Evaluation, Measurement & Verification Report for Truckee Donner Public Utility District 2013 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 2013 Truckee Donner Public Utility District (TDPUD) energy efficiency programs. TDPUD serves electricity and water to the greater Truckee area and operates on a calendar-year budget. This study was conducted by Verified, Incorporated, with public benefits funds under the auspices of the Northern California Power Agency (NCPA), California Municipal Utilities Association (CMUA), and the California Energy Commission (CEC). The study will be posted on www.tdpud.org and www.ncpa.com. TDPUD implemented 25 energy efficiency programs or measures in 2013 as shown in **Table 1.1**. The programs provided educational information, incentives, and free energy efficiency measures to residential and commercial customers. TDPUD's low-income program energy savings and costs are included in the evaluation since it includes an energy efficiency component. In addition energy savings from water conservation programs are included. TDPUD accomplished 48,060 measures or 5% more than the ex ante estimate.

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

Description	Ex Ante Qty.	Ex Post Qty.
Total Installed Measures	45,815	48,060
1. Res. Lighting Rebate	500	667
2. Res. Appl. Rebates Clothes Washers ES/CEE Tier 1-3	201	234
3. Res. Appl. Rebates Dishwashers ES/CEE Tier 1	128	148
4. Res. Appl. Rebates Refrigerators ES/CEE Tier 1-3	171	197
5. Refrigerator Recycle	120	128
6. Res. Building Efficiency Rebates Envelope Testing	4	9
7. Res. Building Efficiency Rebates Duct Testing	4	8
8. Res. Building Efficiency Rebates Envelope Mitigation	4	7
9. Res. Building Efficiency Rebates Duct Mitigation	4	8
10. Thermally Efficient Windows Rebate	1	1.45
11. Commercial Lighting Rebate	25	41
12. High-Efficiency Electric Water Heater Rebate	5	3
13. Energy Saving Program (ESP) – Income Qualified	100	83
14. School Conservation Education (Trashion Show)	1800	1908
15. Res. Energy Surveys (RES)	150	284
16. Business Green Partners Lighting	1300	1242
17. Commercial Refrigeration	8	8
18. Res. Green Partner Lighting	3000	3061
19. Neighborhood Resource Mobilization (Block Party)	765	965
20. Million CFLs	29500	30709
21. LED Holiday Light Exchange	1800	1928
22. Res. Green Partners Water	5500	5680
23. Water-Efficient Toilet Rebate and Exchange	600	548
24. Customer Leak Repair Rebate	25	29
25. HE Clothes Washer Water Rebate CEE Tier 2-3	100	164

TDPUD achieved 17% greater lifecycle electricity savings with ex post savings of 23,607,109 kWh versus ex ante goal of 20,194,467 kWh. TDPUD exceeded the ex ante E3 Calculator Total Resource Cost (TRC) test goal by 8.5% with an ex post TRC of 2.42 and the ex ante TRC of 2.23 as shown in **Table 1.2**.[1] The ex post TRC is greater than the ex ante TRC due to 5% more measures, greater lifecycle savings from LED lighting, and lower measure costs due to purchasing measures in bulk. Ex post accomplishments were verified by checking the tracking database, randomly inspecting 972 measures at 14 participant sites, and conducting surveys of participants, non-participants, and non-contacts. The EM&V ex post savings are based on site inspections, engineering analysis, and previous evaluation studies of TDPUD programs including light logger data from 4,826 fixtures at 47 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)	2,287,599	2,509,741
Net Demand Savings (kW)	767.8	893.2
Net Lifecycle Electricity Savings (kWh)	20,194,467	23,607,109
Net Annual Therm Savings (therm/yr)	19,069	25,964
Net Lifecycle Therm Savings (therm)	190,825	256,664
Net Annual Water Savings (gallon/yr)[2]	17,454,563	19,049,775
Net Lifecycle Water Savings (gallon)	184,555,931	198,580,161
Total Resource Cost (TRC) Test – E3	**2.23**	**2.42**
TRC Test Costs	$897,567	$994,629
TRC Test Benefits	$2,004,981	$2,406,273
TRC Test Net Benefits	$1,107,414	$1,411,644
Participant Test	**1.00**	**1.00**
Participant Test Costs	$504,430	$601,492
Participant Test Benefits	$504,430	$601,492
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 2,287,599 kWh per year, 768 kW, 19,069 therms per year, and 17,454,563 gallons of water per year.

[1] Energy and Environmental Economics (E3), Inc. 2011. EE Reporting Tool 2011 (E3 Calculator). Prepared for the Northern California Power Agency (NCPA) and Southern California Public Power Authority (SCPPA), 353 Sacramento Street, Suite 1700, San Francisco, CA 94111.

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

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

Energy Efficiency Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm)	Gross Ex-Ante Unit Savings (gal/yr)	Net-to-Gross Ratio	Net Ex Ante Program Savings (kWh/y)	Net Ex Ante Program Savings (kW)	Net Ex Ante Program Savings (therm)	Net Ex Ante Program Savings (galyr)
1. Res. Lighting Rebate	59.5	0.014			0.69	20,528	4.8	0	0
2. Res. CW ES/CEE Tier 1-3	210.6	0.179	6.3	8,050	0.68	28,785	24.5	861	1,100,274
3. Res. DW ES/CEE Tier 1	91.3	0.141	1.3	514	0.69	8,066	12.4	115	45,396
4. Res. Refrig ES/CEE Tier 1-3	129.3	0.022			0.70	15,477	2.7	0	0
5. Refrigerator Recycling	1,151.0	0.248			0.85	117,402	25.3	0	0
6. Building Envelope Testing					0.80	0	0.0	0	0
7. Duct System Testing					0.74	0	0.0	0	0
8. Building Envelope Mitigation	71.4	0.059	41.8		0.80	228	0.2	134	0
9. Duct System Mitigation	96.7	0.080	56.6		0.74	286	0.2	168	0
10. Thermally Efficient Window	160.0	0.531	10.9		0.96	154	0.5	10	0
11. Commercial Lighting Rebate	4,988.4	1.008			0.89	110,992	22.4	0	0
12. HE Elec Wtr Heater Rebate	32.0	0.005			0.79	126	0.0	0	0
13. ESP – Income Qualified	314.4	0.233	25.4	4,475	0.84	26,410	19.6	2,134	375,900
14. School Conservation Educ.	59.5	0.014			0.80	85,680	20.2	0	0
15. Res. Energy Surveys (RES)	969.1	0.796	30.6	7,053	0.64	93,034	76.4	2,938	677,088
16. Bus. Green Partners Lighting	165.1	0.046			0.85	182,436	50.8	0	0
17. Commercial Refrigeration	16,483.1	2.152			0.95	125,271	16.4	0	0
18. Res. Green Partner Lighting	59.5	0.014			0.64	114,240	26.9	0	0
19. Neighborhood (Block Party)	59.5	0.014			0.69	31,407	7.4	0	0
20. Million CFLs	59.5	0.014			0.69	1,211,123	285.0	0	0
21. LED Holiday Light Exchange	23.9	0.089			0.91	39,148	145.8	0	0
22. Res. Green Partners Water	3.9	0.002	2.9	1,469	0.77	16,517	8.5	12,282	6,221,215
23. Water-Eff. Toilet Rebate/Exg	26.0	0.004		3,178	0.81	12,636	1.9	0	1,544,508
24. Customer Leak Repair	1,731.6	0.198		360,664	0.77	33,333	3.8	0	6,942,782
25. HE CW Wtr Rebate CEE 2-3	210.6	0.179	6.3	8,050	0.68	14,321	12.2	428	547,400
Total						2,287,599	768	19,069	17,454,563

The EM&V ex post first-year savings are summarized in **Table 1.4**. The EM&V study found first-year net ex post program savings of 2,509,853 ± 82,984 kWh per year, 893 ± 46 kW per year, 25,964 ± 1,792 therms per year, and 19,049,775 ± 2,054,753 gallons (25,468 ± 2,747 CCF) of water per year at the 90 percent confidence level. The net first-year realization rates are 1.11 ± 0.04 for kWh, 1.2 ± 0.06 for kW, 1.4 ± 0.09 for therms, and 1.1 ± 0.12 for gallons of water.

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

Energy Efficiency Measure	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm)	Gross Ex-Post Unit Savings (gal)	Net-to-Gross Ratio	Net Ex Post Program Savings (kWh/y)	Net Ex Post Program Savings (kW)	Net Ex Post Program Savings (therm)	Net Ex Post Program Savings (gal)
1. Res. Lighting Rebate	59.5	0.014			0.69	27,384	6.2	0	0
2. Res. CW ES/CEE Tier 1-3	164.3	0.165	6.3	2,408	0.68	26,141	26.2	1,002	383,180
3. Res. DW ES/CEE Tier 1	91.3	0.141	1.3	514	0.69	9,326	14.4	136	52,531
4. Res. Refrig ES/CEE Tier 1-3	129.3	0.022			0.70	17,830	3.1	0	0
5. Refrigerator Recycling	1,151.0	0.248			0.85	125,233	27.0	0	0
6. Building Envelope Testing					0.80	0	0.0	0	0
7. Duct System Testing					0.74	0	0.0	0	0
8. Building Envelope Mitigation	71.4	0.059	41.8		0.80	400	0.3	234	0
9. Duct System Mitigation	96.7	0.080	56.6		0.74	572	0.5	335	0
10. Thermally Efficient Window	160.0	0.531	10.9		0.96	223	0.7	15	0
11. Commercial Lighting Rebate	4,597.2	1.700			0.89	167,753	62.0	0	0
12. HE Elec Wtr Heater Rebate	32.0	0.005			0.79	76	0.0	0	0
13. ESP – Income Qualified	688.0	0.541	35.0	5,628	0.84	47,970	37.7	2,441	392,355
14. School Conservation Educ.	59.5	0.014			0.80	90,821	20.6	0	0
15. Res. Energy Surveys (RES)	829.1	0.663	40.6	6,566	0.64	150,698	120.6	7,381	1,193,455
16. Bus. Green Partners Lights	162.7	0.049			0.94	189,949	56.7	0	0
17. Commercial Refrigeration	16,483.1	2.152			0.95	125,271	16.4	0	0
18. Res. Green Partner Lighting	60.6	0.017			0.64	118,678	32.5	0	0
19. Neighborhood (Block Party)	52.1	0.014			0.69	34,668	9.4	0	0
20. Million CFLs	59.5	0.014			0.69	1,260,758	286.1	0	0
21. LED Holiday Light Exchnge	23.9	0.089			0.91	41,981	155.5	0	0
22. Res. Green Partners Water	3.8	0.002	3.3	1,524	0.77	16,611	9.0	14,419	6,665,550
23. Wtr-Eff. Toilet Rebate/Exg	26.0	0.004		3,178	0.81	11,521	1.7	0	1,410,772
24. Customer Leak Repair	1,731.6	0.198		360,689	0.77	38,666	4.4	0	8,054,196
25. HECW Wtr Rebate CEE 2-3	65.7	0.020		8050	0.68	7,323	2.2	0	897,736
Total						2,509,853	893.2	25,964	19,049,775
90% Confidence Interval						82,984	46	1,792	2,054,753
Realization Rate						1.1 ± 0.04	1.2 ± 0.06	1.4 ± 0.09	1.1 ± 0.12

The lifecycle electricity and water savings are summarized in **Table 1.5**. The net ex-ante lifecycle program savings are 20,194,467 kWh, 190,825 therms, and 184,555,931 gallons of water. The net ex-post lifecycle program savings are 23,607,109 ± 735,430 kWh, 256,664 ± 17,597 therms, and 198,580,161 ± 20,561,161 gallons of water (265,481 ± 27,489 CCF). The net lifecycle realization rates are 1.17 ± 0.04 for kWh, 1.35 ± 0.09 for therms, and 1.08 ± 0.11 for gallons of water.

Table 1.5 Lifecycle Electricity, Natural Gas, and Water Savings

Energy Efficiency Measure	Ex Ante Effective Useful Life (EUL)	Net Ex-Ante Lifecycle Program Savings (kWh)	Net Ex-Ante Lifecycle Program Savings (therm)	Net Ex-Ante Lifecycle Program Savings (gal)	Ex Post EUL	Net Ex-Post Lifecycle Program Savings (kWh)	Net Ex-Post Lifecycle Program Savings (therm)	Net Ex-Post Lifecycle Program Savings (gal)
1. Res. Lighting Rebate	9	184,748	0	0	9	246,453	0	0
2. Res. CW ES/CEE Tier 1-3	12	345,420	10,333	13,203,288	12	313,691	12,029	4,598,160
3. Res. DW ES/CEE Tier 1	11	88,728	1,263	499,361	11	102,591	1,494	577,836
4. Res. Refrig ES/CEE Tier 1-3	14	216,678	0	0	14	249,624	0	0
5. Refrigerator Recycling	5	587,010	0	0	5	626,167	0	0
6. Building Envelope Testing	5	0	0	0	5	0	0	0
7. Duct System Testing	5	0	0	0	5	0	0	0
8. Building Envelope Mitigation	18	4,113	2,408	0	18	7,193	4,212	0
9. Duct System Mitigation	18	5,152	3,016	0	18	10,302	6,034	0
10. Thermally Efficient Window	20	3,072	209	0	20	4,454	305	0
11. Commercial Lighting Rebate	15	1,664,879	0	0	15	2,516,301	0	0
12. HE Elec Wtr Heater Rebate	15	1,896	0	0	15	1,138	0	0
13. ESP – Income Qualified	9	237,686	19,202	3,383,100	9	431,731	21,965	3,531,193
14. School Conservation Educ.	9	771,120	0	0	9	817,387	0	0
15. Res. Energy Surveys (RES)	9	837,302	26,438	6,093,792	9	1,356,279	66,433	10,741,094
16. Bus. Green Partners Lights	3	547,307	0	0	9	1,709,541	0	0
17. Commercial Refrigeration	8	1,002,171	0	0	8	1,002,171	0	0
18. Res. Green Partner Lighting	9	1,028,160	0	0	9	1,068,100	0	0
19. Neighborhood (Block Party)	9	282,664	0	0	9	312,013	0	0
20. Million CFLs	9	10,900,103	0	0	9	11,346,822	0	0
21. LED Holiday Light Exchnge	16	626,371	0	0	16	671,689	0	0
22. Res. Green Partners Water	10	165,165	122,815	62,212,150	10	166,108	144,192	66,655,504
23. Wtr-Eff. Toilet Rebate/Exg	15	189,540	0	23,167,620	15	172,816	0	21,161,585
24. Customer Leak Repair	10	333,333	0	69,427,820	10	386,660	0	80,541,958
25. HECW Wtr Rebate CEE 2-3	12	171,851	5,141	6,568,800	12	87,878	0	10,772,832
Total		20,194,467	190,825	184,555,931		23,607,109	256,664	198,580,161
90% Confidence Interval						735,430	17,597	20,561,918
Realization Rate						1.17 ± 0.04	1.35 ± 0.09	1.08 ± 0.11

The energy impact reporting for 2013 programs is provided in **Table 1.6**.

Table 1.6 Energy and Water Impact Reporting for 2013 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	2013	3,124	2,510	1.028	0.893	25,547	26,662	30,745	26,660
2	2014	3,124	2,510	1.028	0.893	25,547	26,662	30,745	26,660
3	2015	3,124	2,510	1.028	0.893	25,547	26,662	30,745	26,660
4	2016	2,909	2,510	0.968	0.893	25,547	26,662	30,745	26,660
5	2017	2,909	2,510	0.968	0.893	25,547	26,662	30,745	26,660
6	2018	2,771	2,385	0.938	0.866	25,547	26,662	30,745	26,660
7	2019	2,771	2,385	0.938	0.866	25,547	26,662	30,745	26,660
8	2020	2,771	2,385	0.938	0.866	25,547	26,662	30,745	26,660
9	2021	2,639	2,259	0.921	0.850	25,547	26,662	30,745	26,660
10	2022	346	338	0.281	0.280	18,417	16,840	28,732	24,540
11	2023	282	283	0.265	0.267	2,467	2,421	5,877	4,862
12	2024	270	274	0.247	0.252	2,301	2,285	5,789	4,791
13	2025	206	240	0.193	0.224	405	584	2,549	1,886
14	2026	206	240	0.193	0.224	405	584	2,549	1,886
15	2027	184	223	0.189	0.221	405	584	2,549	1,886
16	2028	44	43	0.161	0.157	405	584	0	0
17	2029	1	1	0.001	0.002	405	584	0	0
18	2030	1	1	0.001	0.002	405	584	0	0
19	2031	0	0	0.001	0.001	11	15	0	0
20	2032	0	0	0.001	0.001	11	15	0	0
21	2033	0	0	0.000	0.000	0	0	0	0
22	2034	0	0	0.000	0.000	0	0	0	0
23	2035	0	0	0.000	0.000	0	0	0	0
24	2036	0	0	0.000	0.000	0	0	0	0
25	2037	0	0	0.000	0.000	0	0	0	0
Total		27,683	23,607			255,559	265,044	324,749	279,796

** 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)	Ex Post TRC
TOTAL EE PORTFOLIO	1,930	893	2,509,853	23,607,109	25,666	12,705	0.05	2.42
20. Million CFLs	1,144	286	1,260,758	11,346,822	0	6,057	0.02	4.70
24. Customer Leak Repair	4	4	38,666	386,660	0	209	0.03	4.11
18. Res. Green Partner Lighting	108	32	118,678	1,068,100	0	570	0.03	3.53
16. Bus. Green Partners Lights	57	57	189,949	1,709,541	0	947	0.04	3.74
22. Res. Green Partners Water	9	9	16,611	166,108	14,419	89	0.33	3.47
19. Neighborhood (Block Party)	32	9	34,668	312,013	0	167	0.03	3.39
1. Res. Lighting Rebate	25	6	27,384	246,453	0	132	0.03	3.14
14. School Conservation Educ.	82	21	90,821	817,387	0	436	0.04	2.75
5. Refrigerator Recycling	27	27	125,233	626,167	0	340	0.04	2.69
15. Res. Energy Surveys (RES)	121	121	150,698	1,356,279	6,643	724	0.07	2.42
6-9. Bldg/Duct Test/Repair	1	1	972	17,495	1,025	11	0.63	1.88
21. LED Holiday Light Exchange	155	155	41,981	671,689	0	359	0.07	1.84
2. Res. CW ES/CEE Tier 1-3	26	26	26,141	313,691	1,203	173	0.14	1.32
17. Commercial Refrigeration	16	16	125,271	1,002,171	0	528	0.09	1.23
11. Commercial Lighting Rebate	62	62	167,753	2,516,301	0	1,394	0.13	1.17
10. Thermally Efficient Window	1	1	223	4,454	30	3	0.31	1.13
13. ESP – Income Qualified	38	38	47,970	431,731	2,197	230	0.15	1.09
4. Res. Refrig ES/CEE Tier 1-3	3	3	17,830	249,624	0	135	0.13	1.03
25. HECW Wtr Rebate CEE Tier 2-3	2	2	7,323	87,878	0	49	0.15	0.94
3. Res. DW ES/CEE Tier 1	14	14	9,326	102,591	149	57	0.17	0.92
12. HE Elec Wtr Heater Rebate	0	0	76	1,138	0	1	0.39	0.32
23. Wtr-Eff. Toilet Rebate/Exg	2	2	11,521	172,816	0	94	0.50	0.27

The TDPUD E3 energy efficiency portfolio total utility resource cost is $0.05/kWh and the net lifecycle green house gas (GHG) reductions are 12,705 tons. TDPUD energy efficiency (EE) portfolio realized a 2.42 TRC which is 8.5% greater than anticipated due to the longer EUL for commercial LED lamps and installing 5% more measures through community-based programs. The top ten programs have an average TRC of 3.4. The Million CFL program realized a TRC of 4.7 by purchasing CFLs in large quantities at low cost and installing CFLs through multiple programs. The Water Leak Repair and Residential Green Partners Water programs realized a TRC of 4.12 and 3.48 respectfully due to electricity savings from water pumping and therm savings from units installed at sites with gas water heaters. The Business Green Partners lighting program realized a TRC of 3.74 due to the longer EUL of LED lamps and bulk purchases of LED lamps and CFLs and distributing directly to commercial customers. The Neighborhood Resource Mobilization (Block Party) program realized a TRC of 3.39 by providing free energy efficient CFLs directly to customers who attended neighborhood events. The Residential Lighting Rebate Program achieved a 3.14 TRC. The School Conservation Education program achieved a TRC of 2.75 by promoting energy and water conservation through activities designed to educate students and deliver free energy and water savings measures. The Refrigerator Recycling program realized a TRC of 2.69 by using a local appliance store to recycle units. Residential Energy Surveys program realized a TRC of 2.42 by providing a large selection of energy efficiency measures to customers. The LED Holiday Lighting Exchange program realized a TRC of 1.84 by exchanging new free energy-efficient LED lighting strands to customers who turn in old incandescent holiday light strands. The Commercial Refrigeration program realized a TRC of 1.23 by installing 284 commercial refrigeration measures including LED refrigeration case lights, door gaskets, floating-head pressure controls, anti-sweat heater controls, efficient

evaporator fan motors (electronically commutated motors - ECMs), and ECM fan controllers. The Energy Star® CEE Tier 1-3 Clotheswasher program realized a TRC of 1.32, and the High Efficiency Clotheswasher Water Rebate CEE Tier 2-3 program realized a TRC of 0.94. When analyzed together these two clotheswasher rebate programs have a combined TRC of 1.16. The Energy Star® and CEE Tier 1-3 Refrigerator Rebate program realized a TRC of 1.03 and the Energy Star® and CEE Tier 1 Dishwasher program realized a TRC of 0.92. Savings were evaluated using the US EPA database (http://www.energystar.gov/). Energy Saving Partners program realized a TRC of 1.09 by combining income-qualified incentives with required energy efficiency retrofits and Commercial Lighting realized a TRC of 1.17. TDPUD offered a wide range of successful programs for residential and commercial customers that generally met or exceeded the ex ante savings goals. As noted above, TDPUD also purchased large quantities of measures at wholesale prices and gave these measures away free to capture significant savings while promoting their other programs. TDPUD partnered with several local organizations to implement projects including: Sierra Watershed Education Partnership, 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.

The Water-Efficient Toilet Rebate and Exchange program TRC is 0.27. The E3 calculator does not account for avoided costs of water. Therefore, the water-efficient toilet TRC is lower than it would be if water savings were included in the analysis. Other water programs save enough energy to be cost effective such as the Residential Green Partner Water program with a TRC of 3.47, Customer Leak Repair program with a TRC of 4.70, High-Efficiency Clotheswasher Water Rebate CEE Tier 2-3 program with a TRC of 0.94, and Residential Dishwasher ES/CEE Tier 1 Rebate program with a TRC of 0.92. Since TDPUD is an electric and water utility the overall energy efficiency savings and costs associated with water conservation programs are included. This provides an accurate accounting of the energy and water saved by all TDPUD programs. When evaluated from a purely energy efficiency point of view some of the water efficiency programs appear to be less cost effective, but these programs offer many other benefits with respect to water conservation that TDPUD is concerned with.

Participant and non-participant process surveys were used to obtain general feedback and suggestions. Survey results indicate 95 percent of participants are satisfied with the program based on 8,137 survey responses to 35 questions from 191 randomly selected participants over a period of 5 years. Most participants expressed appreciation for free measures and incentives. Process survey responses indicated significant demand for the program with an overall rating of 9.51 ± 0.02 out of 10 points. Participants indicated that they would like to see improved programs to better serve TDPUD customers. Non-participant survey results indicate 67 percent would have participated if they had known about the program with 25% declining due to already having compact fluorescent lamps installed, and 7% being too busy or not understanding energy efficiency program benefits. Most customers indicated better advertising, education (i.e., information about savings), and more variety of measures would have helped. Process survey results, on-site verification inspections, and field measurements were used to guide the overall process evaluation in terms of investigating operational characteristics of the program and developing specific recommendations to help make the program more cost effective, efficient,

and operationally effective. The following process evaluation findings and recommendations are provided to improve program services, procedures, and cost effectiveness.

- TDPUD implemented an internet-tracking system (www.energy-orbit.com) to track program accomplishments. The tracking database helps customers understand energy efficiency by providing information about energy savings, apply for rebates online, and provide feedback regarding the rebate process and programs. The database can be used to provide interim information about program energy savings and help document and verify installed measures for EM&V reporting.
- Provide better advertising to increase participation including bill inserts, internet information, handouts or fliers that tell customers about the programs and free services.
- The Million CFLs program has a TRC of 4.70. The program provides CFLs for residential and commercial customers. TDPUD continues to evaluate CFLs and LED lamps to find better quality products with longer life and reasonable price. The program has installed approximately 297,000 CFLs since 2008 or 30% of its goal.
- TDPUD redesigned the Residential Appliance Rebate program in 2013 to promote CEE Tier clotheswashers, dishwashers, and refrigerators. The dishwasher rebate program TRC is 0.92. TDPUD should consider reducing the dishwasher incentive to $50 to make that program cost effective.
- The Energy Star® CEE Tier 1-3 Clotheswasher rebate program realized a TRC of 1.32, and the High Efficiency Clotheswasher Water Rebate CEE Tier 2-3 program realized a TRC of 0.94. When analyzed together these two rebate programs have a combined TRC of 1.16.
- The TDPUD refrigerator and freezer recycling program realized a TRC of 2.69 by recycling 128 units in 2013. This is a 440% increase in recycled units compared to 2011. This successful program should be continued to stimulate the local economy.
- The building envelope and duct mitigation program realized a TRC of 1.88. This program should provide rebates for achieving minimum leakage reduction targets. The duct leakage target should be 15% measured in cubic feet per minute (cfm) or 15% total duct leakage as a percentage of total system airflow. The building envelope sealing target should be 15% CFM50 reduction in air leakage or no less than 0.3 Air Changes per Hour (ACH).[1] Information and incentives should be provided to commercial customers to optimize minimum outdoor air damper settings to save cooling and heating energy.
- Consider offering incentives to all electric homes for passive solar heating and sun spaces with thermal mass, super insulation (attic, wall, floor, and radiant barriers) with the TDPUD building envelope and duct mitigation programs. Consider at least one pilot demonstration sun space project in 2013 at the Senior Center where billing data for one unit with a temporary plastic sun space enclosure reduced electric resistance heating bills by 50%.
- The Thermally Efficient Window program realized a TRC of 1.13. TDPUD should consider 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 by reducing window heat loss in winter and heat gain in summer. Installing low-emissivity windows at the TDPUD offices will reduce energy use to achieve the Energy Star® BEP rating. The Energy Star® window

qualification criteria maximum u-value is 0.32 Btu/hr-ft^2-°F and less than or equal to 0.4 SHGC. In 2013 TDPUD adopted the Energy Star® window criteria to qualify for this program. The SHGC will be effective in reducing residential and commercial cooling loads in summer when solar gains and outdoor temperatures peak on south facing exposures.

- The commercial lighting program realized a TRC of 1.17 which is a 23% improvement compared to 2012. Approximately 93% of the 2013 lighting rebates were for LED fixtures. The program should consider an LED-only retrofit incentive in 2013 (i.e., 10% bonus). The 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.
- TDPUD should encourage at least one customer with an electric water heater to install a solar water heater consistent with the California Solar Initiative (CSI) Thermal Program (see http://www.gosolarcalifornia.org/solarwater/). The CSI-Thermal program offers rebates of up to $1,875 for solar water heating systems on single-family homes. Multifamily and commercial properties qualify for rebates up to $500,000. The CSI program encourages customers to "save money on gas or electricity bills by harnessing the heat of the sun!"
- TDPUD should continue to require energy auditors who perform Low/Moderate Income Energy Assistance and Residential Energy Surveys to install the measures. This will include using ladders to install CFL lamps in ceiling fixtures. Many low income elderly or disabled customers cannot climb ladders. Requiring the installation of all measures will improve cost effectiveness and help low income customers save energy and money.
- The Business Green Partners Lighting program has a TRC of 2.02 and is very popular with small commercial business customers. TDPUD should continue to offer this program to help small local businesses save energy and be successful. This program generates high customer satisfaction ratings with 97% of participants indicating they were very satisfied with the overall energy efficiency services received from TDPUD.
- The Commercial Refrigeration Retrofit program has a TRC of 1.23 and is popular with small commercial business customers. TDPUD should continue to offer this 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 Residential Green Partners Lighting program has a TRC of 3.53. The program distributes information and free energy-efficient lighting measures to residential customers. This program invites customers to visit the TDPUD Conservation office and select various CFLs for free.. The program allows customers to determine which lamps they prefer and purchase additional units to take advantage of the residential $2/lamp lighting rebate.
- The Neighborhood Resource Mobilization Block Party program provides energy efficiency block parties offering CFLs and WaterSense® showerheads and aerators. The program should consider offering additional measures such as, duct sealing, building envelope repair, leak repair, insulation, Energy Star® window upgrades, and Energy Star® residential climate control thermostats. This program should be expanded to reach more customers.
- The Residential Green Partners Water program has a TRC of 3.47. The program provided 5,680 water efficiency measures to customers. The 2010 EM&V study received comments

from some customers who complained that the low-flow showerheads and aerators didn't provide enough flow. TDPUD purchased aerators and WaterSense® showerheads in 2012 and 2013 and this greatly improved customer satisfaction. This cost effective water efficiency program should be continued. WaterSense® showerheads and aerators save the equivalent of one CFL in pumping electricity annually and pre-rinse spray valves save the equivalent of 10 CFLs not including water heating energy savings.

- Consider offering incentives for water conservation gardens and landscaping to save water using the Patricia S. Sutton TDPUD Conservation Garden as an example.
- The Water Efficient Toilet Rebate and Exchange program had a TRC of 0.27. This water conservation program was only evaluated from an energy efficiency point of view. The TRC would be greater if avoided costs of water were included in the analysis.
- The Customer Leak Repair program has high customer satisfaction and TRC test of 4.11. 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 program.
- 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 **4.4.3 Process Evaluation Recommendations**).

Section 2 describes the EM&V checklist information. **Section 3** describes the EM&V objectives, including baseline information, energy efficiency measure information, measurement and verification approach, and the evaluation approach. **Section 3** also includes equations used to develop energy and peak demand savings, sample design, methods used to verify proper installation of measures, and methods used to perform field measurements. **Section 4** provides EM&V study findings including load impact results and process evaluation results regarding what works, what doesn't work, and recommendations to improve the program's services and procedures. **Section 4** also includes measure recommendations to increase savings, achieve greater persistence, and improve customer satisfaction. **Appendix A** provides the CEC EM&V Checklist. **Appendix B** provides the participant decision-maker survey instrument for the TDPUD programs. **Appendix C** provides the Light Logger Metering Equipment Protocols.

2. EM&V Checklist Information

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

2.1 Contextual Reporting

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

Table 2.1 provides a comparison of the EM&V study savings values compared to the associated ex ante savings. The EM&V study found net peak demand savings of 893 ± 46 KW, net annual savings of 2,509,853 ± 82,984 kWh per year, net lifecycle savings of 23,607,109 ± 735,430 kWh, and net lifecycle green house gas savings of 12,072 ± 394 tons. With respect to the ex ante savings for TDPUD, the EM&V study net ex post savings represent 116% of net ex ante peak kW, 110% of annual net ex ante kWh, 117% of net ex ante lifecycle kWh, and 117% of the net ex ante GHG savings.

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

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

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

The uncertainties associated with selecting the components of the portfolio to evaluate are unknown as 100% of the portfolio was evaluated. The uncertainties associated with the EM&V study are 10.4% of the net savings at the 90 percent confidence level. The EM&V study evaluated the uncertainty based on the mean and standard deviation for 10,947 measures included in EM&V studies of similar programs since 2008. The uncertainty is approximately 7% for kW savings, 3.3% for first year kWh savings, and 10.4% for lifecycle kWh savings.

Table 2.1 EM&V Savings Compared to Ex Ante Savings

Description	Ex Ante	EM&V Study	%
Net Peak kW Savings	767.8	893.2	116%
Net Annual kWh Savings	2,287,599	2,509,853	110%
Net Lifecycle kWh Savings	20,194,467	23,607,109	116%
Net Lifecycle GHG Savings (tons)	10,842	12,705	116%
Utility Incentive Cost ($)	$504,430	$601,492	119%
Utility Marketing, EM&V, and Administrative Cost ($)	$393,137	$393,137	100%
Total Utility Cost ($)	$897,567	$994,629	111%
TRC	2.23	2.42	109%

2.2 Overview and Documentation of Evaluation Effort

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

The EM&V study performed site visits and measurements at 12 of the largest non-residential customer sites in 2013 per IPMVP options A and B. The study performed engineering and statistical analyses of all other non-residential and residential programs per IPMVP options A based on EM&V studies conducted over the previous 5 years. The EM&V study performed on-site inspections to verify the measures and installed light loggers to measure hours of operation. The study also conducted surveys with decision maker to evaluate net-to-gross ratios (i.e., free riders) and customer satisfaction and obtain customer feedback and suggestions to improve the program (see **Appendix B**).

☒ Include an assessment of EUL and lifecycle savings.

The EM&V lifecycle savings are generally based an average effective useful lifetime (EUL) values provided in the Energy Environmental Economics (E3) calculator and based on the DEER.[3] The EM&V study found the following gross lifecycle savings of 30,597,118 +/- 1,000,349 kWh and 16,537 ± 541 tons of greenhouse gas (GHG) emissions. The ex ante gross lifecycle savings are 26,996,985 kWh and 14,592 tons of GHG emissions.

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

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

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

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

☒ Include all data collection instruments in an appendix.

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

☒ Describe metering equipment and protocols in an appendix.

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

2.3 Gross Savings

☒ Review the program's choice of baseline.

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

☒ Characterize the population of participants.

The population of TDPUD participants by program application is shown in **Table 2.2**. Approximately 10,390 customers participated in the 2013 programs. The EM&V non-residential participant average floor area is 22,594 +/- 19,101 square feet. The building types included: hotel, hospitality, restaurants, retail, office, elementary schools, and high schools. Average non-residential occupancy is 33 +/- 18. The end use categories include HVAC, refrigeration, VFD pumps, lighting (lamps, fixtures, sensors), and computing (PC network power management). Residential end use categories include HVAC, appliances, refrigerator/freezer recycling, lighting, water heating, toilets, and water pumping (i.e., delivery and treatment).

[3] Ibid.

Table 2.2 Population of TDPUD Participants by Measure

Program	Participant Applications
1. Res. Lighting Rebate	55
2. Res. Appl. Rebates Clothes Washers ES/CEE Tier 1-3	234
3. Res. Appl. Rebates Dishwashers ES/CEE Tier 1	148
4. Res. Appl. Rebates Refrigerators ES/CEE Tier 1-3	198
5. Refrigerator Recycle	128
6. Res. Building Efficiency Rebates Envelope Testing	9
7. Res. Building Efficiency Rebates Duct Testing	8
8. Res. Building Efficiency Rebates Envelope Mitigation	7
9. Res. Building Efficiency Rebates Duct Mitigation	8
10. Thermally Efficient Windows Rebate	1
11. Commercial Lighting Rebate	41
12. High-Efficiency Electric Water Heater Rebate	3
13. Energy Saving Program (ESP) – Income Qualified	83
14. School Conservation Education (Trashion Show)	1908
15. Res. Energy Surveys (RES)	284
16. Business Green Partners Lighting	59
17. Commercial Refrigeration	8
18. Res. Green Partner Lighting	611
19. Neighborhood Resource Mobilization (Block Party)	63
20. Million CFLs	2559
21. LED Holiday Light Exchange	595
22. Res. Green Partners Water	2840
23. Water-Efficient Toilet Rebate and Exchange	347
24. Customer Leak Repair Rebate	29
25. HE Clothes Washer Rebate CEE Tier 2-3	164
Total	10,390

☒ Discuss the sampling approach and sample design.

The sampling approach for gross savings involved selecting a random sample of sites or measures from the program population. Samples were selected to obtain a reasonable level of precision and accuracy at the 90% confidence level. The sample design was based on statistical survey sampling methods.[4] Sampling methods were used to analyze data and extrapolate mean savings estimates from the sample measurements to the population of all program participants and to evaluate the statistical precision of the results.[5] Similar measures were grouped together to reduce the overall sample size requirements necessary to achieve the desired level of confidence and yield the greatest accuracy at the lowest cost. The sample size was based on relative savings per measure assuming a coefficient of variation (Cv) of 0.5 and relative precision of 0.1 to 0.2 to achieve 80 to 90% confidence.

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

[5] 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.

☒ State the sampling precision targets and achieved precision.

The sampling precision targets are +/- 10%. The EM&V study achieved precision of+/- 9% at the 90% +/- 10% confidence level based on average savings per measure and standard deviations for measures in the sample for this study and previous studies.

☒ Present ex post gross savings.

The EM&V study found the following ex post gross savings for the program 1,185 kW, 3,400,352 kWh per year, 35,598 therm/yr, 33,623 CCF/yr, lifecycle savings of 31,809,558 kWh, 350,805 therms, 349,892 CCF of water, and 17,213 tons of greenhouse gas (GHG) emissions. Ex post gross savings do not include the NTGR.

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

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

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

With respect to the ex ante savings for TDPUD, the EM&V study net ex post savings represent 116% of net ex ante peak kW, 110% of annual net ex ante kWh, 117% of net ex ante lifecycle kWh, and 117% of the net ex ante GHG savings. The ex post savings are greater due to installing 5% more measures and longer EUL for LED lamps.

2.4 Net Savings

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

The quantitative assessment of the net-to-gross ratio (NTGR) is provided in **Section 3**. The EM&V study weighted average NTGR is 0.73 for approximately 100% of the total energy savings based on surveys of 191 program participants. The ex ante assumed net to gross ratio is 0.75. Net to gross ratios are used to determine the portion of the total energy savings (gross savings) that is attributable to the utility energy efficiency program. For a complete discussion on rationale and approaches used to establish the program NTGR, please refer to the Model Energy Efficiency Program Impact Evaluation Guide - November 2007, published by the National Action Plan for Energy Efficiency Leadership Group.

☒ Discuss the sampling approach and sample design.

The sampling approach for net savings involved selecting a random sample of representative participants from the program population. Sampling methods were used to analyze data and extrapolate average survey responses (i.e., net-to-gross ratios) to the population of all program participants and to evaluate the statistical precision of the results. Customers in similar programs were grouped together to reduce the overall sample size requirements necessary to achieve the desired level of confidence and yield the greatest accuracy at the

lowest cost. Samples were selected to obtain a reasonable level of precision and accuracy at the 90% confidence level.

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

The EM&V study used a self-report method including interviews with participants. Non participant surveys were not conducted due to time and budget limitations. The survey results indicate free ridership ranges from 0 to 36% with an average of 27% who indicated that they would have installed energy efficiency measures without the rebates. The total gross lifecycle kWh savings are reduced by 27% to account for free-ridership.

2.5 EM&V Summary and Conclusions

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

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

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

The EM&V study evaluated the reliability and uncertainty of the verified savings based on the mean and standard deviation for 10,390 participants who received free measures or submitted rebate applications. The uncertainty is approximately 5.1% for kW savings, 3.3% for first year kWh, 6.9% for therms, and 10.8% for water.

3. Required EM&V Objectives and Components

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

Table 3.1 Components of an EM&V Plan

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

3.1 Baseline Information

Existing studies were used to determine whether or not baseline data exist to reference energy and peak demand savings measurements. Existing baseline data will be obtained from prior EM&V studies, the California Measurement Advisory Committee (CALMAC, http://www.calmac.org), and the California Energy Commission (CEC, http://www.energy.ca.gov). Existing baseline studies are provided in **Table 3.2**.

Table 3.2 Existing Baseline Studies

Study	Description
1	*Evaluation Measurement and Verification Report for the Truckee Donner Public Utility District 2012 Energy Efficiency Programs*, Prepared by Verified, Inc., April 2013.
2	*Evaluation Measurement and Verification Report for the Truckee Donner Public Utility District 2011 Energy Efficiency Programs*, Prepared by Verified, Inc., April 2012.
3	*Evaluation Measurement and Verification Report for the Truckee Donner Public Utility District 2010 Energy Efficiency Programs*, Prepared by Verified, Inc., February 2011.
4	*Evaluation Measurement and Verification Report for the Truckee Donner Public Utility District 2008 Energy Efficiency Programs*, Prepared by Robert Mowris & Associates, February 2009.
5	*Evaluation Measurement and Verification Report for the Small Nonresidential Energy Fitness Program #179*, Prepared by Robert Mowris & Associates, April 30 2004.
6	*Measurement & Verification Summary Report for NCPA SB5X Programs* prepared for NCPA and the California Energy Commission, 2005.
7	*Measurement and Verification Report for NCPA SB5X Commercial and Industrial Lighting Programs*, prepared for NCPA, prepared by RMA, 2005.
8	*Measurement and Verification Report for NCPA SB5X Refrigerator Recycling Programs*, prepared for NCPA, prepared by RMA, 2005.
9	*Measurement and Verification Report for NCPA SB5X Residential Compact Fluorescent Lamp Programs*, prepared for NCPA, prepared by RMA, 2005.
10	*Measurement and Verification Report for NCPA SB5X Miscellaneous Programs*, prepared for NCPA, prepared by Robert Mowris & Associates, 2005.
11	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/.
12	*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
13	*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/.
14	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.
15	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.
16	*California Statewide Residential Appliance Saturation Survey.* Study 300-00-004, prepared for California Energy Commission, prepared by KEMA-XENERGY Inc. Oakland, California, June 2004.
17	*USEPA FTC Databases (http://www.energystar.gov/) and Refrigerator and Freezer Energy Rating Databases (http://www.kouba-cavallo.com/refmods.htm).*

3.2 Energy Efficiency Measure Information

This section provides energy efficiency measure information including assumptions about important variables and unknowns, especially those affecting energy savings. Ex Ante energy, peak demand, water savings, effective useful lifetime (EUL), net-to-gross ratio, and unit goals for each measure are provided in **Table 3.3**.

Table 3.3 Ex Ante Savings for Measures Installed in TDPUD Service Area

Measure	Unit	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm)	Gross Ex-Ante Unit Savings (gal/yr)	EUL	NTG Ratio	Unit Goals
1. Res. Lighting Rebate	Unit	59.5	0.014			9	0.69	500
2. Res. CW ES/CEE Tier 1-3	Unit	210.6	0.179	6.3	8,050	12	0.68	201
3. Res. DW ES/CEE Tier 1	Unit	91.3	0.141	1.3	514	11	0.69	128
4. Res. Refrig ES/CEE Tier 1-3	Unit	129.3	0.022			14	0.70	171
5. Refrigerator Recycling	Unit	1,151.0	0.248			5	0.85	120
6. Building Envelope Testing	Unit	0.0	0.000			5	0.80	4
7. Duct System Testing	Unit	0.0	0.000			5	0.74	4
8. Building Envelope Mitigation	Unit	71.4	0.059	41.8		18	0.80	4
9. Duct System Mitigation	Unit	96.7	0.080	56.6		18	0.74	4
10. Thermally Efficient Window	Unit	160.0	0.531	10.9		20	0.96	1
11. Commercial Lighting Rebate	Site	4,988.4	1.008			15	0.89	25
12. HE Elec Wtr Heater Rebate	Unit	32.0	0.005			15	0.79	5
13. ESP – Income Qualified	Unit	314.4	0.233	25.4	4,475	9	0.84	100
14. School Conservation Educ.	Site	59.5	0.014			9	0.80	1800
15. Res. Energy Surveys (RES)	Kit	969.1	0.796	30.6	7,053	9	0.64	150
16. Bus. Green Partners Lighting	Site	165.1	0.046			3	0.94	1300
17. Commercial Refrigeration	Unit	16,483.1	2.152			8	0.95	8
18. Res. Green Partner Lighting	Site	59.5	0.014			9	0.64	3000
19. Neighborhood (Block Party)	Site	59.5	0.014			9	0.69	765
20. Million CFLs	Unit	59.5	0.014			9	0.69	29500
21. LED Holiday Light Exchange	Unit	23.9	0.089			16	0.91	1800
22. Res. Green Partners Water	Unit	3.9	0.002	2.9	1,469	10	0.77	5500
23. Water-Eff. Toilet Rebate/Exg	Site	26.0	0.004		3,178	15	0.81	600
24. Customer Leak Repair	Unit	1,731.6	0.198		360,664	10	0.77	25
25. HE CW Rebate CEE Tier 2-3	Unit	210.6	0.179	6.3	8,050	12	0.68	100

The intended ex ante net annual energy and peak demand savings for the TDPUD programs are 2,287,599 kWh per year, 768 kW, 19,069 therms per year, and 17,454,563 gallons of water per year. The net ex-ante lifecycle program savings are 20,194,467 kWh, 190,825 therms, and 184,555,931 gallons of water. These savings were is to be accomplished through the installation of 45,815 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 2.2 based on the E3 EE Reporting Tool.

3.2.1 Description of Energy Efficiency Measures

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

1. Residential Lighting Rebate

The Residential Lighting Rebate program provides rebates to TDPUD residential customers to replace existing incandescent and halogen lamps with LED or compact fluorescent lamps (CFL). The rebate of $2 per CFL lamp and $5 per LED is a credit on the customer's bill. Customers must purchase and install at least 5 CFLs or 2 LEDs to receive the rebate. CFL or LED lamps

are designed to replace standard incandescent lamps. They are approximately 4 to 5 times more efficient than incandescent lamps. Screw-in modular CFLs have reusable ballasts that typically last for four lamp lives. LEDs can last 50,000 hours. LED lamps do not contain mercury (Hg). 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 or LED lamps using 2 to 65W. TDPUD assumed average ex ante savings of 59.5 kWh/yr and 0.014 kW for the Residential CFL, Residential Green Partners and Million CFL programs based on the 2011 EM&V study. Ex ante deemed savings for other CFL measures included in the TDPUD programs are shown in **Table 3.4**.

Table 3.4 Ex Ante Savings for CFLs

#	Description	Units	Savings per unit kWh	Demand Savings per unit kW	Annual Hours of Operation per unit	Savings per unit therm	Savings per unit Gallons	EUL	Ex Ante NTGR
1	Residential CFL	Unit	59.5	0.014	1,102.1	n/a	n/a	9.0	0.8
2	Spiral 13/60 (Million CFL)	Unit	59.5	0.014	1,102.1	n/a	n/a	9.0	0.8
	Spiral 13/60	Unit	59.5	0.054	1,101.9	n/a	n/a	9.0	0.8
	Spiral 23/100	Unit	84.8	0.077	1,101.3	n/a	n/a	9.0	0.8
	Globe G25 9/40	Unit	32	0.029	1,103.4	n/a	n/a	9.0	0.8
	R20 14/50	Unit	39.7	0.036	1,102.8	n/a	n/a	9.0	0.8
	R30 15/65 **	Unit	55.1	0.05	1,102.0	n/a	n/a	9.0	0.8
	R30 15/65Dim **	Unit	55.1	0.05	1,102.0	n/a	n/a	9.0	0.8
	PAR38 23/120 **	Unit	106.9	0.097	1,102.1	n/a	n/a	9.0	0.8

2. Residential Appliance Rebates for Energy Star® or CEE Tier 1-3 Clotheswashers, Dishwashers, and Refrigerators

The Residential Appliance Rebate Program provides incentives for Energy Star or Consortium for Energy Efficiency (CEE) Tier 1 through 3 clothes washers, dishwashers, and refrigerators. The rebate is $75 for CEE Tier 1, $100 for CEE Tier 2 and $125 for CEE Tier 3 appliances. Water utility customers are eligible for an additional $50 water rebate for CEE Tier 2 or 3 clotheswashers. Energy Star® or CEE Tier 1-3 qualified appliances incorporate advanced technologies that use 20% to 30% less energy than the US Federal Standard (www.energystar.gov). The Consortium for Energy Efficiency (CEE, www.cee1.org) provides high-efficiency specifications for appliances that are more efficient than the Federal Standard. Energy Star® and CEE provided lists of qualifying appliances.

The Energy Star® and CEE efficiency levels for clotheswashers are shown in **Table 3.5**. Energy Star® qualified clotheswashers use 26 to 63 percent less energy and 37 to 58% less water than the federal minimum standard for energy consumption.

Table 3.5 Energy Star and CEE Tier Efficiency Levels for Clotheswashers

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

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

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

The Energy Star® and CEE efficiency levels for dishwashers are shown in **Table 3.6**.

Table 3.6 Energy Star and CEE Tier Efficiency Levels for Dishwashers

#	Description	Minimum Energy Factor	Maximum kWh/year	Maximum gallons/cycle
	Standard Dishwashers[1]			
	Federal Standard	No Requirement	355	6.50
0	Energy Star®	No Requirement	295	4.25
1	CEE Tier 1	0.75	295	4.25
	Compact Dishwashers[2]			
	Federal Standard	No Requirement	260	4.50
0	Energy Star®	No Requirement	222	3.5
1	CEE Tier 1	1.00	222	3.50

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

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

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

Table 3.7 Energy Star and CEE Tier Efficiency Levels for Refrigerators

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

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

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

Ex ante savings for TDPUD Energy Star® or CEE Tier 1-3 appliances are shown in **Table 3.8**. The pumping and treatment electricity associated with water savings increases the electricity savings. Energy Star® or CEE Tier 1 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 90 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.. 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.

Table 3.8 Residential Appliance Energy Star® or CEE Ex Ante 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)	TDPUD Rebate
ES/CEE Tier 1 Clotheswasher	151.62	0.129	4.5	5796	$75
ES/CEE Tier 2 Clotheswasher	205.63	0.175	6.2	7860	$100
ES/CEE Tier 3 Clotheswasher	233.13	0.198	7.0	8911	$125
ES/CEE Tier 1 Dishwasher	91.3	0.141	1.3	514	$75
ES/CEE Tier 1 Refrigerator	121	0.021			$75
ES/CEE Tier 2 Refrigerator	151.3	0.025			$100
ES/CEE Tier 3 Refrigerator	181.5	0.03			$125

3. Refrigerator and Freezer Recycling

The Refrigerator and Freezer Recycling Program is implemented by a local appliance retailer to remove and recycle existing units. Customers may receive a cash rebate for allowing Sears® to remove and recycle their first, second, third, or fourth refrigerator or freezer. Once approved, Sears® makes an appointment with the customer to pick up the old refrigerators and/or freezers from their home or business. Qualifying customers receive a $30 rebate for each refrigerator or freezer being removed and recycled. In addition to recycling refrigerant, foam, plastic, metals, and other components are also recycled. The effective useful lifetime for refrigerator and freezer recycling is 6 years.[6] TDPUD assumed annual ex ante energy savings of 1,151 kWh/yr and 0.248 kW based on the 2011 EM&V study.

4. Building Envelope and Duct System Mitigation

The Building Envelope and Duct System Mitigation program provides rebates for pressurization testing and sealing of the building envelope (i.e., floors, walls and ceiling) and/or duct system. A leakage test and the building envelope and/or distribution system mitigation must be completed and documented to receive rebates. The testing rebate is $75 per home or business receiving a duct test or blower door test to measure the air leakage and 50% of project cost up to $250 for building or duct mitigation. Building envelope repair involves pressurization testing of the building to 50 Pascal and then sealing leaks in the building shell to reduce total building leakage from 0.5 to 1.0 or more air changes per hour (ACH) to less than 0.3 ACH. Building leakage is tested using a blower door. Duct test and seal involves sealing the forced air unit (FAU) and supply/return ducts to 15% (or 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

[6] 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/.

assumed ex ante savings for building envelope mitigation of 71.4 kWh/year, 0.059 kW, and 41.8 therm/year and for duct mitigation 96.7 kWh/year, 0.080 kW, and 56.6 therm/year based on the 2011 EM&V study.

5. Thermally Efficient Window

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). New windows must meet the Energy Star ratings for the North-Central Climate zone, R-3 or u-value of 0.32 Btu/hr-ft^2-°F and 0.4 SHGC. 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 assumed ex ante savings of 160 kWh/year-unit and 0.531 kW/unit based on the 2011 EM&V study.

6. 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 retrofitting or replacing T12 or standard T8 linear fluorescent fixtures with low wattage T8 fluorescents or LEDs 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. Other lighting retrofits, including those with controls, are rebated at $0.16/kWh of estimated first year savings. The average ex ante savings are 121 kWh/yr and 0.0436 kW (based on two lamp fixtures). The ex ante savings for T-8 lamps with electronic ballasts are shown in **Table 3.9**. TDPUD assumed average gross ex ante savings per project of 4,988.4 kWh/year and 1.008 kW based on EM&V site visits and light logger measurements at 13 sites in the 2011 program and 6 sites in the 2012 program.

Table 3.9 Ex Ante Savings T-8 Lamps with Electronic Ballasts or LED with Transformers

#	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	T8 F32/Elec to T-8 28W Elec.– 1 Lamp	Unit	0.004	4,000	16	n/a	16	0.96
2b	T8 F32/Elec to T-8 LED – 1 Lamp	Unit	0.013	4,000	52	n/a	16	0.96
2c	T12 F40/Mag to T-8 Elec. Ballast – 1 Lamp	Unit	0.020	4,000	80	n/a	16	0.96
2d	T12 F40/Mag to T-8/Elec. Ballast – 2 Lamp	Unit	0.024	4,000	96	n/a	16	0.96
2e	T12 F40/Mag to T-8/Elec. Ballast – 3 Lamp	Unit	0.044	4,000	176	n/a	16	0.96
2f	T12 F40/Mag to T-8/Elec. Ballast – 4 Lamp	Unit	0.052	4,000	208	n/a	16	0.96
2g	T12 F96/Mag F96 to T-8/Elec.– 1 Lamp	Unit	0.017	4,000	68	n/a	16	0.96
2h	T12 F96/Mag to T-8/Elec. Ballast – 1 Lamp	Unit	0.019	4,000	76	n/a	16	0.96

Delamping three-lamp to two-lamp fixtures saves 37 percent on lighting and often provides adequate illumination. TDPUD assumed average ex ante savings for delamping of 256 kWh/year and 0.094 kW. The ex ante savings for delamping are shown in **Table 3.10**.

Table 3.10 Ex Ante Savings for Delamping

#	Description	Units	Demand Savings per unit kW	Annual Hours of Operation per unit	Savings per unit kWh	Savings per unit therm	EUL	Ex Ante NTGR
2i	Delamp T8 F32/Elec. – 1 Lamp	Unit	0.031	4,000	124	n/a	16	0.96
2j	Delamp T12 F40/Mag Ballast – 1 Lamp	Unit	0.044	4,000	176	n/a	16	0.96
2k	Delamp T12 F40/Mag Ballast – 2 Lamp	Unit	0.082	4,000	328	n/a	16	0.96
2l	Delamp T12 F96/Mag Ballast – 1 Lamp	Unit	0.064	4,000	256	n/a	16	0.96
2m	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.

7. High Efficiency Electric Water Heaters (Electric, Solar, and Geothermal Heat Pump)

The High Efficiency Electric Water Heater Rebate program provides a $2 per gallon rebate for removing an existing electric water heater and replacing it with a high efficiency electric water heater, solar or geothermal heat pump water heater. To qualify for the rebate electric water heaters less than 60 gallons must have an Energy Factor of 0.93 or higher. Electric water heaters 60 gallons and larger must have an Energy Factor of 0.91 or higher. Qualifying solar systems must supplement electric water heaters (requires dedicated solar preheat tank) and geothermal heat pump water heaters must replace electric water heaters. The 2004 Federal Standards are 0.9304 EF for 30 gallon units, 0.9172 EF for 40 gallon units, and 0.904 EF for 50 gallon units.[7] Average electric water heater unit energy consumption (UEC) is 3,354 kWh/year.[8] The incremental costs for electric resistance storage water heaters for a 0.02 EF improvement in are approximately $70 to $80 per unit. Savings for an efficient electric water heater with 0.93 EF are 32 kW compared to baseline units with 0.88 EF. Savings for solar water heaters are 50 to 70% or 1,677 to 2,348 kWh/yr at a cost of $6,000 (assuming two four feet by ten feet solar panels, at least 100 gallons of storage, pumps, and controls) with a simple payback of 16 years. Geothermal heat pump water heaters can save 20 to 30% with an installed cost of $10,000 and a simple

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

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

payback of 64 years. TDPUD assumed ex-ante unit savings of 32 kWh/yr and 0.005 kW. The ex ante effective useful lifetime is 15 years.

80. Energy Saving Partners (ESP) Income Qualified

The Energy Savings Partners (ESP) Income Qualified program provides income qualifying TDPUD customers with a free energy survey and free energy and water conservation measures. In 2013 the program included the direct installation of up to 24 CFLs and 2 water-efficient shower heads. The program targets customers who meet the Nevada County's low-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 a one-time credit based on their highest energy use charge 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 Sierra Energy Pros to qualify customers and perform the residential energy surveys, respectively. TDPUD assumed average ex ante site savings of 314.4 kWh/year, 0.233 kW, 24.4 therm/year, and 4,475 gallons/year based on the 2011 EM&V study. The ex ante effective useful lifetime is 9 years.

9. School Conservation Program Conservation Kits

The School Conservation Program provided K-8 students at 6 schools throughout the TDPUD electric service area with CFLs and conservation kits prepared by the Sierra Watershed Education Partnership. Kits were provided to students at school assemblies by the Truckee High School Envirolution environment club during community Trashion fashion shows. The program promotes energy and water conservation through educational activities and delivery of free, energy and water savings measures. TDPUD provided a Par 20 CFL (11 W) in the conservation kit handout. The 2013 program distributed 1,908 PAR 20 CFLs (11W). TDPUD assumed average savings of 59.5 kWh/yr, and 0.014 kW. The assumed effective useful lifetime is 9 years.

10. Residential Energy Survey

The Residential Energy Survey (RES) program provides free energy surveys and conservation measures for any TDPUD residential customer. RES is a similar to 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 Sierra Energy Pros. In 2013 the program included the direct installation of up to 24 CFLs and 2 water-efficient shower heads. TDPUD assumed average ex ante site savings of 969.1 kWh/year, 0.796 kW, 30.6 therm/year, and 7,053 gallons/year based on the 2011 EM&V study. The ex ante effective useful lifetime is 9 years.

11. Business Green Partners Lighting

The Business Green Partners Lighting program provides free CFL and LED lamps to retail, restaurant, hospitality and other TDPUD business customers. 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 businesses to identify specific energy efficient lamps needed for their environment and then provides the lamps to the business at no cost. TDPUD assumed average ex ante savings of 165.1 kWh/year and 0.046 kW based on the 2011 EM&V study. The ex ante effective useful lifetime is 3 years.

12. Commercial Refrigeration Program

The Commercial Refrigeration 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 installed in 2013 include: new refrigeration gaskets, cooler case strip curtains, automatic door closers for walk-in coolers, electronically-commutated refrigeration motors, anti-sweat controllers, floating head pressure controllers and LED case lighting. Truckee businesses must be TDPUD electric customers in order to participate. TDPUD assumed average ex ante site savings of 16,483kWh/year and 2.152 kW based on engineering analyses and measurements from 2012. The ex ante effective useful lifetime is 8 years.

13. Residential Green Partners Lighting

The Residential Green Partners Lighting program provides information and free lighting measures to residential customers. The main focus of the program is to hand out 6 different specialty CFL lamps in addition to the CFL 12-packs handed out to all TDPUD customers through the Million CFL program. The six lamps provided free to customers include: 23 Watt Spirals/100 Watt replacements, 11 Watt globe lights/40 Watt replacements, 13 Watt R-20s/50 watt replacement reflector lamps, 15 Watt R-30s/65 Watt replacements, both dimmable and non-dimmable, and 23 Watt PAR-38/120 Watt replacements. This program involves customers stopping by the TDPUD Conservation office and selecting any mix of 12 of these bulbs for free. 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 lighting rebate program. TDPUD assumed average ex ante savings of 59.5 kWh/year and 0.014 kW based on the 2011 EM&V study. The ex ante effective useful lifetime is 9 years.

14. Neighborhood Resource Mobilization Block Party

The Neighborhood Resource Mobilization Block Party is a collaborative event with other public agencies and provides information, energy surveys, and free energy and water saving measures to residential customers through well organized and advertised block parties. The Block Parties are held in a different Truckee neighborhood(s) each year and provide local service providers an opportunity to exhibit and share information about their community services. TDPUD has its own exhibit which includes a table full of the give-a-way energy and water efficiency measures

including the offer for a free home energy survey. The 2013 block party was held in the Tahoe Donner neighborhood and included over 10 local agency participants. TDPUD assumed ex ante unit savings of 59.5 kWh/year and 0.014 kW based on the 2011 EM&V study. The effective useful life is 9 years.

15. 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 also purchases a large selection of efficient lighting to include specialty lighting such as dimmable CFLs, cold-temp CFLs, and a variety of other CFLs replacing less efficient lighting sources. The “Million CFL” average ex ante savings are 59.5 kWh/yr and 0.014 kW based on the 2011 EM&V study.

16. LED Holiday Light Exchange

The Light Emitting Diode (LED) Holiday Light Exchange program provides LED Holiday Light Strands to swap out for incandescent strands. Customers can drop off and exchange up to 3 incandescent holiday light strands and receive up to three LED holiday light strands at the TDPUD. Marketing for the program mainly consists of bill stuffer, radio spots, newspaper notices, and word-of-mouth. TDPUD had already developed an LED Christmas Light demonstration project in downtown. TDPUD worked with the Town of Truckee to provide LED lights for the Train Depot and annual holiday tree/Bud Fish tree. LED holiday lights use 0.021 Watts per bulb and a 20 feet string of 60 LED bulbs uses 2.1 Watts. Traditional C7 incandescent holiday light strings use 5 Watts per bulb and a 20 feet string of 40 use 200 Watts and M5 incandescent mini lights use 0.5 Watts per bulb so a 20 feet string of 100 use 50 Watts. LED savings compared to C7 incandescent are 197.9 Watts per 20 feet string, and LED savings compared to M5 mini incandescent are 47.9 Watts. LEDs last 50,000 to 100,000 hours and the limited heat output makes for safer illumination of indoor trees. TDPUD assumed ex ante unit savings of 23.9 kWh/year and 0.089 kW based on the 2011 EM&V study. The EUL is 16 years.

17. Residential Green Partners Water Measures

The Residential Green Partners Water program provided 5,680 water efficiency measures including 1,911 WaterSense® showerheads (1.5 gpm), 155 low-flow kitchen swivel aerators (1.5 gpm), 728 low-flow bath aerators, and 2,886 garden spray nozzles (1.5 gpm) handed directly to customers at events and in the office. Low-flow showerheads replace standard showerheads with flow rates equal to or greater than 2.5 gpm at a flowing pressure of 80 pounds per square inch

gauge (psig).[9] Low-flow showerheads are assumed to reduce water flow by 40% (i.e., 1-1.5/2.5=0.4). Low-flow kitchen 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 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 5,000 water efficiency measures, and the program provided customers with 5,680 measures. TDPUD assumed ex ante unit savings of 3.9 kWh/year, 0.002 kW, 2.9 therm/year, and 1,469 gallons/year based on the 2011 EM&V study. The effective useful life is 10 years.

18. Water-Efficient Toilet Rebate and Exchange

The Water Efficient Toilet program provided $100 incentives to customers who purchased a 1.6 or less gallon per flush (gpf) toilet or exchange for free an old inefficient toilet for a WaterSense® toilet through a local plumbing distributor. A $125 incentive was provided to customers replacing high-water use toilets with ultra-water efficient toilets using 1.28 gallons per flush (gpf) or 20% less water than standard 1.6 gpf toilets (www.epa.gov/WaterSense/pubs/toilets.html). And customers replacing 1.6 gpf toilets with 1.28 toilets received a $25 incentive. 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 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 600 toilets and the program provided incentives for 548 water-efficient toilets. TDPUD assumed ex ante unit savings of 26 kWh/year, 0.004 kW, and 3,178 gallons/year based on the 2011 EM&V study. The EUL is 15 years.

19. Customer Leak Repair

The Customer Leak Repair program provided incentives of up to $100 per customer for repairing water leaks at their site that were identified by the new electronic water metering system. Customers received a letter from TDPUD indicating the presence of a potential water leak due to increased or unusually high water usage based on electronic billing data. The TDPUD Water Leak Repair program also referred customers to the Water Efficient Toilet program to replace inefficient leaking toilets with 1.6 or less gpf toilets. The program goal was to have 25 participants and 29 customers participated in the program and received incentives. TDPUD assumed average ex ante unit savings of 1731.6 kWh/yr, 0.198 kW, and 360,664 gallons/year per customer based on the 2011 EM&V study. The EUL is 11 years.

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

3.3 Measurement and Verification Approach

The measurement and verification approach is based on the *International Performance Measurement & Verification Protocols* (IPMVP) defined **Table 3.12**.[10] Ex post energy savings for each measure are determined using IPMVP Option A, B, and C. Statistical analyses are used to extrapolate energy and peak demand savings at the sample level to the program level.

Table 3.12 IPMVP M&V Options

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

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

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

Where,

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

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

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

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

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

Where,

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

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

The standard error, se_i, of the measure sample mean is calculated using **Equation 3, Equation 4** or both depending on the measure.[11]

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

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

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

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.

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

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

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

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

3.4 Cost Effectiveness Approach

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

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

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

3.5 Measure Verification Approach

The measure verification approach relies on previous EM&V studies, TDPUD customer site visits and surveys, billing data, field measurements, light logger data, and on-site surveys. A description of the verification approach for each measure is provided in **Table 3.13**. IPMVP Options A, B, C, and D were used to evaluate energy and peak demand savings for the program. Measurements were short-term, and some, but not all parameters were stipulated, as long as the total impact of possible stipulation errors was not significant to the resultant savings. Due to budget constraints some 2013 programs were evaluated using previous EM&V studies.

Table 3.13 Verification Approach for TDPUD Measures

Measure	Measurement and Verification Approach
1. Res. Lighting Rebate (CFL or LED)	Energy and kW savings based on previous EM&V studies, customer surveys, and site verification.
2-4. Energy Star CEE Tier 1-3 Appliances	Energy and kW 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 kW savings based on previous EM&V studies and Refrigerator and Freezer Energy Rating Databases (http://www.kouba-cavallo.com/refmods.htm).
6-9. Res. Building Envelope & Ducts	Energy and kW savings based on previous EM&V studies, leakage reduction and DEER UECs..
10. Thermally Efficient Windows Rebate	Energy and kW savings based on EM&V site visits and previous EM&V studies.
11. Commercial Lighting Rebate	Energy and kW savings based on EM&V site visits, measurements, and engineering analyses.
12. High-Efficiency Electric Water Heater Rebate	Energy and kW savings based on previous EM&V studies.
13. ESP – Income Qualified	Energy and kW savings based on previous EM&V studies, customer surveys, and site visits.
14. School Conservation Education	Energy and kW savings based on EM&V measurements.
15. Residential Energy Survey (RES)	Energy and kW savings based on previous EM&V studies, customer surveys, and site visits.
16. Business Green Partners Lighting	Energy and kW savings based on previous EM&V studies, customer surveys, and site visits.
17. Commercial Refrigeration	Energy and kW savings based on previous EM&V studies, customer surveys, and site visits.
18. Res. Green Partner Lighting	Energy and kW savings based on previous EM&V studies, customer surveys, and site visits.
19. Neighborhood Resource Mobilization	Energy and kW savings based on previous EM&V studies, customer surveys, and site visits.
20. Million CFLs	Energy and kW savings based on previous EM&V studies, customer surveys, and site visits.
21. LED Holiday Light Exchange	Energy and kW savings based on previous EM&V studies and measurements.
22. Res. Green Partners Water	Energy and kW savings based on previous EM&V studies, customer surveys, and site visits.
23. Water-Efficient Toilet Rebate & Exchange	Energy and kW savings based on previous EM&V studies, customer surveys, and site visits.
24. Customer Water Leak Repair Rebate	Energy and kW savings based on previous EM&V studies and customer surveys.
25. HE Clotheswasher Rebate CEE Tier 2-3	Energy and kW kW savings based on EM&V site visits, measurements, and engineering analyses.

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

Table 3.14 Field Measurement Equipment Tolerances

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

3.6 Sampling Design Approach

The statistical sample design approach for the load impact and process evaluations involved selecting a random sample of customers from the program population. Samples were selected to obtain a reasonable level of precision and accuracy at the 90% confidence level. The proposed sample design was based on statistical survey sampling methods.[12] Sampling methods were used to analyze the data and extrapolate mean savings estimates from the sample measurements to the population of all program participants and to evaluate the statistical precision of the results.[13] Selecting participants for the sample was guided by the statistical sampling plan.

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

Eq. 8 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 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.

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

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

Similar measures were grouped together to reduce the overall sample size requirements necessary to achieve the desired level of confidence and yield the greatest accuracy at the lowest cost. The statistical sample sizes for programs that were inspected from 2008 through 2013 are shown in **Table 3.15**. The sample size is based on relative savings per measure assuming a coefficient of variation (Cv) of 0.5 and relative precision of 0.1 to 0.2 to achieve 80 to 90% confidence.

Table 3.15 Statistical Sample Size for TDPUD Measures

Measure Description	Ex Ante Units	Proposed EM&V Sample	Ex Post Installed Units	EM&V Units Inspected	Ex Post Coefficient of Variation (Cv)	Ex Post Relative Precision (r)
1. Res. Lighting Rebate	500	NA	667	120	0.39	0.059
2. Res. Appl. Clotheswashers ES/CEE Tier 1-3	201	NA	233	11	0.04	0.022
3. Res. Appl. Dishwashers ES/CEE Tier 1	128	NA	148	14	0.12	0.053
4. Res. Appl. Refrigerators ES/CEE Tier 1-3	171	NA	197	16	0.08	0.031
5. Refrigerator Recycle	120	NA	128	13	0.04	0.019
6. Res. Building Eff. Envelope Testing	4	NA	9	8	NA	NA
7. Res. Building Eff. Duct Testing	4	NA	8	12	NA	NA
8. Res. Building Eff. Rebates Envelope Mitigation	4	NA	7	8	0.17	0.100
9. Res. Building Eff. Rebates Duct Mitigation	4	NA	8	12	0.21	0.100
10. Thermally Efficient Windows Rebate	1	NA	1.45	NA	NA	NA
11. Commercial Lighting Rebate	25	5	41	589	0.68	0.03
12. High-Efficiency Electric Water Heater Rebate	5	NA	3	2	0.09	0.100
13. ESP – Income Qualified	100	NA	83	12	0.21	0.100
14. School Conservation Education	1800	NA	1908	10	0.39	0.059
15. Res. Energy Surveys (RES)	150	NA	284	4	0.12	0.100
16. Business Green Partners Lighting	1300	5	1242	420	0.49	0.03
17. Commercial Refrigeration	8	NA	8	7	0.45	0.282
18. Res. Green Partner Lighting	3000	NA	3061	10	0.37	0.055
19. Neighborhood Resource Mobilization	765	NA	965	13	0.77	0.100
20. Million CFLs	29500	200	30709	51	0.88	0.059
21. LED Holiday Light Exchange	1800	NA	1928	10	0.19	0.100
22. Res. Green Partners Water	5500	NA	5680	19	0.27	0.100
23. Water-Efficient Toilet Rebate and Exchange	600	NA	548	10	0.11	0.059
24. Customer Leak Repair Rebate	25	NA	29	10	0.5	0.25
25. HE Clotheswasher Rebate ES/CEE Tier 1-3	100	NA	164	NA	0.5	0.25
Participant Surveys	NA	10	NA	13	0.08	0.01
Non-Participant Surveys	NA	NA	NA	NA	NA	NA

3.7 Process Evaluation Approach

The evaluation approach used process surveys to measure participant satisfaction, and obtain suggestions to improve the program's services and procedures. Process surveys, on-site inspections, and field measurements were used to guide the overall process evaluation in terms of investigating operational characteristics of the program and developing specific recommendations to help make the program more cost effective, efficient and operationally effective. The process evaluation examined how to install a comprehensive package of measures for each customer within the constraints of the program. Interview questions assessed how the program influenced awareness of linkages between efficiency improvements and bill savings and increased comfort for customers. A sample of 12 participants were asked process questions in 2013 (40 non-participant surveys were completed for the 2011 study). The participant and non-participant surveys are provided in the **Appendices**. Participants were asked why and how they decided to participate in the program. Non-participants were asked why they chose not to participate. This was done to identify reasons why program marketing efforts were not successful

with some customers as well as to identify additional hard-to-reach market barriers (i.e., incentives or other inducements to achieve greater participation). The process survey evaluation includes a summary of what works, what doesn't work, and the level of need for the program. The evaluation identified the rejection rate/acceptance rate and size of the rejecter pool. This information was used to define if there were issues to be addressed. On-going feedback was provided based on installation quality.

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

3.7.1 List of Questions Answered by the Study

The following questions are answered by the study.

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

   The study answered this question by conducting 12 participant surveys in 2013 and inspecting 972 measures. In 2012 EM&V study conducted 14 participant surveys and inspected 1,609 measures at a random sample of 14 participant sites. Participants indicated that measures were properly installed as indicated by the rating of 9.8 ± 0.2 on a scale of 1 to 10 for quality of work performed by installers. Light loggers were installed at 6 sites in the 2013 EM&V study and 6 sites in the 2012 EM&V study and previously installed at 30 sites in the 2009 EM&V study to measure hours of operation. These were left at the sites for a period of up to four weeks and then rotated to other sites. Fifty-nine loggers (59) were downloaded to monitor hours of operation on 4,369 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 5,074 measures at a random sample of 182 participant sites (972 in 2013, 1,274 in 2012 and 2,828 previously). The EM&V study inspected the following measures (in 2008, 2010, 2011, 2012, and 2013): 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?

Yes. 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 2013 study conducted participant surveys of commercial lighting projects (0.88) and business green partner projects (0.94). The 2012 study conducted participant surveys of commercial lighting projects (0.96), commercial projects (TTUSD) (0.97), and TDPUD LED programs (1.0). The 2011 study conducted participant surveys and developed specific NTGRs for the following program measures: Residential CFLs (0.69), Energy Star® Clotheswashers (0.68), Energy Star® Dishwashers (0.69), Energy Star® Refrigerator/Freezers (0.70), Refrigerator Recycling (0.85), Building Envelope Mitigation (0.80), Duct Mitigation (0.74), Commercial Lighting (0.85), Electric/Solar Water Heater (0.79), Business Green Partners (0.85), Keep Your Cool (0.95), Business LED Pilot (0.85), WaterSense Toilets (0.81), and Customer Leak Repair (0.77). The 2009 EM&V study evaluated NTGRs for the following programs: Low-Income Assistance Energy Saving Partners (0.64), Residential Energy Surveys (0.64), and Residential Green Partners (0.64). The 2009 EM&V study evaluated NTGRs for the following programs: Commercial Lighting Projects (0.96), Refrigerator Recycling (0.84), Green Partner (0.96), Million CFL (0.90), LED Holiday Lights (0.91), Low-flow Pre-Rinse Spray Valves (1.0), and WaterSense Showerheads (1.0). Otherwise, the study used published values from the EE Reporting Tool and Table 4.2 of the CPUC Energy Efficiency Policy Manual.[14]

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

5. Are the total program savings estimates accurate?

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

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

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

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

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

1. What reasons are there for not participating and how might conditions be revised to motivate participation?
2. Why have you decided not to install similar measures such as compact fluorescent lamps, Energy Star® or CEE Tier 1-3 rated 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 48,060 measures to approximately 10,390 customers and overall participant satisfaction with the program was 99 percent. Ex post measure savings and implementation costs were used to develop ex post Total Resource Cost (TRC) test values for the program using the CPUC cost effectiveness worksheets. Approximately 67 percent of non-participants would have participated if they knew the programs provided rebates, information and free compact fluorescent lamps, indicating a continuing need for the program (based on 2011 non-participant study).

9. Are there measurable program multiplier effects?

Program multiplier effects questions are used to measure program participants sharing information learned from the program with non-participants, and if sharing of information is acted upon in a way that results in the installation of similar measures within a non-participant population. For example, the TDPUD programs provide free compact fluorescent lamps, water saving showerheads, and aerators. The TDPUD programs also provide rebates for CFLs, efficient commercial lighting, Energy Star® appliances, refrigerator recycling, efficient windows, attic insulation, infiltration reduction, duct sealing, , or other measures

and educates customers on the value of these and other measures. Based on process survey responses, 42 percent of interviewed customers shared program information with 16 times as many people. Approximately 37 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. [15] Programs that link technologies with educational measures can have multiplier effects as high as 10-25 percent including the sharing of program information to a population that is several times larger than the participant population. The following questions were included in the participant process surveys.

1. Have you shared program information with any of your friends, neighbors, or business associates about the benefits of screw-in CFLs, LED lamps, hardwired T-8 or T5 fluorescent fixtures, commercial refrigeration, WaterSense® or Energy Star® products, weatherization, leak repair, or other energy or water efficiency measures offered by the programs?
2. With how many people have you shared this information in the last 12 months?
3. About how many of these people have installed any of these measures?

3.7.2 List of Tasks Undertaken by the Study

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

Task 1. Prepare EM&V Plan

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

Task 2. Market Assessments or Baseline Analyses

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

Task 3. Develop Survey Instruments

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

Task 4. Phone or In-person Surveys

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

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

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

[15] Spillover of 0.5% is calculated based on 53 people adopting at least one spillover measure based on information shared by a group of 12 participants who adopted 966 measures (i.e., 53/966/12 = 0.5%).

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

The 2008, 2010, 2011, 2012, and 2013 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.

3.7.3 How Study met the California Energy Efficiency Objectives

The study met the following objectives California energy efficiency objectives.

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

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

- **Measure cost-effectiveness.**

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

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

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

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

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

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

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

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

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

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

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

4. EM&V Findings

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

4.1 Load Impact Results

TDPUD implemented 25 energy efficiency programs or measures in 2013 as shown in **Table 4.1**. The programs provided educational information, incentives, and free energy efficiency measures to residential and commercial customers. TDPUD accomplished 48,060 measures or 5% more than the ex ante estimate.

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

Description	Ex Ante Qty.	Ex Post Qty.
Total Installed Measures	45,815	48,060
1. Res. Lighting Rebate	500	667
2. Res. Appl. Rebates Clothes Washers ES/CEE Tier 1-3	201	234
3. Res. Appl. Rebates Dishwashers ES/CEE Tier 1	128	148
4. Res. Appl. Rebates Refrigerators ES/CEE Tier 1-3	171	197
5. Refrigerator Recycle	120	128
6. Res. Building Efficiency Rebates Envelope Testing	4	9
7. Res. Building Efficiency Rebates Duct Testing	4	8
8. Res. Building Efficiency Rebates Envelope Mitigation	4	7
9. Res. Building Efficiency Rebates Duct Mitigation	4	8
10. Thermally Efficient Windows Rebate	1	1.45
11. Commercial Lighting Rebate	25	41
12. High-Efficiency Electric Water Heater Rebate	5	3
13. Energy Saving Program (ESP) – Income Qualified	100	83
14. School Conservation Education (Trashion Show)	1800	1908
15. Res. Energy Surveys (RES)	150	284
16. Business Green Partners Lighting	1300	1242
17. Commercial Refrigeration	8	8
18. Res. Green Partner Lighting	3000	3061
19. Neighborhood Resource Mobilization (Block Party)	765	965
20. Million CFLs	29500	30709
21. LED Holiday Light Exchange	1800	1928
22. Res. Green Partners Water	5500	5680
23. Water-Efficient Toilet Rebate and Exchange	600	548
24. Customer Leak Repair Rebate	25	29
25. HE Clothes Washer Water Rebate CEE Tier 2-3	100	164

TDPUD achieved 17% greater lifecycle electricity savings with ex post savings of 23,607,109 kWh versus ex ante goal of 20,194,467 kWh. TDPUD exceeded the ex ante E3 Calculator Total Resource Cost (TRC) test goal by 8.5% with an ex post TRC of 2.42 and the ex ante TRC of 2.23 as shown in **Table 4.2**.[16] The ex post TRC is greater than the ex ante TRC due to 5% more measures, greater lifecycle savings from LED lighting, and lower measure costs due to purchasing measures in bulk. Ex post accomplishments were verified by checking the tracking database, randomly inspecting 972 measures at 14 participant sites, and conducting surveys of participants, non-participants, and non-contacts. The EM&V ex post savings are based on site inspections, engineering analysis, and previous evaluation studies of TDPUD programs including light logger data from 4,826 fixtures at 47 sites and pre and post-retrofit utility billing data from 65 sites.

Table 4.2 Ex Ante Goals and Ex Post E3 Cost Effectiveness

Description	Ex Ante Goal	Ex Post Accomplishment
Net Annual Electricity Savings (kWh/yr)	2,287,599	2,509,741
Net Demand Savings (kW)	767.8	893.2
Net Lifecycle Electricity Savings (kWh)	20,194,467	23,607,109
Net Annual Therm Savings (therm/yr)	19,069	25,964
Net Lifecycle Therm Savings (therm)	190,825	256,664
Net Annual Water Savings (gallon/yr)[17]	17,454,563	19,049,775
Net Lifecycle Water Savings (gallon)	184,555,931	198,580,161
Total Resource Cost (TRC) Test – E3	**2.23**	**2.42**
TRC Test Costs	$897,567	$994,629
TRC Test Benefits	$2,004,981	$2,406,273
TRC Test Net Benefits	$1,107,414	$1,411,644
Participant Test	**1.00**	**1.00**
Participant Test Costs	$504,430	$601,492
Participant Test Benefits	$504,430	$601,492
Participant Test Net Benefits	$0	$0

The ex ante first-year savings are summarized in **Table 4.3**. The first-year net ex ante program savings are 2,287,599 kWh per year, 768 kW, 19,069 therms per year, and 17,454,563 gallons of water per year.

[16] 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.

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

Table 4.3 Ex Ante First-Year Electricity, Natural Gas, and Water Savings

Energy Efficiency Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm)	Gross Ex-Ante Unit Savings (gal/yr)	Net-to-Gross Ratio	Net Ex Ante Program Savings (kWh/y)	Net Ex Ante Program Savings (kW)	Net Ex Ante Program Savings (therm)	Net Ex Ante Program Savings (galyr)
1. Res. Lighting Rebate	59.5	0.014			0.69	20,528	4.8	0	0
2. Res. CW ES/CEE Tier 1-3	210.6	0.179	6.3	8,050	0.68	28,785	24.5	861	1,100,274
3. Res. DW ES/CEE Tier 1	91.3	0.141	1.3	514	0.69	8,066	12.4	115	45,396
4. Res. Refrig ES/CEE Tier 1-3	129.3	0.022			0.70	15,477	2.7	0	0
5. Refrigerator Recycling	1,151.0	0.248			0.85	117,402	25.3	0	0
6. Building Envelope Testing					0.80	0	0.0	0	0
7. Duct System Testing					0.74	0	0.0	0	0
8. Building Envelope Mitigation	71.4	0.059	41.8		0.80	228	0.2	134	0
9. Duct System Mitigation	96.7	0.080	56.6		0.74	286	0.2	168	0
10. Thermally Efficient Window	160.0	0.531	10.9		0.96	154	0.5	10	0
11. Commercial Lighting Rebate	4,988.4	1.008			0.89	110,992	22.4	0	0
12. HE Elec Wtr Heater Rebate	32.0	0.005			0.79	126	0.0	0	0
13. ESP – Income Qualified	314.4	0.233	25.4	4,475	0.84	26,410	19.6	2,134	375,900
14. School Conservation Educ.	59.5	0.014			0.80	85,680	20.2	0	0
15. Res. Energy Surveys (RES)	969.1	0.796	30.6	7,053	0.64	93,034	76.4	2,938	677,088
16. Bus. Green Partners Lighting	165.1	0.046			0.85	182,436	50.8	0	0
17. Commercial Refrigeration	16,483.1	2.152			0.95	125,271	16.4	0	0
18. Res. Green Partner Lighting	59.5	0.014			0.64	114,240	26.9	0	0
19. Neighborhood (Block Party)	59.5	0.014			0.69	31,407	7.4	0	0
20. Million CFLs	59.5	0.014			0.69	1,211,123	285.0	0	0
21. LED Holiday Light Exchange	23.9	0.089			0.91	39,148	145.8	0	0
22. Res. Green Partners Water	3.9	0.002	2.9	1,469	0.77	16,517	8.5	12,282	6,221,215
23. Water-Eff. Toilet Rebate/Exg	26.0	0.004		3,178	0.81	12,636	1.9	0	1,544,508
24. Customer Leak Repair	1,731.6	0.198		360,664	0.77	33,333	3.8	0	6,942,782
25. HE CW Wtr Rebate CEE 2-3	210.6	0.179	6.3	8,050	0.68	14,321	12.2	428	547,400
Total						2,287,599	768	19,069	17,454,563

The EM&V ex post first-year savings are summarized in **Table 4.4**. The EM&V study found first-year net ex post program savings of 2,509,853 ± 82,984 kWh per year, 893 ± 46 kW per year, 25,964 ± 1,792 therms per year, and 19,049,775 ± 2,054,753 gallons (25,468 ± 2,747 CCF) of water per year at the 90 percent confidence level. The net first-year realization rates are 1.11 ± 0.04 for kWh, 1.2 ± 0.06 for kW, 1.4 ± 0.09 for therms, and 1.1 ± 0.12 for gallons of water.

Table 4.4 Ex Post First-Year Electricity, Natural Gas, and Water Savings

Energy Efficiency Measure	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm)	Gross Ex-Post Unit Savings (gal)	Net-to-Gross Ratio	Net Ex Post Program Savings (kWh/y)	Net Ex Post Program Savings (kW)	Net Ex Post Program Savings (therm)	Net Ex Post Program Savings (gal)
1. Res. Lighting Rebate	59.5	0.014			0.69	27,384	6.2	0	0
2. Res. CW ES/CEE Tier 1-3	164.3	0.165	6.3	2,408	0.68	26,141	26.2	1,002	383,180
3. Res. DW ES/CEE Tier 1	91.3	0.141	1.3	514	0.69	9,326	14.4	136	52,531
4. Res. Refrig ES/CEE Tier 1-3	129.3	0.022			0.70	17,830	3.1	0	0
5. Refrigerator Recycling	1,151.0	0.248			0.85	125,233	27.0	0	0
6. Building Envelope Testing					0.80	0	0.0	0	0
7. Duct System Testing					0.74	0	0.0	0	0
8. Building Envelope Mitigation	71.4	0.059	41.8		0.80	400	0.3	234	0
9. Duct System Mitigation	96.7	0.080	56.6		0.74	572	0.5	335	0
10. Thermally Efficient Window	160.0	0.531	10.9		0.96	223	0.7	15	0
11. Commercial Lighting Rebate	4,597.2	1.700			0.89	167,753	62.0	0	0
12. HE Elec Wtr Heater Rebate	32.0	0.005			0.79	76	0.0	0	0
13. ESP – Income Qualified	688.0	0.541	35.0	5,628	0.84	47,970	37.7	2,441	392,355
14. School Conservation Educ.	59.5	0.014			0.80	90,821	20.6	0	0
15. Res. Energy Surveys (RES)	829.1	0.663	40.6	6,566	0.64	150,698	120.6	7,381	1,193,455
16. Bus. Green Partners Lights	162.7	0.049			0.94	189,949	56.7	0	0
17. Commercial Refrigeration	16,483.1	2.152			0.95	125,271	16.4	0	0
18. Res. Green Partner Lighting	60.6	0.017			0.64	118,678	32.5	0	0
19. Neighborhood (Block Party)	52.1	0.014			0.69	34,668	9.4	0	0
20. Million CFLs	59.5	0.014			0.69	1,260,758	286.1	0	0
21. LED Holiday Light Exchnge	23.9	0.089			0.91	41,981	155.5	0	0
22. Res. Green Partners Water	3.8	0.002	3.3	1,524	0.77	16,611	9.0	14,419	6,665,550
23. Wtr-Eff. Toilet Rebate/Exg	26.0	0.004		3,178	0.81	11,521	1.7	0	1,410,772
24. Customer Leak Repair	1,731.6	0.198		360,689	0.77	38,666	4.4	0	8,054,196
25. HECW Wtr Rebate CEE 2-3	65.7	0.020		8050	0.68	7,323	2.2	0	897,736
Total						2,509,853	893.2	25,964	19,049,775
90% Confidence Interval						82,984	46	1,792	2,054,753
Realization Rate						1.1 ± 0.04	1.2 ± 0.06	1.4 ± 0.09	1.1 ± 0.12

The lifecycle electricity and water savings are summarized in **Table 4.5**. The net ex-ante lifecycle program savings are 20,194,467 kWh, 190,825 therms, and 184,555,931 gallons of water. The net ex-post lifecycle program savings are 23,607,109 ± 735,430 kWh, 256,664 ± 17,597 therms, and 198,580,161 ± 20,561,161 gallons of water (265,481 ± 27,489 CCF). The net lifecycle realization rates are 1.17 ± 0.04 for kWh, 1.35 ± 0.09 for therms, and 1.08 ± 0.11 for gallons of water.

Table 4.5 Lifecycle Electricity, Natural Gas, and Water Savings

Energy Efficiency Measure	Ex Ante Effective Useful Life (EUL)	Net Ex-Ante Lifecycle Program Savings (kWh)	Net Ex-Ante Lifecycle Program Savings (therm)	Net Ex-Ante Lifecycle Program Savings (gal)	Ex Post EUL	Net Ex-Post Lifecycle Program Savings (kWh)	Net Ex-Post Lifecycle Program Savings (therm)	Net Ex-Post Lifecycle Program Savings (gal)
1. Res. Lighting Rebate	9	184,748	0	0	9	246,453	0	0
2. Res. CW ES/CEE Tier 1-3	12	345,420	10,333	13,203,288	12	313,691	12,029	4,598,160
3. Res. DW ES/CEE Tier 1	11	88,728	1,263	499,361	11	102,591	1,494	577,836
4. Res. Refrig ES/CEE Tier 1-3	14	216,678	0	0	14	249,624	0	0
5. Refrigerator Recycling	5	587,010	0	0	5	626,167	0	0
6. Building Envelope Testing	5	0	0	0	5	0	0	0
7. Duct System Testing	5	0	0	0	5	0	0	0
8. Building Envelope Mitigation	18	4,113	2,408	0	18	7,193	4,212	0
9. Duct System Mitigation	18	5,152	3,016	0	18	10,302	6,034	0
10. Thermally Efficient Window	20	3,072	209	0	20	4,454	305	0
11. Commercial Lighting Rebate	15	1,664,879	0	0	15	2,516,301	0	0
12. HE Elec Wtr Heater Rebate	15	1,896	0	0	15	1,138	0	0
13. ESP – Income Qualified	9	237,686	19,202	3,383,100	9	431,731	21,965	3,531,193
14. School Conservation Educ.	9	771,120	0	0	9	817,387	0	0
15. Res. Energy Surveys (RES)	9	837,302	26,438	6,093,792	9	1,356,279	66,433	10,741,094
16. Bus. Green Partners Lights	3	547,307	0	0	9	1,709,541	0	0
17. Commercial Refrigeration	8	1,002,171	0	0	8	1,002,171	0	0
18. Res. Green Partner Lighting	9	1,028,160	0	0	9	1,068,100	0	0
19. Neighborhood (Block Party)	9	282,664	0	0	9	312,013	0	0
20. Million CFLs	9	10,900,103	0	0	9	11,346,822	0	0
21. LED Holiday Light Exchnge	16	626,371	0	0	16	671,689	0	0
22. Res. Green Partners Water	10	165,165	122,815	62,212,150	10	166,108	144,192	66,655,504
23. Wtr-Eff. Toilet Rebate/Exg	15	189,540	0	23,167,620	15	172,816	0	21,161,585
24. Customer Leak Repair	10	333,333	0	69,427,820	10	386,660	0	80,541,958
25. HECW Water Rebate CEE 2-3	12	171,851	5,141	6,568,800	12	87,878	0	10,772,832
Total		20,194,467	190,825	184,555,931		23,607,109	256,664	198,580,161
90% Confidence Interval						735,430	17,597	20,561,918
Realization Rate						1.17 ± 0.04	1.35 ± 0.09	1.08 ± 0.11

The energy impact reporting for 2013 programs is provided in **Table 4.6**.

Table 4.6 Energy and Water Impact Reporting for 2013 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	2013	3,124	2,510	1.028	0.893	25,547	26,662	30,745	26,660
2	2014	3,124	2,510	1.028	0.893	25,547	26,662	30,745	26,660
3	2015	3,124	2,510	1.028	0.893	25,547	26,662	30,745	26,660
4	2016	2,909	2,510	0.968	0.893	25,547	26,662	30,745	26,660
5	2017	2,909	2,510	0.968	0.893	25,547	26,662	30,745	26,660
6	2018	2,771	2,385	0.938	0.866	25,547	26,662	30,745	26,660
7	2019	2,771	2,385	0.938	0.866	25,547	26,662	30,745	26,660
8	2020	2,771	2,385	0.938	0.866	25,547	26,662	30,745	26,660
9	2021	2,639	2,259	0.921	0.850	25,547	26,662	30,745	26,660
10	2022	346	338	0.281	0.280	18,417	16,840	28,732	24,540
11	2023	282	283	0.265	0.267	2,467	2,421	5,877	4,862
12	2024	270	274	0.247	0.252	2,301	2,285	5,789	4,791
13	2025	206	240	0.193	0.224	405	584	2,549	1,886
14	2026	206	240	0.193	0.224	405	584	2,549	1,886
15	2027	184	223	0.189	0.221	405	584	2,549	1,886
16	2028	44	43	0.161	0.157	405	584	0	0
17	2029	1	1	0.001	0.002	405	584	0	0
18	2030	1	1	0.001	0.002	405	584	0	0
19	2031	0	0	0.001	0.001	11	15	0	0
20	2032	0	0	0.001	0.001	11	15	0	0
21	2033	0	0	0.000	0.000	0	0	0	0
22	2034	0	0	0.000	0.000	0	0	0	0
23	2035	0	0	0.000	0.000	0	0	0	0
24	2036	0	0	0.000	0.000	0	0	0	0
25	2037	0	0	0.000	0.000	0	0	0	0
Total		27,683	23,607			255,559	265,044	324,749	279,796

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

1. Gross Program-Projected savings are those savings projected by the program before NTG adjustments. 1 CCF = 748 gallons.
2. Net Evaluation Confirmed savings are those documented via the evaluation and include the evaluation contractor's NTG adjustments.

The TDPUD energy efficiency program portfolio ranked by ex post TRC is shown in **Table 4.7**.

Table 4.7 TDPUD Energy Efficiency Program Portfolio Ranked by Ex Post TRC

	Net Demand Savings (kW)	Net Coincident Peak Savings (kW)	Net Annual Energy Savings (kWh)	Net Lifecycle Energy Savings (kWh)	Net Lifecycle Gas Savings (MMBtu)	Net Lifecycle GHG Reduction (Tons)	Utility Cost ($/kWh)	Ex Post TRC
TOTAL EE PORTFOLIO	1,930	893	2,509,853	23,607,109	25,666	12,705	0.05	2.42
20. Million CFLs	1,144	286	1,260,758	11,346,822	0	6,057	0.02	4.70
24. Customer Leak Repair	4	4	38,666	386,660	0	209	0.03	4.11
18. Res. Green Partner Lighting	108	32	118,678	1,068,100	0	570	0.03	3.53
16. Bus. Green Partners Lights	57	57	189,949	1,709,541	0	947	0.04	3.74
22. Res. Green Partners Water	9	9	16,611	166,108	14,419	89	0.33	3.47
19. Neighborhood (Block Party)	32	9	34,668	312,013	0	167	0.03	3.39
1. Res. Lighting Rebate	25	6	27,384	246,453	0	132	0.03	3.14
14. School Conservation Educ.	82	21	90,821	817,387	0	436	0.04	2.75
5. Refrigerator Recycling	27	27	125,233	626,167	0	340	0.04	2.69
15. Res. Energy Surveys (RES)	121	121	150,698	1,356,279	6,643	724	0.07	2.42
6-9. Bldg/Duct Test/Repair	1	1	972	17,495	1,025	11	0.63	1.88
21. LED Holiday Light Exchange	155	155	41,981	671,689	0	359	0.07	1.84
2. Res. CW ES/CEE Tier 1-3	26	26	26,141	313,691	1,203	173	0.14	1.32
17. Commercial Refrigeration	16	16	125,271	1,002,171	0	528	0.09	1.23
11. Commercial Lighting Rebate	62	62	167,753	2,516,301	0	1,394	0.13	1.17
10. Thermally Efficient Window	1	1	223	4,454	30	3	0.31	1.13
13. ESP – Income Qualified	38	38	47,970	431,731	2,197	230	0.15	1.09
4. Res. Refrig ES/CEE Tier 1-3	3	3	17,830	249,624	0	135	0.13	1.03
25. HECW Wtr Rebate CEE Tier 2-3	2	2	7,323	87,878	0	49	0.15	0.94
3. Res. DW ES/CEE Tier 1	14	14	9,326	102,591	149	57	0.17	0.92
12. HE Elec Wtr Heater Rebate	0	0	76	1,138	0	1	0.39	0.32
23. Wtr-Eff. Toilet Rebate/Exg	2	2	11,521	172,816	0	94	0.50	0.27

The TDPUD E3 energy efficiency portfolio total utility resource cost is $0.05/kWh and the net lifecycle green house gas (GHG) reductions are 12,705 tons. TDPUD energy efficiency (EE) portfolio realized a 2.42 TRC which is 8.5% greater than anticipated due to the longer EUL for commercial LED lamps and installing 5% more measures through community-based programs. The top ten programs have an average TRC of 3.4. The Million CFL program realized a TRC of 4.7 by purchasing CFLs in large quantities at low cost and installing CFLs through multiple programs. The Water Leak Repair and Residential Green Partners Water programs realized a TRC of 4.12 and 3.48 respectfully due to electricity savings from water pumping and therm savings from units installed at sites with gas water heaters. The Business Green Partners lighting program realized a TRC of 3.74 due to the longer EUL of LED lamps and bulk purchases of LED lamps and CFLs and distributing directly to commercial customers. The Neighborhood Resource Mobilization (Block Party) program realized a TRC of 3.39 by providing free energy efficient CFLs directly to customers who attended neighborhood events. The Residential Lighting Rebate Program achieved a 3.14 TRC. The School Conservation Education program achieved a TRC of 2.75 by promoting energy and water conservation through activities designed to educate students and deliver free energy and water savings measures. The Refrigerator Recycling program realized a TRC of 2.69 by using a local appliance store to recycle units. Residential Energy Surveys program realized a TRC of 2.42 by providing a large selection of energy efficiency measures to customers. The LED Holiday Lighting Exchange program realized a TRC of 1.84 by exchanging new free energy-efficient LED lighting strands to customers who turn in old incandescent holiday light strands. The Commercial Refrigeration program realized a TRC of 1.23 by installing 284 commercial refrigeration measures including LED refrigeration case lights, door gaskets, floating-head pressure controls, anti-sweat heater controls, efficient evaporator fan motors (electronically commutated motors - ECMs), and ECM fan controllers.

The the Energy Star® CEE Tier 1-3 Clotheswasher program realized a TRC of 1.32 and the High Efficiency Clotheswasher Water Rebate CEE Tier 2-3 program realized a TRC of 0.94 from kWh, therm, and water savings. The Energy Star® and CEE Tier 1-3 Refrigerator Rebate program realized a TRC of 1.03 and the Energy Star® and CEE Tier 1 Dishwasher program realized a TRC of 0.92. Savings were evaluated using the US EPA database (http://www.energystar.gov/). Energy Saving Partners program realized a TRC of 1.09 by combining income-qualified incentives with required energy efficiency retrofits and Commercial Lighting realized a TRC of 1.17. TDPUD offered a wide range of successful programs for residential and commercial customers that generally met or exceeded the ex ante savings goals. As noted above, TDPUD also purchased large quantities of measures at wholesale prices and gave these measures away free to capture significant savings while promoting their other programs. TDPUD partnered with several local organizations to implement projects including: Sierra Watershed Education Partnership, Town of Truckee, Truckee Home & Building Show, Tahoe-Truckee USD, Nevada County, Truckee River Watershed Council, Truckee Chamber, and the Truckee Downtown Merchant's Association.

4.1.1 Load Impacts for Residential Lighting

Load impacts for residential lighting are based on field inspections of Energy Star® CFLs, previous interviews with 40 TDPUD residential customers, and verification of rebates paid to TDPUD customers. Residential lighting rebates were issued for CFLs and LEDs. The ex ante and ex post unit savings are shown in **Table 4.8**. The ex ante goal for Residential Lighting rebates was 500 units. The EM&V study verified 667 measures from the TDPUD rebate application database. The ex ante and ex post NTGR are 0.69 ± 0.07 based on decision maker surveys indicating 31% of participants were free riders (i.e., received rebates for lighting measures they said they would have installed without rebates). The average ex post operating hours are 1,100 ± 65 hours/yr based on participant survey data for 40 customers.[18] The ex ante and ex post effective useful lifetime (EUL) is 9 years assuming 10,000 lifecycle operational hours. The net ex ante savings are 20,528 kWh/yr and 4.8 kW. The net ex ante lifecycle savings are 184,748 kWh. The net ex post savings are 27,384 ± 2,335 kWh/yr and 6.2 ± 1.33 kW at the 90% confidence level. The net ex post lifecycle savings are 245,453 ± 21,011 kWh. The ex post savings are approximately 33% more than ex ante for kWh and kW savings due to more units. The TRC is 3.15.

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

Table 4.8 Energy Star® CFLs Ex Ante and Ex Post Savings

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

4.1.2 Load Impacts for Energy Star® and CEE Tier 1-3 Clotheswashers

Load impacts for Energy Star® (ES) and Consortium for Energy Efficiency (CEE) clotheswashers are based on annual energy use for models listed in the Energy Star® and CEE 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® (CEE Tier 1) and CEE Tier 2 and 3 annual energy and water use values are shown in **Table 4.9**.[19] The program provided incentives of $75 for Energy Star® and CEE Tier 1, $100 for CEE Tier 2, and $125 for CEE Tier 3. CEE Tier 2 units are 25% more efficient than the Federal Standard and CEE Tier 3 units are 30% more efficient. The ex ante and adjusted ex post unit savings are shown in **Table 4.10**. The ex ante goal for Energy Star® and CEE Tier 1-3 clothes washers was 201 units. The EM&V study verified 234 units based on the TDPUD rebate application database. The ex ante and NTGR is 0.68 and ex post NTGR is 0.68 +/- 0.08 based on previous decision maker surveys conducted with 11 participants. This indicates 32% of participants were free riders and would have purchased Energy Star clotheswashers without rebates. The ex ante and ex post EUL is 12 years The net ex ante savings are 28,785 kWh/yr, 24.5 kW, 861 therm/yr, and 1,100,274 gallons/year. The net ex ante lifecycle savings are 345,420 kWh, 10,333 therms, and 13,203,288 gallons. The net ex post savings are 26,141 ± 1,067 kWh/yr, 26.2 ± 0.91 kW, 1,002 ± 33 therm/yr, 383,180 ± 11,246 gallons of water per year at the 90% confidence level. The net ex post lifecycle savings are 313,691 ± 11,246 kWh, 12,029 ± 393 therms, and 4,598,160 ± 134,948 gallons. The ex post kWh savings are 9.6% less than ex ante due to water savings credit given to the High Efficiency Clothes Washer CEE 1-3 rebate program offered to customers who are TDPUD water customers. The TRC is 1.32.

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

Description	Annual Electric Use (kWh/y)	Peak Demand (kW)	Total Annual Gas Use (therm)	Total Annual Water Use (gallon)	Annual Water Pump (kWh)	Water Pump Peak Demand (kW)	Total Annual Electric Use (kWh/y)	Total Peak Demand (kW)	Annual Water Use (CCF)
Standard CW	281.8	0.24	22.8	13,558	110.6	0.094	392.4	0.334	18.12
ES/CEE Tier 1 CW	130.2	0.111	18.3	7762	63.3	0.038	187.1	0.159	10.37
ES/CEE Tier 2 CW	76.2	0.065	16.6	5698	46.5	0.026	193.5	0.165	7.61
ES/CEE Tier 3 CW	48.7	0.042	15.8	4647	37.9	0.012	122.6	0.106	6.21

[19] 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 4.10 Energy Star® Clotheswasher Ex Ante and Ex Post Savings

Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Adjusted Gross Ex-Post Unit Savings (kWh/y)	Adjusted Gross Ex-Post Unit Savings (kW)	Adjusted Gross Ex-Post Unit Savings (therm/y)	Adjusted Gross Ex-Post Unit Savings (gallon/y)
ES/CEE Tier 1 CW	151.62	0.129	4.5	5796	151.62	0.129	4.5	5796
ES/CEE Tier 2 CW	205.63	0.175	6.2	7860	205.63	0.175	6.2	7860
ES/CEE Tier 3 CW	233.13	0.198	7.0	8911	233.13	0.198	7.0	8911
Average	210.6	0.179	6.3	8,050	164.3 ± 4.56	0.165 ± 0.004	6.3 ± 0.14	2,408 ± 48

4.1.3 Load Impacts for Energy Star® and CEE Tier 1 Dishwashers

Load impacts for Energy Star® and CEE Tier 1 dishwashers are based on annual energy use for models listed in the Energy Star® database and verification of the TDPUD database consistent with IPMVP Option A (verification of stipulated savings). The US National Appliance Energy Conservation Act (NAECA) standard unit baseline and Energy Star® qualified annual energy and water use and average savings are shown in **Table 4.11**.[20] The ex ante and ex post unit savings are shown in **Table 4.12**. The ex ante goal for Energy Star® and CEE Tier 1 dishwashers was 128 units. The EM&V study verified 148 units based on the TDPUD rebate application database. The ex ante and ex post NTGR is 0.69 and the EUL is 11 years. The TDPUD net ex ante first-year savings are 8,066 kWh/yr, 12.4 kW, 115 therm/yr, and 45,396 gallons/yr based on 128 units. The net ex ante lifecycle savings are 88,728 kWh, 1,263 therms, and 499,361 gallons. The net ex post savings are 9,326 ± 500 first-year kWh, 14.4 ± 0.89 kW, 136 ± 4 first-year therm, and 52,531 ± 2,926 first-year gallons of water at the 90% confidence level. The lifecycle savings are 102,591 ± 5,503 kWh, 1,494 ± 49 therms, 577,836 ± 32,186 gallons of water. The ex post savings are approximately 16% greater than ex ante savings due to more units. The TRC is 0.92.

Table 4.11 Annual Energy and Water Use for Dishwashers

Description	Annual Electric Use (kWh/y)	Peak Demand (kW)	Total Annual Gas Use (therm)	Total Annual Water Use (gallon)	Annual Water Pump (kWh)	Water Pump Peak Demand (kW)	Total Annual Electric Use (kWh/y)	Total Peak Demand (kW)	Annual Water Use (CCF)
Standard DW	355.5	0.551	3.6	1,398	11.4	0.02	366.9	0.569	1.87
ES/CEE Tier 1 DW	264.2	0.41	1.8	668	5.4	0.01	269.6	0.42	0.9

Table 4.12 Energy Star® Dishwashers Ex Ante and Ex Post Savings

Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
ES/CEE Tier 1 DW	91.3	0.141			91.3 ± 3.4	0.141 ± 0.006	1.8 ± 0.03	730 ± 20

[20] 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.

4.1.4 Load Impacts for Energy Star® and CEE Tier 1-3 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® and CEE Tier 1-3 models.[21] 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 4.13**.[22] The ex ante and ex post unit savings are shown in **Table 4.14**. The program provided incentives of $75 for Energy Star® and CEE Tier 1, $100 for CEE Tier 2, and $125 for CEE Tier 3. CEE Tier 2 units are 25% more efficient than the Federal Standard and CEE Tier 3 units are 30% more efficient. The ex ante goal for Energy Star® and CEE Tier 1-3 refrigerators was 171 units. The EM&V study verified 197 units based on the TDPUD rebate application database. The ex ante and ex post NTGR is 0.70 (based on 2011 decision maker survey responses) and the EUL is 14 years. The net ex ante savings are 15,477 kWh/yr and 2.7 kW. Net ex ante lifecycle savings are 216,678 lifecycle kWh. The net ex post savings are 17,830 ± 778 kWh/yr and 3.1 ± 0.2 kW at the 90% confidence level. Net ex post lifecycle savings are 249,624 ± 10,894 kWh. The ex post savings are approximately 15% greater than ex ante for kWh savings due to 15% more units. The TRC is 1.03.

Table 4.13 Annual Energy Use for Refrigerators

Description	Qty.	US Min. Std. Annual Electric Use (kWh/y)	US Min. Federal Std. Peak Demand (kW)	Energy Star® Annual Electric Use (kWh/y)	Energy Star® Peak Demand (kW)	Annual Electric Savings (kWh/y)	Peak Demand Savings (kW)
Top Freezer w/o thru-door ice	67	490.9	0.084	385.9	0.066	105.0	0.018
Bottom Freezer w/o thru-door ice	62	580.3	0.099	457.3	0.078	123.0	0.021
Side Freezer w/ thru-door ice	45	713.7	0.122	553.9	0.095	159.8	0.027
Bottom Freezer w/o thru-door ice	27	694.1	0.119	543.1	0.093	151.0	0.026
Refrig. Only - Single Door	1	457.4	0.078	365.0	0.062	92.4	0.016
Average		593.6	0.101	465.9	0.080	129.3	0.022
+/- 90% CI		10.7	0.002	8.7	0.001	4.0	0.001

Table 4.14 Energy Star® Refrigerator Ex Ante and Ex Post Savings

Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
ES/CEE Tier 1 Refrigerator	121	0.021			121	0.021		
ES/CEE Tier 2 Refrigerator	151.3	0.025			151.3	0.025		
ES/CEE Tier 3 Refrigerator	181.5	0.03			181.5	0.030		
Average	129.3	0.022			129.3 ± 4.0	0.022 ± 0.001		

[21] 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.

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

4.1.5 Load Impacts for Refrigerator & Freezer Recycling

Load impacts for the Refrigerator Recycling program 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 a sample of participating units are provided in **Table 4.15**. The ex ante and ex post unit savings are shown in **Table 4.16**. The ex ante goal for refrigerator recycling was 120 units. The EM&V study verified 128 units based on the TDPUD rebate application database. The ex ante and ex post NTGR is 0.85 ± 0.05 based on 2011 interviews with 13 participants. The ex ante and ex post EUL is 5 years. The net ex ante savings are 117,402 kWh/yr, 25.2 kW and 587,010 lifecycle kWh. The net ex post savings are 125,233 ± 13,568 kWh/yr, 27 ± 2.92 kW, and 626,167 ± 75,260 lifecycle kWh at the 90% confidence level. The ex post kWh and kW savings are 7% greater than ex ante due to more measures. The TRC is 2.69.

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

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

Table 4.16 Refrigerator Recycling Ex Ante and Ex Post Savings

Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
Refrigerator Recycling	1,151	0.248			1,151 ± 22	0.248 ± 0.023		

4.1.6 Load Impacts for Building Envelope & Duct Testing

Load impacts for building envelope and duct testing are based on 2012 field inspections of measures at 3 participant sites and engineering analysis consistent with IPMVP Option B. Field measurements of three participant sites showed average duct leakage reduction of 22%, and the average ex post duct leakage reduction for the 2011 TDPUD program is 14%.[23] Field measurements of three participant sites showed average infiltration reduction of 17%. Infiltration represents approximately 40% of the space heating UEC. Therefore, the ex post infiltration savings are assumed to be 6.8%. The weighted average unit energy consumption (UEC) values are 602 therm/yr for space heating and 244 kWh/yr for heating ventilation in climate zone 16.[24] The ex ante and ex post unit energy savings are shown in **Table 4.17**. The ex ante goal for building envelope and duct mitigation was 4 units for each measure. The EM&V study verified 7 building envelope mitigation measures and 8 duct mitigation measures based on the TDPUD rebate application database. The net-to-gross ratio is 0.80 for building envelope mitigation and 0.74 for duct repair. The EUL is 18 years. The ex ante savings for building envelope mitigation are 228 kWh/year, 0.2 kW, 134 therm/year, 4,113 lifecycle kWh, and 2,406 lifecycle therms. The ex ante savings for duct mitigation are 286 kWh/year, 0.2 kW, 168 therm/year, 5,152 lifecycle kWh, and 3,016 lifecycle therms. The building envelope mitigation program net ex post savings are 400 ± 50 kWh/yr, 0.3 ± 0.04 kW, 234 ± 29 therm/yr, 7,193 ± 899 lifecycle kWh, and 4,212 ± 527 lifecycle therms. The duct leakage mitigation program net ex post savings are 572 ± 77 kWh/yr, 0.5 ± 0.06 kW, 335 ± 45 therm/yr, 10,302 ± 1,392 kWh lifecycle kWh, and 6,034 ± 815 lifecycle therms. Net ex post savings are 75 to 100% greater than ex ante due to more units. The TRC is 1.88.

Table 4.17 Building Envelope and Duct Leakage Mitigation Ex Ante and Ex Post Savings

Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
Bldg Envelope Mitigation	71.4	0.059	41.8		71.4 ± 7.1	0.059 ± 0.006	41.8 ± 4	
Duct Leakage Mitigation	96.7	0.080	56.6		96.7 ± 9.7	0.080 ± 0.008	56.6 ± 6	

4.1.7 Load Impacts for Thermally Efficient Windows

Load impacts for thermally efficient windows are based on engineering analysis consistent with IPMVP Option A. The ex ante goal was 1 unit (or 100 ft^2). The EM&V study verified 1.45 unit (or 145 ft^2) of thermally efficient windows based on the TDPUD rebate application database. The net-to-gross ratio is 0.96. The EUL is 20 years. TDPUD defined a performance threshold (i.e., minimum overall R-value or maximum u-value) for qualifying windows. For double-pane low-emissivity windows, the maximum u-value is 0.32 Btu/hr-ft^2-°F and 0.4 solar heat gain

[23] 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).

[24] 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/.

coefficient (SHGC) including the frame. The ex ante and ex post unit energy savings are shown in **Table 4.18**. The net ex ante savings are 154 kWh/yr, 0.5 kW, 10 therm/yr, 3,072 lifecycle kWh, and 209 lifecycle therms. The net ex post savings are 223 ± 22 kWh/yr, 0.7 ± 0.07 kW, 15 ± 2 therm/yr, 4,454 ± 445 kWh lifecycle kWh, and 305 ± 31 lifecycle therms. Net ex post savings are 45% greater than ex ante due to more units. The TRC is 1.13.

Table 4.18 Thermally Efficient Windows 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)
Thermally Eff. Windows	160	0.531	10.9		160 ± 16	0.531 ± 0.053	10.9 ± 1	

4.1.8 Load Impacts for Commercial Lighting

Load impacts for commercial lighting are based on previous EM&V studies, electric power measurements, and lighting logger measurements of fixtures consistent with IPMVP Option B.[25] The ex post ex ante and ex post unit savings are shown in **Table 4.19**. The ex ante goal was 30 commercial lighting projects. The EM&V study verified 41 projects based on the TDPUD rebate application database. The ex ante net-to-gross ratio is 0.89 based on 2012 decision maker surveys. The ex post NTGR is 0.89 ± 0.03 based on 2013 and 2012 decision maker surveys of participants. The ex ante and ex post effective useful lifetime (EUL) is 15 years based on 93% of projects having LED lamps. The estimated gross ex ante site savings per project are 4,988 kWh/yr and 1.009 kW. The net ex ante savings are 110,992 kWh/yr and 22.4 kW. The net ex ante lifecycle savings are 1,664,879 kWh. The net ex post savings are 167,753 ± 2,908 kWh/yr and 62.0 ± 0.94 kW at the 90% confidence level. The net ex post lifecycle savings are 2,516,301 ± 43,622 kWh. The ex post kWh savings are approximately 51% greater and kW savings are 177% greater due to 37% more projects. The TRC is 1.17 or 23% greater than 2012 due to cost effective savings from more LED fixtures.

Table 4.19 Commercial Lighting Projects Ex Ante and Ex Post Site Savings

Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
11. Commercial Lights	4,988.4	1.008			4,597.2 ± 70.9	1.7 ± 0.023		

[25] *Evaluation, Measurement & Verification Report for Truckee Donner Public Utility District 2011 Energy Efficiency Programs*. R., Mowris. E. Jones. 2012. *Evaluation, Measurement & Verification Report for Truckee Donner Public Utility District 2008 Energy Efficiency Programs*. R., Mowris. E. Jones. 2009. Prepared for Truckee Donner Public Utility District. *Measurement and Verification Report for NCPA SB5X Programs*, prepared for NCPA, prepared by RMA, 2005.

4.1.10 Load Impacts for High Efficiency Water Heater

Load impacts for electric high efficiency water heater are based on the difference between average annual energy use for standard efficiency water heaters and efficient water heaters consistent with IPMVP Option A. 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 ex ante goal was 5 units. The EM&V study verified 3 units based on the TDPUD rebate application database. The baseline gross ex ante and ex post unit energy savings are shown in **Table 4.20**.[28] The ex ante and ex post NTGR is 0.79 and the EUL is 15 years. The net ex ante savings are 126 kWh/yr, 0.0 kW and 1,896 lifecycle kWh. The net ex post savings are 76 ± 10 kWh/yr, 0.0 kW, and 1,138 ± 144 lifecycle kWh. The TRC is 0.32.

Table 4.20 High Efficiency Electric (or Solar) Water Heater 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)
High Eff. Water Heater	32	0.005			32 ± 3.2	0.005 ± 0.001		

4.1.11 Load Impacts for Low/Moderate Income Energy Assistance

Load impacts low/moderate income energy assistance (Energy Saving Partners) are based on previous EM&V studies, verification inspections at 17 sites, and engineering analysis per IPMVP Option B and C. The ex ante goal was 100 participants. The EM&V study verified 83 participants and 6140 measures from the TDPUD rebate application database. Gross ex ante and ex post unit savings are shown in **Table 4.21**. 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 net ex ante savings are 26,410 kWh/yr, 19.6 kW, 2,134 therms/year, 375,900 gallons/year, 237,686 lifecycle kWh, 19,202 lifecycle therm, and 3,383,100 lifecycle gallons of water. The net ex post savings are 47,970 ± 3,769 first-year kWh, 37.7 ± 1.8 kW, 2,441 ± 296 first-year therm, 392,355 ± 46,709 first-year gallons of water, 431,731 ± 33,922 lifecycle kWh, 21,965 ± 2,664 lifecycle therm, and 3,531,193 ± 420,380 lifecycle gallons of water.[29] The ex post kWh and kW savings are approximately 82% greater than ex ante savings due to more measures installed at each participant site. The program installed 74 measures per site in 2013 versus 25 measures per site in 2012. The TRC is 1.09.

[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.

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

Table 4.21 Energy Savings Program (ESP) Ex Ante and Ex Post Savings

Energy Efficiency Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
14. Low Income ESP	314.4	0.233	25.4	4,475	688 ± 45	0.514 ± 0.021	35 ± 3.6	5,628 ± 563

4.1.12 Load Impacts for School Conservation Education

The School Conservation Education Program provided K-8 students at 6 schools throughout the TDPUD electric service area with CFLs and a conservation education kit. The conservation kits were prepared by the Sierra Watershed Education Partnership. Kits were given to students at school assemblies by the Truckee High School Bright Schools/Envirolution environment club during community Trashion fashion shows. The program promotes energy and water conservation through activities to educate students and delivery of free, energy and water savings measures. TDPUD provided a Par 20 CFL (11 W) in the conservation kit handout. The 2013 program distributed 1,908 PAR 20 CFLs (11W). Load impacts are based on Energy Star® CFLs. The ex ante and ex post unit savings are shown in **Table 4.22**. The ex ante goal was 1,800 units. The EM&V study verified 1,908 CFLS from the TDPUD rebate application database. The ex ante and ex post NTGR are 0.80. 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 effective useful lifetime (EUL) is 9 years assuming 10,000 lifecycle operational hours. The net ex ante savings are 85,680 kWh/yr and 20.2 kW. The net ex ante lifecycle savings are 771,120 kWh. The net ex post savings are 90,821 ± 6,678 kWh/yr and 20.6 ± 3.82 kW at the 90% confidence level. The net ex post lifecycle savings are 817,387 ± 60,102 kWh. The ex post savings are approximately 6% more than ex ante due to more units. The TRC is 2.76.

Table 4.22 School Conservation Education 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)
1. Residential CFLs	59.5	0.014			59.5 ± 3.5	0.014 ± 0.002		

4.1.13 Load Impacts for Residential Energy Survey

Load impacts for Residential Energy Survey (RES) program are based on field inspections, interviews with residential customers, and verification of the TDPUD database. Gross ex ante and ex post unit savings are shown in **Table 4.23**. The ex ante goal was 150 participants. The

[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 is consistent with 1,624 ± 298 hours/yr based on light logger data for 1,173 fixtures at 66 residential sites from a previous EM&V study (see Evaluation, Measurement, and Verification Report for the Moderate Income Comprehensive Attic Insulation Program #1082-04, Study ID: BOE0001.01, Prepared for California Public Utilities Commission, San Francisco, CA, and BO Enterprises, Inc., Los Gatos, CA, Prepared by Robert Mowris & Associates, Olympic Valley, CA, June 12, 2008, Available online: www.calmac.org).

EM&V study verified 284 participants based on the TDPUD rebate application database. RES energy savings are different than ESP due to different household characteristics and quantities of measures installed. The ex ante and ex post NTGR is 0.64 ± 0.09 based on decision maker surveys of 40 participants. The average ex post operating hours are 1,100 ± 65 hours/yr based on participant survey data for 40 customers.[31] The ex ante and ex post EUL is 9 years. The ex ante savings are 93,034 kWh/yr, 76.4 kW, 2,938 therm/yr, 677,088 gallons/year of water, 837,302 lifecycle kWh, 26,438 lifecycle therm, and 6,093,792 lifecycle gallons of water. The total net ex post savings are 150,698 ± 15,359 kWh/yr, 120.6 ± 7.43 kW, 7,381 ± 1,180 therm/yr, 1,193,455 ± 186,477 gallons of water, 1,356,279 ± 138,231 kWh lifecycle kWh, 66,433 ± 10,621 lifecycle therm, and 10,741,094 ± 1,678,296 lifecycle gallons of water. The ex post savings are 62% greater than ex ante due to more participants.

Table 4.23 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)
Residential Energy Survey	969.1	0.796	30.6	7,053	829.1 ± 54	0.663 ± 0.026	40.6 ± 4.2	6,566 ± 657

4.1.14 Load Impacts for Business Green Partners Lighting

Load impacts for the Business Green Partners (BGP) Lighting program are based on field inspections and light logger measurements of 420 measures at 8 participant sites consistent with IPMVP Option B. The average annual hours of operation are 3,350 ± 75 hours per year based on light logger data. Gross ex ante and ex post unit savings are shown in **Table 4.24**. The ex ante goal was 1,300 units. The EM&V study verified 1,242 units based on the TDPUD rebate application database. 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 net ex ante savings are 182,436 kWh/yr, 50.8 kW and 547,307 lifecycle kWh. The net ex post savings are 189,949 ± 4,496 first-year kWh, 56.7 ± 1.24 kW, and 569,847 ± 13,488 kWh lifecycle kWh. The ex post kWh savings are 4% greater than ex ante. The BGP program has a TRC of 2.03 with high customer satisfaction due to the custom delivery approach.

Table 4.24 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)	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)
BGP CFL and LED	165.1	0.046			162.7 ± 3.6	0.049 ± 0.001		

[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).

4.1.15 Load Impacts for Commercial Refrigeration Retrofit

Load impacts for the Commercial Refrigeration Retrofit program are based on data for 8commercial customer sites with energy efficiency refrigeration upgrades consistent with IPMVP Option A. The average gross ex ante and ex post site savings are shown in **Table 4.25**. The ex ante goal was 8 sites. The EM&V study verified 8 sites from the TDPUD rebate application database. The ex ante and ex post net-to-gross ratio is 0.95 based on surveys conducted with seven participants in 2011. The ex ante and ex post effective useful lifetime (EUL) is 8 years. The TDPUD ex ante savings are 125,271 kWh/yr, 16.4 kW and 1,002,171 lifecycle kWh. The net ex post savings are 125,271 ± 31,898 kWh/yr, 16.4 ± 2.71 kW, and 1,002,171 ± 255,186 lifecycle kWh. The TRC is 1.23.

Table 4.25 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	16,483	2.152			16,483 ± 3,987	2.152 ± 0.339		

4.1.16 Load Impacts for Residential Green Partner Lighting

Load impacts for residential green partner lighting are based on field inspections, interviews with residential customers, and verification of the TDPUD database. Gross ex ante and ex post unit savings are shown in **Table 4.26**. The ex ante goal was 3,000 units. The EM&V study verified 3,061 units from the TDPUD rebate application database. 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 114,240 kWh/yr, 26.9 kW, and 1,028,160 lifecycle kWh. The net ex post savings are 118,678 ± 10714 first-year kWh, 32.5 ± 6.12 kW, and 1,068,100 ± 96,422 lifecycle kWh. The ex post kWh savings are 4% greater due to more units installed. The TRC is 3.54.

Table 4.26 Load Impacts for Residential Green Partner Lighting

Energy Efficiency Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
Res. Green Partner Lighting	59.4	0.014			60.6 ± 3.5	0.017 ± 0.002		

4.1.17 Load Impacts for Neighborhood Resource Mobilization

Load impacts for the Neighborhood Resource Mobilization Block Party are based on interviews with residential customers and verification of the TDPUD database. Gross ex ante and ex post unit savings are shown in **Table 4.27**. The ex ante goal was 765 units. The EM&V study verified 965 units based on the TDPUD rebate application database. 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 31,407 kWh, 7.4 kW, and 282,664 lifecycle kWh. The net ex post savings are 34,668 ± 3,378 kWh/yr, 9.4 ± 1.93 kW, and 312,013 ± 9,591 lifecycle kWh. The ex post kWh savings are 10% greater than ex ante savings

due to more units installed. The Neighborhood Block Party program has high customer satisfaction and should be expanded to reach more customers. The TRC is 3.39.

Table 4.27 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)
Neighborhood Block Party	59.5	0.014			52.1 ± 3.5	0.014 ± 0.002		

4.1.18 Load Impacts for Million CFLs

Load impacts for Million CFLs are based on field inspections of Energy Star® CFLs and interviews with TDPUD residential customers. The ex ante and ex post unit savings are shown in **Table 4.28**. The ex ante goal was 29,500 units. The EM&V study verified 30,709 units based on the TDPUD rebate application database and 35,028 units were installed under this and other programs. The program has installed approximately 297,000 CFLs since 2008 or 30% of its goal. 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.[32] 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 1,211,123 first-year kWh and 285 kW and 10900,103 lifecycle kWh. The total net ex post savings are 1,260,758 ± 107,482 first-year kWh, 286.1 ± 61.42 kW, and 11,346,822 ± 967,334 lifecycle kWh. The ex post savings are 4% greater than ex ante savings due to more units being installed than anticipated. The Million CFLs program has a TRC of 4.7 and represents approximately 51% of total energy efficiency program savings. The Million CFLs program is provides educational information, hand-outs, and displays at the TDPUD headquarters to help customers understand different types of CFLs and LEDs that are available for their home or business in terms of lumens and Watts (i.e., LEDs for holiday lights, standard bulbs, MR16s, and T8s).

Table 4.28 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		

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

4.1.19 Load Impacts for LED Holiday Light Swap

Load impacts for the Light Emitting Diode (LED) Holiday Light Swap program are based on field inspections of 10 measures at 4 participant sites performed in previous TDPUD EM&V studies consistent with IPMVP Option B. The ex ante and ex post unit savings are shown in **Table 4.29**. The ex ante goal was 1,800 units. The EM&V study verified 1,928 units based on the TDPUD rebate application database. The ex ante and ex post NTGR values are 0.91 ± 0.01 based on 2011 participant surveys. The ex ante and ex post EUL is 16 years based on manufacturer data of 30,000 lifecycle operational hours Mean Life Before Failure (MLBF) for LEDs (actual MLBF is 50,000 hours). The ex ante savings are 39,148 kWh/yr, 145.8 kW and 626,371 lifecycle kWh. The net ex post savings are 41,981 ± 4,613 kWh/yr, 155.5 ± 17.09 kW, and 626,371 ± 73,812 kWh lifecycle kWh. The ex post savings are 7.2% greater than ex ante due to more units being installed. The LED Light Swap program can be improved by tracking participants in a database (i.e., customer name, number of strings, Watts per string received, and distributed). The TRC is 1.84.

Table 4.29 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		

4.1.20 Load Impacts Residential Green Partners Water Efficiency

Load impacts for the Residential Green Partners Water Efficiency program are evaluated using field measurements of pre- and post-retrofit flow rates from previous EM&V studies per IPMVP Option A and B.[33] TDPUD distributed 5,680 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).[34] 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

[33] 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).

[34] 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.

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.[35] The ex post savings are based on the average reduction in flow rate and the average percentage of usage attributable to showering (i.e., 23% for gas and 26% for electric water heating) multiplied times the baseline water heating Unit Energy Consumption (UEC) of 3,079 kWh per year for electric water heaters and 193 therms per year for gas water heaters (*California Statewide Residential Appliance Saturation Survey.* Study 300-00-004, prepared for California Energy Commission, prepared by KEMA-XENERGY Inc. Oakland, California, June 2004.).[36] The gross ex ante and ex post unit savings are shown in **Table 4.30**. The ex ante goal was 5,500 units. The EM&V study verified 5,680 units based on the TDPUD rebate application database. 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.[37] 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 ex ante savings are 16,517 kWh/yr, 8.5 kW, 12,282 therm/yr, and 6,221,215 gallons/yr of water. Net ex ante lifecycle savings are 165,165 kWh, 122,815 therm, and 62,212,150 gallons of water. The net ex post savings are 17,440 ± 3,671 first-year kWh, 8.9 ± 0.44 kW, 12,884 ± 2,085 first-year therm, 6,496,451 ± 530,787 first-year gallons of water. The net ex post lifecycle savings are 166,108 ± 36,713 lifecycle kWh, 144,192 ± 20,853 lifecycle therm, and 66,655,504 ± 5,307,870 lifecycle gallons of water. The ex post savings are 1% greater than ex ante savings due to more units. The TRC is 3.48.

Table 4.30 Residential Green Partners Water 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.	3.9	0.002	2.9	1,469	3.8 ± 0.6	0.002 ± 0.0001	3.3 ± 0.37	1,524 ± 93

4.1.21 Load Impacts for Water Efficient Toilet Rebate and Exchange

Load impacts for the Water Efficient Toilet Rebate and Exchange program are based on the rated water use per flush and 5.1 flushes per day (see http://www.epa.gov/WaterSense/product_search.html). The pre-existing toilet water use is based

[35] Ibid.

[36]. 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.

[37] 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.

on 3.4 gallons per flush (gpf) and 1.6 gpf for toilets from 1994 through 2010.[38] The embedded energy of water pumping and treatment is 0.008157374 kWh per gallon based on TDPUD total 2007 electricity usage for water pumping and water treatment or 19,202,459 kWh per year and total water use of 2.354 billion gallons. Annual water and energy use for each toilet that received a rebate is based on the difference between the rated gallons per flush of the pre-existing toilet and the rated gallons per flush for the specific make and model listed in the WaterSense® database consistent with IPMVP Option B. The ex ante and ex post unit savings are shown in **Table 4.31**. The ex ante goal was 600 units. The EM&V study verified 548 units based on the TDPUD rebate application database. 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 12,636 kWh/yr, 1.9 kW, 1,544,506 gallons/yr, 189,540 lifecycle kWh, and 23,167,620 lifecycle gallons. The net ex post savings are 11,521 ± 843 first-year kWh/yr, 1.7 ± 0.12 kW, 1,410,772 ± 103,265 gallons/yr, 172,816 ± 12,650 lifecycle kWh, and 21,161,585 ± 1,548,976 lifecycle gallons of water. The ex ante and ex post savings are the same based on actual units and savings based on previous EM&V studies. The Water Efficient Toilet Rebate and Exchange programs have a TRC of 0.27 due to the E3 calculator not including the avoided costs of water savings. This water conservation program was only evaluated from an energy efficiency point of view. The TRC would be greater if avoided costs of water were included in the analysis.

Table 4.31 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		3,178	26 ± 1.5	0.004 ± 0.0002		3,178 ± 188

4.1.22 Load Impacts for Water Leak Repair

Load impacts for the Customer Water Leak Repair program are based on the measured water leak rate reported by the TDPUD water department which identifies leaks based on electronic metering and historical water use for each customer consistent with IPMVP Option D. The embedded energy of water pumping requires approximately 0.00480080 kWh per gallon based on total 2007 electricity usage for water pumping and total water use of 2.354 billion gallons. The leaks are generally caused by leaking underground shut-off valves, leaking fittings, or leaking toilet flapper valves that would not be obvious to customers. Before the program was established residential customers did not have water meters and billing was based on a flat rate per site. The Customer Leak Repair program was established after electronic meters were installed. The TDPUD water department provides customers with a letter indicating the magnitude of the leak and when the leak was identified. Based on 2011 program data, the average time to repair leaks is 155 +/- 27 days and the average cost of repairs is $844 +/- $184 per site. The ex ante and ex post unit savings are shown in **Table 4.32**. The ex ante goal was 25 participants. The EM&V study verified 29 participants based on the TDPUD rebate application

[38] 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.

database. The ex ante and ex post net-to-gross ratio is 0.77 ± 0.14 based on surveys with 10 participants. The ex ante and ex post effective useful lifetime (EUL) is 10 years since leaks often occur again at the same site. The ex ante savings are 33,333 first-year kWh/yr, 3.8 kW, 6,942,790 gallons/yr, 333,333 lifecycle kWh, and 69,427,896 lifecycle gallons. The net ex post savings are 38,666 ± 12,519 first-year kWh, 4.4 ± 1.43 kW, 8,054,196 ± 2,607,709 first-year gallons, 386,660 ± 125,192 lifecycle kWh, and 80,541,958 ± 26,077,090 lifecycle gallons of water. The ex ante and ex post savings are the same based on previous EM&V studies.[39] The Customer Leak Repair program has a TRC of 4.12 and very high customer satisfaction. This program should be widely publicized to acknowledge excellence in program design and implementation by the TDPUD energy and water efficiency departments. Water supply leaks represent 10 to 50% of the total water supplied by municipal utilities (see http://www.corrosion-club.com/waterfigures.htm). The total water supply loss due to leaks in California is estimated at 81 billion gallons per year (US EPA). The typical large municipal city water leak rate is 17.2% (F. van der Leeden et al.: "The Water Encyclopedia", Second Edition, Lewis Publishers, 1990). The estimated leak rate in London is 50% (Marq de Villiers: "Water", Stoddart Publishing Co., 1999).

Table 4.32 Customer Leak Repair Ex Ante and Ex Post Unit Savings

Energy Efficiency Measure	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (therm/y)	Gross Ex-Ante Unit Savings (gal/y)	Gross Ex-Post Unit Savings (kWh/y)	Gross Ex-Post Unit Savings (kW)	Gross Ex-Post Unit Savings (therm/y)	Gross Ex-Post Unit Savings (gallon/y)
28. Customer Leak Repair	1732	0.198		360,684	1732 ± 432	0.198 ± 0.049		360,684 ± 89,921

4.1.23 Load Impacts for High Efficiency Clotheswasher CEE Tier 2-3 Water Rebate

Load impacts for High Efficiency Clotheswasher Energy Star® and CEE Tier 2-3 are based on annual energy use for models listed in the Energy Star® and CEE database and verification of the TDPUD database consistent with IPMVP Option A. The program provided incentives of $50 for TDPUD water customers who purchased a CEE Tier 2 or 3 clotheswasher. CEE Tier 3 units are 30% more efficient than the Federal Standard. The ex ante and ex post unit savings are shown in **Table 4.33**. The ex post electricity savings only include water and pumping. The ex ante goal was 100 units. The EM&V study verified 164 units based on the TDPUD rebate application database. The ex ante and NTGR is 0.68 and ex post NTGR is 0.68 +/- 0.08 based on previous decision maker surveys conducted with 11 participants. This indicates 32% of participants were free riders and would have purchased Energy Star clotheswashers without rebates. The ex ante and ex post EUL is 12 years. The net ex ante savings are 14,321 kWh/yr, 12.2 kW, 426 therm/yr, and 547,400 gallons/yr. The net ex ante lifecycle savings are 171,851 kWh, 5,141 therms, and 6,568,800 gallons. The net ex post savings are 7,323 ± 748 kWh/yr, 2.2 ± 0.64 kW, and, 897,736 ± 26,348 gallons of water per year at the 90% confidence level. The net ex post lifecycle savings are 87,878 ± 8,970 kWh and 10,772,832 ± 316,181 gallons. The ex post

[39] 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.

kWh savings are 49% less than ex ante due to only taking credit for water pumping electricity savings. Other electric and gas savings are accounted for in the Residential ES/CEE Clotheswasher Rebate program discussed above. The TRC is 0.94.

Table 4.33 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)
ES/CEE Tier 2-3 CW	210.6	0.179	6.3	8,050	64.7 ± 4.56	0.020 ± 0.004		8,050 ± 161

4.2 Verification Inspection Findings

Verification inspections were conducted in 2013 and for the previous EM&V studies in 2012, 2011, 2010, 2008, and 2001 through 2004. Results of the on-site verification inspections were used in the impact evaluation to estimate the overall energy savings. Inspections were conducted for the following measures: T8 and LED commercial lighting fixtures, residential and commercial CFLs, attic insulation, duct sealing, whole house air infiltration reduction, electric and solar water heaters, and Energy Star® appliances. Building infiltration was checked at three sites and duct leakage was checked at three sites for the 2010 programs and all sites passed inspections. On-site inspections and survey responses were used to evaluate pre- and post-retrofit lighting fixture wattages. A total of 972 measures were inspected in 2013, 1,609 measures were inspected for 2012 programs, 1,131 measures were inspected for the 2010 programs and 3,388 measures were inspected for the 2008 programs. Electric power measurements were made on a number of fixtures at different sites as shown in **Table 4.34**.

Table 4.34 Field Measurements of Lighting Fixture Average Power (2012 and 2010)

Description	String	1 lamp W	2 lamp W	3 lamp W	4 lamp W
T12 F40 (4 ft) with magnetic ballast		57	96	143	189
T8 F32 (4 ft) with 4 lamp electronic ballast		41	64	90	108
T8 F32 (4 ft) with 2 lamp electronic ballast		39	61		
T12 F34 (4 ft) with magnetic ballast		43	78	116	154
T8 F32 (4 ft) with 4 lamp electronic ballast		41	64	90	108
T8 F32 (4 ft) with 2 lamp electronic ballast		39	61		
T12 F96 (8 ft) with magnetic ballast		75	128		
T8 F96 (8 ft) with electronic ballast		61	111		
T8 4 ft linear LED		18	36	54	72
T8 2 ft linear LED		9	18	27	36
HID HPS Highbay (Rated/Actual W)		150/188	250/295	400/465	
LED Highbay (dark sky compliant)		36	75	145	
100W PAR38		100			
LED PAR38		18			
Incandescent Exit Sign		25/40			
CFL Exit Sign		12/20			
LED Exit Sign		3/6			
LED Holiday String (60 qty. 0.021W LED Lamp 20 ft)	2.1				
LED Holiday String (200 qty. 0.021W LED Lamp 66 ft)	7.0				
Incand. Holiday String (100 qty. 0.5W M5 Lamp 20 ft)	50				
Incand. Holiday String (330 qty. 0.5W M5 Lamp 66 ft)	165				
Incand. Holiday String (40 5W C7 Lamp 20 ft)	200				
Incand. Holiday String (132 5W C7 Lamp 66 ft)	660				
Incand. Holiday String (40 7W C9 Lamp 20 ft)	280				
Incand. Holiday String (132 7W C9 Lamp 66 ft)	924				

Light loggers were installed at 6 sites in the 2013, 6 sites in 2012, and 30 sites in 2011 study to measure hours of operation. These were left at the sites for a period of up to eight weeks. Light loggers were used to monitor hours of operation on 4,826 fixtures. Lighting hours of operation are based on data from 59 light loggers as shown in **Table 4.35**. The average EM&V ex post hours of operation are 3,425 ± 377 hours per year which compares favorably to the ex ante assumption of 3,409 hours per year.

Table 4.34 Light Logger Measurements of Lighting Hours (2013, 2012, 2009)

Logger	Business Description	Program	Percent On	Hrs/day	Hrs/year
1	Restaurant	Commercial Lighting	50.6	12.14	4676
2	Retail	Commercial Lighting	36.9	8.86	3410
3	Restaurant	Commercial Lighting	63.3	15.19	5545
4	Retail	Commercial Lighting	18	4.32	1577
5	Retail	Commercial Lighting	34.8	8.35	3048
6	Office	Commercial Lighting	21.8	5.23	1910
7	Retail	Commercial Lighting	44.2	10.61	3872
8	Retail	Commercial Lighting	68.6	16.46	6009
9	Retail	Commercial Lighting	37.1	8.9	3250
10	Retail	Commercial Lighting	21.4	5.14	1875
11	Health	Commercial Lighting	25.6	6.14	2242
12	Retail	Commercial Lighting	19.6	4.7	1717
13	Office	Commercial Lighting	37.4	8.98	3276
14	Office	Commercial Lighting	28.4	6.82	2488
15	Office	Commercial Lighting	27.1	6.5	2374
16	Office	BGP-CFL	56.1	13.46	4914
17	Retail	Commercial Lighting	52.1	12.5	4564
18	Hospitality	BGP-CFL	100	24	8760
19	Retail	BGP-CFL	51.2	12.29	4485
20	Hospitality	BGP-CFL	100	24	8760
21	Health	BGP-CFL	31.2	7.49	2733
22	Retail	BGP-CFL	24.4	5.86	2137
23	Retail	BGP-CFL	30.3	7.27	2654
24	Retail	BGP-CFL	19.8	4.75	1734
25	Retail	BGP-CFL	32.3	7.75	2830
26	Retail	BGP-CFL	29.2	7.01	2558
27	Restaurant	BGP-CFL	33.3	7.99	2917
28	Restaurant	BGP-CFL	29.7	7.13	2603
29	Office	Comm Lighting	28.6	6.86	2503
30	Office	Comm Lighting	22.9	5.49	2003
31	Office	Comm Lighting	17.6	4.22	1541
32	Storage	Comm Lighting	60.9	14.62	5337
33	Storage	Comm Lighting	60.9	14.62	5337
34	Retail	Comm Lighting	31.7	7.60	2773
35	Retail	Comm Lighting	10.6	2.55	930
36	Retail	Comm Lighting	43.8	10.51	3838
37	Retail	Comm Lighting	42.1	10.10	3688
38	Retail	Comm Lighting	28.0	6.71	2450
39	Office	TDPUD LED	27.1	6.51	2377
40	Office	TDPUD LED	28.2	6.77	2469
41	Health Recreation	Comm Lighting	16.7	4.02	1467
42	Retail	Comm Lighting	32.6	7.82	2854
43	Office	Comm Lighting	27.3	6.56	2394
44	Office	Comm Lighting	10.1	2.43	887
45	Restaurant	BGP-LED	56.1	13.45	4911
46	Retail	BGP-LED	69.8	16.76	6117
47	Restaurant	Comm Lighting	43.6	10.47	3822
48	Retail	BGP-CFL	0.24	5.70	2080
49	Office	Comm Lighting	0.50	11.97	4368
50	Retail	Comm Lighting	1.00	24.00	8760
51	Restaurant	Comm Lighting	0.44	10.47	3822
52	Office	Comm Lighting	0.27	6.56	2394
53	Parking	Comm Lighting	0.50	12.00	4380
54	Retail	BGP-LED	0.41	9.83	3588
55	Retail	BGP-LED	0.43	10.26	3744
56	Office	BGP-LED	0.32	7.60	2773
57	Retail	BGP-LED	0.42	10.00	3650
58	Retail	BGP-LED	0.50	12.00	4380
59	School	BGP-LED	0.18	4.21	1536
	Average	EM&V Ex Post	38.2	9.2	3425 +/- 377
		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 ex post savings estimates for the other measures.

4.3 Participant Survey Results

This study uses participant surveys to estimate the net-to-gross ratios for kWh and kW savings. In 2013, participant surveys were completed with 12 customers representing 32% of total savings. In 2012, participant surveys were completed with 12 commercial customers representing 17.5% of total savings. In 2011, participant surveys were completed with 167 participants. In 2011, non participant surveys were completed for 10 customers who were not contacted by programs in 2011. In 2010, non participant surveys were completed for 40 customers who were not contacted by programs in 2010.

4.3.1 Participant Survey Methodology

Participant surveys are used to evaluate retention (i.e., measures still installed), pre-retrofit Watts, hours of operation, and time-of-use. The participant surveys were also used to evaluate net-to-gross ratios (NTGR) for calculating net kW and kWh savings. The NTGR is used to estimate the fraction of free riders who would have otherwise implemented lighting improvements in the absence of the program. For most programs, nine participant survey questions were used to assess net-to-gross ratios as shown in **Table 4.36**. The NTGR score for each completed participant survey is the average score based on answers to questions 5 through 13. No score is assigned to responses of "don't know", "refused to answer," or "other."

Table 4.36 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

Table 4.36 Net-to-Gross Ratio Participant Survey Questions and Scoring

#	Question	Answer	Score
11	I would not have purchased or installed the Energy Star® appliances or measures without the Utility Program rebates or information.	0 to 10	0=0, 10=1
12	The Energy Star® information or Utility Program was nice but unnecessary to have energy efficient appliances or measures installed.	0 to 10	0=1, 10=0
13	If you had not received the [Energy Star® information, rebate or service] from the Utility, when would you have purchased or installed the Energy Star® appliance or energy efficiency upgrades?	Within 6 months	0
		< 1 year	0.125
		1 to 2 years	0.25
		2 to 3 years	0.5
		3 to 4 years	0.75
		4 or more years	1
		Never	1

4.3.2 Findings of the Participant Surveys (NTGR)

Results of the participant surveys regarding the net to gross ratio (NTGR) are presented in **Table 4.37**. The participant findings indicate that approximately 23% 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 23% of their customers to make energy efficient purchasing decisions while 77% of customers lack sufficient information or economic resources to make energy efficient purchasing decisions without information and/or incentives from TDPUD.

Table 4.37 Findings of Participant Surveys for TDPUD Programs (NTGR)

TDPUD Program	Sample Size	Units Installed	NTGR	+/- 90% CI
1. Residential CFLs (2010/11)	10	282	0.69	0.07
2. Energy Star® Clotheswashers (2010/11)	11	224	0.68	0.08
3. Energy Star® Dishwasher (2010/11)	14	177	0.69	0.07
4. Energy Star® Refrigerator/Freezer (2010/11)	19	209	0.7	0.06
5. Refrigerator Recycling (2010/11)	13	24	0.85	0.05
6-8. Bldg Envelope Mitigation (2010/11)	8	4	0.8	0.08
7-9. Duct Mitigation (2010/11)	11	11	0.74	0.08
11. Commercial Lighting 2013	5	589	0.88	0.08
11. Commercial Lighting 2012	13	1,596	0.89	0.03
11. Commercial Lighting (2010/11)	15	1,909	0.85	0.03
12. High-Eff. Electric Water Heater Rebate (2011)	2	2	0.79	0
13. ESP – Income Qualified (2009)	17	175	0.64	0.09
15. Residential Energy Survey (2009)	4	48	0.64	0.09
16. Business Green Partners (2013)	8	420	0.94	0.03
16. Business Green Partners (2010/11)	10	10	0.85	0.03
16. Business Green Partners LED Pilot (2011)	10	10	0.85	0.03
16. Business Green Partners LED Accent (2011)	10	10	0.85	0.03
17. Commercial Refrigeration (2010/11)	7	15	0.95	0.02
18. Residential Green Partners (2009)	19	3,671	0.64	0.09
23.Water-Efficient Toilets and Exchange (2011)	10	821	0.81	0.07
24. Customer Leak Repair (2011)	10	89	0.77	0.14
29. TDPUD Bldg. LED Lighting (2012)	1	694	1.00	0
Total	226	10,990	0.77	0.07

4.4 Process Evaluation Results

Process evaluation recommendations are based on process surveys conducted with 193 participants and 10 non participants or individuals who were not contacted by the programs in 2013, 2012, or 2011 and 40 non participants who were not contacted by the programs in 2010. The process surveys were used to evaluate participant satisfaction and obtain suggestions to improve the program's services and procedures. Interview questions assessed how the program influenced awareness of linkages between efficiency improvements, bill savings, and increased comfort for customers. Participants were asked why and how they decided to participate in the program. Non-participants were asked why they chose not to participate. Non-contacted customers were asked if they would have participated had they been made aware of the program. The surveys identified reasons why program marketing efforts were not successful with non-participants as well as to identify additional hard-to-reach market barriers. The process survey instruments are provided in **Appendix A**.

4.4.1 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 – 98.7 percent rating (i.e., average score of 9.87 ± 0.06 out of 10 points).
- Presentation of information – 99 percent rating (i.e., 9.9 ± 0.05 out of 10 points).
- Increased Understanding of Link between Energy Efficiency, Savings, and Comfort - 76 percent rating (i.e., average score of 7.6 ± 1.8 out of 10 points), indicating a need to improve energy education efforts. Some customers who received free LED or CFL lamps said they didn't receive sufficient information to understand the energy savings.

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

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

- 95 percent of customers are still using the measures installed by the program (i.e., 181 out of 191 surveyed customers were still using all installed measures).
- 98% ± 2% of customers are satisfied with measures offered or installed by the program (i.e., average score of 9.8 ± 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.

- 99 ± 1 percent presentation satisfaction rating.
- 99 ± 1 percent accuracy satisfaction rating.
- 76 ± 18 percent satisfaction rating of program increasing understanding of the linkage between energy efficiency, bill savings, and comfort.
- 58 percent of participants indicated that others would benefit from the program.

4. What are the participant demographics?

- 26% of customers have electric water heaters and 74% have gas water heaters.
- Average water temperature set point is 127 ± 4°F.
- Residential average conditioned floor area is 2,141 ± 10.5 ft^2.
- Average number of occupants is 3.02 ± 0.03.
- 75% owned the home and 25% are tenants.
- Commercial average floor area is 22,594 ± 19,101 ft^2.
- Average number of employees is 33 ± 18.
- 68% own the business and 32% are tenants.
- 100 percent spoke English well enough to understand and answer the questions.
- Participants had the following primary languages: 97% English, 3% Spanish.

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

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

- 45% provided the following satisfactory comments. “Michael Ukraine completed the energy survey at my home yesterday. He was very professional and completed the work in a timely manner. He informed me of some improvements I could make and gave me a variety of fluorescent bulbs to use inside and outside my house. Thank you for this valuable service.” “Extremely happy!!” “Could not be happier with TDPUD and Trisha Ruby! They were extremely helpful and answered all questions. She had wanted to upgrade interior lighting for a while but had questions that she needed answers to and had not got until TDPUD helped.” “Very pleased with new lights.” “First year in program. Was quite pleased, couldn't think of any suggestions to improve program.” “Really like that new lighting saves on utility bill.” “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.” “I’m amazed that a public utility district is able to provide such a generous program to its customers for free! Thank you for this opportunity to take steps forward to conserve energy and water and lower our monthly bills.”
- 10% provided the comments regarding importance of programs. “Could not have done LED retrofit without TDPUD program.” “Would not have installed LEDs until they became federally required without TDPUD program” “Without program would have never changed to LED lamps and continued to re-lamp old inefficient fixtures wasting energy.” “Extremely happy with LED lighting.” “I had an energy review on my house in September. I wanted to let you know how great it was and to tell you a startling outcome. The fellow that did it discovered that the duct work from the heater in the garage to certain parts of the house was no longer hooked up! He estimated that 40% of the heat was being lost. The prior resident was likely freezing and had huge bills. I am addressing the issues one by one, but had the duct work re-hooked up thank goodness right before it snowed! I would never in a million years have known that without the energy audit. So, I really appreciate the opportunity and think it is an amazing service.”
- 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.”
- 5% 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 electricity, 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)?

Eight customers submitted written testimonials regarding sharing information with friends or neighbors about the benefits of energy efficiency services provided by TDPUD. Based on process survey responses, 42 percent of interviewed customers shared program information with 12 times as many people. Approximately 37 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.

4.4.2 Non-Participant Survey Results

Non-participant process survey results are summarized 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.

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

2. Why have customers chosen not to participate (i.e., market barriers)? [Multiple answers are provided and sum of percentages is greater than 100%]

- 58% didn't participate due to not knowing about the program (i.e., information costs).
- 4% didn't participate due to not understanding the benefits of energy efficiency.
- 2% didn't participate due to not owning the building.
- 8% didn't participate due to being too busy or not having time to participate (hassle factor).
- 28% didn't participate due to already having installed CFLs, already taken steps to improve home, didn't understanding what programs provided beyond CFLs, were renters or did not own the building (i.e., misplaced or split incentive) or were sold non-Energy Star appliances that didn't qualify for the rebate programs (i.e., performance uncertainty).

[40] Spillover of 0.5% is calculated based on 53 people adopting at least one spillover measure based on information shared by a group of 12 participants who adopted 966 measures (i.e., 53/966/12 x 100 = 0.5%).

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

Non-participants provided suggestions to improve participation.

- From 2008 to 2011, approximately 47% suggested better advertising and information. 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."
- TDPUD responded to these suggestions by significantly improving advertising and information through their website, local newspapers, retail appliance stores, community events, and neighborhood resource mobilization block parties. TDPUD has provided more than 800 residential energy surveys and given away approximately 25,000 water efficiency measures, 297,000 CFLs, 11,390 LED holiday light strings, and thousands of LED lamps since 2008.

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

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

- 90% of non-participants are owners and 10% are renters.
- Average age is 53.9 ± 5.5 years.
- 57% of non-participants are male and 43% are female.
- Non-participants had the following primary languages: 100% English.
- Average income range of non-participants is $34,000 to $64,000.

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

4.4.3 Process Evaluation Recommendations

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

4.4.3.1 Recommendations for Database

TDPUD implemented an internet-tracking system (www.energy-orbit.com) to track program accomplishments in 2013. The database helps customers learn about rebates, provides feedback

regarding the rebate process, and helps document program measures for EM&V reporting. The database should be improved to provide pre-existing and energy efficiency measure descriptions as well as other relevant information to document program accomplishments. The following is a partial list: pre-existing description, energy efficiency measure description (from pull-down list or entered), make, model, serial, USDOE FTC energy label rating (kWh/yr), CEE rating (Consortium for Energy Efficiency, www.cee1.orgm Tier 1, 2 or 3), efficiency rating (AFUE, MEF, WF, EF, etc.), pre/post duct leakage, pre/post building envelope leakage, and pre/post Watts or efficiency units.

4.4.3.2 Recommendations for Million CFLs and LED Holiday Light Exchange

The Million CFLs program has a TRC of 4.7 and the Residential CFLs program has a TRC of 3.53. The Million CFL program represents approximately 51% of total energy efficiency program savings. The Million CFLs program provides educational information to help customers understand the types of CFLs and LEDs that are available for their home or business in terms of lumens and Watts (i.e., LEDs for holiday lights, standard bulbs, MR16s, and T8s). The program has installed approximately 297,000 CFLs since 2008 or 30% of its goal. TDPUD continues to evaluate CFLs and LED lamps to find better quality products with longer life. The LED Holiday Light Exchange program has a TRC of 1.84 and should be continued.

4.4.3.3 Recommendations for Energy Star® and CEE Tier 1-3 Appliances

TDPUD redesigned the Residential Appliance Rebate program in 2013 to promote CEE Tier 1-3 clotheswashers, dishwashers, and refrigerators. The dishwasher rebate program TRC is 0.92 and the High Efficiency CEE Tier 3 Clotheswasher Water Rebate program TRC is 0.94. As noted above, TDPUD is an electric and water utility and the overall energy efficiency savings and costs associated with water conservation programs are included. This provides an accurate accounting of the energy and water saved by all TDPUD programs. When evaluated from a purely energy efficiency point of view some of the water efficiency programs appear to be less cost effective. These programs offer other water conservation benefits that TDPUD is concerned with.

4.4.3.4 Recommendations for Refrigerator & Freezer Recycling

The TDPUD refrigerator and freezer recycling program realized a TRC of 2.69 by recycling 128 units in 2013. This is a 440% increase in recycled units compared to 2011. This successful program should be continued to stimulate the local economy.

4.4.3.5 Recommendations for Building Envelope and Duct Mitigation

Customers were very satisfied with the programs and sent many email messages to let TDPUD know how much they appreciated the program. The building envelope and duct mitigation programs realized a TRC of 1.88. The program should provide rebates for achieving minimum leakage reduction targets. The duct leakage target should be 15% measured in cubic feet per minute (cfm) or 15% total duct leakage as a percentage of total system airflow. The building envelope sealing target should be 15% CFM50 reduction in air leakage or no less than 0.3 Air

Changes per Hour (ACH).[1] Information and incentives should be provided to commercial customers to optimize minimum outdoor air damper settings to save cooling and heating energy.

4.4.3.6 Recommendations for Thermally Efficient Windows

The Thermally Efficient Window program realized a TRC of 1.13. TDPUD had one participant in 2013. TDPUD should implement a thermally efficient window program for its office building and encourage at least five customers per year to install thermally efficient low-emissivity windows. This will help customers understand the importance of saving electricity and natural gas by reducing window heat loss in winter and heat gain in summer. Installing low-emissivity windows at the TDPUD offices will reduce energy use to achieve the Energy Star® BEP rating. The Energy Star® window qualification criteria maximum u-value is 0.32 Btu/hr-ft^2-°F and less than or equal to 0.4 SHGC. In 2013 TDPUD adopted the Energy Star® window criteria for this incentive program. The SHGC will be effective in reducing residential and commercial cooling loads in summer when solar gains and outdoor temperatures peak on south facing exposures.

4.4.3.7 Recommendations for Commercial Lighting

The commercial lighting program realized a TRC of 1.17 which is a 23% improvement compared to 2012. Approximately 93% of the 2013 lighting rebates were for LED fixtures. The program should consider an LED-only retrofit incentive in 2013 (i.e., 10% bonus). The program will benefit from an online application process so customers can enter the pre- and post-retrofit fixtures, quantities, Watts, and hours of operation. This will streamline the rebate application process and provide better tracking information for EM&V purposes.

4.4.3.8 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 electric heating energy efficiency measure viable.

4.4.3.9 Recommendations for High Efficiency Water Heaters

The High Efficiency Water Heater program only achieved a 0.32 TRC in 2013. TDPUD should encourage at least one customer with an electric water heater to install a solar thermal water heater 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 CSI program encourages customers to “save money on gas or electricity bills by harnessing the heat of the sun!” TDPUD might promote the benefits of solar water heating by showcasing successful solar projects already installed by customers.

4.4.3.10 Recommendations for Energy Assistance and Residential Energy Survey

The 2013 ESP program TRC is 1.09 and the RES program TRC is 2.42. These are very similar to 2012 where ESP had a 1.09 TRC and RES had a 2.45 TRC. TDPUD should consider requiring energy auditors to install all measures. This will include using ladders to install efficient lamps in ceiling fixtures. Installing measures will improve cost effectiveness and help low-income customers save energy and money. TDPUD should provide high R-value (i.e., R-14) low-emissivity (low-e) reflective closed-cell foam insulation for water heaters to overcome clearance issues (if compatible with the California Conventional Home Weatherization Installation Standards and ASTM E84, ASTM C534, UL723, NFPA255, UL181A-P, or UL-181B-FX). TDPUD should provide low-emissivity (low-e) reflective closed-cell foam insulation for pipes to overcome clearance issues (if compatible with the California Conventional Home Weatherization Installation Standards and ASTM E84, ASTM C534, UL723, NFPA255, UL181A-P, or UL-181B-FX).

4.4.3.11 Recommendations for School Conservation Education

The School Conservation Education program TRC is 2.75 in 2013. TDPUD should continue to explore new ideas and methods to educate students about resource conservation through installation of energy and/or water efficiency measures provided by TDPUD.

4.4.3.12 Recommendations for Business Green Partners Lighting

The Business Green Partners Lighting program has a TRC of 2.02 and is very popular with small commercial business customers. TDPUD should continue to offer this program to help small local businesses save energy and be successful. This program generates high customer satisfaction ratings with 97% of participants indicating they were very satisfied with the overall energy efficiency services received from TDPUD.

4.4.3.13 Recommendations for Commercial Refrigeration

The Commercial Refrigeration program has a TRC of 1.23 and is very popular with small commercial business customers. TDPUD should continue to offer this program to help small local businesses save refrigeration energy.

4.4.3.14 Recommendations for Residential Green Partners Lighting

The Residential Green Partners Lighting program TRC is 3.53. The program distributes information and free energy-efficient lighting measures to residential customers. This program invites customers to visit the TDPUD Conservation office and select various CFLs for free. The program allows customers to determine which lamps they prefer and purchase additional units to take advantage of the residential $2/lamp lighting rebate.

4.4.3.15 Recommendations for Neighborhood Resource Mobilization (Block Party)

The Neighborhood Resource Mobilization (Block Party) program TRC is 3.39. The program provided 5,680 water efficiency measures to customers. The 2010 EM&V study received comments from some customers who complained that the low-flow showerheads and aerators didn't provide enough flow. TDPUD purchased aerators and WaterSense® showerheads in 2012 and 2013 and this greatly improved customer satisfaction. This cost effective water efficiency program should be continued. WaterSense® showerheads and aerators save the equivalent of one CFL in pumping electricity annually and pre-rinse spray valves save the equivalent of 10 CFLs not including water heating energy savings.

4.4.3.16 Recommendations for Residential Green Partners Water

The Residential Green Partners Water program has a TRC of 3.47. This program provided 5,680 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 has been purchasing WaterSense® showerheads and aerators since 2011 and this greatly improved customer satisfaction. This cost effective water efficiency program should be continued. WaterSense® showerheads and aerators save the equivalent of one CFL in pumping electricity annually and pre-rinse spray valves save the equivalent of 10 CFLs not including water heating energy savings. Consider offering incentives for water conservation gardens and landscaping to save water using the Patricia S. Sutton TDPUD Conservation Garden as an example.

4.4.3.17 Recommendations for High-Efficiency Toilet Rebate and Exchange

The High-Efficiency Toilet Rebate and Exchange programs had a TRC of 0.27. This water conservation program was only evaluated from an energy efficiency point of view. The TRC would be greater if avoided costs of water were included in the analysis. 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%.

4.4.3.18 Recommendations for Customer Leak Repair

The Customer Leak Repair program has high customer satisfaction and TRC test of 4.11. 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 program.

4.4.3.19 Recommendations for High Efficiency Clotheswasher Water Rebates

The Energy Star® CEE Tier 1-3 Clotheswasher rebate program realized a TRC of 1.32, and the High Efficiency Clotheswasher Water Rebate CEE Tier 2-3 program realized a TRC of 0.94. When analyzed together these two rebate programs have a combined TRC of 1.16.

Appendix A: CEC EM&V Check List

Contextual Reporting

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

Overview and Documentation of Specific Evaluation Effort

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

Gross Savings

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

Net Savings

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

EM&V Summary and Conclusions

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

Appendix B: Participant and Non Participant Decision-Maker Survey

Interview Instructions for Decision-Maker Survey

1. Purpose

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

2. Selection of Respondent

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

3. Selection of Respondent

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

4. Two Types of Sites

This survey will be used for two types of sites:

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

5. How to Start a Survey

Complete the following steps to start one of these surveys:

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

   Say: "Hello! My name is [_____], and I am conducting a survey regarding the TDPUD Energy Efficiency Programs. The programs provided free energy efficiency measures (CFLs, LED lamps, showerheads, etc.), Energy Surveys, and rebates for energy efficient lighting, leak repair, building envelope and duct testing/repair, refrigerator/freezer recycling, Energy Star® appliances and equipment, and WaterSense® toilets and showerheads. Would you mind spending 10 minutes to answer a few questions to help us evaluate and improve the program?

4. Non-participant Survey Introduction.

   Say: "Hello! My name is [_____], and I am conducting a survey regarding the 2011 TDPUD Energy Efficiency Programs. You didn't participate in the programs, but your feedback will help us evaluate and improve the program. The programs provided free energy efficiency measures (CFLs, LED lamps, showerheads, etc.), Energy Surveys, and rebates for energy efficient lighting, leak repair, building envelope and duct testing/repair, refrigerator/freezer recycling, Energy Star® appliances and equipment, and WaterSense® toilets and showerheads. Would you mind spending 10 minutes to answer a few questions?

TDPUD PARTICIPANT SURVEY #_____

Customer Name:_____ Date: _____

Phone Number:_____ City: _____

Start Call Time: _____ End Call time:_____

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

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

Participant Survey

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

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

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

For non- CFL or LED Programs Skip to Question 10

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

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

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

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

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

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

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

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

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

Skip to Question 10 for non-Lighting Programs

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

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

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

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

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

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

    Please list measures not used? _____

TDPUD PARTICIPANT SURVEY (cont'd) #_____

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

Please list measures not installed? _____

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

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

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

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

_____

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

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

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

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

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

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

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

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

DECISION-MAKER SURVEY #_____

Customer Name: _____ Date: _____

Phone Number: _____ City:_____

Start Call Time: _____ End Call time: _____

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

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

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

Introduction

Say: "Hello. My name is [_____] and I am conducting a survey regarding the TDPUD energy efficiency programs. Would you mind spending 5 minutes to answer some questions to help us evaluate the programs?"

Begin Survey

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

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

   Notes: _____

Special Instruction for Contradictory Responses: If [**Q.7 is 0,1,2** *and* **Q.8 is 0,1,2**] *or* [**Q.7 is 8,9,10** *and* **Q.8 is 8,9,10**]. Find the explanation. Do not communicate a challenging attitude when posing the question. For example, say,

> When you answered "8" for the question about the influence of the rebate or service, I interpreted that to mean that the Utility Program was important to your decision. Then, when you answered "8" for how likely you would be to take the same action *without* the rebate or service, it sounds like the Utility was *not* very important. I want to check to see if I understand your answers or if the questions may have been unclear. If they volunteer a helpful answer at this point, respond by changing the appropriate answer. If not, follow up with something like: "Would you explain in your own words, the role the Utility Program played in your decision to take this action?

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

DECISION-MAKER SURVEY (Continued) #_____

9. What role did the Utility information or rebates (or Energy Star®) play in your decision to install the measures? [Prompt by reading list if the respondent has trouble answering.]

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

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

10. Utility incentives were a critical factor to purchase or install the energy efficiency measures
___ Response (**0-10**) **98** Don't Know **99** Refused to Answer

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

12. The Utility incentives were nice but unnecessary to install or purchase the energy efficiency measures.
___ Response (**0-10**) **98** Don't Know **99** Refused to Answer

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

When you answered question 12 about "the Utility incentives being 'nice' but unnecessary," I interpreted that to mean that the Utility incentives were unimportant to your decision. Then, you answered question 10 about "the Utility incentives being a critical factor." I want to check to see if I understand your response. If they volunteer a helpful answer, respond by changing the appropriate answer. If not, follow up with something like: "Would you explain in your own words, why the Utility Program was a critical factor in your decision?"

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

Answer: _____

13. If you had not received Utility rebates or information (such as Energy Star®) from the utility, when would you have purchased or installed the same or similar energy efficiency measures...

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

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

TDPUD NON-PARTICIPANT SURVEY #_____

Customer Name:_____ Date: _____

Phone Number:_____ City: _____

Start Call Time: _____ End Call time:_____

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

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

Non-Participant Survey

I am conducting a survey regarding the 2011 TDPUD Energy Efficiency Programs. You didn't participate in the program, but your feedback will help us evaluate and improve the program. The program provided incentives for energy efficiency measures and free Compact Fluorescent Lamps (CFL), LED lamps, WaterSense® showerheads, and other energy efficiency measures to customers like you. The energy efficiency measures use 20 to 75% less energy than standard products. Would you mind spending 5 minutes to answer a few questions?

1. Would you have participated in the TDPUD Energy Efficiency Programs if you knew the program provided incentives and free energy efficiency measures for customers like you to save 20 to 75% on your energy costs (for example a typical CFL costs $2/year to operate compared to a 60W incandescent bulb that costs $10/year)?

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

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

   1 Didn't know about free CFLs, incentives, or the survey programs (i.e., information cost).

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

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

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

   5 Other _____

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

3. Please provide the following demographic information?

   _____Language ___Own Lease ____Income ____Age ___Male or Female ___TDPUD Customer ___ **99** Refused

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

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

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

   _____

Appendix C: Light Logger Metering Equipment Protocols

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

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

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

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