per lamp and more lamps installed

than anticipated. The Business LED Pilot has a TRC of 3.8 with very high customer satisfaction. The custom delivery and installation approach should be expanded in 2012.

Table 3.30 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	96.2	0.030			180.7 ± 18.1	0.042 ± 0.004		

3.1.17 Load Impacts for LED Business Accent Lighting

Load impacts for the LED Business Accent Lighting are based on data for 3 commercial sites that received LED lamps and light logger measurements of retail and restaurant sites from previous TPDUD EM&V studies consistent with IPMVP Option B. Gross ex ante and ex post unit savings are shown in **Table 3.31**. 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 8,330 kWh/yr, 3.0 kW and 133,280 lifecycle kWh based on 500 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 15,782 ± 1,578 first-year kWh, 3.6 ± 0.36 kW, and 252,509 ± 25,251 kWh lifecycle kWh based on 271 units. The ex post kWh savings are 89.5% greater and the kW savings are 21.1% greater than ex ante savings due to three times greater savings per lamp.

Table 3.31 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	19.6	0.007			68.5 ± 6.9	0.016 ± 0.002		

3.1.18 Load Impacts for LED Exit Signs

Load impacts for the LED Exit Signs are based on data for 2 commercial sites that received LED lamps and light logger measurements of retail and restaurant sites from previous TPDUD EM&V studies consistent with IPMVP Option B. Gross ex ante and ex post unit savings are shown in **Table 3.32**. 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 6,515 kWh/yr, 0.7 kW and 104,244 lifecycle kWh based on 70 units. 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 931 ± 93 first-year kWh, 0.1 ± 0.01 kW, and 14,892 ± 1,482 kWh lifecycle kWh based on 10 units. The ex post savings are 86% less than ex ante savings due to 86% fewer units installed than anticipated.

Table 3.32 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		

3.1.19 Load Impacts for Residential Green Partners

Load impacts for residential green partners (RGP) are based on field inspections, interviews with residential customers, and verification of the TDPUD database. On-site inspections verified installation of 312 measures compared to 184 measures reported in the TDPUD database. An additional 115 measures were installed during the EM&V inspections to motivate customers to participate in site visits. Gross ex ante and ex post unit savings are shown in **Table 3.33**. 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 274,330 first-year kWh, 62.2 kW, and 2,468,969 lifecycle kWh based on 7,000 units. The total net ex post savings are 212,581 ± 11,693 first-year kWh, 192.9 ± 6.68 kW, and 1,913,227 ± 105,235 lifecycle kWh based on 2,220 units installed. The ex post kWh savings are 22.5% less than ex ante savings due to 25% fewer units installed. The ex post kW savings are 210% greater than ex ante kW savings due to four times greater kW savings per lamp.

Table 3.33 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	61.2	0.014			63.6 ± 3.5	0.058 ± 0.002		

3.1.20 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 3.34**. 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 8,211 first-year kWh, 7.5 kW, 1,294 first-year therms, 287,577 first-year gallons of water, 73,899 lifecycle kWh, 11,642 lifecycle therms, and 2,588,194 lifecycle gallons of water based on 200 units. The total net ex post savings are 51,218 ± 5,122 first-year kWh, 44.8 ± 4.48 kW, 1,307 ± 131 therms, 290,453 ± 29,045 gallons of water, 460,957 ± 46,096 lifecycle kWh, 11,759 ± 1,176 lifecycle therms, and 2,614,076 ± 261,408 lifecycle gallons of water based on 202 units installed. The ex post kWh and kW savings are approximately five times greater than ex ante savings due to five times greater savings per unit installed. This is due to five times more measures installed per participant than anticipated. The Neighborhood Block Party program has high customer satisfaction and should be expanded to reach more customers.

Table 3.34 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	59.5	0.054	9.4	2,084	368 ± 36.7	0.321 ± 0.032	9.4 ± 0.94	2,084 ± 208

3.1.21 Load Impacts for Million CFLs

Load impacts for Million CFLs are based on field inspections of Energy Star® CFLs and interviews with TDPUD residential customers. The ex ante and ex post unit savings are shown in **Table 3.35**. The ex ante goal for Energy Star® CFL rebates 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.[31] 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 1,593,468 ± 93,733 first-year kWh, 361.5 ± 53.6 kW, and 14,341,209 ± 843,601 lifecycle kWh for 38,813 units. The ex post savings are approximately 29% greater than ex ante savings due to 28% more units being installed than anticipated. The Million CFLs program has a TRC of 9.9 and represents approximately 46% 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 3.35 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		

3.1.22 Load Impacts for LED Light Swap

Load impacts for the Light Emitting Diode (LED) Light Swap program are based on field inspections of 10 measures at 4 participant sites performed in previous TDPUD EM&V studies consistent with IPMVP Option B. The ex ante and ex post unit savings are shown in **Table 3.36**. The ex ante net-to-gross ratio is 0.80, and the ex post NTGR is 0.91 ± 0.01 based on participant surveys. The ex ante effective useful lifetime (EUL) is 5 years and the ex post EUL is 16 years based on manufacturer data of 30,000 lifecycle operational hours Mean Life Before Failure (MLBF) for LEDs (actual MLBF is 50,000 hours). The ex ante savings are 16,331 kWh/yr, 60.5 kW and 261,290 lifecycle kWh based on 750 units. The net ex post savings are 40,108 ± 4,011 first-year kWh, 148.5 ± 14.9 kW, and 641,727 ± 641,173 kWh lifecycle kWh based on 1,842 units. The ex post savings are 146% greater than ex ante kWh savings due to swapping 146% more units than anticipated. The LED Light Swap program can be improved by tracking

[31] 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).

participants in a database (i.e., customer name, number of strings, Watts per string received, and distributed).

Table 3.36 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		

3.1.23 Load Impacts Miscellaneous Water Efficiency

Load impacts for the miscellaneous water efficiency measures are evaluated using field measurements of pre- and post-retrofit flow rates from previous EM&V studies per IPMVP Option A and B.[32] TDPUD distributed 6,445 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).[33] 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.[34] 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,

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

[33] 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.

[34] Ibid.

California, June 2004.).[35] The gross ex ante and ex post unit savings are shown in **Table 3.37**. 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.[36] The study assumes that 30% of water efficiency measures are installed at homes with electric water heaters and 70% are installed at homes with gas water heaters. The ex ante and ex post NTGR is 0.77. The ex ante and ex post EUL is 10 years. The TDPUD ex ante savings are 29,364 first-year kWh, 3.6 kW, 16,679 first-year therm, 4,245,361 first-year gallons of water, 293,643 lifecycle kWh, 166,790 lifecycle therm, and 42,453,614 lifecycle gallons of water based on 5,900 units. The net ex post savings are 32,077 ± 3,208 first-year kWh, 3.9 ± 0.39 kW, 18,220 ± 1,822 first-year therm, 4,637,518 ± 463,752 first-year gallons of water, 320,768 ± 32,077 lifecycle kWh, 182,197 ± 18,220 lifecycle therm, and 46,375,177 ± 4,637,518 lifecycle gallons of water based on 6,445 units installed. The ex post savings are 9.2% greater than ex ante savings due to 9.2% more units being installed.

Table 3.37 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	0.001	3.7	934	6.5 ± 0.6	0.001 ± 0.000	3.7 ± 0.37	934 ± 93

3.1.24 Load Impacts for Water Sense® Toilets and Exchange

Load impacts for the WaterSense® Toilet 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.[37] 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 toiler 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 3.38**. 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 550 units. The net ex post savings are 17,261 ± 1,023 first-year kWh, 2.4

[35]. 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.

[36] 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.

[37] 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.

± 0.14 kW, 2,113,584 ± 15,351 first-year gallons, 258,913 ± 15,351 lifecycle kWh, and 31,703,759 ± 1,879,716 lifecycle gallons of water based on 821 units. The ex post savings are 49% greater than ex ante savings due to 49% more units than anticipated. The WaterSense® Toilet Rebate and Exchange programs have a TRC of 0.2 due to the E3 calculator not including the avoided costs of water savings. Reducing the rebate to $20 per WaterSense® toilet will make the program cost effective.

Table 3.38 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 ± 0.000		3,178 ± 188

3.1.25 Load Impacts for Customer Leak Repair

Load impacts for the Customer 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. 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 3.39**. 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 27,773,087 first-year gallons and 277,730,869 lifecycle gallons based on 100 customer sites. The net ex post savings are 118,665 ± 29,584 first-year kWh, 13.5 ± 3.38 kW, 24,718,047 ± 6,162,286 first-year gallons, 1,186,647 ± 295,841 lifecycle kWh, and 247,180,473 ± 61,622,861 lifecycle gallons of water based on 89 customer sites. The ex post savings are 11% less than ex ante savings due to 11% less participant sites than anticipated.[38] The Customer Leak Repair program has a TRC of 6.3 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",

[38] 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.

Second Edition, Lewis Publishers, 1990). The estimated leak rate in London is 50% (Marq de Villiers: "Water", Stoddart Publishing Co., 1999).

Table 3.39 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	0	0		360,689	1732 ± 432	0.198 ± 0.049		360,689 ± 89,921

3.1.26 Load Impacts for TDPUD Building EE Project

Load impacts for the TDPUD Building Energy Efficiency (EE) Project are based on the Study prepared by Enovity, Inc. of Rancho Cordova, CA.[39] The project included energy efficient HVAC operation and maintenance (O&M) measures, boiler controls, garage door insulation, and lighting controls. The TDPUD building received a commercial building energy performance (BEP) benchmark rating of 14. The TDPUD BEP rating indicates that the energy intensity needs to be reduced by 55% to qualify for the Energy Star rating of 75 (current site energy intensity is 91 kBtu/ft^2 and EPA Energy Star performance requires site energy intensity of 41 kBtu/ft^2). The ex ante and ex post unit savings are shown in **Table 3.40**. The ex ante and ex post net-to-gross ratio is 0.85. The ex ante and ex post effective useful lifetime (EUL) is 11 years. The ex ante savings are 9,265 first-year kWh, 2.1 kW, 2,465 first-year therms, 101,915 lifecycle kWh, and 27,115 lifecycle therms. The net ex post savings are 9,265 ± 927 first-year kWh, 2.1 ± 0.21 kW, 2,465 ± 247 first-year therms, 101,915 ± 10,192 lifecycle kWh, and 27,115 ± 2,712 lifecycle therms. The TDPUD Building EE Project should be continued to reduce site energy intensity by 55% and qualify for the Energy Star rating of 75.

Table 3.40 TDPUD Building EE 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. EE Project	9265	2,1	2,465		9,265 ± 927	2.1 ± 0.21	2,465 ± 247	

3.2 Verification Inspection Findings

Verification inspections were conducted in 2011 and for the previous EM&V studies in 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 and all sites passed the inspection. On-site inspections

[39] Enovity, Inc., 2009. Building Energy Use Assessment and Improvement Study for Truckee Donner Public Utility District. Prepared by Enovity, Inc., Rancho Cordova, CA. December 2009.

and survey responses were used to evaluate pre- and post-retrofit lighting fixture wattages. A total of 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 3.41**.

Table 3.41 Field Measurements of Lighting Fixture Average Power (2009 Study)

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

Light loggers were installed at 30 sites to measure hours of operation. These were left at the sites for a period of up to four weeks. Data loggers at two (2) sites were tampered with by the occupants and the data was lost. Twenty eight (28) data loggers were successfully downloaded to monitor hours of operation on 2,640 fixtures. Lighting hours of operation are based on data from twenty-eight (28) light loggers as shown in **Table 3.42**. The average EM&V ex post hours of operation are 3,533 ± 588 hours per year which compares favorably to the TDPUD ex ante assumption of 3,409 hours per year.

Table 3.42 Light Logger Measurements of Lighting Hours of Operation (2009 Study)

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

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

3.3 Participant Survey Results

This study uses participant surveys to estimate the net-to-gross ratios for kWh and kW savings. Participant surveys were completed for 167 participants and non participant surveys were completed for 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.

3.3.1 Participant Survey Methodology

Participant surveys are used to evaluate retention (i.e., measures still installed), pre-retrofit Watts, hours of operation, and time-of-use. The participant surveys were also used to evaluate net-to-gross ratios (NTGR) for calculating net kW and kWh savings. The NTGR is used to estimate the fraction of free riders who would have otherwise implemented lighting improvements in the absence of the program. For most programs, nine participant survey

questions were used to assess net-to-gross ratios as shown in **Table 3.43**. The NTGR score for each completed participant survey is the average score based on answers to questions 5 through 13. No score is assigned to responses of "don't know", "refused to answer," or "other."

Table 3.43 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

3.3.2 Findings of the Participant Surveys

Results of the participant surveys are presented in **Table 3.44**. 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 3.44 Findings of Participant Surveys for TDPUD Programs

TDPUD Program	Sample Size	Units Installed	NTGR	+/- 90% CI
1. Residential CFLs	10	282	0.69	0.07
2. Energy Star® Clotheswashers	11	224	0.68	0.08
3. Energy Star® Dishwasher	14	177	0.69	0.07
4. Energy Star® Refrigerator/Freezer	19	209	0.70	0.06
5. Refrigerator Recycling	13	24	0.85	0.05
8. Bldg Envelope Mitigation	8	4	0.80	0.08
9. Duct Mitigation	11	11	0.74	0.08
11. Commercial Lighting	15	15	0.85	0.03
13. Elec/Solar Water Heater	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	10	10	0.85	0.03
18. Keep Your Cool	7	15	0.95	0.02
19. Business LED Pilot	10	10	0.85	0.03
20. LED Business Accent	10	10	0.85	0.03
22. Residential Green partners (2009)	19	3,671	0.64	0.09
27.WaterSense® Toilets	10	821	0.81	0.07
28. Customer Leak Repair	10	89	0.77	0.14
Total	200	5,797	0.75	0.07

3.2 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**.

3.2.1 Participant Survey Results

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

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

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

- Overall Satisfaction with Program – 93.6 percent satisfaction rating (i.e., average score of 9.36 ± 0.25 out of 10 points).

- Presentation of information – 89 percent satisfaction rating (i.e., 8.9 ± 0.24 out of 10 points).
- Increased Understanding of Link between Energy Efficiency, Savings, and Comfort - 84 ± 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., 157 out of 167 surveyed customers were still using all installed measures). One customer experienced water damage and measures were damaged in the flood. Another customer indicated that door gaskets on both refrigerator and freezer were torn in half, but they were still using the gaskets even though their sealing ability failed.
- 92.1% ± 2% of customers are satisfied with measures offered or installed by the program ((i.e., average score of 9.21 ± 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.

- 89 ± 2 percent presentation rating.
- 91.2 ± 2.4 percent accuracy rating.
- 84.3 ± 2.4 percent rating of program increasing understanding of the linkage between energy efficiency, bill savings, and comfort.
- 50 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?

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

- 44% 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."
- 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, 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.[40] 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.

3.2.2 Non-Participant Survey Results

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

1. Is there a continuing need for the program?

The following responses indicate a continuing need for the program.

- 96.5 percent of participants were very satisfied with the program and said they would like the TDPUD to "do all businesses and homes in town!"
- 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.

[40] 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).

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.

3.2.3 Process Evaluation Recommendations

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

3.2.3.1 Recommendations for Database

Implement an internet-tracking system to help customers understand energy efficiency and renewable energy, apply for rebates online, and provide feedback (i.e., reviews of products and programs). The database should also be used document and verify installed measures for EM&V purposes. The online database should include the following information for each measure: name, address, phone number, e-mail address, account number, incentives paid, measure description (from pull-down list or entered), make, model number, USDOE FTC energy label rating (kWh/yr), CEE rating (Consortium for Energy Efficiency, www.cee1.orgm Tier 1, 2 or 3), efficiency rating (AFUE, MEF, WF, EF, etc.), pre/post duct leakage, pre/post building envelope leakage, pre/post Watts (lighting), date installed, pre-existing measure.

3.2.3.2 Recommendations for Million CFLs and LED Lamps

The Million CFLs program has a TRC of 9.9 and the Residential CFLs program has a TRC of 11. The Million CFL program represents approximately 46% 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). Some customers complained that CFLs and LEDs were not bright enough, and some complained about LEDs burning out quickly. TDPUD should continue to evaluate CFLs and LED lamps to find better quality products with high quality light output and longer life.

3.2.3.3 Recommendations for Energy Star® Appliances

TDPUD offers a $100 rebate to customers who purchase Energy Star® qualified appliances regardless of efficiency. Most new refrigerators currently meet the Energy Star® specification which is 20% more efficient than Federal Standards. The US Department of Energy (DOE) recently adopted new federal standards for refrigerators which will increase the minimum efficiency standards by 25% starting in 2014.[41] The Consortium for Energy Efficiency (CEE) provides three (3) Tier levels to identify appliances that are more efficient than the minimum Energy Star® rating. For refrigerators, TDPUD should offer a $50 rebate for CEE Tier 2 which is 25% more efficient than Federal Standards and $100 for CEE Tier 2 which is 30% more efficient than Federal Standards. For dishwashers, TDPUD should offer a $50 rebate for CEE Tier 1 which is 14% better than Federal Standards and $100 for CEE Tier 2 which is 17% more efficient than Federal Standards. For clotheswashers, TDPUD should offer a $50 rebate for CEE Tier 1 which is 59% more efficient than Federal Standards, $100 for CEE Tier 2 which is 75%

[41] DOE Increases Efficiency Standard for Refrigerators by 25%. September 28, 2010. SustainableBusiness.com News: http://www.sustainablebusiness.com/index.cfm/go/news.display/id/21126

more efficient, and $150 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.

3.2.3.4 Recommendations for Refrigerator & Freezer Recycling

The TDPUD refrigerator and freezer recycling program only recycled 24 units in 2011 due to using a contractor who only picked up and recycled units during the summer months. TDPUD should hire a local appliance retailer to recycle refrigerators and freezers year round since this program is very cost effective with a TRC of 3.1. Using a local retailer will significantly increase the number of units recycled and improve the local economy.

3.2.3.5 Recommendations for Building Envelope and Duct Mitigation

The building envelope and duct mitigation programs should provide rebates for contractors who achieve target leakage reduction values. The duct leakage target should be 20% 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).[42] 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. 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.).

3.2.3.6 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 to help customers understand the importance of saving electricity and natural gas by reducing window heat loss in winter and heat gain in summer. This is especially important for commercial sites that use heating and electric cooling year round such as the TDPUD district offices, local

[42] 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]),

retail stores, offices, and the hospital with south facing windows. Installing low-emissivity windows at the TDPUD offices will reduce energy use to achieve the Energy Star® BEP rating.

3.2.3.7 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.

3.2.3.8 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.

3.2.3.9 Recommendations for Electric/Solar Water Heaters

TDPUD should encourage at least one to five customers 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!”

3.2.3.10 Recommendations for Energy Assistance and Residential Energy Survey

TDPUD should encourage surveyors who perform low/moderate income energy assistance and residential energy surveys to install the measures. This will include using ladders to install CFLs and LED 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).

3.2.3.11 Recommendations for Green Schools

The Green Schools program TRC is 0.2 because the E3 calculator only values energy savings and does not currently include avoided costs for water savings. In addition to providing efficient

garden nozzles, the Green Schools program should provide each student with at least one LED or CFL lamp and one efficient showerhead and aerator to teach students how to measure fluid mechanics (volumetric flow rates at various flowing pressure), electric power (voltage, current, and Watts), and thermal heat energy (specific heat, temperature, and British thermal units – Btu). This will encourage more students to appreciate and understand science, electric power, and energy and water efficiency.

3.2.3.12 Recommendations for Business Green Partners

The Business Green Partners program has a TRC of 2.1 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.

3.2.3.13 Recommendations for Keep Your Cool

The Keep Your Cool program has a TRC of 1.2 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 Keep Your Cool 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.

3.2.3.14 Recommendations for Business LED Pilot, Accent Lighting, and Exits

The Business LED Accent Lighting program has a TRC of 11.4, Business LED Pilot program has a TRC of 3.8, and LED Exit Sign program has a TRC of 1.3. 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 and installation approach should be expanded in 2012.

3.2.3.15 Recommendations for Residential Green Partners

The Residential Green Partners program has a TRC of 2.3 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.

3.2.3.16 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.

3.2.3.17 Recommendations for Miscellaneous Water Efficiency

The Miscellaneous Water Efficiency program has a TRC of 5.1. This innovative program provided 5,900 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.

3.2.3.18 Recommendations for WaterSense® Toilets

The WaterSense® Toilets program had a TRC of 0.2. 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%.

3.2.3.19 Recommendations for Customer Leak Repair

The Customer Leak Repair program has high customer satisfaction and TRC test of 6.3. 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.

3.2.3.20 Recommendations for TDPUD Building EE Project

The TDPUD Building EE Project had a TRC of 1.2. The project should be continued to reduce site energy intensity by 55% and qualify for the Energy Star rating of 75.

Appendix A: Participant and Non Participant Decision-Maker Survey

Interview Instructions for Decision-Maker Survey

1. Purpose

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

2. Selection of Respondent

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

3. Selection of Respondent

1. **Participants** must be the person responsible for allowing program measures to be installed at the site. If this person is unavailable locate someone who is at least familiar with how that decision was made.
2. **Non-participants** must be a residential customer in the TDPUD service area that was unaware of the program or decided not to allow program measures to be installed at their home (see non-participant survey at end). Non--participant question 3 is used to verify one or more of the following attributes: 1) Primary language non-English; 2) Own 3) Lease; 4) Male or Female; or 5) Located outside TDPUD.

4. Two Types of Sites

This survey will be used for two types of sites:

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

5. How to Start a Survey

Complete the following steps to start one of these surveys:

1. Review TDPUD customer file information (for participants).
2. Make sure you understand what was installed with incentives from TDPUD prior to initiating the visit or call.
3. Participant Survey Introduction.

   Say: "Hello! My name is [_____], and I am conducting a survey regarding the TDPUD 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). _____

   _____