

Evaluation, Measurement, and Verification Report for the 2011 Modesto Irrigation District Energy Efficiency Programs

Prepared for Modesto Irrigation District

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1. Executive Summary

This report provides the Evaluation, Measurement, and Verification (EM&V) findings for the 2011 Modesto Irrigation District (MID) energy efficiency programs. This study was conducted by Robert Mowris & Associates, Inc., (RMA) with MID public benefits funds. MID implemented fourteen energy efficiency programs in 2011 as shown in **Table 1.1**. The programs provided educational information and incentives to agricultural, commercial, industrial, new construction, and residential customers and contractors. Energy efficiency measures included network computer power management, space cooling, ventilation, refrigeration, lighting, Energy Star® appliances, insulation, windows, freezer/refrigerator recycling, and duct sealing. The MID ex ante quantity of installed energy efficiency measures was 51,239, and the EM&V study found 52,336 installed measures which is 2.1% greater. The EM&V study ex post gross kW savings are 11.2% greater, ex post kWh savings are 8.3% greater, and ex post lifecycle kWh savings are 6.9% greater.

Table 1.1 MID Ex Ante and Ex Post Accomplishments

#	Program	Ex Ante Qty.	Ex Ante Gross kW	Ex Ante Gross kWh/y	Ex Ante Gross Lifecycle kWh	EM&V Ex Post Qty.	EM&V Ex Post Gross kW	EM&V Ex Post Gross kWh/y	EM&V Ex Post Gross Lifecycle kWh
1	Agricultural-Custom	5	29.8	235,069	3,526,035	5	32.0	235,817	3,537,258
2	Non-Res-Computing	1,474	29.5	294,800	1,474,000	1,820	38.5	335,286	1,676,428
3	Non-Res-Cooling	264	59.8	78,774	1,181,610	264	59.8	78,774	1,181,610
4	Non-Res-Custom	16	168.1	2,304,985	34,574,775	16	169.1	2,269,877	34,048,160
5	Non-Res-Lighting	24,247	1156.6	8,955,893	96,219,612	24,999	1277.3	9,836,578	104,047,349
6	Non-Res-NewConst.	3	33.2	513,966	7,709,490	3	41.7	513,966	7,709,490
7	Non-Res-Refrig.	13,896	154.7	891,937	4,808,830	13,896	154.7	891,937	4,808,830
8	Non-Res-Windows	2,710	5.4	46,073	460,726	2,710	5.4	46,073	460,726
9	LIEE-All	4,921	96.5	318,776	3,749,730	4,921	96.4	318,775	3,749,706
10	Res-Appliance	957	180.5	292,620	1,706,615	957	139.1	526,757	4,264,468
11	Res-Cooling	746	159.4	126,503	2,264,106	746	312.7	186,430	3,342,780
12	Res-Gen Improve.	126	30.8	5,612	140,289	126	30.8	5,612	140,289
13	Res-Lighting	1,429	14.4	89,393	473,783	1,429	14.4	89,393	473,783
14	Res-Windows	444	151.7	147,630	2,563,098	444	151.7	147,630	2,563,098
	Total	51,239	2,270	14,302,030	160,852,699	52,336	2,524	15,482,904	172,003,975

The EM&V study sample included 24 program elements including 11,913 ex ante measures representing 58.2% of the first-year ex ante gross savings as shown in **Table 1.2**. MID accomplished 12,665 measures or 9.5% more than anticipated for the EM&V sample. The EM&V sample ex post gross kW savings are 24.1% greater, ex post kWh savings are 13.7% greater, and ex post lifecycle kWh savings are 10.9% greater.

Table 1.2 EM&V Sample Ex Ante and Ex Post Accomplishments

#	Program	Ex Ante Qty.	Ex Ante Gross kW	Ex Ante Gross kWh/y	Ex Ante Gross Lifecycle kWh	Ex Post Qty.	Ex Post Gross kW	Ex Post Gross kWh/y	Ex Post Gross Lifecycle kWh
1	Non Res-Lighting (industrial)	3,047	225.2	1,952,354	21,669,602	3,416	255.5	2,230,709	24,350,307
2	Non Res-Lighting (industrial)	1,336	152.0	1,349,349	13,692,788	1,335	200.4	1,943,075	17,265,943
3	Non Res-Lighting (industrial)	132	25.4	162,784	1,790,619	132	38.7	137,981	1,517,795
4	Non Res-Lighting (commercial)	91	17.9	178,542	1,963,962	91	21.6	52,343	575,774
5	Non-Res Lighting (commercial)	203	21.8	133,092	1,424,575	203	25.4	88,075	950,042
6	Non-Res Lighting (commercial)	65	12.8	127,530	1,402,830	65	15.7	47,426	521,685

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Table 1.2 EM&V Sample Ex Ante and Ex Post Accomplishments

#	Program	Ex Ante Qty.	Ex Ante Gross kW	Ex Ante Gross kWh/y	Ex Ante Gross Lifecycle kWh	Ex Post Qty.	Ex Post Gross kW	Ex Post Gross kWh/y	Ex Post Gross Lifecycle kWh
7	Non-Res Lighting (commercial)	473	29.4	186,381	2,031,067	325	6.9	16,361	175,594
8	Non-Res Lighting (commercial)	35	6.9	68,670	755,370	35	8.3	20,132	221,452
9	Non-Res-Lighting (industrial)	3,274	172.3	1,398,682	14,941,011	3,804	198.7	1,765,508	19,052,650
10	Non Res-Lighting (industrial)	170	52.7	305,660	4,584,900	172	53.0	442,117	6,631,761
11	Non Res-Refrigeration	12	8.0	463,812	6957180	12	12.4	490,818	7,362,269
12	Ag-VFD Vacuum Pump	1	11.9	120,012	1,800,180	1	13.8	120,760	1,811,403
13	Non Res-VFD Cooling Tower	1	5.6	81,641	1224615	1	5.6	46,533	698,000
14	Non Res-Network PC Power Mgmt	1,820	36.4	364,000	1,820,000	1,820	38.5	335,286	1,676,428
15	Non Res-Refrigeration	6	55.5	1,118,102	16,771,530	6	55.5	1,118,102	16,771,530
16	Res-Freezer Recycling, uncond	57	8.4	40,071	160,284	57	11.2	53,181	212,724
17	Res-Freezer Recycling, cond. Space	8	0.9	4,312	17,248	8	2.2	10,680	42,720
18	Res-Refrig. Recycling, uncond	123	24.0	113,898	569,490	146	27.4	130,270	651,350
19	Res-Refrig Recycling – cond. Space	122	20.3	92,354	461,770	99	18.8	89,436	447,179
20	Res-Energy Star Clotheswasher	622	98.9	38,564	462,768	622	85.0	239,513	2,874,161
21	Res-MF Duct Seal (10-19% reduction)	12	1.4	696	12,528	12	2.0	1,000	18,005
22	Res-MF Duct Seal (20% reduction)	125	15.0	7,250	130,500	125	67.1	33,640	605,522
23	Res-SF Duct Seal (10-19% reduction)	8	0.2	128	2,304	8	2.9	1,198	21,564
24	Res-SF Duct Seal (≥20% reduction)	170	39.4	19,890	358,020	170	127.3	52,052	936,935
	Total	11,913	1042	8,327,773	95,005,141	12,665	1294	9,466,198	105,392,793

Modesto Irrigation District achieved 16.8% greater peak demand savings, 12.8% greater first-year savings, and 11.6% greater lifecycle electricity savings with ex post savings of 148,943,506 +/- 7,950,249 kWh versus ex ante savings of 133,447,311. Natural gas savings are 27,294 +/- 1,559 therms per year, 443,949 +/- 23,697 lifecycle therms. Water savings are 4,224 +/- 439 hundred cubic feet (CCF) per year and 50,686 +/- 5,272 lifecycle CCF. MID exceeded the ex ante E3 Calculator Total Resource Cost (TRC) test by 18.9% with an ex post TRC of 2.53 and the ex ante TRC of 2.13 as shown in **Table 1.3**.¹ The ex post TRC is greater than the ex ante TRC due to greater savings per measure due to field measurements of pre and post retrofit installations and operational hours. Ex post accomplishments were verified by checking the tracking database, randomly inspecting 11,472 measures at 185 participant sites, installing 21 light loggers, and conducting surveys of participants, non-participants, and non-contacts. The EM&V ex post savings are based on site inspections, light logger data, and engineering analysis including light logger data from 420 fixtures and pre and post-retrofit utility billing data.

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.

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Table 1.3 Ex Ante and Ex Post E3 Cost Effectiveness

Description	Ex Ante	Ex Post
Net Annual Electricity Savings (kWh/yr)	11,941,532	13,470,249
Net Demand Savings (kW)	1,841	2,151
Net Lifecycle Electricity Savings (kWh)	133,447,311	148,943,506
Net Annual Gas Savings (therm)	NA	27,294
Net Lifecycle Gas Savings (therm)	NA	443,949
Net Annual Water Savings (CCF)	NA	4,224
Net Lifecycle Water Savings (CCF)	NA	50,686
Total Resource Cost (TRC) Test – E3	2.13	2.53
TRC Test Costs	\$5,230,873	\$5,091,330
TRC Test Benefits	\$11,126,193	\$12,891,463
TRC Test Net Benefits	\$5,895,320	\$7,800,133
Participant Test	3.32	4.07
Participant Test Costs	\$4,671,531	\$4,401,261
Participant Test Benefits	\$15,526,735	\$17,918,076
Participant Test Net Benefits	\$10,855,204	\$13,516,815

The ex ante first-year savings are summarized in **Table 1.4**. The first-year net ex ante program savings are 1,841 kW and 11,941,532 kWh per year.

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

Program	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (therm)	Gross Ex-Ante Unit Savings (CCF)	Net-to-Gross Ratio	Net Ex Ante Program Savings (kW)	Net Ex Ante Program Savings (kWh/y)	Net Ex Ante Program Savings (therm)	Net Ex Ante Program Savings (CCF)
Ag-Custom	29.8	235,069			0.71	21	166,496		
Non-Res-Computing	29.5	294,800			1.00	29	294,800		
Non-Res-Cooling	59.8	78,774			0.80	48	63,019		
Non-Res-Custom	168.1	2,304,985			0.80	134	1,843,988		
Non-Res-Lighting	1156.6	8,955,893			0.85	981	7,596,233		
Non-Res-NewConstruct.	33.2	513,966			0.80	27	411,173		
Non-Res-Refrigeration	154.7	891,937			0.85	131	755,387		
Non-Res-Windows	5.4	46,073			0.80	4	36,858		
LIEE-All	96.5	318,776			1.00	96	318,776		
Res-Appliance	180.5	292,620			0.67	120	195,207		
Res-Cooling	159.4	126,503			0.81	129	102,394		
Res-Gen Improvement	30.8	5,612			0.80	25	4,489		
Res-Lighting	14.4	89,393			0.80	12	71,514		
Res-Windows	151.7	147,630			0.55	83	81,197		
Total	2,270	14,302,030				1,841	11,941,532		

The EM&V ex post first-year savings are summarized in **Table 1.5**. The EM&V study found first-year net ex post program savings of 2,151 +/- 140 kW, 13,470,249 +/- 769,585 kWh per year, 27,294 +/- 1,559 therms per year, and 4,224 +/- 439 CCF (hundred cubic feet) of water per year at the 90 percent confidence level. The net first-year realization rates are 1.17 +/- 0.05 for kW and 1.13 +/- 0.04 for kWh.

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Table 1.5 Ex Post First-Year Electricity, Natural Gas, and Water Savings

Program	Gross Ex-Post Savings (kW)	Gross Ex-Post Savings (kWh/y)	Gross Ex-Post Savings (therm)	Gross Ex-Post Savings (CCF)	Net-to-Gross Ratio	Net Ex Post Program Savings (kW)	Net Ex Post Program Savings (kWh/y)	Net Ex Post Program Savings (therm)	Net Ex Post Program Savings (CCF)
Ag-Custom	32.0	235,817			0.91	29	214,535		
Non-Res-Computing	38.5	335,286			0.97	37	325,227		
Non-Res-Cooling	59.8	78,774			0.80	48	63,019		
Non-Res-Custom	169.1	2,269,877			0.93	157	2,105,359		
Non-Res-Lighting	1277.3	9,836,578			0.88	1,119	8,619,519		
Non-Res-NewConstuction	41.7	513,966			0.59	25	303,871		
Non-Res-Refrigeration	154.7	891,937			0.85	131	755,387		
Non-Res-Windows	5.4	46,073			0.80	4	36,858		
LIEE-All	96.4	318,775			1.00	96	318,775		
Res-Appliance	139.1	526,757	13,808	7,282	0.77	107	405,375	8,009	4,224
Res-Cooling	312.7	186,430	19,678		0.89	277	165,124	19,285	
Res-Gen Improvement	30.8	5,612			0.80	25	4,489		
Res-Lighting	14.4	89,393			0.80	12	71,514		
Res-Windows	151.7	147,630			0.55	83	81,197		
Total	2,524	15,482,904	33,487	7,282		2,151	13,470,249	27,294	4,224
90% Confidence Interval						140	769,585	1,559	439
Realization Rate						1.17	1.13		

The lifecycle electricity, energy, and water savings are summarized in **Table 1.6**. The net ex-ante lifecycle program savings are 133,447,311 kWh. The net ex-post lifecycle program savings are 148,943,506 +/- 7,950,249 kWh, 443,949 +/- 23,697 therms, and 50,686 ± 5,272 CCF of water. The net lifecycle realization rate is 1.12 ± 0.05 for kWh.

Table 1.6 Lifecycle Electricity, Natural Gas, and Water Savings

Program	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 (CCF)	Ex Post EUL	Net Ex-Post Lifecycle Program Savings (kWh)	Net Ex-Post Lifecycle Program Savings (therm)	Net Ex-Post Lifecycle Program Savings (CCF)
Ag-Custom	15.0	2,497,445			15.0	3,218,023		
Non-Res-Computing	5.0	1,474,000			5.0	1,626,135		
Non-Res-Cooling	15.0	945,288			15.0	945,288		
Non-Res-Custom	15.0	27,659,820			15.0	31,580,379		
Non-Res-Lighting	10.7	81,592,800			10.7	91,008,426		
Non-Res-NewConstuction	15.0	6,167,592			15.0	4,558,066		
Non-Res-Refrigeration	5.4	4,073,676			5.4	4,073,676		
Non-Res-Windows	10.0	368,580			10.0	368,580		
LIEE-All	11.8	3,749,730			11.8	3,749,706		
Res-Appliance	6.1	1,184,688			6.1	2,952,391	96,106	50,686
Res-Cooling	17.9	1,832,730			17.9	2,961,874	347,842	
Res-Gen Improvement	25.0	112,231			25.0	112,231		
Res-Lighting	5.3	379,026			5.3	379,026		
Res-Windows	17.4	1,409,704			17.4	1,409,704		
Total		133,447,311				148,943,506	443,949	50,686
90% Confidence Interval						7,950,249	23,697	5,272
Realization Rate						1.12		

The required energy impact reporting for 2011 programs is provided in **Table 1.7**.

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Table 1.7 Required Energy and Water Impact Reporting for 2011 Program

Program ID:		Modesto Irrigation District Energy Efficiency Programs							
Program Name:		All							
Year	Year	Ex-ante Gross Program-Projected Program MWh Savings (1)	Ex-Post Net Evaluation Confirmed Program MWh Savings (2)	Ex-Ante Gross Program-Projected Peak Program MW Savings (1**)	Ex-Post Evaluation Projected Peak MW Savings (2**)	Ex-Ante Gross Program-Projected Program Therm Savings (1)	Ex-Post Net Evaluation Confirmed Program Therm Savings (2)	Ex-Ante Gross Program-Projected Program Water CCF Savings (1)	Ex-Post Net Evaluation Confirmed Program Water CCF Savings (2)
1	2012	15,483	13,470	2.27	2.15		27,294		4,224
2	2013	15,483	13,470	2.27	2.15		27,294		4,224
3	2014	15,483	13,470	2.27	2.15		27,294		4,224
4	2015	15,483	13,470	2.27	2.15		27,294		4,224
5	2016	15,483	13,470	2.27	2.15		27,294		4,224
6	2017	14,550	12,642	2.14	2.03		27,294		4,224
7	2018	13,692	11,953	1.91	1.87		27,294		4,224
8	2019	13,640	11,913	1.89	1.86		27,294		4,224
9	2020	13,640	11,913	1.89	1.86		27,294		4,224
10	2021	13,640	11,913	1.89	1.86		27,294		4,224
11	2022	10,642	9,290	1.54	1.52		27,294		4,224
12	2023	3,693	3,193	0.71	0.72		27,294		4,224
13	2024	3,438	2,938	0.63	0.64		19,285		
14	2025	3,438	2,938	0.63	0.64		19,285		
15	2026	3,438	2,938	0.63	0.64		19,285		
16	2027	340	251	0.34	0.39		19,285		
17	2028	340	251	0.34	0.39		19,285		
18	2029	232	186	0.23	0.31		19,285		
19	2030	6	4	0.03	0.02				
20	2031	6	4	0.03	0.02				
Total		172,004	148,944				443,238		50,686

** 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 Modesto Irrigation District energy efficiency portfolio utility cost is \$0.05/kWh and the net lifecycle green house gas (GHG) reductions are 81,769 tons. MID programs realized a 2.53 TRC which is 18.9% greater than anticipated due to installing 2.1% more measures and greater savings per measure based on pre-existing fixture Wattage versus installed energy efficient fixture Wattage or hours of operation based on light logger data or other engineering data.

Participant and non-participant process surveys were used to obtain general feedback and suggestions. Survey results indicate 98 percent of participants are satisfied with the program based on 1890 survey responses to 35 questions from 54 participants. Most participants expressed appreciation for information and incentives. Process survey responses indicated significant demand for the program with an overall rating of 9.8 out of 10 points. Participants indicated that the “programs are great” and participants are very satisfied with the energy efficiency measures. Process survey results, on-site verification inspections, and field measurements were used to guide the overall process evaluation in terms of investigating operational characteristics of the program and developing specific recommendations to help make the program more cost effective, efficient, and operationally effective. The following process evaluation recommendations are provided to improve program services, procedures, and cost effectiveness.

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- Implement an internet-tracking system to help customers understand energy efficiency and renewable energy, apply for rebates online, and provide feedback (i.e., reviews of products and programs). The database should also be used to document and verify installed measures for EM&V purposes.
- Offer appliance incentives based on CEE Tier levels (Tier 2 for dishwashers and Tier 2 and 3 for clotheswashers and refrigerators). Identify products based on CEE Tiers levels and work cooperatively with retailers to advertise CEE Tier ratings that exceed Energy Star®. Provide targeted advertising to identify inexpensive CEE Tier 2 and 3 Energy Star® models to help moderate income customers participate in rebate programs.
- For refrigerators, MID could offer a \$50 rebate for CEE Tier 2 which is 25% more efficient than Federal Standards and \$100 for CEE Tier 3 which is 30% more efficient than Federal Standards. For dishwashers, MID could offer a \$25 rebate for CEE Tier 1 which is 14% better than Federal Standards and \$50 for CEE Tier 2 which is 17% more efficient than Federal Standards. For clotheswashers, MID could offer a \$25 rebate for CEE Tier 1 which is 59% more efficient than Federal Standards, \$50 for CEE Tier 2 which is 75% more efficient, and \$75 for CEE Tier 3 which is 90% more efficient. These recommendations will motivate customers to purchase more efficient appliances and make the Energy Star® programs more cost effective.
- MID could evaluate hiring a local appliance retailer to recycle refrigerators and freezers year round since this program is very cost effective. Using a local retailer will significantly increase the number of units recycled and improve the local economy.
- MID could consider working cooperatively with the City of Modesto (local water retailer) to offer incentives and information for WaterSense® showerheads, aerators, and toilets to save electricity used for water pumping and treatment. MID could also work with the City of Modesto to offer incentives and information for water conservation gardens (WaterSense® irrigation) and landscaping to save water pumping electricity. MID could work with the City of Modesto to consider bulk purchase WaterSense® showerheads, aerators, water efficient pre-rinse spray valves, and water-efficient garden spray nozzles. Water efficiency measures can be given away at home shows and local community events. They can also be provided to hotels, restaurants, and multi-family apartments as part of a “Green Partners” program. 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. WaterSense® toilets are cost effective with a rebate of \$20 per toilet and they 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 in other public utility programs who receive incentives for WaterSense® products are very satisfied with overall satisfaction ratings of 96%. Water supply leak repair programs implemented by other public utilities are very cost effective. Water supply leaks represent 10 to 50% of the total water supplied by municipal utilities. A water leak repair program should be implemented jointly with the City of Modesto water utility.
- MID might work with PG&E to encourage MID customers with gas water heaters and MID customers with electric water heaters to install solar thermal water heaters to help customers understand the importance of saving electricity and natural gas by heating water with solar power consistent with the California Solar Initiative (CSI) Thermal Program (see

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<http://www.gosolarcalifornia.org/solarwater/>). The CSI-Thermal Program offers cash rebates of up to \$1,875 for solar water heating systems on single-family homes. Multifamily and Commercial properties qualify for rebates of up to \$500,000. The California CSI program encourages customers to “save money on gas or electricity bills by harnessing the heat of the sun!” MID could target this program to customers with electric water heaters.

- The overall net-to-gross ratio (NTGR) was 0.87 based on conducting decision maker surveys with 54 participants. This indicates that 13 percent of customers are free riders who might have installed energy efficient lighting without the incentives. This indicates the effectiveness of Modesto Irrigation District energy efficient lighting programs in transforming the market for energy efficient commercial lighting.
- Based on findings from this study, many large commercial customers (87%) do not have sufficient capital or motivation to invest in improving the energy efficiency of their lighting systems without incentives from Modesto Irrigation District. To overcome these market barriers, Modesto Irrigation District energy efficiency programs should be continued and expanded to save energy 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 **4.4.2 Process Evaluation Recommendations**).

Section 2 describes the CEC 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 Modesto Irrigation District programs. **Appendix C** provides the Light Logger Metering Equipment Protocols. **Appendix D** provides the Lighting Rebate Site EM&V Reports.

2. CEC 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 SB 1037 annual report.

Table 2.1 provides a comparison of the EM&V savings values compared to the associated SB 1037 annual report.² The EM&V study found net peak demand savings of 1,176 ± 76 kW, net annual savings of 8,540,612 ± 487,944 kWh per year, net lifecycle savings of 94,785,014 ± 5,059,398 kWh, and net lifecycle green house gas savings of 50,686 ± 2,705 tons. With respect to the SB 1037 annual report for Modesto Irrigation District, the EM&V study savings represent 63.9% of peak kW, 59.7% of annual kWh, and 58.9% of lifecycle kWh, and 71.1% of the GHG savings.

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

The EM&V study evaluated the commercial lighting, agricultural custom, commercial computing, commercial refrigeration, residential appliance recycling, residential clotheswasher, and residential duct sealing programs. These programs represent 37% of the total budget and 58.9% of the total lifecycle savings (see **Table 2.1**). The study did not evaluate residential or small commercial programs which represent 63% of the total budget and 41.1% of the total lifecycle savings.

- Assess risk or uncertainty in selecting the components of the portfolio to evaluate.

The uncertainties associated with selecting the components of the portfolio to evaluate are unknown. The uncertainties associated with the EM&V study of the commercial lighting program are 4.6% of the net savings at the 90 percent confidence level. The EM&V study evaluated the uncertainty based on the mean and standard deviation for 12,655 measures included in the EM&V study sample. The uncertainty is approximately 6.5% for kW savings, 5.7% for first year kWh savings, and 5.3% for lifecycle kWh savings.

Table 2.1 EM&V Savings Compared to SB 1037 Annual Report

Description	SB 1037	EM&V Study	%
Net Peak kW Savings	1,841	1,176	63.9%
Net Annual kWh Savings	11,941,532	8,540,612	59.7%
Net Lifecycle kWh Savings	133,447,311	94,785,014	58.9%
Net Lifecycle GHG Savings (tons)	73,189	52,036	71.1%
Utility Incentive Cost (\$)	\$1,359,195	\$501,907	36.9%
Utility Marketing, EM&V, and Administrative Cost (\$)	\$1,316,857	\$486,273	36.9%
Total Utility Cost (\$)	\$2,676,053	\$988,179	36.9%
TRC	2.13	2.53	118.9%

² Energy Efficiency in California's Public Power Sector: A Status Report, March 2012, prepared by the California Municipal Utilities Association (CMUA), Scott Tomashefsky, Northern California Power Agency (NCPA), Julie Felipe, Southern California Public Power Authority (SCPPA), Tony Andreoni, CMUA.

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 evaluated the commercial lighting, customer wine tank insulation, agricultural vacuum pump (dairy), wine cooling tower, network PC power management, supermarket refrigeration controls, refrigerator recycling, Energy Star® clotheswasher, and duct sealing programs which provided incentives of \$501,907. 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 at each site 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 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 did not have sufficient time or budget to assess the EUL for the commercial lighting program measures. The EM&V study found the following gross lifecycle savings of 172,003,975 kWh and 94,429 tons of greenhouse gas (GHG) emissions. The ex ante gross lifecycle savings of 160,852,699 kWh and 88,220 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**.

³ Ibid.

2.3 Gross Savings

- Review the program's choice of baseline.

MID used the E3 calculator, manufacturers' data, engineering analyses, spreadsheets, and data logger measurements to develop baseline savings estimates.⁴

- Characterize the population of participants.

The population of MID participants by program application is shown in **Table 2.2**. There were 4,261 program participant applications. The EM&V non-residential sample includes 15 participants with average floor area of 145,500 +/- 117,113 square feet. The EM&V non-residential building types included agricultural dairy, industrial food and beverage processing, manufacturing, large retail, medium/large office, high technology manufacturing, industrial warehouse, large grocery, elementary schools, and high schools. Average non-residential occupancy is 90 +/- 55. The end use categories include agricultural custom (VFD vacuum pump), computing (PC network power management), lighting (lamps, fixtures, sensors), and refrigeration (cooling tower VFD, wine tank insulation, and controls). The EM&V residential sample includes 35 participants with average floor area of 1799 +/- 209 ft² square feet. Average residential occupancy is 2.9 +/- 0.5. The building types include single and multi-family and the end use categories include residential appliances (clotheswasher, refrigerator recycling measures) and residential space cooling and heating (duct sealing measures).

Table 2.2 Population of MID Participants by Program

Program	Participant Applications
Ag-Custom	5
Non-Res-Computing	2
Non-Res-Cooling	22
Non-Res-Custom	16
Non-Res-Lighting	183
Non-Res-NewConstuction	3
Non-Res-Refrigeration	278
Non-Res-Windows	4
LIEE-All	1,749
Res-Appliance	949
Res-Cooling	606
Res-Gen Improvement	52
Res-Lighting	66
Res-Windows	326
Total	4,261

- Discuss the sampling approach and sample design.

The sample selection includes 15 of the largest non-residential sites plus 37 residential sites representing 59.7% of the total ex ante savings for all participants.

⁴ 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.

- 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 12,655 measures (see **Table 3.2**).

- Present ex post gross savings.

The EM&V study found the following ex post gross savings for the program 2,524 kW, 15,482,904 kWh per year, 33,487 therm/yr, 7,282 CCF/yr, lifecycle savings of 172,003,975 kWh, 519,909 therms, 87,389 CCF of water, and 94,429 tons of greenhouse gas (GHG) emissions.

- 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 cannot be expanded to the total portfolio savings since the residential and small commercial programs which represent 63% of the total budget and 41.1% of the total lifecycle savings were not included in the evaluation. These programs are different than the programs that were evaluated in terms of implementation, end use technologies, energy efficiency measures, and operational characteristics. The following residential and small commercial net ex ante savings are passed through: 974 kW, 4,929,637 kWh first year savings, 54,158,492 lifecycle kWh, and 29,925 lifecycle tons of GHG emissions.

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

The ex ante gross savings for the non-residential lighting, custom, computing, and refrigeration programs and the residential clotheswashers, refrigerator recycling, and residential duct sealing are 1,176 kW, 8,540,612 kWh per year and lifecycle savings of 94,785,014 kWh and 51,844 tons of GHG emissions. MID programs achieved 13.7% greater gross ex post savings than the ex ante savings for the following reasons: 1) 2.1% more measures were installed, and 2) the EM&V study found greater savings per measure (ex ante savings are based on deemed savings from E3). The ex post savings are based on accurate measurements of lighting hours of operation (based on light logger data) and verification of pre and post fixture Wattages, appliance energy use, and duct leakage reduction.

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 0.90 for approximately 60% of the total energy savings is based on surveys of 14 non-residential lighting and custom program participants, 2 non-residential school district network PC power management program participants, 2 multi-family duct sealing program participants, 20 residential clotheswasher rebate program participants, and 13 refrigerator recycling program participants. The E3 default net to gross ratio is 0.83 for 40.3% of program savings not evaluated. 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 EM&V study sample approach and sample design are based on a virtual census. The sample included on-site visits at 33 sites and surveys conducted with 52 decision makers. This sample represents 60% of the ex ante savings for the large commercial lighting program.

- 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 10 to 30% of participants are free riders who indicated that they would have installed energy efficiency measures without the rebates. The total gross savings are reduced by 19% 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., 86%) said they would not have installed energy efficient measures without incentives and information from Modesto Irrigation District. 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 MID energy 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 12,655 measures. The uncertainty is approximately 6.5% for kW savings, 5.7% for first year kWh savings, and 5.3% for lifecycle kWh savings.

3. EM&V Approach

The measurement and verification analysis for the study is based on the *International Performance Measurement & Verification Protocols* (IPMVP) defined **Table 3.1**.⁵ The EM&V

⁵ See *International Performance Measurement & Verification Protocols*, DOE/GO-102000-1132, October 2000. *Concepts and Options for Determining Energy and Water Savings Volume 1*, prepared by Efficiency Valuation Organization (EVO), www.evo-world.org, January 2012.

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approach for the load impact evaluation involved performing on-site measurement and verification activities for a statistically significant sample of participating customers (10 of the largest non-residential lighting sites representing 41% of the total MID ex ante savings). The ex post energy and peak demand savings were determined using IPMVP Option A (i.e., partially measured retrofit isolation) and IPMVP Option B (i.e., retrofit isolation).

Table 3.1 IPMVP M&V Options

M&V Option	How Savings Are Calculated	Typical Applications
<p>Option A. Partially Measured Retrofit Isolation Savings are determined by partial field measurement of energy use of system(s) to which a measure was applied, separate from facility energy use. Measurements may be either short-term or continuous. Partial measurement means that some but not all parameters may be stipulated, if total impact of possible stipulation errors is not significant to resultant savings. Careful review of measure design and installation will ensure that stipulated values fairly represent the probable actual value.</p>	Engineering calculations using short term or continuous post-retrofit measurements or stipulations.	Pre- and post-retrofit Wattage values are estimated and operating hours are based on interviews with occupants, stipulated values, or measured with lighting loggers.
<p>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.</p>	Engineering calculations using short term or continuous measurements	Lighting system electricity use is estimated (pre) or measured (post) with a kW meter. Hours of operation are measured (post) with light loggers or power meters.
<p>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.</p>	Analysis of whole facility utility meter or sub-meter data using techniques from simple comparison to regression analysis or conditional demand analysis.	Energy management program affecting many systems in a building. Utility meters measure energy use for 12-month base year and throughout post-retrofit period.
<p>Option D. Calibrated Simulation Savings are determined through simulation of the energy use of components or the whole facility. Simulation routines must be demonstrated to adequately model actual energy performance measured in the facility. This option usually requires considerable skill in calibrated simulation.</p>	Energy use simulation, calibrated with hourly or monthly utility billing data and/or end-use metering.	Project affecting many systems in a building but where base year data are unavailable. Utility meters measure post-retrofit energy use. Base year energy use is determined by simulation using a model calibrated with post-retrofit utility data.

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**.

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

Where,

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

n_i = Number of measures “i” in the sample.

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

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

Where,

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

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.⁶

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 the mean savings is calculated using **Equation 4**.

Eq. 4 se_{i_s} = Standard error of the 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.

⁶ 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., Prah, R., Reed, J., Vine, E., Waterbury, S., Wright, R. February 2004.

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

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

Net savings are calculated as gross savings times the EM&V net-to-gross ratios or default net-to-gross ratios from the E3 Calculator. Impact results (kW, kWh/yr, and lifecycle kWh) are based on EM&V findings or default ex ante values from the E3 Calculator.

The evaluation includes an assessment of the cost effectiveness inputs used by MID (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).

MID used several sources and methods to develop the 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.

3.1 EM&V Methodology

The following EM&V methodology was used at each site.

1. Select EM&V sites from the commercial lighting program tracking database.
2. Review rebate applications for selected sites to determine EM&V plan for each site.
3. Perform site visits. Post-retrofit site inspections were performed at all sites. Sites were inspected with personnel who were familiar with the lighting retrofit to ensure a thorough understanding of the lighting retrofit project.
 - Verify pre-retrofit equipment power and hours of operation to develop the EM&V baseline of energy and peak demand (i.e., kWh/yr and kW).
 - Verify post-retrofit equipment including proper installation of all lamps, ballasts, fixtures, and controls that received rebates including make, model, fixture counts, and power use.
 - Collect data for representative lighting fixtures using light loggers, interviews, and telephone surveys (i.e., decision maker survey).
4. Perform decision maker surveys to evaluate net-to-gross ratios at the site or via telephone.
5. Perform the EM&V engineering analyses for each site based on information collected during the on-site surveys in order to evaluate energy and peak demand savings for each site consistent with IPMVP Option A (i.e., partially measured retrofit isolation) and IPMVP Option B (i.e., retrofit isolation).

EM&V site work was performed at customer sites from December 2011 through April 2012.

3.2 EM&V Algorithms for Estimating kW and kWh Savings

EM&V algorithms for estimating kW and kWh savings for each site in the random sample are based on the verified quantity of installed measures, pre- and post-installation fixture wattages and hours of operation (obtained from light loggers or maintenance personnel). Savings for each EM&V site are summed and compared to the ex ante savings to develop EM&V Average Gross Realization Rates (AGRR) for kW and kWh savings. The AGRR is combined with the Net-to-Gross Ratio (NTGR) to develop the Net Realization Rate (NRR) relative to planning.

The EM&V kW and kWh savings for each site are calculated using **Equations 8 and 9**.

$$\text{Eq. 8} \quad \text{kW Savings}_k = \sum_{k=1}^n \text{Quantity} \times [\text{kW}_{\text{pre}} - \text{kW}_{\text{post}}]$$

Where,

kW Savings_k = kW savings for site “k” in the random sample.

Quantity = Quantity of fixtures.

kW_{pre} = Pre-installation kW use per measure.

kW_{post} = Post-installation kW use per measure.

$$\text{Eq. 9} \quad \text{kWh Savings}_k = \sum_{j=1}^m \text{Quantity} \times [\text{kW}_{\text{pre}} - \text{kW}_{\text{post}}] \times \text{hours/year}$$

Where,

kWh Savings_k = kWh savings for site “k” in the sample.

hours/year = Hours of operation per year per fixture.

Savings for the EM&V sites are summed and compared to ex ante savings to develop Average Gross Realization Rates (AGRR) for kW and kWh savings. The AGRR for kW and kWh savings are calculated using **Equation 10**.

$$\text{Eq. 10} \quad \text{AGRR}_h = \frac{\sum_{k=1}^n \text{Ex Post Sample Savings}_k}{\sum_{k=1}^n \text{Ex Ante Sample Savings}_k}$$

Where,

AGRR_h = Average gross realization rate. Defined as the sum of EM&V savings for measures in the sample divided by ex ante savings for measures in the sample (kW or kWh).

The AGRR is combined with the Net-to-Gross Ratio (NTGR) to develop the Net Realization Rate (NRR) relative to planning. The net realization rates for kW and kWh savings are calculated using **Equation 11**.

$$\text{Eq. 11} \quad \text{NRR}_h = \text{NTGR}_h \times \text{AGRR}_h$$

Where,

NRR_h = Net Realization Rate for kW or kWh savings in program stratum “h”

NTGR_h = Net to Gross Ratio defined as the number of units that would not have been installed without the program divided by the total number of units installed through the program (kW or kWh).

3.3 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.⁷ 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.⁸

The sample size necessary to obtain the desired 10% to 20% relative precision for program mean savings estimates is calculated using **Equation 12**.

Eq. 12 Sample Size = $n_i = \frac{t^2 C_{vi}^2}{r^2}$

The standard deviation of the mean savings is calculated using **Equation 13**.

Eq. 13 $s_i = \text{Standard deviation of the Mean Savings} = \sqrt{\frac{\sum_{j=1}^n (y_j - \bar{y}_i)^2}{n}}$

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%.

⁷ Hall, N., Barata, S., Chernick, P., Jacobs, P., Keating, K., Kushler, M., Migdal, L., Nadel, S., Prah, 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.

⁸ 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.

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

For small populations, the sample size is corrected using the finite population correction (FPC) equation as follows using **Equation 14**.

$$\text{Eq. 14} \quad \text{FPC Sample Size} = n_{\text{FPC}i} = \frac{n_i}{1 + (n_i - 1)/N}$$

Where,

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

The 15 sites with the largest savings were evaluated based on detailed on-site inspections and 9 programs were evaluated based on verification of the rebate application information. The ex ante units, proposed EM&V sample, ex post installed units, EM&V units inspected, coefficient of variation (Cv), and relative precision for each site are shown in **Table 3.2**. The coefficient of variation with respect to energy savings (kWh/yr) varies from 0.01 to 0.57 with an average of 0.25. The relative precision with respect to energy savings (kWh/yr) varies from 0.01 to 0.41 with an average of 0.09. The net-to-gross ratio (NTGR) Cv is 0.16 and the relative precision is 0.02.

Table 3.2 Sample Sizes, EM&V Inspections, and Statistics

Site	Program	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	Non-Res Lighting	3,047	3,047	3,416	3,416	0.08	0.00
2	Non-Res Lighting	1,336	1,336	1,335	1,335	0.20	0.01
3	Non-Res Lighting	132	132	132	132	0.19	0.03
4	Non-Res Lighting	91	91	91	91	0.20	0.04
5	Non-Res Lighting	203	203	203	203	0.10	0.01
6	Non-Res Lighting	65	65	65	65	0.05	0.01
7	Non-Res Lighting	473	473	325	325	0.01	0.00
8	Non-Res Lighting	35	35	35	35	0.20	0.06
9	Non-Res Lighting	3,274	3,274	3,804	3,804	0.09	0.00
10	Non-Res Lighting	170	170	172	172	0.10	0.01
11	Non-Res Custom	12	12	12	12	0.50	0.24
12	VFD Vacuum Pump	1	1	1	1	0.25	0.41
13	Cooling Tower VFD	1	1	1	1	0.02	0.03
14	Network PC Power Mgmt	1,474	1,474	1,820	1,820	0.59	0.02
15	Non-Res Refrig. Cntrl	6	6	6	6	0.50	0.34
16	Res-Fzr Recycling, uncond	57	57	57	57	0.38	0.08
17	Res-Fzr Recycling, cond. Space	8	8	8	8	0.37	0.22
18	Res-Refrig. Recycling, uncond	123	123	146	146	0.34	0.05
19	Res-Refrig Recycling - cond.	122	122	99	99	0.40	0.07
20	Res-Energy Star Clotheswasher	622	622	622	622	0.16	0.01
21	Res-MF Duct Seal (10-19% reduc)	12	12	12	12	0.20	0.10
22	Res-MF Duct Seal (≥20% reduc.)	125	125	125	125	0.57	0.08
23	Res-SF Duct Seal (10-19% reduc)	8	8	8	8	0.42	0.25
24	Res-SF Duct Seal (≥20% reduc)	170	170	170	170	0.12	0.02
Average						0.25	0.09
NTGR	Participant Surveys					0.16	0.02

3.4 Process Evaluation Approach

The process evaluation approach used decision maker surveys (DMS) to measure participant satisfaction, obtain suggestions to improve the program's services and procedures, and evaluate the net-to-gross ratio (NTGR) and freerider issues. 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 the comprehensive lighting measures were installed for each customer. Interview questions assessed how the program influenced awareness of linkages between efficiency improvements and bill savings and increased efficiency or comfort for customers. Twelve participants were asked process survey questions. The participant survey instrument is provided in **Appendix B**. Participants were asked why and how they decided to participate in the program. The process survey evaluation includes a summary of what works, what doesn't work, and the level of need for the program. This information was used to define if there were issues to be addressed.

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.

4. EM&V Study Findings

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

4.1 Load Impact Results

Modesto Irrigation District implemented 14 energy efficiency programs in 2011 as shown in **Table 4.1**. The programs provided educational information and incentives to residential, commercial, industrial, and agricultural customers. The MID ex ante quantity of installed energy efficiency measures was 51,239, and the EM&V study found 52,336 installed measures which is 2.1% greater. The EM&V study ex post gross kW savings are 11.2% greater, ex post kWh savings are 8.3% greater, and ex post lifecycle kWh savings are 6.9% greater.

EM&V Report for 2011 MID Energy Efficiency Programs

Table 4.1 MID Ex Ante and Ex Post Accomplishments

#	Program	Ex Ante Qty.	Ex Ante Gross kW	Ex Ante Gross kWh/y	Ex Ante Gross Lifecycle kWh	EM&V Ex Post Qty.	EM&V Ex Post Gross kW	EM&V Ex Post Gross kWh/y	EM&V Ex Post Gross Lifecycle kWh
1	Agricultural-Custom	5	29.8	235,069	3,526,035	5	32.0	235,817	3,537,258
2	Non-Res-Computing	1,474	29.5	294,800	1,474,000	1,820	38.5	335,286	1,676,428
3	Non-Res-Cooling	264	59.8	78,774	1,181,610	264	59.8	78,774	1,181,610
4	Non-Res-Custom	16	168.1	2,304,985	34,574,775	16	169.1	2,269,877	34,048,160
5	Non-Res-Lighting	24,247	1156.6	8,955,893	96,219,612	24,999	1277.3	9,836,578	104,047,349
6	Non-Res-NewConst.	3	33.2	513,966	7,709,490	3	41.7	513,966	7,709,490
7	Non-Res-Refrig.	13,896	154.7	891,937	4,808,830	13,896	154.7	891,937	4,808,830
8	Non-Res-Windows	2,710	5.4	46,073	460,726	2,710	5.4	46,073	460,726
9	LIEE-All	4,921	96.5	318,776	3,749,730	4,921	96.4	318,775	3,749,706
10	Res-Appliance	957	180.5	292,620	1,706,615	957	139.1	526,757	4,264,468
11	Res-Cooling	746	159.4	126,503	2,264,106	746	312.7	186,430	3,342,780
12	Res-Gen Improve.	126	30.8	5,612	140,289	126	30.8	5,612	140,289
13	Res-Lighting	1,429	14.4	89,393	473,783	1,429	14.4	89,393	473,783
14	Res-Windows	444	151.7	147,630	2,563,098	444	151.7	147,630	2,563,098
	Total	51,239	2,270	14,302,030	160,852,699	52,336	2,524	15,482,904	172,003,975

The EM&V study sample included 24 program elements including 11,913 ex ante measures representing 459.7% of the first-year ex ante gross savings as shown in **Table 4.2**. MID accomplished 12,665 measures or 9.5% more than anticipated for the EM&V sample. The EM&V sample ex post gross kW savings are 24.1% greater, ex post kWh savings are 13.7% greater, and ex post lifecycle kWh savings are 10.9% greater.

Table 4.2 EM&V Sample Ex Ante and Ex Post Accomplishments

#	Program	Ex Ante Qty.	Ex Ante Gross kW	Ex Ante Gross kWh/y	Ex Ante Gross Lifecycle kWh	Ex Post Qty.	Ex Post Gross kW	Ex Post Gross kWh/y	Ex Post Gross Lifecycle kWh
1	Non Res-Lighting (industrial)	3,047	225.2	1,952,354	21,669,602	3,416	255.5	2,230,709	24,350,307
2	Non Res-Lighting (industrial)	1,336	152.0	1,349,349	13,692,788	1,335	200.4	1,943,075	17,265,943
3	Non Res-Lighting (industrial)	132	25.4	162,784	1,790,619	132	38.7	137,981	1,517,795
4	Non Res-Lighting (commercial)	91	17.9	178,542	1,963,962	91	21.6	52,343	575,774
5	Non Res-Lighting (commercial)	203	21.8	133,092	1,424,575	203	25.4	88,075	950,042
6	Non Res-Lighting (commercial)	65	12.8	127,530	1,402,830	65	15.7	47,426	521,685
7	Non Res-Lighting (commercial)	473	29.4	186,381	2,031,067	325	6.9	16,361	175,594
8	Non Res-Lighting (commercial)	35	6.9	68,670	755,370	35	8.3	20,132	221,452
9	Non Res-Lighting (industrial)	3,274	172.3	1,398,682	14,941,011	3,804	198.7	1,765,508	19,052,650
10	Non Res-Lighting (industrial)	170	52.7	305,660	4,584,900	172	53.0	442,117	6,631,761
11	Non Res-Refrigeration	12	8.0	463,812	695,7180	12	12.4	490,818	7,362,269
12	Ag-VFD Vacuum Pump	1	11.9	120,012	1,800,180	1	13.8	120,760	1,811,403
13	Non Res-VFD Cooling Tower	1	5.6	81,641	122,4615	1	5.6	46,533	698,000
14	Non Res-Network PC Power Mgmt	1,820	36.4	364,000	1,820,000	1,820	38.5	335,286	1,676,428
15	Non Res-Refrigeration	6	55.5	1,118,102	16,771,530	6	55.5	1,118,102	16,771,530
16	Res-Freezer Recycling, uncond	57	8.4	40,071	160,284	57	11.2	53,181	212,724
17	Res-Freezer Recycling, cond. Space	8	0.9	4,312	17,248	8	2.2	10,680	42,720
18	Res-Refrig. Recycling, uncond	123	24.0	113,898	569,490	146	27.4	130,270	651,350
19	Res-Refrig Recycling – cond. Space	122	20.3	92,354	461,770	99	18.8	89,436	447,179
20	Res-Energy Star Clotheswasher	622	98.9	38,564	462,768	622	85.0	239,513	2,874,161
21	Res-MF Duct Seal (10-19% reduction)	12	1.4	696	12,528	12	2.0	1,000	18,005
22	Res-MF Duct Seal (20% reduction)	125	15.0	7,250	130,500	125	67.1	33,640	605,522
23	Res-SF Duct Seal (10-19% reduction)	8	0.2	128	2,304	8	2.9	1,198	21,564
24	Res-SF Duct Seal (≥20% reduction)	170	39.4	19,890	358,020	170	127.3	52,052	936,935
	Total	11,913	1042	8,327,773	95,005,141	12,665	1294	9,466,198	105,392,793

EM&V Report for 2011 MID Energy Efficiency Programs

Modesto Irrigation District achieved 16.8% greater peak demand savings, 12.8% greater first-year savings, and 11.6% greater lifecycle electricity savings with ex post savings of 148,943,506 +/- 7,950,249 kWh versus ex ante savings of 133,447,311. Natural gas savings are 27,294 +/- 1,559 therms per year, 443,949 +/- 23,697 lifecycle therms. Water savings are 4,224 +/- 439 hundred cubic feet (CCF) per year and 50,686 +/- 5,272 lifecycle CCF. MID exceeded the ex ante E3 Calculator Total Resource Cost (TRC) test by 18.9% with an ex post TRC of 2.53 and the ex ante TRC of 2.13 as shown in **Table 4.3**.⁹ The ex post TRC is greater than the ex ante TRC due to greater savings per measure due to field measurements of pre and post retrofit installations and operational hours. Ex post accomplishments were verified by checking the tracking database, randomly inspecting 11,472 measures at 185 participant sites, installing 21 light loggers, and conducting surveys of participants, non-participants, and non-contacts. The EM&V ex post savings are based on site inspections, light logger data, and engineering analysis including light logger data from 420 fixtures and pre and post-retrofit utility billing data.

Table 4.3 Ex Ante and Ex Post E3 Cost Effectiveness

Description	Ex Ante	Ex Post
Net Annual Electricity Savings (kWh/yr)	11,941,532	13,470,249
Net Demand Savings (kW)	1,841	2,151
Net Lifecycle Electricity Savings (kWh)	133,447,311	148,943,506
Net Annual Gas Savings (therm)	NA	27,294
Net Lifecycle Gas Savings (therm)	NA	443,949
Net Annual Water Savings (CCF)	NA	4,224
Net Lifecycle Water Savings (CCF)	NA	50,686
Total Resource Cost (TRC) Test – E3	2.13	2.53
TRC Test Costs	\$5,230,873	\$5,091,330
TRC Test Benefits	\$11,126,193	\$12,891,463
TRC Test Net Benefits	\$5,895,320	\$7,800,133
Participant Test	3.32	4.07
Participant Test Costs	\$4,671,531	\$4,401,261
Participant Test Benefits	\$15,526,735	\$17,918,076
Participant Test Net Benefits	\$10,855,204	\$13,516,815

The ex ante first-year savings are summarized in **Table 4.4**. The first-year net ex ante program savings are 1,841 kW and 11,941,532 kWh per year.

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

Program	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (therm)	Gross Ex-Ante Unit Savings (CCF)	Net-to-Gross Ratio	Net Ex Ante Program Savings (kW)	Net Ex Ante Program Savings (kWh/y)	Net Ex Ante Program Savings (therm)	Net Ex Ante Program Savings (CCF)
Ag-Custom	29.8	235,069			0.71	21	166,496		
Non-Res-Computing	29.5	294,800			1.00	29	294,800		
Non-Res-Cooling	59.8	78,774			0.80	48	63,019		
Non-Res-Custom	168.1	2,304,985			0.80	134	1,843,988		
Non-Res-Lighting	1156.6	8,955,893			0.85	981	7,596,233		

⁹ 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.

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

Program	Gross Ex-Ante Unit Savings (kW)	Gross Ex-Ante Unit Savings (kWh/y)	Gross Ex-Ante Unit Savings (therm)	Gross Ex-Ante Unit Savings (CCF)	Net-to-Gross Ratio	Net Ex Ante Program Savings (kW)	Net Ex Ante Program Savings (kWh/y)	Net Ex Ante Program Savings (therm)	Net Ex Ante Program Savings (CCF)
Non-Res-NewConstruct.	33.2	513,966			0.80	27	411,173		
Non-Res-Refrigeration	154.7	891,937			0.85	131	755,387		
Non-Res-Windows	5.4	46,073			0.80	4	36,858		
LIEE-All	96.5	318,776			1.00	96	318,776		
Res-Appliance	180.5	292,620			0.67	120	195,207		
Res-Cooling	159.4	126,503			0.81	129	102,394		
Res-Gen Improvement	30.8	5,612			0.80	25	4,489		
Res-Lighting	14.4	89,393			0.80	12	71,514		
Res-Windows	151.7	147,630			0.55	83	81,197		
Total	2,270	14,302,030				1,841	11,941,532		

The EM&V ex post first-year savings are summarized in **Table 4.5**. The EM&V study found first-year net ex post program savings of 2,151 +/- 140 kW, 13,470,249 +/- 769,585 kWh per year, 27,294 +/- 1,559 therms per year, and 4,224 +/- 439 CCF (hundred cubic feet) of water per year at the 90 percent confidence level. The net first-year realization rates are 1.17 +/- 0.05 for kW and 1.13 +/- 0.04 for kWh.

Table 4.5 Ex Post First-Year Electricity, Natural Gas, and Water Savings

Program	Gross Ex-Post Savings (kW)	Gross Ex-Post Savings (kWh/y)	Gross Ex-Post Savings (therm)	Gross Ex-Post Savings (CCF)	Net-to-Gross Ratio	Net Ex Post Program Savings (kW)	Net Ex Post Program Savings (kWh/y)	Net Ex Post Program Savings (therm)	Net Ex Post Program Savings (CCF)
Ag-Custom	32.0	235,817			0.91	29	214,535		
Non-Res-Computing	38.5	335,286			0.97	37	325,227		
Non-Res-Cooling	59.8	78,774			0.80	48	63,019		
Non-Res-Custom	169.1	2,269,877			0.93	157	2,105,359		
Non-Res-Lighting	1277.3	9,836,578			0.88	1,119	8,619,519		
Non-Res-NewConstruction	41.7	513,966			0.59	25	303,871		
Non-Res-Refrigeration	154.7	891,937			0.85	131	755,387		
Non-Res-Windows	5.4	46,073			0.80	4	36,858		
LIEE-All	96.4	318,775			1.00	96	318,775		
Res-Appliance	139.1	526,757	13,808	7,282	0.77	107	405,375	8,009	4,224
Res-Cooling	312.7	186,430	19,678		0.89	277	165,124	19,285	
Res-Gen Improvement	30.8	5,612			0.80	25	4,489		
Res-Lighting	14.4	89,393			0.80	12	71,514		
Res-Windows	151.7	147,630			0.55	83	81,197		
Total	2,524	15,482,904	33,487	7,282		2,151	13,470,249	27,294	4,224
90% Confidence Interval						140	769,585	1,559	439
Realization Rate						1.17	1.13		

The lifecycle electricity, energy, and water savings are summarized in **Table 4.6**. The net ex-ante lifecycle program savings are 133,447,311 kWh. The net ex-post lifecycle program savings are 148,943,506 +/- 7,950,249 kWh, 443,949 +/- 23,697 therms, and 50,686 ± 5,272 CCF of water. The net lifecycle realization rate is 1.12 ± 0.05 for kWh.

EM&V Report for 2011 MID Energy Efficiency Programs

Table 4.6 Lifecycle Electricity, Natural Gas, and Water Savings

Program	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 (CCF)	Ex Post EUL	Net Ex-Post Lifecycle Program Savings (kWh)	Net Ex-Post Lifecycle Program Savings (therm)	Net Ex-Post Lifecycle Program Savings (CCF)
Ag-Custom	15.0	2,497,445			15.0	3,218,023		
Non-Res-Computing	5.0	1,474,000			5.0	1,626,135		
Non-Res-Cooling	15.0	945,288			15.0	945,288		
Non-Res-Custom	15.0	27,659,820			15.0	31,580,379		
Non-Res-Lighting	10.7	81,592,800			10.7	91,008,426		
Non-Res-NewConstuction	15.0	6,167,592			15.0	4,558,066		
Non-Res-Refrigeration	5.4	4,073,676			5.4	4,073,676		
Non-Res-Windows	10.0	368,580			10.0	368,580		
LIEE-All	11.8	3,749,730			11.8	3,749,706		
Res-Appliance	6.1	1,184,688			6.1	2,952,391	96,106	50,686
Res-Cooling	17.9	1,832,730			17.9	2,961,874	347,842	
Res-Gen Improvement	25.0	112,231			25.0	112,231		
Res-Lighting	5.3	379,026			5.3	379,026		
Res-Windows	17.4	1,409,704			17.4	1,409,704		
Total		133,447,311				148,943,506	443,949	50,686
90% Confidence Interval						7,950,249	23,697	5,272
Realization Rate						1.12		

The required energy impact reporting for 2011 programs is provided in Table 4.7.

Table 4.7 Required Energy and Water Impact Reporting for 2011 Program

Program ID:		Modesto Irrigation District Energy Efficiency Programs							
Program Name:		All							
Year	Year	Ex-ante Gross Program-Projected Program MWh Savings (1)	Ex-Post Net Evaluation Confirmed Program MWh Savings (2)	Ex-Ante Gross Program-Projected Peak Program MW Savings (1**)	Ex-Post Evaluation Projected Peak MW Savings (2**)	Ex-Ante Gross Program-Projected Program Therm Savings (1)	Ex-Post Net Evaluation Confirmed Program Therm Savings (2)	Ex-Ante Gross Program-Projected Program Water CCF Savings (1)	Ex-Post Net Evaluation Confirmed Program Water CCF Savings (2)
1	2012	15,483	13,470	2.27	2.15		27,294		4,224
2	2013	15,483	13,470	2.27	2.15		27,294		4,224
3	2014	15,483	13,470	2.27	2.15		27,294		4,224
4	2015	15,483	13,470	2.27	2.15		27,294		4,224
5	2016	15,483	13,470	2.27	2.15		27,294		4,224
6	2017	14,550	12,642	2.14	2.03		27,294		4,224
7	2018	13,692	11,953	1.91	1.87		27,294		4,224
8	2019	13,640	11,913	1.89	1.86		27,294		4,224
9	2020	13,640	11,913	1.89	1.86		27,294		4,224
10	2021	13,640	11,913	1.89	1.86		27,294		4,224
11	2022	10,642	9,290	1.54	1.52		27,294		4,224
12	2023	3,693	3,193	0.71	0.72		27,294		4,224
13	2024	3,438	2,938	0.63	0.64		19,285		
14	2025	3,438	2,938	0.63	0.64		19,285		
15	2026	3,438	2,938	0.63	0.64		19,285		
16	2027	340	251	0.34	0.39		19,285		
17	2028	340	251	0.34	0.39		19,285		
18	2029	232	186	0.23	0.31		19,285		
19	2030	6	4	0.03	0.02				
20	2031	6	4	0.03	0.02				
Total		172,004	148,944				443,238		50,686

** Peak MW savings are defined as the 2PM to 6PM weekday peak period Monday through Friday from 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.

EM&V Report for 2011 MID Energy Efficiency Programs

The Modesto Irrigation District energy efficiency portfolio utility cost is \$0.05/kWh and the net lifecycle green house gas (GHG) reductions are 81,769 tons. MID programs realized a 2.53 TRC which is 1893% greater than anticipated due to installing 2.1% more measures and greater savings per measure based on pre-existing fixture Wattage versus installed energy efficient fixture Wattage or hours of operation based on light logger data or other engineering data.

4.2 Findings of the EM&V On-Site Audits

Findings of the EM&V on-site audits are provided in the **Tables 4.8** through **4.34**. The ex post savings are based on verification of the quantity of installed fixtures times the difference between pre-existing and installed fixture Wattages times annual hours of operation based on lighting logger data or information provided by building maintenance personnel or the Modesto Irrigation District rebate applications. Detailed EM&V reports for each site are provided in **Appendix D**.

4.2.1 EM&V Findings for Site #1

The summary of the gross EM&V findings for site #1 are provided in Appendix D-1. The net ex ante and ex post savings are provided in **Table 4.8**. The total measure costs are \$476,755 and the total incentives are \$81,766. The total gross ex ante savings are 225.2 kW, 1,952,354 kWh/yr, and 21,669,602 kWh lifecycle with an average EUL of 10.9 years. The total gross ex post savings are 255.5 +/- 9.6 kW, 2,230,709 +/- 83,913 kWh/yr, and 24,350,307 +/- 915,987 kWh lifecycle. The average ex ante NTGR is 0.85 based on decision maker survey interviews with the participants. Total net ex ante savings are 191.5 kW, 1,659,501 kWh/yr, and 18,419,162 kWh lifecycle. The ex post NTGR is 0.94. The total net ex post savings are 240.2 +/- 9 kW, 2,096,866 +/- 78,878 kWh/yr, and 22,889,289 +/- 861,028 kWh lifecycle. Net ex post kW and kWh savings are 25% greater than ex ante savings due to the slightly greater savings per measure and the higher net to gross ratio. **Appendix D-1** provides detailed findings of the EM&V on-site audit for Site #1.

Table 4.8 Summary of Net Ex Ante and Ex Post EM&V Findings for Site #1

Rebate ID	Description	Ex Ante NTGR	Net Ex Ante kW	Net Ex Ante kWh/y	Net Ex Ante Lifecycle kWh	Ex Post NTGR	Net Ex Post kW	Net Ex Post kWh/y	Net Ex Post Lifecycle kWh
CL002	400W HID to T8 6Lx4ft	0.85	112.9	1,124,030	12,364,328	0.94	128.1	1,122,143	12,343,571
CL002	400W HID to T8 6Lx4ft w/sensors	0.85	26.5	263,497	2,898,463	0.94	34.1	298,588	3,284,463
CL004	250W HID to T8 (MISC)	0.85	1.1	6,828	75,110	0.94	2.3	20,059	220,649
CL006	T12 <=100W to T8 <=64 Watt	0.85	0.7	4,418	48,601	0.94	1.3	11,413	125,542
CL008	Incand. 176 - 399W to CFL	0.85	0.0	220	2,639	0.94	0.0	0	0
CL017	1000W HID to 750W PS MH	0.77	6.3	25,935	414,956	0.94	9.1	80,121	1,281,931
CL019	400W HID to 320 PS MH	0.77	2.8	11,450	183,207	0.94	3.2	28,260	452,167
CL020	250W HID to 200W PS MH	0.77	3.6	14,832	237,305	0.94	2.4	21,097	337,545
CL039	Exit Sign Incand to LED	0.85	2.4	20,222	323,544	0.94	1.2	10,375	166,006
CL028	T12 U-Lamp to T8 U-Lamp	0.85	0.1	316	3,471	0.94	0.0	231	2,536
CL030	F96 2L-8' T12 to 4L-4' T8 tandem	0.85	11.6	70,926	780,186	0.94	6.0	52,865	581,513
CL030	T12 4L-4' to T8 3L-4'	0.85	2.0	12,051	132,556	0.94	7.3	64,105	705,153
CL030	T12 3L-4' to T8 3L-4'	0.85	1.2	7,058	77,640	0.94	2.0	17,927	197,198
CL030	T12 2L-4' to T8 2L-4' T8	0.85	1.0	6,197	68,172	0.94	5.3	46,689	513,580
CL034	Delamp: 4 foot lamp	0.85	2.0	11,135	122,485	0.94	3.6	31,159	342,749
CL050	Occupancy Sensors	0.84	0.9	4,453	35,621	0.94	2.4	20,606	164,849
CL052	Occ. Sensors Fixture Mounted	0.84	15.1	61,703	493,624	0.94	30.0	262,728	2,101,827
CL054	Photocell	0.84	0.0	7,925	63,396	0.94	1.8	8,501	68,010
Total			189.9	1,653,194	18,325,305		240.2	2,096,866	22,889,289

4.2.2 EM&V Findings for Site #2

The summary of the gross EM&V findings for site #2 are provided in Appendix D-2. The net ex ante and ex post savings are provided in **Table 4.9**. The total measure costs are \$249,000 and the total incentives are \$67,650. The total gross ex ante savings are 152.02 kW, 1,349,349 kWh/yr, and 13,692,788 kWh lifecycle with an average EUL of 10.1 years. Rebate ID CL002A is an energy adjustment by MID to reduce deemed savings for occupancy sensors by 40 kW and 15,000 kWh per year to account for the difference between calculated and deemed savings. The total gross ex post savings are 200.4 +/- 1.77 kW, 1,943,075 +/- 14,783 kWh/yr, and 17,265,943 +/- 131,359 kWh lifecycle. The average ex ante NTGR is 0.85 based on decision maker survey interviews with the participants. Total net ex ante savings are 123.88 kW, 1,141,463 kWh/yr, and 11,590,052 kWh lifecycle. The ex post NTGR is 0.83 based on decision maker survey interviews with the participants. The ex post EUL is 8.9 years. The total net ex post savings are 166.3 +/- 1.47 kW, 1,612,753 +/- 12,270 kWh/yr, and 14,330,733 +/- 109,028 kWh lifecycle. Net ex post kW savings are 34% greater and kWh savings are 41% greater than ex ante savings due to operational hours based on lighting logger data and all new fixtures have integral occupancy sensors. The ex ante occupancy sensor savings are based on E3 commercial customer segments with lower hours of operation than industrial customer segments and all measures are industrial. **Appendix D-2** provides detailed findings of the EM&V on-site audit for Site #2.

Table 4.9 Summary of Net Ex Ante and Ex Post EM&V Findings for Site #2

Rebate ID	Description	Ex Ante NTGR	Net Ex Ante kW	Net Ex Ante kWh/y	Net Ex Ante Lifecycle kWh	Ex Post NTGR	Net Ex Post kW	Net Ex Post kWh/y	Net Ex Post Lifecycle kWh
CL002	400W HID to T8 6Lx4ft	0.85	39.4	391,910	4,311,005	0.83	25.6	223,832	2,462,147
CL002	400W HID to T8 6Lx4ft	0.85	83.7	833,850	9,172,350	0.83	54.4	476,237	5,238,611
CL052	T8 4Lx4ft w/Occ. Sensors	0.84	22.1	90,626	725,011	0.83	21.5	343,877	2,751,020
CL052	T8 4Lx4ft w/Occ. Sensors	0.84	56.4	231,386	1,851,091	0.83	90.5	792,638	6,341,102
CL002A	Energy Adjustment	0.96	(38.4)	(14,400)	(158,400)	0.83	0.0	0	0
Total			123.88	1,141,463	11,590,052		166.30	1,612,753	14,330,733

4.2.3 EM&V Findings for Site #3

The summary of the gross EM&V findings for site #3 are provided in **Table 4.10**. The total measure costs are \$30,505 and the total incentives are \$9,525. The total gross ex ante savings are 25.4 kW, 162,784 kWh/yr, and 1,790,619 kWh lifecycle assuming an EUL of 11 years. The total gross ex post savings are 38.7 kW, 137,981 kWh/yr, 1,517,795 kWh lifecycle. The ex ante NTGR is 0.85 based on decision maker survey interviews with the participants. Total net ex ante savings are 21.6 kW, 138,366 kWh/yr, and 1,522,026 kWh lifecycle. The ex post NTGR is 0.89. The total net ex post savings are 34.5 +/- 1.0 kW, 122,803 +/- 3,934 kWh/yr, and 1,350,838 +/- 43,270 kWh lifecycle. Net ex post kW savings are 60% greater and net ex post kWh savings are 11% lower due to larger unit savings and fewer hours of operation. **Appendix D-3** provides detailed findings of the EM&V on-site audit for Site #3.

Table 4.10 Summary of Net Ex Ante and Ex Post EM&V Findings for Site #3

Rebate ID	Description	Ex Ante NTGR	Net Ex Ante kW	Net Ex Ante kWh/y	Net Ex Ante Lifecycle kWh	Ex Post NTGR	Net Ex Post kW	Net Ex Post kWh/y	Net Ex Post Lifecycle kWh
CL002	400W HID to T8 4Lx4ft	0.85	18.1	115,677	1,272,449	0.89	29.9	107,616	1,183,775
CL002	400W HID to T8 6Lx4ft w/sensors	0.85	3.0	19,280	212,075	0.89	2.7	9,872	108,587
CL002	400W HID to T8 2Lx4ft w/sensors	0.85	0.1	631	6,943	0.89	1.1	3,986	43,844
CL004	400W HID to T8 4Lx4ft	0.85	0.3	1,707	18,778	0.89	0.3	1,115	12,265
CL006	T12 2x4ft to T8 2Lx4ft	0.85	0.0	0	0	0.89	0.0	19	204
CL005	T12 2x8ft to T8 4Lx4ft	0.85	0.0	0	0	0.89	0.1	53	580
CL004	400W HID to T8 4Lx4ft	0.85	0.2	1,071	11,782	0.89	0.3	144	1,583
Total			21.6	138,366	1,522,026		34.5	122,803	1,350,838

4.2.4 EM&V Findings for Site #4

The summary of the gross EM&V findings for site #4 are provided in **Table 4.11**. The total measure costs are \$16,375 and the total incentives are \$9,450. The total gross ex ante savings are 24.8 kW, 247,212 kWh/yr, and 2,719,332 kWh lifecycle assuming an EUL of 11 years. The total gross ex post savings are 29.9 kW, 72,475 kWh/yr, 797,226 kWh lifecycle. The ex ante NTGR is 0.85. Total net ex ante savings are 21.1 kW, 210,130 kWh/yr, and 2,311,432 kWh lifecycle. The ex post NTGR is 1.0 based on decision maker survey interviews with the participants. The total net ex post savings are 29.9 +/- 0.7 kW, 72,475 +/- 12,645 kWh/yr, and 797,226 +/- 139,094 kWh lifecycle. Net ex post kW savings are 42% greater and net ex post kWh savings are 64% lower due to fewer hours of operation. The ex ante savings are based on E3 industrial customer segments with greater hours of operation than commercial customer segments. **Appendix D-4** provides detailed findings of the EM&V on-site audit for Site #4.

Table 4.11 Summary of Net Ex Ante and Ex Post EM&V Findings for Site #4

Rebate ID	Description	Ex Ante NTGR	Net Ex Ante kW	Net Ex Ante kWh/y	Net Ex Ante Lifecycle kWh	Ex Post NTGR	Net Ex Post kW	Net Ex Post kWh/y	Net Ex Post Lifecycle kWh
CL002	400W HID to T8 6Lx4ft HiBay	0.85	2.7	26,683	293,515	1	3.8	9,203	101,235
CL002	400W HID to T8 6Lx4ft HiBay	0.85	1.8	18,345	201,792	1	3.1	7,478	82,253
CL002	400W HID to T8 6Lx4ft HiBay	0.85	1.5	15,009	165,102	1	2.1	5,177	56,945
CL002	400W HID to T8 6Lx4ft HiBay	0.85	5.5	55,034	605,375	1	7.8	18,982	208,797
CL002	400W HID to T8 6Lx4ft HiBay	0.85	3.7	36,689	403,583	1	5.2	12,654	139,198
CL002	400W HID to T8 6Lx4ft HiBay	0.85	5.9	58,370	642,065	1	7.8	18,982	208,797
Total			21.1	210,130	2,311,432		29.9	72,475	797,226

4.2.5 EM&V Findings for Site #5

The summary of the gross EM&V findings for site #5 are provided in **Table 4.12**. The total measure costs are \$28,798 and the total incentives are \$6,300. The total gross ex ante savings are 21.8 kW, 133,092 kWh/yr, and 1,424,575 kWh lifecycle assuming an EUL of 11 years. The total gross ex post savings are 25.4 kW, 88,075, 950,042 kWh lifecycle. The ex ante NTGR is 0.85. Total net ex ante savings are 18.5 kW, 112,997 kWh/yr, and 1,209,837 kWh lifecycle. The ex post NTGR is 0.89 based on decision maker survey interviews with the participants. The total net ex post savings are 22.6 +/- 2.0 kW, 78,387 +/- 7,020 kWh/yr, and 845,537 +/- 75,724 kWh lifecycle. Net ex post kW savings are 22% greater due to larger unit savings and net ex post kWh savings are 30% less due to lower hours of operation based on lighting logger data. **Appendix D-5** provides detailed findings of the EM&V on-site audit for Site #5.

Table 4.12 Summary of Net Ex Ante and Ex Post EM&V Findings for Site #5

Rebate ID	Description	Ex Ante NTGR	Net Ex Ante kW	Net Ex Ante kWh/y	Net Ex Ante Lifecycle kWh	Ex Post NTGR	Net Ex Post kW	Net Ex Post kWh/y	Net Ex Post Lifecycle kWh
CL002	T12 4Lx4ft to T8 4Lx4ft	0.85	14.0	89,971	989,683	0.89	16.7	57,975	637,730
CL003	T12 6Lx4ft to T8 6Lx4ft	0.85	1.1	7,163	78,791	0.89	2.8	9,663	106,288
CL030	T12 2Lx8ft to T8 4Lx4ft	0.85	0.8	4,820	53,022	0.89	1.5	5,176	56,940
CL051	T12 6Lx4ft to T8 6Lx4ft	0.84	2.6	11,043	88,341	0.89	1.6	5,572	44,578
Total			18.5	112,997	1,209,837		22.6	78,387	845,537

4.2.6 EM&V Findings for Site #6

The summary of the gross EM&V findings for site #6 are provided in **Table 4.13**. The total measure costs are \$7,220 and the total incentives are \$4,875. The total gross ex ante savings are 12.8 kW, 127,530 kWh/yr, and 1,402,830 kWh lifecycle assuming an EUL of 11 years. The total gross ex post savings are 15.7 kW, 47,426 kWh/yr, 521,685 kWh lifecycle. The ex ante NTGR is 0.85. Total net ex ante savings are 10.9 kW, 108,401 kWh/yr, and 1,192,406 kWh lifecycle. The ex post NTGR is 1.0 based on decision maker survey interviews with the participants. The total net ex post savings are 15.7 +/- 0.6 kW, 47,426 +/- 16,344 kWh/yr, and 521,685 +/- 179,786 kWh lifecycle. Net ex post kW savings are 45% greater and net ex post kWh savings are 64% lower due to lower hours of operation based on light logger data. The ex ante savings are based on E3 industrial customer segments with greater hours of operation than commercial customer segments. **Appendix D-6** provides detailed findings of the EM&V on-site audit for Site #6.

Table 4.13 Summary of Net Ex Ante and Ex Post EM&V Findings for Site #6

Rebate ID	Description	Ex Ante NTGR	Net Ex Ante kW	Net Ex Ante kWh/y	Net Ex Ante Lifecycle kWh	Ex Post NTGR	Net Ex Post kW	Net Ex Post kWh/y	Net Ex Post Lifecycle kWh
CL002	400W HID to T5 HO 4Lx4ft	0.85	10.9	108,401	1,192,406	1	15.7	47,426	521,685
Total			10.9	108,401	1,192,406		15.7	47,426	521,685

4.2.7 EM&V Findings for Site #7

The summary of the gross EM&V findings for site #7 are provided in **Table 4.14**. The total measure costs are \$18,091 and the total incentives are \$3,975. The total gross ex ante savings are 29.4 kW, 186,381 kWh/yr, and 2,031,067 kWh lifecycle assuming an EUL of 11 years. The total gross ex post savings are 6.9 kW, 16,361 kWh/yr, 175,594 kWh lifecycle. The ex ante NTGR is 0.85. Total net ex ante savings are 25.0 kW, 158,360 kWh/yr, and 1,725,897 kWh lifecycle. The ex post NTGR is 0.97 based on decision maker survey interviews with the participants. The total net ex post savings are 6.1 +/- 0.3 kW, 14,561 +/- 699 kWh/yr, and 156,279 +/- 7,504 kWh lifecycle. Net ex post kW savings 25% greater due to higher unit savings and net ex post kWh savings are 91% lower due to lower hours of operation based on lighting logger data. The ex ante savings are based on E3 industrial customer segments with greater hours of operation than commercial customer segments. **Appendix D-7** provides details of the EM&V on-site audit for Site #7.

Table 4.14 Summary of Net Ex Ante and Ex Post EM&V Findings for Site #7

Rebate ID	Description	Ex Ante NTGR	Net Ex Ante kW	Net Ex Ante kWh/y	Net Ex Ante Lifecycle kWh	Ex Post NTGR	Net Ex Post kW	Net Ex Post kWh/y	Net Ex Post Lifecycle kWh
CL002	T12 4Lx4ft to T8 4Lx4ft	0.85	8.9	88,388	972,269	0.89	1.4	3,066	33,727
CL052	T12 6Lx4ft to T8 6Lx4ft	0.84	0.0	623	4,986	0.89	0.0	633	5,065
CL051	T12 2Lx8ft to T8 4Lx4ft	0.84	0.7	3,155	25,240	0.89	0.2	489	3,914
CL051	T12 6Lx4ft to T8 6Lx4ft	0.84	0.4	1,578	12,620	0.89	0.1	177	1,415
CL035	T12 4Lx4ft to T8 4Lx4ft	0.85	13.1	52,941	582,349	0.89	1.4	3,121	34,326
CL030	T12 2Lx4ft to T8 2Lx4ft	0.85	1.9	11,676	128,432	0.89	3.1	7,076	77,832
Total			25.0	158,360	1,725,897		6.1	14,561	156,279

4.2.8 EM&V Findings for Site #8

The summary of the gross EM&V findings for site #8 are provided in **Table 4.15**. The total measure costs are \$237,834 and the total incentives are \$41,000. The total gross ex ante savings are 172.3 kW, 1,398,682 kWh/yr, and 14,941,011 kWh lifecycle assuming an EUL of 11 years. The total gross ex post savings are 198.7 kW, 1,765,508 kWh/yr, 19,052,650 kWh lifecycle. The ex ante NTGR is 0.85. Total net ex ante savings are 198.7 kW, 1,765,508 kWh/yr, and 12,691,522 kWh lifecycle. The ex post NTGR is 1.0 based on decision maker survey interviews with the participants. The total net ex post savings are 198.7 +/- 9.3 kW, 1,765,508 +/- 81,025 kWh/yr, and 19,052,650 +/- 874,385 kWh lifecycle. Net ex post kW savings 36% greater due to higher unit savings and net ex post kWh savings are 50% greater due greater hours of operation based on light logger data. Approximately 85% of the ex ante savings are based on E3 commercial customer segments with lower hours of operation than industrial customer segments and all measures are industrial. **Appendix D-8** provides details of the EM&V on-site audit for Site #8.

Table 4.15 Summary of Net Ex Ante and Ex Post EM&V Findings for Site #8

Rebate ID	Description	Ex Ante NTGR	Net Ex Ante kW	Net Ex Ante kWh/y	Net Ex Ante Lifecycle kWh	Ex Post NTGR	Net Ex Post kW	Net Ex Post kWh/y	Net Ex Post Lifecycle kWh
CL002	T12 to T8 HiBay	0.85	93.1	927,241	10,199,653	1	152.1	1,289,780	14,187,585
CL030	T12 to T8 or T5 4-ft lamp installed	0.85	12.9	78,960	868,557	1	29.6	220,413	2,424,548
CL034	Delamp: 4 foot lamp	0.85	6.0	22,282	245,101	1	5.8	43,620	479,823
CL052	Occ. Sensor Integrated over 12'	0.84	21.4	87,541	700,330	1	7.9	58,707	469,658
CL061	Exterior T12 to T8 or T5	0.85	6.4	40,701	447,714	1	0.0	38,981	428,788
CL064	Exterior T12 to T8 or T5	0.85	2.7	17,104	188,144	1	0.0	88,449	972,937
CL070	T8 32W to T8 28W 4ft lamp	0.85	3.9	14,008	42,024	1	3.3	24,585	73,755
CL039	Incand. to LED Exit signs	0.85	0.0	0	0	1	0.1	972	15,558
Total			146.2	1,187,837	12,691,522		198.7	1,765,508	19,052,650

4.2.9 EM&V Findings for Site #9

The summary of the gross EM&V findings for site #9 are provided in **Table 4.16**. The total measure costs are \$79,133 and the total incentives are \$18,444. The total gross ex ante savings are 52.7 kW, 305,660 kWh/yr, and 4,584,900 kWh lifecycle assuming an EUL of 11 years. The total gross ex post savings are 38.5 kW, 433,839 kWh/yr, 6,507,580 kWh lifecycle. The ex ante NTGR is 0.85. Total net ex ante savings are 42.2 kW, 244,528 kWh/yr, and 3,667,920 kWh lifecycle. The ex post NTGR is 0.83 based on decision maker survey interviews with the participants. The total net ex post savings are 44.0 +/- 1.7 kW, 366,957 +/- 5,827 kWh/yr, and 5,504,362 +/- 62,851 kWh lifecycle. Net ex post kW savings are 2% lower due to lower unit

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savings and NTGR and net ex post kWh savings are 41% greater due to hours of operation based on light logger data of the fixture-mounted occupancy sensors. **Appendix D-9** provides detailed findings of the EM&V on-site audit for Site #9.

Table 4.16 Summary of Net Ex Ante and Ex Post EM&V Findings for Site #9

Rebate ID	Description	Ex Ante NTGR	Net Ex Ante kW	Net Ex Ante kWh/y	Net Ex Ante Lifecycle kWh	Ex Post NTGR	Net Ex Post kW	Net Ex Post kWh/y	Net Ex Post Lifecycle kWh
CC066	400W HID to 150W LED HB1C5J Dialight w/Occ. Sensors	0.80	42.2	244,528	3,667,920	0.83	44.0	366,957	5,504,362
Total			42.2	244,528	3,667,920		44.0	366,957	5,504,362

4.2.10 EM&V Findings for Site #10

The summary of the gross EM&V findings for site #10 are provided in **Table 4.17**. The total measure costs are \$60,000 and the total incentives are \$30,000. The total gross ex ante savings are 8.0 kW, 463,812 kWh/yr, and 6,957,180 kWh lifecycle assuming an EUL of 15 years. The total gross ex post savings are 12.4 kW, 490,818 kWh/yr, 7,362,269 kWh lifecycle. The ex ante NTGR is 0.85. Total net ex ante savings are 6.4 kW, 371,050 kWh/yr, and 5,565,744 kWh lifecycle. The ex post NTGR is 0.56 based on decision maker survey interviews with the participants. The total net ex post savings are 6.9 +/- 1.33 kW, 274,858 +/- 5,251 kWh/yr, and 4,122,870 +/- 78,761 kWh lifecycle. Net ex post kW savings are 15.4% greater due to higher unit savings and net ex post kWh savings are 26% lower due to the net to gross ratio being 0.56 instead of 0.8. **Appendix D-10** provides detailed findings of the EM&V on-site audit for Site #10.

Table 4.17 Summary of Net Ex Ante and Ex Post EM&V Findings for Site #10

Rebate ID	Description	Ex Ante NTGR	Net Ex Ante kW	Net Ex Ante kWh/y	Net Ex Ante Lifecycle kWh	Ex Post NTGR	Net Ex Post kW	Net Ex Post kWh/y	Net Ex Post Lifecycle kWh
CNC008	Wine Tank Insulation	0.80	6.40	371,050	5,565,744	0.56	6.9	274,858	4,122,870
Total			6.40	371,050	5,565,744		6.9	274,858	4,122,870

4.2.11 EM&V Findings for Site #11

The summary of the gross EM&V findings for site #11 are provided in **Table 4.18**. The total measure costs are \$14,802 and the total incentives are \$7,125. The total gross ex ante savings are 11.9 kW, 120,012 kWh/yr, and 1,800,180 kWh lifecycle assuming an EUL of 15 years. The total gross ex post savings are 13.79 kW, 120,760 kWh/yr, 1,811,403 kWh lifecycle. The ex ante NTGR is 0.75. Total net ex ante savings are 8.93 kW, 90,009 kWh/yr, and 1,350,135 kWh lifecycle. The ex post NTGR is 0.97 based on decision maker survey interviews with the participants. The total net ex post savings are 13.4 +/- 0.35 kW, 117,137 +/- 12,167 kWh/yr, and 1,757,061 +/- 182,499 kWh lifecycle. Net ex post kW savings are 50% greater and net ex post kWh savings are 30% greater based on the greater measured electric power savings and net to gross ratio (0.97 ex post versus 0.75 ex ante). **Appendix D-11** provides detailed findings of the EM&V on-site audit for Site #11.

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Table 4.18 Summary of Net Ex Ante and Ex Post EM&V Findings for Site #11

Rebate ID	Description	Ex Ante NTGR	Net Ex Ante kW	Net Ex Ante kWh/y	Net Ex Ante Lifecycle kWh	Ex Post NTGR	Net Ex Post kW	Net Ex Post kWh/y	Net Ex Post Lifecycle kWh
AC010	VFD for Vacuum Pump	0.75	8.93	90,009	1,350,135	0.97	13.4	117,137	1,757,061
Total			8.93	90,009	1,350,135		13.4	117,137	1,757,061

4.2.12 EM&V Findings for Site #12

The summary of the gross EM&V findings for site #12 are provided in **Table 4.19**. The total measure costs are \$22,445 and the total incentives are \$5,715. The total gross ex ante savings are 5.6 kW, 81,641 kWh/yr, and 1,224,615 kWh lifecycle assuming an EUL of 11 years. The total gross ex post savings are 5.6 kW, 46,533 kWh/yr, 698,000 kWh lifecycle. The ex ante NTGR is 0.85. Total net ex ante savings are 4.48 kW, 65,313 kWh/yr, and 979,692 kWh lifecycle. The ex post NTGR is 0.83 based on decision maker survey interviews with the participants. The total net ex post savings are 4.6 +/- 0.22 kW, 38,623 +/- 1,328 kWh/yr, and 579,340 +/- 19,925 kWh lifecycle. Net ex post kWh savings are 41% lower due lower average electric power savings. **Appendix D-12** provides detailed findings of the EM&V on-site audit for Site #12.

Table 4.19 Summary of Net Ex Ante and Ex Post EM&V Findings for Site #12

Rebate ID	Description	Ex Ante NTGR	Net Ex Ante kW	Net Ex Ante kWh/y	Net Ex Ante Lifecycle kWh	Ex Post NTGR	Net Ex Post kW	Net Ex Post kWh/y	Net Ex Post Lifecycle kWh
CC075	Cooling Tower VFD	0.80	4.48	65,313	979,692	0.83	4.6	38,623	579,340
Total			4.48	65,313	979,692		4.6	38,623	579,340

4.2.13 EM&V Findings for Site #13

The summary of the gross EM&V findings for site #13 are provided in **Table 4.20**. The total measure costs are \$14,740 and the total incentives are \$14,740. The total gross ex ante savings are 36.4 kW, 294,800 kWh/yr, and 1,474,000 kWh lifecycle assuming an EUL of 5 years. The total gross ex post savings are 38.5 kW, 335,286 kWh/yr, and 1,676,428 kWh lifecycle. The ex ante NTGR is 1.0. Total net ex ante savings are 36.4 kW, 364,000 kWh/yr, and 1,820,000 kWh lifecycle. The ex post NTGR is 0.99 based on decision maker survey interviews with the participants. The total net ex post savings are 37.4 +/- 0.47 kW, 325,227 +/- 4,089 kWh/yr, and 1,626,135 +/- 20,445 kWh lifecycle. Net ex post kW savings are 3% greater and net ex post kWh savings are 10% lower due to fewer hours of network PC power off time based on audit data. **Appendix D-13** provides detailed findings of the EM&V on-site audit for Site #13.

Table 4.20 Summary of Net Ex Ante and Ex Post EM&V Findings for Site #13

Rebate ID	Description	Ex Ante NTGR	Net Ex Ante kW	Net Ex Ante kWh/y	Net Ex Ante Lifecycle kWh	Ex Post NTGR	Net Ex Post kW	Net Ex Post kWh/y	Net Ex Post Lifecycle kWh
CB001	Net PC Power Mgmt. Software	1.0	36.4	364,000	1,820,000	0.99	37.4	325,227	1,626,135
Total			36.4	364,000	1,820,000		37.4	325,227	1,626,135

4.2.14 EM&V Findings for Site #14

The summary of the gross EM&V findings for site #14 are provided in **Table 4.21**. The total measure costs are \$168,768 and the total incentives are \$66,030. The total gross ex ante savings

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are 55.5 kW, 1,118,102 kWh/yr, and 16,771,530 kWh lifecycle assuming an EUL of 15 years. The total gross ex post savings are 55.5 kW, 1,118,102 kWh/yr, and 16,771,530 kWh lifecycle. The ex ante NTGR is 0.80. Total net ex ante savings are 44.4 kW, 894,482 kWh/yr, and 13,417,224 kWh lifecycle. The ex post NTGR is 1.0. The total net ex post savings are 55.5 +/- 2.57 kW, 1,118,102 +/- 47,595 kWh/yr, and 16,771,530 +/- 713,920 kWh lifecycle. Net ex post kW and kWh savings are 25% greater due to the greater ex post net to gross ratio of 1.0 compared to ex ante of 0.8. **Appendix D-14** provides findings of the EM&V on-site audit.

Table 4.21 Summary of Net Ex Ante and Ex Post EM&V Findings for Site #14

Rebate ID	Description	Ex Ante NTGR	Net Ex Ante kW	Net Ex Ante kWh/y	Net Ex Ante Lifecycle kWh	Ex Post NTGR	Net Ex Post kW	Net Ex Post kWh/y	Net Ex Post Lifecycle kWh
CC058 to CC063	Refrigeration Controller Retrofit	0.8	44.4	894,482	13,417,224	1.0	55.5	1,118,102	16,771,530
Total			44.4	894,482	13,417,224		55.5	1,118,102	16,771,530

4.2.15 EM&V Findings for Refrigerator and Freezer Recycling

The ex ante assumptions and savings for refrigerator and freezer recycling are provided in **Table 4.22**. The total measure costs are \$38,989 and the total incentives are \$38,989. The total gross ex ante savings are 53.62 kW, 250,635 kWh/yr, and 1,208,792 kWh lifecycle.

Table 4.22 Ex Ante Assumptions and Savings for Refrigerator and Freezer Recycling

Rebate ID	E3 #	Description	E3 Rebate	E3 kWh per unit	E3 kW per unit	E3 EUL	E3 NTGR	Ex ante Qty.	Ex Ante Gross kW	Ex Ante Gross kWh/y	Ex Ante Gross Lifecycle kWh
HA204	1321	Freezer Recycling - removal of secondary freezer - unconditioned space	\$125.77	703	0.148	4.0	0.75	57	8.44	40,071	160,284
HA204	1322	Freezer Recycling - conditioned space	\$125.77	539	0.118	4.0	0.75	8	0.94	4,312	17,248
HA205	1326	Refrigerator Recycling - removal of secondary refrigerator - unconditioned space	\$125.77	926	0.195	5.0	0.61	123	23.99	113,898	569,490
HA205	1327	Refrigerator Recycling - conditioned space	\$125.77	757	0.166	5.0	0.61	122	20.25	92,354	461,770
Total								310	53.62	250,635	1,208,792

EM&V savings per unit for refrigerator and freezer recycling measures are shown in **Table 4.23**. EM&V kWh and kW savings per unit are based on the average annual energy consumption for all recycled units based on make and model number looked up in the US Department of Energy (DOE) database and the Refrigerator and Freezer Energy Rating Database from <http://www.kouba-cavallo.com/refmods.htm>. The total gross ex post savings are 59.67 kW, 283,567 kWh/yr, and 1,353,973 kWh lifecycle.

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Table 4.23 EM&V Savings for Refrigerator and Freezer Recycling

Rebate ID	Description	EM&V kWh/y per unit	EM&V kW per unit	E3 EUL	EM&V NTGR	EM&V Qty.	EM&V Gross kW	EM&V Gross kWh/y	EM&V Gross Lifecycle kWh
HA204	Freezer Recycling - removal of secondary freezer - unconditioned space	933	0.196	4	0.93	57	11.17	53,181	212,724
HA204	Freezer Recycling - conditioned space	1335	0.281	4	0.93	8	2.25	10,680	42,720
HA205	Refrigerator Recycling - removal of secondary refrigerator - unconditioned space	892	0.188	5	0.93	146	27.42	130,270	651,350
HA205	Refrigerator Recycling - conditioned space	903	0.190	5	0.93	99	18.83	89,436	447,179
Total						310	59.67	283,567	1,353,973

Net ex ante and ex post EM&V findings for refrigerator and freezer recycling are shown in **Table 4.24**. The ex ante NTGR is 0.75 for freezer recycling and 0.61 for refrigerator recycling. Total net ex ante savings are 34.02 kW, 159,101 kWh/yr, and 762,218 kWh lifecycle. The ex post NTGR is 0.93 for freezer and refrigerator recycling based on decision maker survey interviews with 13 participants. The total net ex post savings are 55.49 +/- 1.9 kW, 263,717 +/- 9,219 kWh/yr, and 1,259,194 +/- 44,017 kWh lifecycle. Net ex post kW savings are 62% greater and net ex post kWh savings are 65% greater due to greater ex post savings per unit and greater EM&V ex post net to gross ratios of 0.93 compared to ex ante of 0.75 for freezer and 0.61 for refrigerator recycling.

Table 4.24 Net Ex Ante and Ex Post EM&V Findings for Freezer/Refrigerator Recycling

Rebate ID	Description	Ex Ante NTGR	Net Ex Ante kW	Net Ex Ante kWh/y	Net Ex Ante Lifecycle kWh	Ex Post NTGR	Net Ex Post kW	Net Ex Post kWh/y	Net Ex Post Lifecycle kWh
HA204	Freezer Recycling - removal of secondary freezer - unconditioned space	0.75	6.33	30,053	120,213	0.93	10.39	49,458	197,833
HA204	Freezer Recycling - conditioned space	0.75	0.71	3,234	12,936	0.93	2.09	9,932	39,730
HA205	Refrigerator Recycling - removal of secondary refrigerator - unconditioned space	0.61	14.63	69,478	347,389	0.93	25.50	121,151	605,756
HA205	Refrigerator Recycling - conditioned space	0.61	12.35	56,336	281,680	0.93	17.51	83,175	415,876
Total			34.02	159,101	762,218		55.49	263,717	1,259,194

4.2.16 EM&V Findings for Energy Star® Clotheswashers

The ex ante assumptions and savings for Energy Star® clotheswashers are provided in **Table 4.25**. The ex ante NTGR is 0.85 and the EUL is 12 years. MID paid 622 Energy Star® clothes washer rebates with total incentives of \$21,770. The total gross ex ante savings are 98.9 kW, 38,564 kWh/yr, and 462,768 kWh lifecycle.

Table 4.25 Ex Ante Assumptions and Savings for Energy Star® Clotheswashers

Rebate ID	E3 #	Description	E3 Rebate	E3 kWh per unit	E3 kW per unit	E3 EUL	E3 NTGR	Ex ante Qty.	Ex Ante Gross kW	Ex Ante Gross kWh/y	Ex Ante Gross Lifecycle kWh
HA202	1321	Energy Star® Clothes Washer	\$35.00	62	0.159	12.0	0.85	622	98.90	38,564	462,768
Total								622	98.90	38,564	462,768

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Clothes washers impact household energy use in three ways.

- 1) Electricity is used to operate the agitator, drum motor, valves, and controls.
- 2) Hot water is often used to wash clothes impacting total household hot water use.
- 3) The final spin cycle impacts how much energy is used by the dryer to remove water.

Load impacts for Energy Star® clotheswashers are based on annual energy use for models listed in the Energy Star® database and verification of the MID database consistent with IPMVP Option A (verification of stipulated savings). The estimated energy use of the standard clothes washer (non-Energy Star®) is based on the following equation.

$$kWh_{std. CW} = 379.47 \times C^{0.1748}$$

Where, C = rated capacity of the clothes washer container (ft^3).

The estimated energy savings of the Energy Star® clothes washer is based on the following equation.

$$kWh \text{ Savings}_{ES CW} = kWh_{std. CW} - kWh_{ES CW}$$

Where, $kWh_{ES CW}$ = annual energy use of Energy Star® clothes washer based on ratings provided at the Energy Star® website (see <http://www.energystar.gov>).

$$kW \text{ Savings}_{ES CW} = \frac{kWh \text{ Savings}_{ES CW} / yr}{392 \text{ h / yr}} \times \frac{\sum_{i=1}^m h_{i 2-4PM}}{\sum_{i=1}^n h_{i May-Sep}}$$

Where, $kW \text{ Savings}_{ES CW}$ = peak demand savings of Energy Star® clothes washer,

$\sum_{i=1}^m h_{i 2-4PM} = 420$ hours = sum of hours from 2 to 4 PM during peak period from May through September, and

$\sum_{i=1}^n h_{i May-Sep} = 3018$ hours = total hours during peak period from May through September.

The EM&V unit energy and water savings for Energy Star® Clothes Washers are shown in **Table 4.26** based on the above equations and data available for each make and model based on ratings provided at the Energy Star® website.¹⁰ The embedded electricity for water pumping and treatment is valued at 0.0072 kWh per gallon from House, L. 2006. Water Supply Related

¹⁰ 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.

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Electricity Demand in California, LBNL-62041. Lawrence Berkeley National Laboratory.
http://www.fypower.org/pdf/CA_WaterSupply_Electricity.pdf.

Table 4.26 EM&V Unit Energy and Water Savings for Energy Star® Clotheswashers

Description	EM&V Annual Electric Use (kWh/y-unit)	EM&V Peak Demand (kW/unit)	EM&V Annual Gas Use (therm/y-unit)	EM&V Annual Water Use (gal/y-unit)	EM&V Annual Water Pump Use (kWh/y-unit)	EM&V Water Pump Peak Demand (kW/unit)	EM&V Total Annual Electric Use (kWh/y-unit)	EM&V Total Peak Demand (kW/unit)
Standard Clothes Washer	477	0.17	36.0	14,244	110.6	0.04	587.6	0.21
Energy Star® Clothes Washer	157.5	0.06	13.9	5,487	47.5	0.017	202.5	0.072
Average Savings	322.0	0.11	22.2	8,758	63.1	0.02	385.1	0.137
+/- 90% CI	3.31	0.001	0.20	77.8	0.56	0.001	3.35	0.002

EM&V gross ex post unit energy and water savings for Energy Star® clotheswashers are shown in **Table 4.27**. E3 requires water savings to be entered in Centum (hundred) Cubic Feet (CCF). One CCF equals 748 gallons. The ex post NTGR is 0.58 +/- 0.1 based on decision maker surveys conducted with 20 participants. This indicates 42% of participants were free riders and would have purchased Energy Star® clotheswashers without rebates.

Table 4.27 EM&V Ex Post Unit Savings for Energy Star® Clotheswashers

Rebate ID	Description	EM&V kWh/y per unit	EM&V kW per unit	EM&V therm/y per unit	EM&V CCF/y per unit	E3 EUL	EM&V NTGR
HA202	Clothes Washer	385	0.137	22.2	11.7	12	0.58

The EM&V gross ex post savings for the MID Energy Star® Clothes Washer rebate program are shown in **Table 4.28**. The EM&V gross ex post savings are 85.05 kW, 239,513, kWh/yr, 2,874,161 kWh lifecycle, 13,782 therm/yr, 165,378 lifecycle therms, 7,282 CCF per year, and 87,389 lifecycle CCF.

Table 4.28 EM&V Gross Ex Post Savings for Energy Star® Clotheswashers

Rebate ID	Description	EM&V Qty.	EM&V Gross kW	EM&V Gross kWh/y	EM&V Gross Lifecycle kWh	EM&V Gross therm/y	EM&V Gross Lifecycle therm	EM&V Gross CCF	EM&V Gross Lifecycle CCF
HA202	Energy Star® Clothes Washer	622	85.03	239,513	2,874,161	13,782	165,378	7,282	87,389
Total		622	85.03	239,513	2,874,161	13,782	165,378	7,282	87,389

Net ex ante and ex post EM&V findings for Energy Star® clotheswashers are shown in **Table 4.29**. The MID net ex ante savings are 32,779 kWh/yr, 84.06 kW and 393,353 lifecycle kWh based on 622 units. The total net ex post savings are 138,918 ± 1,193 first-year kWh, 49.3 ± 0.36 kW, 7,993 ± 71 first-year therm, 4,224 ± 38 first-year CCF, 1,667,013 ± 14,312 lifecycle kWh, 95,919 ± 852 lifecycle therm, and 50,686 ± 450 lifecycle CCF at the 90% confidence level for 622 units. The net ex post kW savings are 41% lower and the net ex post kWh savings are approximately 324% greater than net ex ante. The ex post savings are based on the difference between the energy use for standard models compared to energy use for Energy Star® models.

Table 4.29 Net Ex Ante and Ex Post EM&V Findings for Energy Star® Clotheswashers

Rebate ID	Description	Net Ex Ante kW	Net Ex Ante kWh/y	Net Ex Ante Lifecycle kWh	Net Ex Post kW	Net Ex Post kWh/y	Net Ex Post Lifecycle kWh	Net Ex Post therm/y	Net Ex Post Lifecycle therm	Net Ex Post CCF	Net Ex Post Lifecycle CCF
HA202	Clothes Washer	84.06	32,779	393,353	49.32	138,918	1,667,013	7,993	95,919	4,224	50,686
Total		84.06	32,779	393,353	49.32	138,918	1,667,013	7,993	95,919	4,224	50,686

The E3 ex ante measure cost is \$475 per unit, and the ex ante Total Resource Cost (TRC) test is 0.1. The EM&V study conducted research on measure costs for standard units and non-Energy Star® units and determined that the incremental measure cost is \$0 to \$400 depending on the number of additional non-energy efficiency features on the Energy Star® units. Excluding non-energy efficiency features, the incremental measure cost is \$35. The ex post TRC test is 4.3 based on a measure cost of \$35 including ex post electricity, natural gas, and water savings.

4.2.17 EM&V Findings for Duct Sealing

The ex ante assumptions and savings for duct sealing are provided in **Table 4.30**. The ex ante NTGR varies from 0.78 for single family to 1.0 for multi-family. The EUL is 18 years. MID paid 315 duct sealing rebates with total incentives of \$78,750. The total gross ex ante savings are 56.13 kW, 27,964 kWh/yr, and 503,352 lifecycle kWh.

Table 4.30 Ex Ante Assumptions and Savings for Duct Sealing

Rebate ID	E3 #	Description	E3 Rebate	E3 kWh per unit	E3 kW per unit	E3 EUL	E3 NTGR	Ex ante Qty.	Ex Ante Gross kW	Ex Ante Gross kWh/y	Ex Ante Gross Lifecycle kWh
HC111	5123	Duct Sealing (MF 10-19% reduction)	\$250.00	58	0.120	18	1.00	12	1.44	696	12,528
HC112	5124	Duct Sealing (MF ≥20% reduction)	\$250.00	58	0.120	18	1.00	125	15.00	7,250	130,500
HC106	5019	Duct Sealing (SF 10-19% reduction)	\$250.00	16	0.031	18	0.80	8	0.25	128	2,304
HC101	622	Duct Sealing (SF10-≥20% reduction)	\$250.00	117	0.232	18	0.78	170	39.44	19,890	358,020
Total								315	56.13	27,964	503,352

The EM&V ex post load impacts for duct sealing are based on the average duct leakage reduction percentage times annual unit energy consumption (UEC) for cooling plus forced air unit (FAU) or heating from the DEER Database (<http://www.deeresources.com/>).¹¹ The EM&V study measured pre and post duct leakage at 16 sites per IPMVP Option B. The estimated energy savings for duct sealing are based on the following equations.

$$\text{Savings}_{\text{DS}} = UEC_{\text{DEER}} \times \overline{DL\%}$$

Where, $\text{Savings}_{\text{DS}}$ = annual energy savings from duct sealing (kWh/yr, therm/yr),

UEC_{DEER} = unit energy consumption based on DEER database (i.e., kWh/yr for cooling or forced air unit and therm/yr or heating), and

$\overline{DL\%}$ = average duct leakage reduction percentage.

¹¹ DEER 2008a. DEER2008 unit energy consumption values are from the Measure Inspection and Summary viewer tool (MISer Version 1.10.25) and DEER (Version: DEER2008.2.2). See <http://www.deeresources.com/>.

The duct leakage reduction percentage is proportional to the application Energy Efficiency Ratio (EER*) and Seasonal Energy Efficiency Ratio (SEER*) reduction as indicated in **Figure 4.1** based on Intertek Test Data.¹²

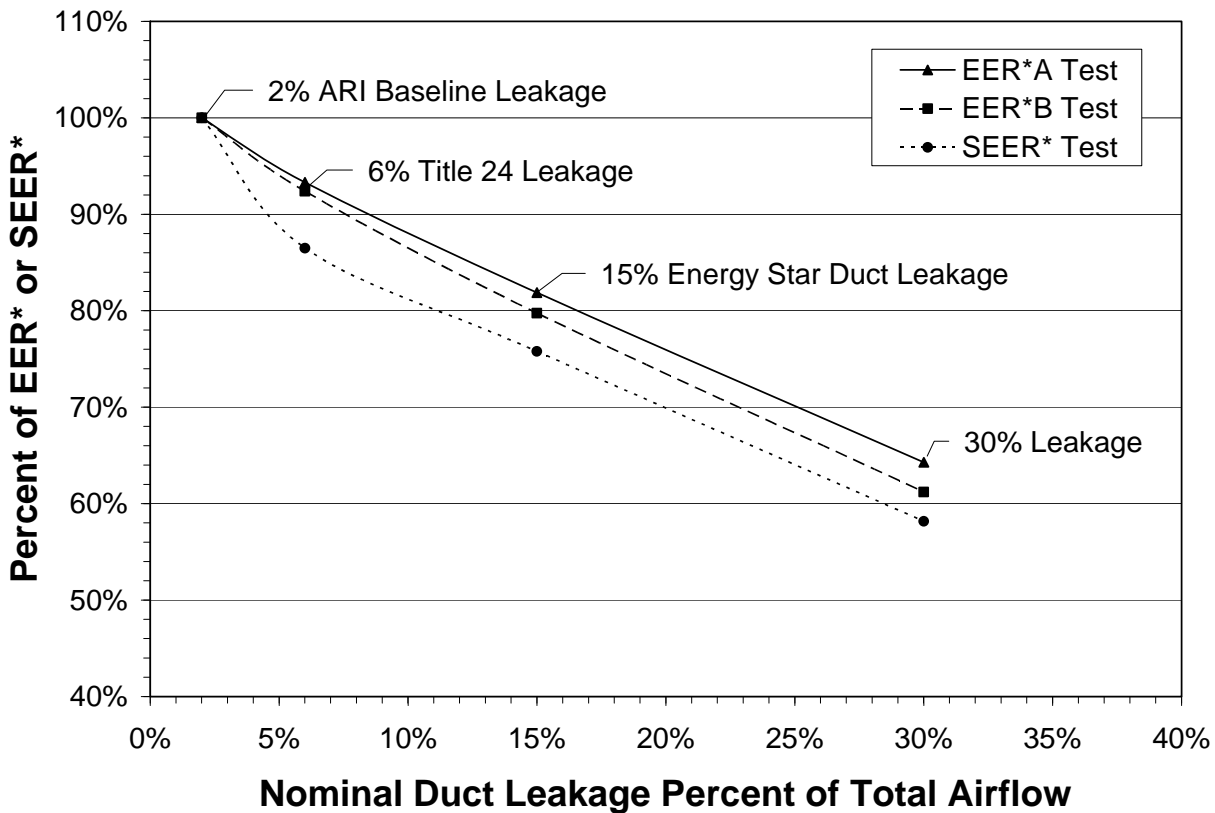


Figure 4.1 EER and SEER versus Nominal Duct Leakage Percent of Total Airflow

$$kW \text{ Savings}_{DS} = kW_{DEER} \times \overline{DL\%}$$

Where, $kW \text{ Savings}_{DS}$ = peak kW savings from duct sealing, and

kW_{DEER} = peak kW based on DEER database.

The DEER baseline UEC and peak demand data are provided in **Table 4.31**.

¹² R. Mowris, E. Jones, R. Eshom. 2012. Laboratory Measurements of HVAC Installation and Maintenance Faults. American Society of Heating Refrigeration and Air-conditioning Engineers (ASHRAE), San Antonio, TX, June 2012. Evaluation, Measurement & Verification of Air Conditioner Quality Maintenance and Quality Installation Measures, R. Mowris, E. Jones, R. Eshom, Prepared for James J. Hirsch & Associates under the auspices of the California Public Utilities Commission, Draft June 2011.

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Table 4.31 DEER Baseline Unit Energy Consumption and Peak Demand

Rebate ID	Description	DEER Base Annual End-Use: Elec Cooling (kWh/unit)	DEER Base Annual End-Use: Elec Cooling (kW/unit)	DEER Base Annual End-Use: Elec Ventilation (kWh/unit)	DEER Base Annual End-Use: Elec Vent (kW/unit)	DEER Base Annual End-Use: Gas Heating (therm/unit)
HC111	Duct Sealing (MF 10-19% reduction)	466.4	1.055	129	0.1325	135.6
HC112	Duct Sealing (MF ≥20% reduction)	466.4	1.055	129	0.1325	135.6
HC106	Duct Sealing (SF 10-19% reduction)	981.3	2.7	261.3	0.338	275.1
HC101	Duct Sealing (SF10-≥20% reduction)	981.3	2.7	261.3	0.338	275.1

The EM&V unit average energy and peak demand savings are provided in **Table 4.32**. The EM&V EUL is 18 years. The EM&V NTGR is 0.98 based on decision maker survey interviews with program participants.

Table 4.32 EM&V Unit Average Energy and Peak Demand Savings

Rebate ID	Description	EM&V Ex Post Duct Leakage Reduction Average (%)	EM&V Annual Electric Use (kWh/y-unit)	EM&V Peak Demand (kW/unit)	EM&V Annual Gas Use (therm/y-unit)	EM&V EUL	EM&V NTGR
HC111	Duct Sealing (MF 10-19% reduction)	14.00%	83.4	0.166	19.0	18	0.98
HC112	Duct Sealing (MF ≥20% reduction)	45.20%	269.1	0.537	61.3	18	0.98
HC106	Duct Sealing (SF 10-19% reduction)	12.05%	149.7	0.366	33.2	18	0.98
HC101	Duct Sealing (SF10-≥20% reduction)	24.64%	306.2	0.749	67.8	18	0.98

The EM&V ex post savings for duct sealing are provided in **Table 4.33**. The total EM&V ex post gross savings are 199.3 ± 13.9 kW, 87,890 ± 6,197kWh/yr, 19,678 ± 1,390 therm/yr, 1,582,025 ± 111,542 lifecycle kWh, and 354,208 ± 25,017 lifecycle therm.

Table 4.33 EM&V Ex Post Gross Energy and Peak Demand Savings

Rebate ID	Description	EM&V Ex Post Qty.	EM&V Ex Post Gross kW	EM&V Ex Post Gross kWh/y	EM&V Ex Post Gross Lifecycle kWh	EM&V Ex Post Gross therm/y	EM&V Ex Post Gross Lifecycle therm
HC111	Duct Sealing (MF 10-19% reduction)	12	2.0	1,000	18,005	228	4,101
HC112	Duct Sealing (MF ≥20% reduction)	125	67.1	33,640	605,522	7,661	137,905
HC106	Duct Sealing (SF 10-19% reduction)	8	2.9	1,198	21,564	265	4,774
HC101	Duct Sealing (SF10-≥20% reduction)	170	127.3	52,052	936,935	11,524	207,429
Total		315	199.3	87,890	1,582,025	19,678	354,208

Net ex ante and ex post EM&V findings for duct sealing are shown in **Table 4.34**. The MID net ex ante savings are 23,563 kWh/yr, 47.4 kW and 424,127 lifecycle kWh based on 622 units. The EM&V net ex post savings are 86,132 ± 6,073 first-year kWh, 195.3 ± 13.6 kW, 19,285 ± 1,362 first-year therm, 1,550,385 ± 109,311 lifecycle kWh, and 347,124 ± 24,517 lifecycle therm. The EM&V net ex post kW savings are 312% greater and the net ex post kWh savings are 266% greater than net ex ante. Differences between ex ante and EM&V ex post savings are due to using the DEER UEC values times average duct leakage reduction to calculate the savings rather than using E3 ex ante savings.

Table 4.34 Net Ex Ante and Ex Post EM&V Findings for Duct Sealing

Rebate ID	Description	Net Ex Ante kW	Net Ex Ante kWh/y	Net Ex Ante Lifecycle kWh	EM&V Net Ex Post kW	EM&V Net Ex Post kWh/y	EM&V Net Ex Post Lifecycle kWh	EM&V Net Ex Post therm/y	EM&V Net Ex Post Lifecycle therm
HC111	Duct Sealing (MF 10-19% reduction)	1.4	696	12,528	2.0	980	17,645	223	4,019
HC112	Duct Sealing (MF ≥20% reduction)	15.0	7,250	130,500	65.8	32,967	593,411	7,508	135,147
HC106	Duct Sealing (SF 10-19% reduction)	0.2	102	1,843	2.9	1,174	21,132	260	4,679
HC101	Duct Sealing (SF10-≥20% reduction)	30.8	15,514	279,256	124.7	51,011	918,196	11,293	203,280
Total		47.4	23,563	424,127	195.3	86,132	1,550,385	19,285	347,124

The E3 ex ante Total Resource Cost (TRC) test for the duct leakage program is 0.3. The ex post TRC test for the duct leakage program is 1.1 based on ex post NTGRs and ex post electricity and natural gas savings.

4.3 Participant Survey Results

This EM&V study used participant surveys to estimate the net-to-gross ratios (NTGR) for kWh and kW savings (see **Appendix B**). Participant surveys were completed for 34 participants and the weighted average NTGR is 0.92 for the non-residential lighting, appliance recycling, Energy Star® clotheswashers, and residential duct sealing programs.

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. **Table 4.35** provides the NTGR participant survey questions and scores. 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 4.35 Net-to-Gross Ratio Participant Survey Questions and Scores

#	Question	Answer	Score
1	Are you using the energy efficient lighting that you purchased with rebates from MID?	Yes, No	1=Y, 2=N
2	How many hours per year are the lights on? Clarify, not just when the business is open, but lights are actually on. Think about early arrivals, late janitorial service, etc...	<3, 4.5, 6, DK	
3	Are your lights turned on from 2-6PM weekdays (i.e., peak period)?	Yes, No	1=Y, 2=N
4	When and how did you first learn about the utility energy efficiency program?	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 measures 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 Rebates have on your decision to install the efficiency upgrades?	0 to 10	0=0, 10=1
8	If the Rebates had not been available, how likely is it you would have done exactly the same thing. Please use a scale from 0 to 10, with 0 being not at all likely and 10 being very likely.	0 to 10	0=1, 10=0
9	What role did the utility program play in your decision to install the measures?	1 = Reminded	0.25
		2 = Speeded Up (i.e., early replacement)	0.5
		3 = Showed Benefits	1

Table 4.35 Net-to-Gross Ratio Participant Survey Questions and Scores

#	Question	Answer	Score
		Didn't Know Before	
		4 = Clarified Benefits	0.75
		5 = No role	0
10	The utility program was nice but not necessary to have the measures installed. (0=Disagree, 10=Agree).	0 to 10	0=0, 10=1
11	I would not have purchased or installed the Energy Star® appliances or measures without the Utility Program rebates or information.	0 to 10	0=0, 10=1
12	The utility program was a critical factor in installing the measures? (0=Disagree, 10=Agree).	0 to 10	0=1, 10=0
13	We would not have installed measures without the utility program. (0=Disagree, 10=Agree).	0 to 10	0=1, 10=0
14	If you had not received the incentives from the utility, when would you have installed the lighting measures?	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

Results of the participant surveys are presented in **Table 4.36**. The weighted average NTGR is 0.87. The participant findings indicate that approximately 100% of customers were very satisfied with the program. This indicates that MID has been successful in motivating their customers to participate in the program.

Table 4.36 Participant Survey Findings

Site	Program	Units Installed	NTGR
1	Non-Res Lighting	3,416	0.94
2	Non-Res Lighting	1,335	0.83
3	Non-Res Lighting	132	0.89
4	Non-Res Lighting	91	1.00
5	Non-Res Lighting	203	0.89
6	Non-Res Lighting	65	1.00
7	Non-Res Lighting	325	0.89
8	Non-Res Lighting	35	1.00
9	Non-Res Lighting	3,804	1.00
10	Non-Res Lighting	172	0.83
11	Non-Res Custom	12	0.56
12	VFD Vacuum Pump	1	0.97
13	Cooling Tower VFD	1	0.83
14	Network PC Power Mgmt	1,820	0.97
15	Non-Res Refrig. Cntrl	6	1.00
16	Res-Fzr Recycling, unconditioned space	57	0.95
17	Res-Fzr Recycling, conditioned space	8	0.94
18	Res-Refrig. Recycling, unconditioned space	146	0.93
19	Res-Refrig Recycling – conditioned space	99	0.89
20	Res-Energy Star Clotheswasher	622	0.58
21	Res-MF Duct Seal (10-19% reduction)	12	0.99
22	Res-MF Duct Seal (≥20% reduction)	125	0.99
23	Res-SF Duct Seal (10-19% reduction)	8	0.99
24	Res-SF Duct Seal (≥20% reduction)	8	0.99
Total	Total	12,655	0.87

4.4 Process Evaluation Results

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

4.4.1 Participant Survey Results

Participant survey results are summarized to answer the following questions.

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 percent satisfaction rating (i.e., average score of 9.8 out of 10 points).
- Presentation of information – 99 percent satisfaction rating (i.e., 9.9 out of 10 points).
- Increased Understanding of Link between Energy Efficiency, Savings, and Comfort – 98 percent (i.e., 9.8 out of 10 points), indicating MID energy education efforts are doing a good job.

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

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

- 100 percent of customers are still using the measures installed by the program.
- 100 percent of customers are satisfied with measures offered or installed by the program ((i.e., average score of 10 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 percent presentation rating.
- 98 percent accuracy rating.
- 98 percent rating of program increasing understanding of the linkage between energy efficiency, bill savings, and comfort.

4. What are the participant demographics?

- Average conditioned floor area for non-residential participants is 235,867 ft² ± 214,987 ft², and the average conditioned floor area for 35 residential participants is 1799 +/- 209 ft² (i.e., clotheswasher, refrigerator recycling, and duct sealing) .
- Average number of occupants for non-residential participants is 90 +/- 55, and the average for residential participants is 2.87 +/- 0.5.
- 79% of customers own their building and 21% are tenants.

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

Thirty seven participants provided comments or suggestions to improve the program. The following comments are provided.

- Non-residential lighting participants provided the following comments and suggestions.
 - “Participated twice previously and working on third rebate. Great program for building which sorely needed new lights and especially occupancy sensors in large areas used infrequently.”
 - “Been looking into efficient lighting for awhile and this program and LED lights allowed substantial wattage reduction with enough light to still work.”
 - “Program was great. Wanted efficient lighting and motion sensors for awhile but couldn't afford cost without rebates. Light output and color superior to old lamps.”
 - “Lighting in warehouse is great. Had to get OK from union workers which he thought would not happen but the motion sensor lighting doesn't affect their work and employees wanted the company to save money and be more successful which in turn helps them.”
 - “Really likes program. Also did PV through MID incentives. Likes the color of new lighting, less yellow and no warm up.”
- Non-residential dairy participants provided the following comments and suggestions.
 - “MID should meet with dairymen to explain programs and other benefits.”
 - “Programs help avoid wasting power for milking and irrigation during peak demand.”
 - “Amazed at how much power is saved with VFD, didn't even know that was an option before Total Dairy explained potential savings.”
- Non-residential custom (wine tank insulation) processing participants provided the following comments and suggestions.
 - “Participated in wine tank insulation since 2008. Old program provided rebate of \$0.07/kWh saved which rated '10' in satisfaction. 2011 program reduced rebate to \$0.04/kWh saved which rated as '5' as it has influenced the bottom line. Will continue to install and insulate new wine tanks and will participate again in future if rebates are available.”
- Non-residential refrigeration participants provided the following comments and suggestions.
 - “Quite pleased with refrigeration controls. Seems to work as well as before but need for service calls has been reduced and refrigeration system is more reliable.”
- Non-residential network PC power management participants provided the following comments and suggestions.

- “Software is easy to deploy and manage, but it will install two copies if computers have old version of same software (10-15 CPUs had older version of same software and when installing district wide two copies are on each CPU).”
- Refrigerator recycling participants provided the following comments and suggestions.
 - “Happy with program and it speeded up completely removing one unit and replacing other with new high efficiency unit.”
 - “Liked program, picked up units promptly, would use again if needed.”
 - “Program was so busy it took about two weeks to schedule pick up. Pleased with program, would have otherwise tried to sell units in yardsale.”
 - “Would not have recycled both units without program and would have held onto second unit for spare if MID didn't offer recycling program.”
 - “Very pleased and would have never stopped using old freezer and have it recycled without program.”
- Energy Star® Clotheswasher participants provided the following comments and suggestions.
 - “Easy program to participate in due to online and in-store information. Rebate process was very easy.”
 - “Encouraging Energy Star® is a good idea.”
 - “Good program and satisfied.”
 - “Increase the rebate to \$50 similar to PG&E (advertising from PG&E). Amazed at difference in bill after buying Energy Star® clotheswasher, refrigerator, range, and dishwasher.”
 - “MID program was easy to participate it. Love my Energy Star clotheswasher.”
 - “More advertising with radio, facebook or internet.”
 - “MID rebate helped make purchase and very happy with washer.”
 - “Rebate sped up decision to buy as daughter has same model and they were impressed with its cleaning. Were planning on getting that model in about a year if rebate was not available.”
 - “Rebate sped up their decision to buy Energy Star® unit.”
 - “Wash 10 to 14 loads of laundry per week and are happy with rebate made it as cheap as other non-Energy Star® model.”
 - “Very happy MID offers program. Please promote water efficiency since this is very important.”
 - “Glad program was available as he was unhappy with old unit but was going to keep it until in stopped working. MID rebate program allowed replacing with new efficient unit.”
 - “Was unhappy with sales staff as they were not knowledgeable about Energy Star® but unit is too complicated to use.”

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

21% of participants (11 out of 52) shared information about the benefits of measures offered by the MID program with friends or neighbors and 28 installed similar measures.

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

4.4.2 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.

4.4.2.1 Recommendations for E3 and Tracking Database

MID uses the E3 model to track measures. An over estimate of savings from commercial lighting measures will occur if accidentally entered as industrial instead of commercial. Estimated savings will be almost two times greater due to E3 assumption of 8,760 hours per year of operation for industrial customers. Underestimate of savings will occur if industrial lighting measures are accidentally entered as commercial. MID should double-check tracking database entries to avoid these problems. Large non-residential lighting sites should be entered into tracking database or E3 based on spreadsheet data from installing contractor or customer to accurately track savings. Recommend an internet tracking and reporting system such as Energy Orbit which allows customers and contractors to submit online rebate applications for energy efficiency and renewable energy programs. The system will track paid and reserved rebate applications, incentives paid, energy and peak demand savings associated with the rebate including supporting documentation required for EM&V purposes. MID staff will be able to process rebates in a secure, paperless environment.

4.4.2.2 Recommendations for Energy Star® Appliances

In 2011 MID offered a \$35 incentive for Energy Star® clotheswashers. MID does not offer incentives to customers who purchase Energy Star® qualified refrigerators or dishwashers. Most new refrigerators currently meet the Energy Star® specification which is 20% more efficient than Federal Standards. The US Department of Energy (DOE) recently adopted new federal standards for refrigerators which will increase the minimum efficiency standards by 25% starting in 2014.¹³ The Consortium for Energy Efficiency (CEE) provides three (3) Tier levels to identify appliances that are more efficient than the minimum Energy Star® rating. For refrigerators, MID could offer a \$50 rebate for CEE Tier 2 which is 25% more efficient than Federal Standards and \$100 for CEE Tier 3 which is 30% more efficient than Federal Standards. For dishwashers, MID could offer a \$25 rebate for CEE Tier 1 which is 14% better than Federal Standards and \$50 for CEE Tier 2 which is 17% more efficient than Federal Standards. For clotheswashers, MID could offer a \$25 rebate for CEE Tier 1 which is 59% more efficient than Federal Standards, \$50 for CEE Tier 2 which is 75% more efficient, and \$75 for CEE Tier 3 which is 90% better. These recommendations will motivate customers to purchase more efficient appliances and make the Energy Star® programs more cost effective. High efficiency dishwashers and clotheswashers save electricity used for water pumping and treatment which requires approximately 0.0072 kWh

¹³ DOE Increases Efficiency Standard for Refrigerators by 25%. September 28, 2010. SustainableBusiness.com News: <http://www.sustainablebusiness.com/index.cfm/go/news.display/id/21126>

per gallon (see House, L. 2006. Water Supply Related Electricity Demand in California, LBNL-62041. Lawrence Berkeley National Laboratory. http://www.fypower.org/pdf/CA_WaterSupply_Electricity.pdf).

4.4.2.3 Recommendations for Refrigerator & Freezer Recycling

The MID refrigerator and freezer recycling program recycled 310 units in 2011 due to using a contractor who picked up and recycled units infrequently. MID could hire a local appliance retailer to recycle refrigerators and freezers year round since this program is very cost effective. Using a local retailer will significantly increase the number of units recycled and improve the local economy.

4.4.2.4 Recommendations for Miscellaneous Water Efficiency

MID could consider offering incentives and information for WaterSense® showerheads, aerators, and toilets to save electricity used for water pumping and treatment. MID could also consider offering incentives and information for water conservation gardens (WaterSense® irrigation) and landscaping to save water pumping electricity. MID could consider bulk purchase of WaterSense® showerheads, aerators, water efficient pre-rinse spray valves, and water-efficient garden spray nozzles. Water efficiency measures can be given away at home shows and local community events. They can also be provided to hotels, restaurants, and multi-family apartments as part of a “Green Partners” program. 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. WaterSense® toilets are cost effective with a rebate of \$20 per toilet and they 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 in other public utility programs who receive incentives for WaterSense® products are very satisfied with overall satisfaction ratings of 96%. Water supply leak repair programs implemented by other public utilities are very cost effective. Water supply leaks represent 10 to 50% of the total water supplied by municipal utilities. A water leak repair program should be implemented jointly with the City of Modesto water utility.

4.4.2.5 Recommendations for Electric/Solar Water Heaters

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

4.4.2.6 Recommendations for the Non-Residential Lighting Program

Based on findings from this study, many large non-residential lighting customers (87%) do not have sufficient capital or motivation to invest in improving the energy efficiency of their lighting systems without incentives from Modesto Irrigation District. To overcome these market barriers, MID energy efficiency programs should be continued and expanded to save energy and peak demand and reduce carbon dioxide emissions.

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 uncertainty 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: Modesto Irrigation District Commercial Lighting 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 MID commercial lighting 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.

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 MID customer file information (for participants).
2. Make sure you understand what was installed with incentives from MID prior to initiating the visit or call.
3. Participant or Decision Maker Survey Introduction.
Say: "Hello! My name is [_____], and I am conducting a survey regarding the MID Commercial Lighting Energy Efficiency Programs. The programs provided free information, rebates, and no-cost energy efficiency measures for your business. Funding for the program is from MID. Would you mind spending 10 minutes to answer a few questions to help us evaluate and improve the program?"

Modesto Irrigation District PARTICIPANT SURVEY # _____

Business Name: _____ Business Type/ID: _____
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 MID providing rebates for energy efficient lighting for your business?
___ 1 (Yes) ___ 2 (No) 98 Don't Know 99 Refused to Answer
2. If yes, how satisfied were you with the MID rebates on a scale from 1 to 10?
___ Rebates (1=low, 10=high) 98 DK 99 Refused
3. If yes, on a scale from 1 to 10 how satisfied were you with the information provided by MID on energy efficiency lighting?
___ Rebates (1=low, 10=high) (1=low, 10=high) 98 DK 99 Refused
4. How would you rate the amount of light output from the energy efficient lighting as compared to your previous lighting system on a scale from 1 to 10?
___ Response (1 is low and 10 is high) 98 Don't Know 99 Refused to Answer
5. How would you rate the color output of the energy efficient lighting to the previous lamps on a scale from 1 to 10?
___ Response (1 is low and 10 is high) 98 Don't Know 99 Refused to Answer
6. How would you rate the MID program in terms of presentation on a scale from 1 to 10 (i.e., rebate application, website, meetings with personnel regarding rebate program)?
___ Response (1 is low and 10 is high) 98 Don't Know 99 Refused to Answer
7. How would you rate the information about energy savings in terms of accuracy on a scale from 1 to 10 (i.e., estimation of energy savings resulting from rebated measures provided by the lighting contractor)?
___ Response (1 is low and 10 is high) 98 Don't Know 99 Refused to Answer
8. How would you rate the overall energy efficiency services you received from MID on a scale from 1 to 10?
___ Response (1 is low and 10 is high) 98 Don't Know 99 Refused to Answer
9. How would you rate the program or utility representative in terms of increasing your understanding of the link between energy efficiency, bill savings, and comfort?
___ Response (1 is low and 10 is high) 98 Don't Know 99 Refused to Answer
10. To the best of your knowledge is everything installed correctly?
___ 1 (Yes) ___ 2 (No) 98 Don't Know 99 Refused to Answer
11. 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? _____
12. Were there any measures for which you received rebates that you have since had removed? (i.e., check MID database to verify installation)? If they have removed it, it is important to find out why – and to remind them we have a 5 year requirement in our terms and conditions that they signed as a program participant.
___ 1 (Yes) ___ 2 (No) 98 Don't Know 99 Refused to Answer
Please list measures no longer installed? _____

Modesto Irrigation District PARTICIPANT SURVEY (cont'd) # _____

13. Have you shared information with any of your business acquaintances about the benefits of energy efficient lighting from the MID program?

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

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

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

14. Do you know any other business acquaintances that would benefit from this program (name/address)? _____

15. Please verify the quantity of MID energy measures installed? The following table is completed by surveyor prior to interview based on MID rebate application data.

#	Energy Efficiency Measures	Qty. MID Database	Qty. Verified Installed	Annual Hours of Operation (hrs/year)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

16. Please provide the following demographic information?

___ # Occupants ___ Own or Lease Building ___ Floor Area **99** Refused

17. 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

Business Name: _____

Business Type: _____

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 MID energy efficiency programs. Would you mind spending 5 minutes to answer a few questions to help us evaluate the programs?"

Begin Survey

- 1. Are you using the energy efficient lighting that you purchased with rebates from MID?
2. How many hours per year are the lights on? Clarify, not just when the business is open, but lights are actually on. Think about early arrivals, late janitorial service, etc... Is lighting turned on 2-6PM WDs?
3. When and how did you first learn about the Lighting Rebate Program?
4. Keeping that in mind, did you understand the value of the program BEFORE or AFTER you installed the energy efficient lighting?
5. Did you install energy efficient lighting measures BEFORE or AFTER you received information, rebates from the utility?
6. 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 energy efficiency measures?
7. If rebates had not been available, how likely is it you would have done exactly the same thing. Please use scale from 0 to 10, with 0 being not likely and 10 very likely.

Notes: _____

Special Instruction for Contradictory Responses: If [Q.6 is 0,1,2 and Q.7 is 0,1,2] or [Q.6 is 8,9,10 and Q.7 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 6 and 7 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)

8. What role did the Utility Account Representative play in your decision to install energy efficient lighting?
[Prompt by reading list if the respondent has trouble answering.]

- 1 Reminded us of something we already knew
- 2 Sped up the 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 business about the MID Rebate Program [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.

- 9. Utility Rebate was nice but unnecessary for me to install efficient lighting.
___ Response (0-10) 98 Don't Know 99 Refused to Answer
- 10. Utility Rebate was a critical factor to install efficient lighting.
___ Response (0-10) 98 Don't Know 99 Refused to Answer
- 11. We would not have installed the efficient lighting without the Utility Rebate.
___ Response (0-10) 98 Don't Know 99 Refused to Answer

Special Instruction for Contradictory Responses: If [Q.9 is 0,1,2, and Q.10/11 is 8,9,10] or [Q.9 is 8,9,10 and Q.10/11 is 0,1,2]. When you answered "8, 9 or 10" for the question about "the Utility Program being 'nice' but unnecessary," I interpreted that to mean that the Utility Program was unimportant to your decision. Then, you answered "8, 9 or 10" for "the Utility Program being a critical factor." I want to check to see if I understand your response. If they volunteer a helpful answer, respond by changing the appropriate answer. If not, follow up with something like: "Would you explain in your own words, why the Utility Program was a critical factor in your decision?"

If possible translate their answer into responses for **Questions 9/10/11**. If the answer doesn't allow you to decide what answer should be changed, write the answer down and continue the interview.

Answer: _____

- 12. If you hadn't received efficient lighting rebates from MID would you have installed the same measures ...
 - 1 ..within 6 months?
 - 2 ..6 months to 1 year?
 - 3 ..one to two years later?
 - 4 ..two to three years later?
 - 5 ..three to four years later?
 - 6 ..four or more years later?
 - 7 ..Never
 - 98 ..Don't Know - **Try less precise response, if still "don't know" use 98**
 - 8 ...less than one year?
 - 9 ...one year or more?
 - 99 ...Refused to Answer

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

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 $\frac{1}{4}$ 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.

Appendix D-1: Lighting Rebate Site #1

EM&V REPORT FOR LIGHTING SITE #1

Prepared for Modesto Irrigation District

Prepared by Robert Mowris & Associates, Inc.

SITE SUMMARY INFORMATION

Company Name: Site #1
Site Name: Site #1
Site Address: 415 Kansas Avenue, Modesto, CA 95351
Principal Site Contact Name: N/A **Telephone:** N/A
Utility Representative Name: Peter Govea **Telephone:** (209) 526-7344
Assigned Lead Engineer: Robert Mowris, P.E., Ean Jones, B.S.

Site: MID Site #1

PROJECTS PAID BY PB FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #1	n/a	Lighting	MID	Comm. Lighting	500,000	Rebate

MEASURES FOR EACH PROJECT

Item No.	Efficiency Measure	Ex Ante Savings Estimate			Rebate (\$)
		(kW)	(kWh/yr)	(therms)	
Site #1	Lighting	225.2	1,952,354	n/a	81,766

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

Item No.	Efficiency Measure	EM&V Gross Savings			Cost (\$)
		(kW)	(kWh/yr)	(therms)	
Site #1	Lighting	255.5	2,230,709	n/a	476,755

Spillover

No evidence of spillover was found.

Impact Evaluation Report: Modesto Irrigation District

End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Modesto Irrigation District, the following efficiency improvements were planned under this project at Site #1. The Modesto Irrigation District rebates are provided in Table 1. For 3,047 reported measures the total rebate was \$81,766. The EM&V findings are based on installed fixtures including lamps and ballasts. The program tracks quantities of measures rather than fixtures.

Table 1. Planned Efficiency Improvements at Site #1

Rebate ID	Description	Qty.	Location
CL002	Interior Linear Fluorescent 400W Basecase: <=244 Watts Replacement	674	Manufacturing and warehouse
CL002	Interior Linear Fluorescent 400W Basecase: <=244 Watts Replacement	158	Manufacturing and warehouse
CL004	Interior Linear Fluorescent 176 - 399 W Basecase: <=192 Watt Replacement	12	Manufacturing and warehouse
CL006	Interior Linear Fluorescent <=100W Basecase: <=64 Watt Replacement	14	Manufacturing and warehouse
CL008	Compact Fluorescent Hardwired Interior 176 - 399W Base: <= 275 Replacement	2	Manufacturing and warehouse
CL017	Pulse-Start Metal Halide - Hardwired Exterior >400W Base: <=820W Replacement	31	Manufacturing and warehouse
CL019	Pulse-Start Metal Halide - Hardwired Exterior 400W Base: <=400W Replacement	39	Manufacturing and warehouse
CL020	Pulse-Start Metal Halide - Hardwired Ext. 176-399W Base: <=275W Replacement	54	Manufacturing and warehouse
CL039	LED or Electroluminescent Exit signs replaces Incandescent	65	Manufacturing and warehouse
CL028	T8 or T5 Linear Fluorescent 2-ft lamp installed T12 U-Lamp to T8 U-Lamp	6	Manufacturing and warehouse
CL030	T8 or T5 Linear Fluorescent 4-ft lamp installed F96 2L-8' T12 to 4L-4' T8 (tandem)	1236	Manufacturing and warehouse
CL030	T8 or T5 Linear Fluorescent 4-ft lamp installed 4L-4' T12 to 3L-4' T8	210	Manufacturing and warehouse
CL030	T8 or T5 Linear Fluorescent 4-ft lamp installed 3L-4' T12 to 3L-4' T8	123	Manufacturing and warehouse
CL030	T8 or T5 Linear Fluorescent 4-ft lamp installed 2L-4' T12 to 2L-4' T8	108	Manufacturing and warehouse
CL034	Delamp: 4 foot lamp	50	Manufacturing and warehouse
CL050	Occupancy Sensor Wall Box or Ceiling Mounted < 500W	16	Manufacturing and warehouse
CL052	Occupancy Sensor Fixture Integrated over 12'	160	Manufacturing and warehouse
CL054	Photocell	89	Manufacturing and warehouse
Total		3047	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #1.

Table 2. Verified Efficiency Improvements at Site #1

Rebate ID	Description	Qty.	Location
CL002	Interior Linear Fluorescent 400W Basecase: <=244 Watts Replacement	575	Manufacturing and warehouse
CL002	Interior Linear Fluorescent 400W Basecase: <=244 Watts Replacement	153	Manufacturing and warehouse
CL004	Interior Linear Fluorescent 176 - 399 W Basecase: <=192 Watt Replacement	12	Manufacturing and warehouse
CL006	Interior Linear Fluorescent <=100W Basecase: <=64 Watt Replacement	14	Manufacturing and warehouse
CL008	Compact Fluorescent Hardwired Interior 176 - 399W Base: <= 275 Replacement	0	Manufacturing and warehouse
CL017	Pulse-Start Metal Halide - Hardwired Exterior >400W Base: <=820W Replacement	35	Manufacturing and warehouse
CL019	Pulse-Start Metal Halide - Hardwired Exterior 400W Base: <=400W Replacement	39	Manufacturing and warehouse
CL020	Pulse-Start Metal Halide - Hardwired Ext. 176-399W Base: <=275W Replacement	42	Manufacturing and warehouse
CL039	LED or Electroluminescent Exit signs replaces Incandescent	63	Manufacturing and warehouse
CL028	T8 or T5 Linear Fluorescent 2-ft lamp installed T12 U-Lamp to T8 U-Lamp	1	Manufacturing and warehouse
CL030	T8 or T5 Linear Fluorescent 4-ft lamp installed F96 2L-8' T12 to 4L-4' T8 (tandem)	1284	Manufacturing and warehouse
CL030	T8 or T5 Linear Fluorescent 4-ft lamp installed 4L-4' T12 to 3L-4' T8	450	Manufacturing and warehouse
CL030	T8 or T5 Linear Fluorescent 4-ft lamp installed 3L-4' T12 to 3L-4' T8	123	Manufacturing and warehouse
CL030	T8 or T5 Linear Fluorescent 4-ft lamp installed 2L-4' T12 to 2L-4' T8	324	Manufacturing and warehouse
CL034	Delamp: 4 foot lamp	80	Manufacturing and warehouse
CL050	Occupancy Sensor Wall Box or Ceiling Mounted < 500W	12	Manufacturing and warehouse
CL052	Occupancy Sensor Fixture Integrated over 12'	153	Manufacturing and warehouse
CL054	Photocell	89	Manufacturing and warehouse
Total		3,449	

Primary Business Descriptions: Site #1 consists of manufacturing and warehouse space.

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Variability in Schedule and Production: Discussions were held with personnel at the building to determine pre-existing lighting hours of use. Lighting loggers were installed at representative locations in the facility to determine ex post operational hours. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times \text{Number}_{\text{fixtures}}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times \text{hours/year} \times \text{Number}_{\text{fixtures}}$$

Ex ante assumptions and gross savings are provided in **Table 3**.

Table 3 Ex Ante Assumptions and Savings for Site #1

Rebate ID	E3 #	Description	E3 Rebate	E3 kWh per unit	E3 kW per unit	E3 EUL	E3 NTGR	Ex ante Qty.	Ex Ante Gross kW	Ex Ante Gross kWh/y	Ex Ante Gross Lifecycle kWh
CL002	5010	400W HID to T8 6Lx4ft	\$75	1,962	0.197	11.0	0.85	674	132.78	1,322,388	14,546,268
CL002	5010	400W HID to T8 6Lx4ft w/sensors	\$75	1,962	0.197	11.0	0.85	158	31.13	309,996	3,409,956
CL004	4935	250W HID to T8 (MISC)	\$55	669	0.105	11.0	0.85	12	1.25	8,033	88,365
CL006	4937	T12 <=100W to T8 <=64 Watt	\$25	371	0.058	11.0	0.85	14	0.81	5,198	57,177
CL008	4943	Incand. 176 - 399W to CFL	\$15	129	0.020	12.0	0.85	2	0.04	259	3,105
CL017	4952	1000W HID to 750W PS MH	\$75	1,087	0.265	16.0	0.77	31	8.22	33,682	538,904
CL019	4954	400W HID to 320 PS MH	\$35	381	0.093	16.0	0.77	39	3.63	14,871	237,931
CL020	4955	250W HID to 200W PS MH	\$30	357	0.087	16.0	0.77	54	4.70	19,262	308,189
CL039	5056	Exit Sign Incand to LED	\$20	366	0.044	16.0	0.85	65	2.86	23,790	380,640
CL028	4938	T12 U-Lamp to T8 U-Lamp	\$3.5	62	0.010	11.0	0.85	6	0.06	371	4,084
CL030	4940	F96 2L-8' T12 to 4L-4' T8 (tandem)	\$5	68	0.011	11.0	0.85	1236	13.60	83,442	917,866
CL030	4940	T12 4L-4' to T8 3L-4'	\$5	68	0.011	11.0	0.85	210	2.31	14,177	155,948
CL030	4940	T12 3L-4' to T8 3L-4'	\$5	68	0.011	11.0	0.85	123	1.35	8,304	91,341
CL030	4940	T12 2L-4' to T8 2L-4' T8	\$5	68	0.011	11.0	0.85	108	1.19	7,291	80,202
CL034	5080	Delamp: 4 foot lamp	\$4.5	262	0.047	11.0	0.85	50	2.35	13,100	144,100
CL050	4973	Occupancy Sensors	\$15	331	0.066	8.0	0.84	16	1.05	5,301	42,406
CL052	4975	Occ. Sensors Fixture Mounted	\$15.00	459	0.112	8.0	0.84	160	17.92	73,456	587,648
CL054	5087	Photocell	\$5.00	106	-	8.0	0.84	89	-	9,434	75,472
Total								3047	225.24	1,952,354	21,669,602

Findings of the EM&V on-site audit for site #1 are provided in **Table 4**.

Table 4. Findings of the EM&V On-Site Audits for Site #1

Rebate ID	Description	Pre W/unit	Post W/unit	Pre h/y	Post h/y	EM&V Qty.	EM&V Ex Post kW	EM&V Ex Post kWh/y	EM&V Ex Post Lifecycle kWh
CL002	400W HID to T8 6Lx4ft	458	221	8,760	8,760	575	136.3	1,193,769	13,131,459
CL002	400W HID to T8 6Lx4ft w/sensors	458	221	8,760	8,760	153	36.3	317,646	3,494,110
CL004	250W HID to T8 (MISC)	293	90	8,760	8,760	12	2.4	21,339	234,733
CL006	T12 <=100W to T8 <=64 Watt	189	90	8,760	8,760	14	1.4	12,141	133,555
CL008	Incand. 176 - 399W to CFL	200	50	8,760	8,760	0	0.0	0	0
CL017	1000W HID to 750W PS MH	1080	802	8,760	8,760	35	9.7	85,235	1,363,757
CL019	400W HID to 320 PS MH	458	370	8,760	8,760	39	3.4	30,064	481,029

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CL020	250W HID to 200W PS MH	293	232	8,760	8,760	42	2.6	22,443	359,090
CL039	Exit Sign Incand to LED	25	5	8,760	8,760	63	1.3	11,038	176,602
CL028	T12 U-Lamp to T8 U-Lamp	68	40	8,760	8,760	1	0.0	245	2,698
CL030	F96 2L-8' T12 to 4L-4' T8 (tandem)	32	27	8,760	8,760	1,284	6.4	56,239	618,631
CL030	T12 4L-4' to T8 3L-4'	47.3	30	8,760	8,760	450	7.8	68,197	750,163
CL030	T12 3L-4' to T8 3L-4'	47.7	30	8,760	8,760	123	2.2	19,071	209,785
CL030	T12 2L-4' to T8 2L-4' T8	48	30.5	8,760	8,760	324	5.7	49,669	546,361
CL034	Delamp: 4 foot lamp	47.3	0	8,760	8,760	80	3.8	33,148	364,626
CL050	Occupancy Sensors		221	8,760	494	12	2.5	21,921	175,371
CL052	Occ. Sensors Fixture Mounted		221	8,760	494	153	31.9	279,498	2,235,986
CL054	Photocell		232	4,818	4,380	89	1.9	9,044	72,351
Total						3,449	255.5	2,230,709	24,350,307

Data Collection

Fixture Wattage and hours of operation are based on the rebate application and on-site audit information collected at Site #1. Lighting logger data were collected for representative lighting fixtures as shown in **Table 5**.

Table 5. Lighting Logger Measurements for Site #1

Site Location	No Occupancy Sensor hours/yr	Occupancy Sensor hours/yr
Warehouse 3 Row A	8760	419
Warehouse 3 Row G	8760	568
Slakey Bldg	8760	509
Average	8760	494

Customer Cost/Benefit Analysis

Cost and Payback based on 2011 Modesto Irrigation District Rates of 0.097 \$/kWh.

- Site #1: (Retrofit Cost \$476,755 - Rebate \$81,766) / (Energy Savings\$216,379) = Simple Payback 1.83 Years.

Appendix D-2: Lighting Rebate Site #2

EM&V REPORT FOR LIGHTING SITE #2

Prepared for Modesto Irrigation District

Prepared by Robert Mowris & Associates, Inc.

SITE SUMMARY INFORMATION

Company Name: Site #2

Site Name: Site #2

Site Address: 600 Yosemite Blvd., Modesto, CA 95353

Principal Site Contact Name: N/A **Telephone:** N/A

Utility Representative Name: Peter Govea **Telephone:** (209) 526-7344

Assigned Lead Engineer: Robert Mowris, P.E., Ean Jones, B.S.

Site: MID Site #2

PROJECTS PAID BY PB FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #2	n/a	Lighting	MID	Comm. Lighting	2,000,000	Rebate

MEASURES FOR EACH PROJECT

Item No.	Efficiency Measure	Ex Ante Savings Estimate			Rebate (\$)
		(kW)	(kWh/yr)	(therms)	
Site #2	Lighting	152.02	1,349,349	n/a	67,650

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

Item No.	Efficiency Measure	EM&V Gross Savings			Cost (\$)
		(kW)	(kWh/yr)	(therms)	
Site #2	Lighting	200.37	1,943,075	n/a	249,000

Spillover

No evidence of spillover was found.

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Modesto Irrigation District, the following efficiency improvements were planned under this project at Site #2. The Modesto Irrigation District rebates are provided in Table 1. For 1,336 reported measures the total rebate was \$67,650. The EM&V findings are based on installed fixtures including lamps and ballasts. The program tracks quantities of measures rather than fixtures.

Table 1. Planned Efficiency Improvements at Site #1

Rebate ID	Description	Qty.	Location
CL002	Interior Linear Fluorescent 400W Basecase: <=244 Watts Replacement	235	Warehouse Safety
CL002	Interior Linear Fluorescent 400W Basecase: <=244 Watts Replacement	500	Warehouse General
CL052	Occupancy Sensor Fixture Integrated over 12'	235	Warehouse Safety
CL052	Occupancy Sensor Fixture Integrated over 12'	600	Warehouse General
CL002A	Hardwired Compact and Linear Fluor - Energy Savings Adjustment	1	Warehouse
Total		1,336	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #2.

Table 2. Verified Efficiency Improvements at Site #1

Rebate ID	Description	Qty.	Location
CL002	Interior Linear Fluorescent 400W Basecase: <=244 Watts Replacement	235	Warehouse Safety
CL002	Interior Linear Fluorescent 400W Basecase: <=244 Watts Replacement	500	Warehouse General
CL052	Occupancy Sensor Fixture Integrated over 12'	235	Warehouse Safety
CL052	Occupancy Sensor Fixture Integrated over 12'	600	Warehouse General
CL002A	Hardwired Compact and Linear Fluor - Energy Savings Adjustment	0	
Total		1,335	

Primary Business Descriptions: Site #2 consists of warehouse space.

Variability in Schedule and Production: Discussions were held with personnel at the building to determine pre-existing lighting hours of use. Lighting loggers were installed at representative locations in the facility to determine ex post operational hours. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times \text{Number}_{\text{fixtures}}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times \text{hours/year} \times \text{Number}_{\text{fixtures}}$$

Ex ante assumptions and gross savings are provided in **Table 3**. Rebate ID CL002A is an energy adjustment by MID to reduce deemed savings for occupancy sensors by 40 kW and 15,000 kWh per year to account for the difference between calculated and deemed savings. Ex post savings are

EM&V Report for 2011 MID Energy Efficiency Programs

greater than ex ante savings due to operational hours based on lighting logger data and all new fixtures have integral occupancy sensors. The ex ante occupancy sensor savings are based on E3 commercial customer segments with lower hours of operation than industrial customer segments and all measures are industrial.

Table 3 Ex Ante Assumptions and Savings for Site #2

Rebate ID	E3 #	Description	E3 Rebate	E3 kWh per unit	E3 kW per unit	E3 EUL	E3 NTGR	Ex ante Qty.	Ex Ante Gross kW	Ex Ante Gross kWh/y	Ex Ante Gross Lifecycle kWh
CL002	5010	400W HID to T8 6Lx4ft	\$75.00	1,962	0.197	11.0	0.85	235	46.30	461,070	5,071,770
CL002	5010	400W HID to T8 6Lx4ft	\$75.00	1,962	0.197	11.0	0.85	500	98.50	981,000	10,791,000
CL052	4975	T8 4Lx4ft w/Occ. Sensors	\$15.00	459	0.112	8.0	0.84	235	26.32	107,889	863,108
CL052	4975	T8 4Lx4ft w/Occ. Sensors	\$15.00	459	0.112	8.0	0.84	500	67.20	275,460	2,203,680
CL002A	5105	Hardwired CFL –Non Adjustment	\$0.00	-15000	-40	11.0	0.96	1	(40.00)	(15,000)	(165,000)
Total								1,336	152.02	1,349,349	13,692,788

Findings of the EM&V on-site audit for site #2 are provided in **Table 4**.

Table 4. Findings of the EM&V On-Site Audits for Site #2

Rebate ID	Description	Pre W/unit	Post W/unit	Pre h/y	Post h/y	EM&V Qty.	EM&V Ex Post Gross kW	EM&V Ex Post Gross kWh/y	EM&V Ex Post Gross Lifecycle kWh
CL002	400W HID to T8 6Lx4ft	352	221	8,760	8,760	235	30.8	269,677	2,966,443
CL002	400W HID to T8 6Lx4ft	352	221	8,760	8,760	500	65.5	573,780	6,311,580
CL052	T8 4Lx4ft w/Occ. Sensors	221	111	8,760	1,558	235	25.9	414,310	3,314,481
CL052	T8 4Lx4ft w/Occ. Sensors	0	221	8,760	1,558	600	109.0	954,985	7,639,882
CL002A	Hardwired CFL –Non Adjustment	0	0	8,760	1,558	0	0.0	0	0
Total						1,335	200.37	1,943,075	17,265,943

Data Collection

Fixture Wattage and hours of operation are based on the rebate application and on-site audit information collected at Site #2. Lighting logger data were collected for representative lighting fixtures as shown in **Table 5**.

Table 5. Lighting Logger Measurements for Site #2

Site Location	No Occupancy Sensor hours/yr	Occupancy Sensor hours/yr
Warehouse high use	8760	2271
Warehouse low use	8760	844
Average	8760	1557

Customer Cost/Benefit Analysis

Cost and Payback based on 2011 Modesto Irrigation District Rates of 0.097 \$/kWh.

- Site #2: (Retrofit Cost \$249,000 - Rebate \$67,650) / (Energy Savings \$188,478) = Simple Payback 0.96 Years.

Appendix D-3: Lighting Rebate Site #3

M&V REPORT FOR LIGHTING SITE #3

Prepared for Modesto Irrigation District

Prepared by Robert Mowris & Associates, Inc.

SITE SUMMARY INFORMATION

Company Name: Site #3

Site Name: Site #3

Site Address: 3142 Talbot Ave., Riverbank, CA95367

Principal Site Contact Name: N/A **Telephone:** N/A

Utility Representative Name: Peter Govea **Telephone:** (209) 526-7344

Assigned Lead Engineer: Robert Mowris, P.E., Ean Jones, B.S.

Site: MID Site #3

PROJECTS PAID BY PB FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #3	n/a	Lighting	MID	Comm. Lighting	15,000	Rebate

MEASURES FOR EACH PROJECT

Item No.	Efficiency Measure	Ex Ante Savings Estimate			Rebate (\$)
		(kW)	(kWh/yr)	(therms)	
Site #3	Lighting	25.41	162,784	n/a	9,525

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

Item No.	Efficiency Measure	EM&V Gross Savings			Cost (\$)
		(kW)	(kWh/yr)	(therms)	
Site #3	Lighting	38.7	137,981	n/a	30,505

Spillover

No evidence of spillover was found.

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Modesto Irrigation District, the following efficiency improvements were planned under this project at Site #3. The Modesto Irrigation District rebates are provided in Table 1. For 28 reported measures the total rebate was \$9,525.

Table 1. Planned Efficiency Improvements at Site #3

Measure	Description	Qty.	Location
1	Interior Linear Fluorescent 400W Basecase: <=244 Watts Replacement	108	Factory
2	Interior Linear Fluorescent 400W Basecase: <=244 Watts Replacement	18	Factory
3	Interior Linear Fluorescent <=100W Basecase: <=64 Watt Replacement	2	Factory
4	Interior Linear Fluorescent 176 - 399 W Basecase: <=192 Watt Replacement	3	Factory
5	Interior Linear Fluorescent <=100W Basecase: <=64 Watt Replacement	0	Factory
6	Interior Linear Fluorescent 101-175W Basecase: <=128 Watts Replacement	0	Factory
7	Interior Linear Fluorescent 400W Basecase: <=244 Watts Replacement	1	Factory
Total		131	

Verified Efficiency Improvement: According to the rebate application, the following energy efficiency improvements were installed at Site #3.

Table 2. Verified Efficiency Improvements at Site #3

Measure	Description	Qty.	Location
1	Interior Linear Fluorescent 400W Basecase: <=244 Watts Replacement	108	Factory
2	Interior Linear Fluorescent 400W Basecase: <=244 Watts Replacement	13	Factory
3	Interior Linear Fluorescent <=100W Basecase: <=64 Watt Replacement	4	Factory
4	Interior Linear Fluorescent 176 - 399 W Basecase: <=192 Watt Replacement	1	Factory
5	Interior Linear Fluorescent <=100W Basecase: <=64 Watt Replacement	2	Factory
6	Interior Linear Fluorescent 101-175W Basecase: <=128 Watts Replacement	3	Factory
7	Interior Linear Fluorescent 400W Basecase: <=244 Watts Replacement	1	Factory
Total		132	

Primary Business Descriptions: Site #3 consists of factory production and warehouse space.

Variability in Schedule and Production: The EM&V study evaluated the rebate application information to determine pre-existing and ex-post lighting operational hours.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$kW \text{ Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$kWh \text{ Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Ex ante assumptions and gross savings are provided in **Table 3**.

Table 3 Ex Ante Assumptions and Savings for Site #3

EM&V Report for 2011 MID Energy Efficiency Programs

Rebate ID	E3 #	Description	E3 Rebate	E3 kWh per unit	E3 kW per unit	E3 EUL	E3 NTGR	Ex ante Qty.	Ex Ante Gross kW	Ex Ante Gross kWh/y	Ex Ante Gross Lifecycle kWh
CL002	4933	400W HID to T8 4Lx4ft	\$75.00	1,260	0.197	11.0	0.85	108	21.24	136,091	1,496,999
CL002	4933	400W HID to T8 6Lx4ft w/sensors	\$75.00	1,260	0.197	11.0	0.85	18	3.54	22,682	249,500
CL002	4937	400W HID to T8 2Lx4ft w/sensors	\$25.00	371	0.058	11.0	0.85	2	0.12	743	8,168
CL004	4935	400W HID to T8 4Lx4ft	\$55.00	669	0.105	11.0	0.85	3	0.31	2,008	22,091
CL006	4937	T12 2x4ft to T8 2Lx4ft	\$25.00	371	0.058	11.0	0.85	0	-	0	0
CL005	4936	T12 2x8ft to T8 4Lx4ft	\$40.00	411	0.064	11.0	0.85	0	-	0	0
CL004	4933	400W HID to T8 4Lx4ft	\$75.00	1,260	0.197	11.0	0.85	1	0.20	1,260	13,861
Total								132	25.4	162,784	1,790,619

Findings of the EM&V on-site audit for site #3 are provided in **Table 4**.

Table 4. Findings of the EM&V On-Site Audits for Site #3

Rebate ID	Description	Pre W/unit	Post W/unit	Pre h/y	Post h/y	EM&V Qty.	EM&V Ex Post Gross kW	EM&V Ex Post Gross kWh/y	EM&V Ex Post Gross Lifecycle kWh
CL002	400W HID to T8 4Lx4ft	458	147	3,600	3,600	108	33.6	120,917	1,330,085
CL002	400W HID to T8 6Lx4ft w/sensors	458	221	3,600	3,600	13	3.1	11,092	122,008
CL002	400W HID to T8 2Lx4ft w/sensors	458	147	3,600	3,600	4	1.2	4,478	49,262
CL004	400W HID to T8 4Lx4ft	458	110	3,600	3,600	1	0.3	1,253	13,781
CL006	T12 2x4ft to T8 2Lx4ft	96	76	520	520	2	0.0	21	229
CL005	T12 2x8ft to T8 4Lx4ft	185	147	520	520	3	0.1	59	652
CL004	400W HID to T8 4Lx4ft	458	147	520	520	1	0.3	162	1,779
Total						132	38.7	137,981	1,517,795

Data Collection

Fixture Wattage and hours of operation are based on the rebate application and audit information. Lighting logger data were collected for representative lighting fixtures as shown in **Table 5**.

Table 5. Lighting Logger Measurements for Site #3

Site Location	No Occupancy Sensor hours/yr	Occupancy Sensor hours/yr
Bldg. B	1862	NA
Press 1	3216	NA
Press 2	3277	NA
Press 3	2357	NA

Customer Cost/Benefit Analysis

Cost and Payback based on 2011 Modesto Irrigation District Rates of 0.097 \$/kWh.

- Site #3: (Retrofit Cost \$30,505 - Rebate \$9,525) / (Energy Savings \$13,384) = Simple Payback 1.57 Years.

Appendix D-4: Lighting Rebate Site #4

M&V REPORT FOR LIGHTING SITE #4

Prepared for Modesto Irrigation District

Prepared by Robert Mowris & Associates, Inc.

SITE SUMMARY INFORMATION

Company Name: Site #4 (Multiple Sites)

Site Name: Site #4 (Multiple Sites)

Site Address: 331 Bangs Ave., Modesto, CA 95747, 4452 Spyres Ave., Modesto, CA 95356, 4462 Spyres Ave., Modesto, CA 95356, 319 Bangs Ave., Modesto, CA 95747, 417 Galaxy Ave., Modesto, CA 95356, 4736 Stratos Ave., Modesto, CA 95356

Principal Site Contact Name: N/A **Telephone:** N/A

Utility Representative Name: Peter Govea **Telephone:** (209) 526-7344

Assigned Lead Engineer: Robert Mowris, P.E., Ean Jones, B.S.

Site: MID Site #4

PROJECTS PAID BY PB FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #4	n/a	Lighting	MID	Comm. Lighting	60,000	Rebate

MEASURES FOR EACH PROJECT

Item No.	Efficiency Measure	Ex Ante Savings Estimate			
		(kW)	(kWh/yr)	(therms)	Rebate (\$)
Site #4	Lighting	24.8	247,212	n/a	9,450

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

Item No.	Efficiency Measure	EM&V Gross Savings			Cost (\$)
		(kW)	(kWh/yr)	(therms)	
Site #4	Lighting	29.9	72,475	n/a	16,375

Spillover

No evidence of spillover was found.

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Modesto Irrigation District, the following efficiency improvements were planned under this project at Site #4. The Modesto Irrigation District rebates are provided in Table 1. For 126 reported measures the total rebate was \$9,450. The EM&V findings are based on installed fixtures including lamps and ballasts. The program tracks quantities of measures rather than fixtures.

Table 1. Planned Efficiency Improvements at Site #4

Measure	Description	Qty.	Location
1	400W HID to T8 6Lx4ft HiBay	16	331 Bangs Ave., Modesto, CA
2	400W HID to T8 6Lx4ft HiBay	11	4452 Spyres Ave., Modesto, CA
3	400W HID to T8 6Lx4ft HiBay	9	4462 Spyres Ave., Modesto, CA
4	400W HID to T8 6Lx4ft HiBay	33	319 Bangs Ave., Modesto, CA
5	400W HID to T8 6Lx4ft HiBay	22	417 Galaxy Ave., Modesto, CA
6	400W HID to T8 6Lx4ft HiBay	35	4736 Stratos Ave., Modesto, CA
Total		126	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #4.

Table 2. Verified Efficiency Improvements at Site #4

Measure	Description	Qty.	Location
1	400W HID to T8 6Lx4ft HiBay	16	331 Bangs Ave., Modesto, CA
2	400W HID to T8 6Lx4ft HiBay	11	4452 Spyres Ave., Modesto, CA
3	400W HID to T8 6Lx4ft HiBay	9	4462 Spyres Ave., Modesto, CA
4	400W HID to T8 6Lx4ft HiBay	33	319 Bangs Ave., Modesto, CA
5	400W HID to T8 6Lx4ft HiBay	22	417 Galaxy Ave., Modesto, CA
6	400W HID to T8 6Lx4ft HiBay	35	4736 Stratos Ave., Modesto, CA
Total		126	

Primary Business Descriptions: Site #4 consists of automotive repair and retail space.

Variability in Schedule and Production: Discussions were held with personnel at the building to determine pre-existing lighting hours of use. Lighting loggers were installed at representative locations in the facility to determine ex post operational hours. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times \text{Number}_{\text{fixtures}}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times \text{hours/year} \times \text{Number}_{\text{fixtures}}$$

EM&V Report for 2011 MID Energy Efficiency Programs

Ex ante assumptions and gross savings are provided in **Table 3**.

Table 3 Ex Ante Assumptions and Savings for Site #4

Rebate ID	E3 #	Description	E3 Rebate	E3 kWh per unit	E3 kW per unit	E3 EUL	E3 NTGR	Ex ante Qty.	Ex Ante Gross kW	Ex Ante Gross kWh/y	Ex Ante Gross Lifecycle kWh
CL002	5010	400W HID to T8 6Lx4ft HiBay	\$75.00	1,962	0.197	11.0	0.85	16	3.15	31,392	345,312
CL002	5010	400W HID to T8 6Lx4ft HiBay	\$75.00	1,962	0.197	11.0	0.85	11	2.16	21,582	237,402
CL002	5010	400W HID to T8 6Lx4ft HiBay	\$75.00	1,962	0.197	11.0	0.85	9	1.77	17,658	194,238
CL002	5010	400W HID to T8 6Lx4ft HiBay	\$75.00	1,962	0.197	11.0	0.85	33	6.49	64,746	712,206
CL002	5010	400W HID to T8 6Lx4ft HiBay	\$75.00	1,962	0.197	11.0	0.85	22	4.33	43,164	474,804
CL002	5010	400W HID to T8 6Lx4ft HiBay	\$75.00	1,962	0.197	11.0	0.85	35	6.88	68,670	755,370
Total								126	24.8	247,212	2,719,332

Findings of the EM&V on-site audit for site #4 are provided in **Table 4**.

Table 4. Findings of the EM&V On-Site Audits for Site #4

Rebate ID	Description	Pre W/unit	Post W/unit	Pre h/y	Post h/y	EM&V Qty.	EM&V Ex Post Gross kW	EM&V Ex Post Gross kWh/y	EM&V Ex Post Gross Lifecycle kWh
CL002	400W HID to T8 6Lx4ft HiBay	458	221	2,427	2,427	16	3.8	9,203	101,235
CL002	400W HID to T8 6Lx4ft HiBay	458	221	2,427	2,427	13	3.1	7,478	82,253
CL002	400W HID to T8 6Lx4ft HiBay	458	221	2,427	2,427	9	2.1	5,177	56,945
CL002	400W HID to T8 6Lx4ft HiBay	458	221	2,427	2,427	33	7.8	18,982	208,797
CL002	400W HID to T8 6Lx4ft HiBay	458	221	2,427	2,427	22	5.2	12,654	139,198
CL002	400W HID to T8 6Lx4ft HiBay	458	221	2,427	2,427	33	7.8	18,982	208,797
Total						126	29.9	72,475	797,226

Data Collection

Lighting logger data were collected for representative lighting fixtures as shown in **Table 5**.

Table 5. Lighting Logger Measurements for Site #4

Site Location	No Occupancy Sensor hours/yr	Occupancy Sensor hours/yr
331 Bangs Ave., Modesto, CA	2427	NA
4736 Stratos Ave., Modesto, CA	2310	NA

Customer Cost/Benefit Analysis

Cost and Payback based on 2011 Modesto Irrigation District Rates of 0.137 \$/kWh.

- Site #4: (Retrofit Cost \$16,375 - Rebate \$9,450) / (Energy Savings \$9,929) = Simple Payback 0.65 Years.

Appendix D-5: Lighting Rebate Site #5

M&V REPORT FOR LIGHTING SITE #5

Prepared for Modesto Irrigation District

Prepared by Robert Mowris & Associates, Inc.

SITE SUMMARY INFORMATION

Company Name: Site #5
Site Name: Site #5
Site Address: 2200 Lapham Drive, Modesto, CA 95354
Principal Site Contact Name: N/A **Telephone:** N/A
Utility Representative Name: Peter Govea **Telephone:** (209) 526-7344
Assigned Lead Engineer: Robert Mowris, P.E., Ean Jones, B.S.

Site: MID Site #5

PROJECTS PAID BY PB FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #5	n/a	Lighting	MID	Comm. Lighting	15,000	Rebate

MEASURES FOR EACH PROJECT

Ex Ante Savings Estimate

Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate (\$)
Site #5	Lighting	21.8	133,092	n/a	6,300

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

EM&V Gross Savings

Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Cost (\$)
Site #5	Lighting	25.44	88,075	n/a	28,789

Spillover

No evidence of spillover was found.

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Modesto Irrigation District, the following efficiency improvements were planned under this project at Site #5. The Modesto Irrigation District rebates are provided in Table 1. For 203 reported measures the total rebate was \$6,300.

Table 1. Planned Efficiency Improvements at Site #5

Measure	Description	Qty.	Location
1	Interior Linear Fluorescent 400W Basecase: <=244 Watts Replacement	84	Warehouse
2	Interior Linear Fluorescent 400W Basecase: 245 - 360 Watts Replacement	14	Warehouse
3	T8 or T5 Linear Fluorescent 4-ft lamp installed	84	Office
4	Occupancy Sensor Wall Box or Ceiling Mounted >= 500W	21	Warehouse/Office
Total		203	

Verified Efficiency Improvement: According to the rebate application, the following energy efficiency improvements were installed at Site #5.

Table 2. Verified Efficiency Improvements at Site #5

Measure	Description	Qty.	Location
1	Interior Linear Fluorescent 400W Basecase: <=244 Watts Replacement	84	Warehouse
2	Interior Linear Fluorescent 400W Basecase: 245 - 360 Watts Replacement	14	Warehouse
3	T8 or T5 Linear Fluorescent 4-ft lamp installed	84	Office
4	Occupancy Sensor Wall Box or Ceiling Mounted >= 500W	21	Warehouse/Office
Total		203	

Primary Business Descriptions: Site #5 consists of consists of production and warehouse space.

Variability in Schedule and Production: The EM&V study evaluated the rebate application information to determine pre-existing and ex-post lighting operational hours.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times \text{Number}_{\text{fixtures}}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times \text{hours/year} \times \text{Number}_{\text{fixtures}}$$

Ex ante assumptions and gross savings are provided in **Table 3**.

EM&V Report for 2011 MID Energy Efficiency Programs

Table 3 Ex Ante Assumptions and Savings for Site #5

Rebate ID	E3 #	Description	E3 Rebate	E3 kWh per unit	E3 kW per unit	E3 EUL	E3 NTGR	Ex ante Qty.	Ex Ante Gross kW	Ex Ante Gross kWh/y	Ex Ante Gross Lifecycle kWh
CL002	4933	T12 4Lx4ft to T8 4Lx4ft	\$75.00	1,260	0.197	11.0	85%	84	16.52	105,848	1,164,332
CL003	4934	T12 6Lx4ft to T8 6Lx4ft	\$55.00	602	0.094	11.0	85%	14	1.32	8,427	92,696
CL030	4940	T12 2Lx8ft to T8 4Lx4ft	\$5.00	68	0.011	11.0	85%	84	0.92	5,671	62,379
CL051	4974	T12 6Lx4ft to T8 6Lx4ft	\$33.00	626	0.145	8.0	84%	21	3.05	13,146	105,168
Total								203	21.8	133,092	1,424,575

Findings of the EM&V on-site audit for site #5 are provided in **Table 4**.

Table 4. Findings of the EM&V On-Site Audits for Site #5

Rebate ID	Description	Pre W/unit	Post W/unit	Pre h/y	Post h/y	EM&V Qty.	EM&V Ex Post Gross kW	EM&V Ex Post Gross kWh/y	EM&V Ex Post Gross Lifecycle kWh
CL002	T12 4Lx4ft to T8 4Lx4ft	458	234	3,462	3,462	84	18.8	65,141	716,551
CL003	T12 6Lx4ft to T8 6Lx4ft	458	234	3,462	3,462	14	3.1	10,857	119,425
CL030	T12 2Lx8ft to T8 4Lx4ft	128	108	3,462	3,462	84	1.7	5,816	63,978
CL051	T12 6Lx4ft to T8 6Lx4ft		176	3,456	1,762	21	1.8	6,261	50,088
Total						203	25.4	88,075	950,042

Data Collection

Fixture Wattage and hours of operation are based on the rebate application and on-site audit information. Lighting logger data were collected for representative lighting fixtures as shown in **Table 5**.

Table 5. Lighting Logger Measurements for Site #5

Site Location	No Occupancy Sensor hours/yr	Occupancy Sensor hours/yr
Production Area	3456	NA
Warehouse 1	2722	2722
Warehouse 2	803	803
Sensor Average	3456	1762

Customer Cost/Benefit Analysis

Cost and Payback based on 2011 Modesto Irrigation District Rates of 0.137 \$/kWh.

- Site #5: (Retrofit Cost \$28,789 - Rebate \$6,300) / (Energy Savings \$12,066) = Simple Payback 1.86 Years.

Appendix D-6: Lighting Rebate Site #6

EM&V REPORT FOR LIGHTING SITE #6

Prepared for Modesto Irrigation District

Prepared by Robert Mowris & Associates, Inc.

SITE SUMMARY INFORMATION

Company Name: Site #6

Site Name: Site #6

Site Address: 2900 Hickman Street, Waterford, CA 95386

Principal Site Contact Name: N/A **Telephone:** N/A

Utility Representative Name: Peter Govea **Telephone:** (209) 526-7344

Assigned Lead Engineer: Robert Mowris, P.E., Ean Jones, B.S.

Site: MID Site #6

PROJECTS PAID BY PB FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #6	n/a	Lighting	MID	Comm. Lighting	45,000	Rebate

MEASURES FOR EACH PROJECT

Item No.	Efficiency Measure	Ex Ante Savings Estimate			Rebate (\$)
		(kW)	(kWh/yr)	(therms)	
Site #6	Lighting	12.81	127,530	n/a	4,875

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

Item No.	Efficiency Measure	EM&V Gross Savings			Cost (\$)
		(kW)	(kWh/yr)	(therms)	
Site #6	Lighting	15.73	47,426	n/a	7,220

Spillover

No evidence of spillover was found.

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Modesto Irrigation District, the following efficiency improvements were planned under this project at Site #6. The Modesto Irrigation District rebates are provided in Table 1. For 65 reported measures the total rebate was \$4,875. The program tracks quantities of measures (efficient lamps or removed lamps) rather than fixtures.

Table 1. Planned Efficiency Improvements at Site #6

Measure	Description	Qty.	Location
1	Interior Linear Fluorescent 400W Basecase: <=244 Watts Replacement	65	Shop Area
Total		65	

Verified Efficiency Improvement: According to the rebate application, the following energy efficiency improvements were installed at Site #6.

Table 2. Verified Efficiency Improvements at Site #6

Measure	Description	Qty.	Location
1	Interior Linear Fluorescent 400W Basecase: <=244 Watts Replacement	65	Shop Area
Total		65	

Primary Business Descriptions: Site #6 consists of office, cafeteria, manufacturing, and storage space.

Variability in Schedule and Production: Discussions were held with personnel at the building to determine pre-existing lighting hours of use. Lighting loggers were installed at representative locations in the facility to determine ex post operational hours. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$kW \text{ Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$kWh \text{ Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Ex ante assumptions and gross savings are provided in **Table 3**.

Table 3 Ex Ante Assumptions and Savings for Site #6

Rebate ID	E3 #	Description	E3 Rebate	E3 kWh per unit	E3 kW per unit	E3 EUL	E3 NTGR	Ex ante Qty.	Ex Ante Gross kW	Ex Ante Gross kWh/y	Ex Ante Gross Lifecycle kWh
CL002	5010	400W HID to T5 HO 4Lx4ft	\$75.00	1,962	0.197	11.0	85%	65	12.81	127,530	1,402,830
Total								65	12.8	127,530	1,402,830

Findings of the EM&V on-site audit for site #6 are provided in **Table 4**.

EM&V Report for 2011 MID Energy Efficiency Programs

Table 4. Findings of the EM&V On-Site Audits for Site #6

Rebate ID	Description	Pre W/unit	Post W/unit	Pre h/y	Post h/y	EM&V Qty.	EM&V Ex Post Gross kW	EM&V Ex Post Gross kWh/y	EM&V Ex Post Gross Lifecycle kWh
CL002	400W HID to T5 HO 4Lx4ft	458	216	3,015	3,015	65	15.7	47,426	521,685
Total						65	15.7	47,426	521,685

Data Collection

Fixture Wattage and hours of operation are based on the Modesto Irrigation District rebate application and on-site audit information collected at Site #6. Lighting logger data were collected for representative lighting fixtures as shown in **Table 5**.

Table 5. Lighting Logger Measurements for Site #6

Site Location	No Occupancy Sensor hours/yr	Occupancy Sensor hours/yr
Shop Area	3,015	NA

Customer Cost/Benefit Analysis

Cost and Payback based on 2011 Modesto Irrigation District Rates of 0.137 \$/kWh.

- Site #6: (Retrofit Cost \$7,220 - Rebate \$4,875) / (Energy Savings \$6,497) = Simple Payback 0.36 Years.

Appendix D-7: Lighting Rebate Site #7

M&V REPORT FOR LIGHTING SITE #7

Prepared for Modesto Irrigation District

Prepared by Robert Mowris & Associates, Inc.

SITE SUMMARY INFORMATION

Company Name: Site #7
Site Name: Site #7
Site Address: 619 Kansas Ave., Modesto, CA 95351
Principal Site Contact Name: N/A **Telephone:** N/A
Utility Representative Name: Peter Govea **Telephone:** (209) 526-7344
Assigned Lead Engineer: Robert Mowris, P.E., Ean Jones, B.S.

Site: MID Site #7

PROJECTS PAID BY PB FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #7	n/a	Lighting	MID	Comm. Lighting	25,000	Rebate

MEASURES FOR EACH PROJECT

Item No.	Efficiency Measure	Ex Ante Savings Estimate			
		(kW)	(kWh/yr)	(therms)	Rebate (\$)
Site #7	Lighting	29,39	186,381	n/a	3,975

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

Item No.	Efficiency Measure	EM&V Gross Savings			
		(kW)	(kWh/yr)	(therms)	Cost (\$)
Site #7	Lighting	6.91	16,361	n/a	4,549

Spillover

No evidence of spillover was found.

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Modesto Irrigation District, the following efficiency improvements were planned under this project at Site #7. The Modesto Irrigation District rebates are provided in Table 1. For 473 reported measures the total rebate was \$3,975. The EM&V findings are based on installed fixtures including lamps and ballasts. The program tracks quantities of measures rather than fixtures.

Table 1. Planned Efficiency Improvements at Site #7

Measure	Description	Qty.	Location
1	Interior Linear Fluorescent 400W Basecase: <=244 Watts Replacement	53	Sales Area
2	Photocell	7	Sales Area
3	Occupancy Sensor Wall Box or Ceiling Mounted >= 500W	6	Warehouse
4	Occupancy Sensor Wall Box or Ceiling Mounted >= 500W	3	Warehouse
5	Delamp: 8 foot lamp	202	Manufacturing
6	T8 or T5 Linear Fluorescent 4-ft lamp installed	202	Manuf. Offices
Total		473	

Verified Efficiency Improvement: According to the rebate application, the following energy efficiency improvements were installed at Site #7.

Table 2. Verified Efficiency Improvements at Site #7

Measure	Description	Qty.	Location
1	Interior Linear Fluorescent 400W Basecase: <=244 Watts Replacement	39	Sales Area
2	Photocell	7	Sales Area
3	Occupancy Sensor Wall Box or Ceiling Mounted >= 500W	6	Warehouse
4	Occupancy Sensor Wall Box or Ceiling Mounted >= 500W	3	Warehouse
5	Delamp: 8 foot lamp	36	Manufacturing
6	T8 or T5 Linear Fluorescent 4-ft lamp installed	234	Manuf. Offices
Total		325	

Primary Business Descriptions: Site #7 consists of classrooms.

Variability in Schedule and Production: Discussions were held with personnel at the building to determine pre-existing lighting hours of use. Lighting loggers were installed at representative locations in the facility to determine ex post operational hours. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times \text{Number}_{\text{fixtures}}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times \text{hours/year} \times \text{Number}_{\text{fixtures}}$$

EM&V Report for 2011 MID Energy Efficiency Programs

Ex ante assumptions and gross savings are provided in **Table 3**.

Table 3 Ex Ante Assumptions and Savings for Site #7

Rebate ID	E3 #	Description	E3 Rebate	E3 kWh per unit	E3 kW per unit	E3 EUL	E3 NTGR	Ex ante Qty.	Ex Ante Gross kW	Ex Ante Gross kWh/y	Ex Ante Gross Lifecycle kWh
CL002	5010	T12 4Lx4ft to T8 4Lx4ft	\$75.00	1,962	0.197	11.0	0.85	53	10.44	103,986	1,143,846
CL052	5087	T12 6Lx4ft to T8 6Lx4ft	\$5.00	106	-	8.0	0.84	7	-	742	5,936
CL051	4974	T12 2Lx8ft to T8 4Lx4ft	\$33.00	626	0.145	8.0	0.84	6	0.87	3,756	30,048
CL051	4974	T12 6Lx4ft to T8 6Lx4ft	\$33.00	626	0.145	8.0	0.84	3	0.44	1,878	15,024
CL035	1463	T12 4Lx4ft to T8 4Lx4ft	\$7.00	308	0.076	11.0	0.85	202	15.42	62,283	685,117
CL030	4940	T12 2Lx4ft to T8 2Lx4ft	\$5.00	68	0.011	11.0	0.85	202	2.22	13,736	151,096
								473	29.4	186,381	2,031,067

Findings of the EM&V on-site audit for site #7 are provided in **Table 4**.

Table 4. Findings of the EM&V On-Site Audits for Site #7

Rebate ID	Description	Pre W/unit	Post W/unit	Pre h/y	Post h/y	EM&V Qty.	EM&V Ex Post Gross kW	EM&V Ex Post Gross kWh/y	EM&V Ex Post Gross Lifecycle kWh
CL002	T12 4Lx4ft to T8 4Lx4ft	170	131	2,427	2,427	39	1.5	3,445	37,896
CL052	T12 6Lx4ft to T8 6Lx4ft	0	232	2,427	2,427	7	0.0	711	5,690
CL051	T12 2Lx8ft to T8 4Lx4ft	0	112	2,427	2,427	6	0.2	550	4,398
CL051	T12 6Lx4ft to T8 6Lx4ft	0	81	2,427	2,427	3	0.1	199	1,590
CL035	T12 4Lx4ft to T8 4Lx4ft	43	0	2,427	2,427	36	1.5	3,506	38,568
CL030	T12 2Lx4ft to T8 2Lx4ft	43	28	2,427	2,427	234	3.5	7,950	87,452
Total						325	6.9	16,361	175,594

Data Collection

Fixture Wattage and hours of operation are based on the Modesto Irrigation District rebate application and on-site audit information collected at Site #7. Lighting logger data were collected for representative lighting fixtures at Site #7 as shown in **Table 5**.

Table 5. Lighting Logger Measurements for Site #7

Site Location	No Occupancy Sensor hours/yr	Occupancy Sensor hours/yr
Warehouse Suite A	2,265	629
Warehouse Suite B	2,265	NA
Average	2,265	1,447

Customer Cost/Benefit Analysis

Cost and Payback based on 2011 Modesto Irrigation District Rates of 0.137 \$/kWh.

- Site #7: (Retrofit Cost \$18,091 - Rebate \$3,975) / (Energy Savings \$2,291) = Simple Payback 6.3 Years.

Appendix D-8: Lighting Rebate Site #8

M&V REPORT FOR LIGHTING SITE #8

Prepared for Modesto Irrigation District

Prepared by Robert Mowris & Associates, Inc.

SITE SUMMARY INFORMATION

Company Name: Site #8
Site Name: Site #8
Site Address: 3400 Finch Road, Modesto, CA 95357
Principal Site Contact Name: N/A **Telephone:** N/A
Utility Representative Name: Peter Govea **Telephone:** (209) 526-7344
Assigned Lead Engineer: Robert Mowris, P.E., Ean Jones, B.S.

Site: MID Site #8

PROJECTS PAID BY PB FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #8	n/a	Lighting	MID	Comm. Lighting	350,000	Rebate

MEASURES FOR EACH PROJECT

Item No.	Efficiency Measure	Ex Ante Savings Estimate			
		(kW)	(kWh/yr)	(therms)	Rebate (\$)
Site #8	Lighting	172.3	1,398,682	n/a	41,700

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

Item No.	Efficiency Measure	EM&V Gross Savings			
		(kW)	(kWh/yr)	(therms)	Cost (\$)
Site #8	Lighting	198.8	1,765,508	n/a	237,834

Spillover

No evidence of spillover was found.

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Modesto Irrigation District, the following efficiency improvements were planned under this project at Site #8. The Modesto Irrigation District rebates are provided in Table 1. For 3,274 reported measures the total rebate was \$41,700. The EM&V findings are based on installed fixtures including lamps and ballasts. The program tracks quantities of measures rather than fixtures.

Table 1. Planned Efficiency Improvements at Site #8

Measure	Description	Qty.	Location
1	Interior Linear Fluorescent 400W Basecase: <=244 Watts Replacement	556	Manufacturing
2	T8 or T5 Linear Fluorescent 4-ft lamp installed	1376	Manufacturing
3	Delamp: 4 foot lamp	204	Manufacturing
4	Occupancy Sensor Fixture Integrated over 12'	227	Manufacturing
5	Exterior Linear Fluorescent 400W Basecase: <=244 Watts Replacement	38	Exterior Parking Lot
6	Exterior Linear Fluorescent 101-175W Basecase: <=128 Watts Replacement	49	Exterior Parking Lot
7	28 Watt 4-Foot T8 Fluorescent (used in place of 32 Watt Fluorescent T8)	824	Manufacturing
8	LED or Electroluminescent Exit signs replaces Incandescent	0	Manufacturing
Total		3,274	

Verified Efficiency Improvement: The following energy efficiency improvements were verified as installed at Site #8.

Table 2. Verified Efficiency Improvements at Site #8

Measure	Description	Qty.	Location
1	Interior Linear Fluorescent 400W Basecase: <=244 Watts Replacement	556	Manufacturing
2	T8 or T5 Linear Fluorescent 4-ft lamp installed	1970	Manufacturing
3	Delamp: 4 foot lamp	136	Manufacturing
4	Occupancy Sensor Fixture Integrated over 12'	227	Manufacturing
5	Exterior Linear Fluorescent 400W Basecase: <=244 Watts Replacement	39	Exterior Parking Lot
6	Exterior Linear Fluorescent 101-175W Basecase: <=128 Watts Replacement	49	Exterior Parking Lot
7	28 Watt 4-Foot T8 Fluorescent (used in place of 32 Watt Fluorescent T8)	824	Manufacturing
8	LED or Electroluminescent Exit signs replaces Incandescent	3	Manufacturing
Total		3,804	

Primary Business Descriptions: Site #8 consists of manufacturing, office, and parking space.

Variability in Schedule and Production: The EM&V study reviewed the rebate application to determine lighting hours of use.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$kW \text{ Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$kWh \text{ Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

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Ex ante assumptions and gross savings are provided in **Table 3**.

Table 3 Ex Ante Assumptions and Savings for Site #8

Rebate ID	E3 #	Description	E3 Rebate	E3 kWh per unit	E3 kW per unit	E3 EUL	E3 NTGR	Ex ante Qty.	Ex Ante Gross kW	Ex Ante Gross kWh/y	Ex Ante Gross Lifecycle kWh
CL002	5010	T12 to T8 HiBay	\$75.00	1,962	0.197	11.0	0.85	556	109.53	1,090,872	11,999,592
CL030	4940	T12 to T8 or T5 4-ft lamp installed	\$5.00	68	0.011	11.0	0.85	1376	15.14	92,894	1,021,831
CL034	1448	Delamp: 4 foot lamp	\$4.50	129	0.035	11.0	0.85	204	7.04	26,214	288,354
CL052	4975	Occupancy Sensor Integrated over 12'	\$15.00	459	0.112	8.0	0.84	227	25.42	104,216	833,726
CL061	5093	Exterior T12 to T8 or T5	\$40.00	1,260	0.197	11.0	0.85	38	7.47	47,884	526,722
CL064	5096	Exterior T12 to T8 or T5	\$200.0	411	0.064	11.0	0.85	49	3.14	20,122	221,346
CL070	5113	T8 32W to T8 28W 4ft lamp	\$0.75	20	0.006	3.0	0.85	824	4.53	16,480	49,440
CL039	5056	Incand. to LED Exit signs	\$20.00	366	0.044	16.0	0.85	0	0	0	0
Total								3,274	172.3	1,398,682	14,941,011

Findings of the EM&V on-site audit for site #8 are provided in **Table 4**.

Table 4. Findings of the EM&V On-Site Audits for Site #8

Rebate ID	Description	Pre W/unit	Post W/unit	Pre h/y	Post h/y	EM&V Qty.	EM&V Ex Post Gross kW	EM&V Ex Post Gross kWh/y	EM&V Ex Post Gross Lifecycle kWh
CL002	T12 to T8 HiBay	421	169	5,343	5,343	556	152.1	1,289,780	14,187,585
CL030	T12 to T8 or T5 4-ft lamp installed	43	28	5,343	5,343	1970	29.6	220,413	2,424,548
CL034	Delamp: 4 foot lamp	43	0	5,343	5,343	136	5.8	43,620	479,823
CL052	Occupancy Sensor Integrated		91	5,343	4,617	227	7.9	58,707	469,658
CL061	Exterior T12 to T8 or T5	458	216	4,380	4,380	39	0.0	38,981	428,788
CL064	Exterior T12 to T8 or T5	207	97	4,380	4,380	49	0.0	88,449	972,937
CL070	T8 32W to T8 28W 4ft lamp	39	35	5,343	5,343	824	3.3	24,585	73,755
CL039	Incand. to LED Exit signs	40	3	8,760	8,760	3	0.1	972	15,558
Total						3,804	198.7	1,765,508	19,052,650

Data Collection

Fixture Wattage and hours of operation are based on the Modesto Irrigation District rebate application and audit information collected at Site #8. Lighting logger data were collected for representative lighting fixtures as shown in **Table 5**.

Table 5. Lighting Logger Measurements for Site #8

Site Location	No Occupancy Sensor hours/yr	Occupancy Sensor hours/yr
Manufacturing Plastics Area	5,343	5,343
Manufacturing Office Area	5,343	4,632
Manufacturing Pre Assembly Area	5,343	4,602

Customer Cost/Benefit Analysis

Cost and Payback based on 2011 Modesto Irrigation District Rates of 0.097 \$/kWh.

- Site #8: (Retrofit Cost \$237,834 - Rebate \$41,700) / (Energy Savings \$171,254) = Simple Payback 1.15 Years.

Appendix D-9: Lighting Rebate Site #9

M&V REPORT FOR LIGHTING SITE #9

Prepared for Modesto Irrigation District

Prepared by Robert Mowris & Associates, Inc.

SITE SUMMARY INFORMATION

Company Name: Site #9

Site Name: Site #9

Site Address: 4000 Yosemite Blvd., Modesto, CA 95357

Principal Site Contact Name: N/A **Telephone:** N/A

Utility Representative Name: Peter Govea **Telephone:** (209) 526-7344

Assigned Lead Engineer: Robert Mowris, P.E., Ean Jones, B.S.

Site: MID Site #9

PROJECTS PAID BY PB FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #9	n/a	Lighting	MID	Comm. Lighting	18,000	Rebate

MEASURES FOR EACH PROJECT

Item No.	Efficiency Measure	Ex Ante Savings Estimate			Rebate (\$)
		(kW)	(kWh/yr)	(therms)	
Site #9	Lighting	52.7	305,660	n/a	18,445

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

Item No.	Efficiency Measure	EM&V Gross Savings			Cost (\$)
		(kW)	(kWh/yr)	(therms)	
Site #9	Lighting	53.0	442,117	n/a	79,133

Spillover

No evidence of spillover was found.

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Modesto Irrigation District, the following efficiency improvements were planned under this project at Site #9. The Modesto Irrigation District rebates are provided in Table 1. For 170 reported measures the total rebate was \$18,445. The EM&V findings are based on installed fixtures including lamps and ballasts. The program tracks quantities of measures rather than fixtures.

Table 1. Planned Efficiency Improvements at Site #9

Measure	Description	Qty.	Location
1	Metal Halide Highbay to LED Lighting Retrofit	170	Warehouse
Total		170	

Verified Efficiency Improvement: The following energy efficiency improvements were verified as installed at Site #9.

Table 2. Verified Efficiency Improvements at Site #9

Measure	Description	Qty.	Location
1	Metal Halide Highbay to LED Lighting Retrofit	172	Warehouse
Total		172	

Primary Business Descriptions: Site #9 consists of warehouse space.

Variability in Schedule and Production: The EM&V study reviewed the rebate application to determine lighting hours of use.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$kW \text{ Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$kWh \text{ Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Ex ante assumptions and gross savings are provided in **Table 3**.

Table 3 Ex Ante Assumptions and Savings for Site #9

Rebate ID	E3 #	Description	E3 Rebate	E3 kWh per unit	E3 kW per unit	E3 EUL	E3 NTGR	Ex ante Qty.	Ex Ante Gross kW	Ex Ante Gross kWh/y	Ex Ante Gross Lifecycle kWh
CC066	5077	400W HID to 150W LED HB1C5J Dialight w/Occ. Sensors	\$108.5	1,798	0.310	15.0	0.80	170	52.7	305,660	4,584,900
								170	52.7	305,660	4,584,900

Findings of the EM&V on-site audit for site #9 are provided in **Table 4**.

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Table 4. Findings of the EM&V On-Site Audits for Site #9

Rebate ID	Description	Pre W/unit	Post W/unit	Pre h/y	Post h/y	EM&V Qty.	EM&V Ex Post Gross kW	EM&V Ex Post Gross kWh/y	EM&V Ex Post Gross Lifecycle kWh
CC066	400W HID to 150W LED HB1C5J Dialight w/Occ. Sensors	458	150	5,800	573	172	53.0	442,117	6,631,761
Total						172	53.0	442,117	6,631,761

Data Collection

Fixture Wattage and hours of operation are based on the Modesto Irrigation District rebate application and audit information collected at Site #9. Lighting logger data were collected for representative lighting fixtures as shown in **Table 5**.

Table 5. Lighting Logger Measurements for Site #9

Site Location	No Occupancy Sensor hours/yr	Occupancy Sensor hours/yr
Warehouse	5,800	573

Customer Cost/Benefit Analysis

Cost and Payback based on 2011 Modesto Irrigation District Rates of 0.097 \$/kWh.

- Site #9: (Retrofit Cost \$79,133 - Rebate \$18,445) / (Energy Savings \$42,885) = Simple Payback 1.42 Years.

Appendix D-10: Refrigeration Rebate Site #10

M&V REPORT FOR REFRIGERATION SITE #10

Prepared for Modesto Irrigation District

Prepared by Robert Mowris & Associates, Inc.

SITE SUMMARY INFORMATION

Company Name: Site #10
Site Name: Site #10
Site Address: 17000 E. Highway 120, Ripon, CA 95356
Principal Site Contact Name: N/A **Telephone:** N/A
Utility Representative Name: Peter Govea **Telephone:** (209) 526-7344
Assigned Lead Engineer: Robert Mowris, P.E., Ean Jones, B.S.

Site: MID Site #10

PROJECTS PAID BY PB FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #10	n/a	Refrigeration	MID	Comm. New Const.	200,000	Rebate

MEASURES FOR EACH PROJECT

Item No.	Efficiency Measure	Ex Ante Savings Estimate			Rebate (\$)
		(kW)	(kWh/yr)	(therms)	
Site #10	Wine Tank Insul.	8.0	463,812	n/a	30,000

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

Item No.	Efficiency Measure	EM&V Gross Savings			Cost (\$)
		(kW)	(kWh/yr)	(therms)	
Site #10	Wine Tank Insul.	12.4	490,818	n/a	60,000

Spillover

No evidence of spillover was found.

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Modesto Irrigation District, the following efficiency improvements were planned under this project at Site #10. The Modesto Irrigation District rebates are provided in Table 1. For 12 reported measures the total rebate was \$30,000. The EM&V findings are based on installed fixtures including lamps and ballasts. The program tracks quantities of measures rather than fixtures.

Table 1. Planned Efficiency Improvements at Site #10

Measure	Description	Qty.	Location
1	Wine Tank Insulation	12	Tank Farm
Total		12	

Verified Efficiency Improvement: The EM&V findings are based on installed fixtures including lamps and ballasts. The study verified 12 installed measures.

Table 2. Verified Efficiency Improvements at Site #10

Measure	Description	Qty.	Location
1	Wine Tank Insulation	12	Tank Farm
Total		12	

Primary Business Descriptions: Site #10 consists of wine processing and storage.

Variability in Schedule and Production: The EM&V study reviewed the rebate application and conducted a site visit to verify the installed measures and operational characteristics.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre- and post-installation wine tank insulation u-values, temperatures, and chiller efficiency. The pre and post-retrofit wine tank insulation UA values are shown in **Table 3**. Three inches of foam insulation (R-21) was installed on the exterior wall of each wine tank and 8 inches of foam insulation (R-56) was installed on the exterior roof of each wine tank. The estimated wine chiller efficiency versus ambient temperature data are shown in **Figure 1**.

Table 3. Pre and Post-Retrofit Wine Tank Insulation UA Values

Area	Area (ft ²)	Pre U-value (Btu/ft ² -F-hr)	UA-pre	Insul. Thickness (ft)	Post U-value (Btu/ft ² -F-hr)	UA-post
Wall	571.5	3.84	2194.5	0.25	0.047619	27.2
Roof	132.7	1.16	153.9	0.125	0.017857	2.4
Total	704.1		2348.4			29.6

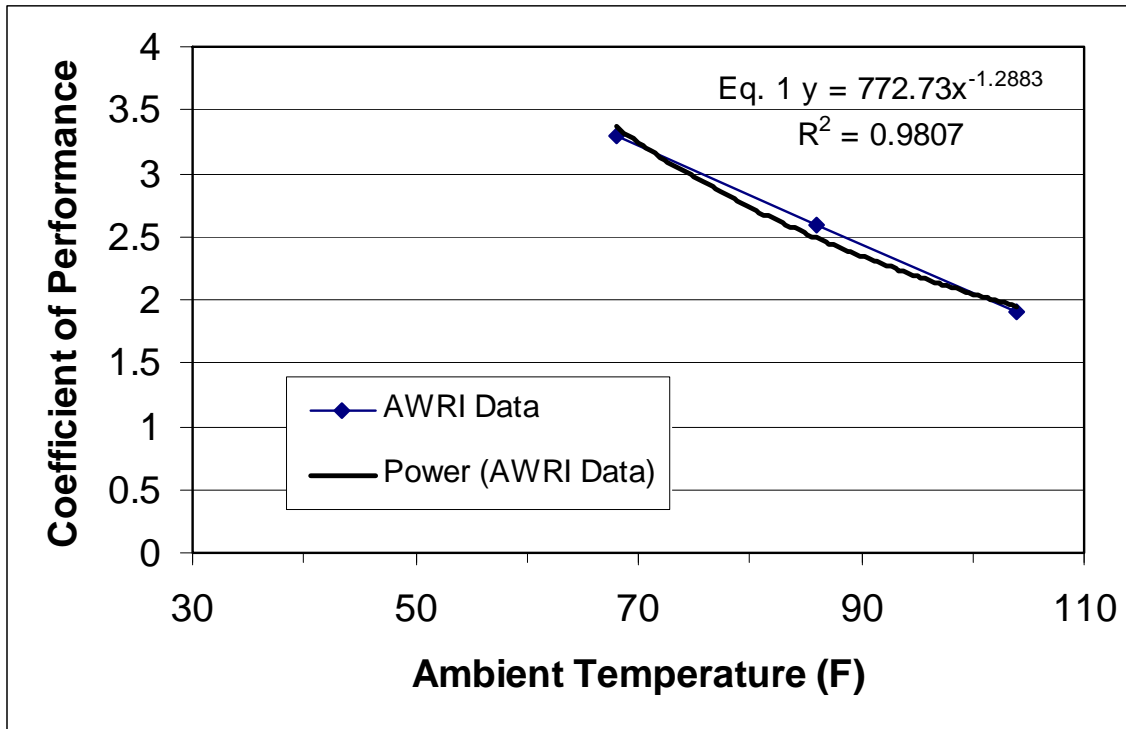


Figure 1. Wine Chiller Coefficient of Performance versus Ambient Temperature¹⁴

The general equations for calculating kW and kWh savings are as follows.

$$\text{kWh Savings} = \sum_{i=1}^n \frac{(T_i - T_w) \times t_i \times (UA_{pre} - UA_{post})}{3412 \times 772.73 \times T_i^{-1.2883}}$$

Where, T_i = ambient temperature for bin “i,”

T_w = wine temperature (e.g., 33°F),

t_i = operational hours for bin “i,”

UA_{pre} = pre-existing heat transfer times area of wine tank (Btu/ft²-hr-°F),

UA_{post} = post-retrofit heat transfer times area of wine tank (Btu/ft²-hr-°F), and

n = number of temperature bins.

$$\text{Ave kW Savings}_{i=79 \text{ to } 104F} = \frac{\sum_{i=1}^n \frac{(T_i - T_w) \times (UA_{pre} - UA_{post})}{3412 \times 772.73 \times T_i^{-1.2883}} \times \frac{420}{7194}}{n}$$

Where, $\text{Ave kW Savings}_{i=79 \text{ to } 104F}$ = Average kW savings in the 79 to 104°F temperature bins times the probability that the chillers are operating during the peak weekday period from 2 to 4 PM which represents 420 hours out of 7194 total hours of operation.

¹⁴ Australian Wine Research Institute (AWRI). 2011. S. Nordestgaard, K. Forsyth, W. Roget, V. O’Brien. "Improving Winery Refrigeration Efficiency. page 8. Available online: www.awri.com.

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The wine refrigeration chillers are operated as needed to maintain the setpoint temperature of each wine tank. Wine is pumped from each tank to the chillers to cool the wine and then returned to the tank. Flex hose is used to connect each tank to the fixed distribution piping that goes to the chiller. Wine tank insulation reduces heat gain, increases the time interval between cooling cycles, and reduces the total number of cooling cycles needed annually. More tanks are cooled after the new insulated tanks were installed, so overall power use of the refrigeration plant has increased, but by less than if the tanks were uninsulated.

The ambient temperature bins, time (hours), chiller efficiency and energy savings per tank for the wine tank insulation measure are shown in **Table 4**.

Table 4. Temperature bins, Time, Chiller Efficiency and Energy Savings per Tank

T _i (°F)	Temp Diff. (°F)	t _i (hours)	COP (AWRI data)	kW/ton	kWh Savings	kW Savings
104	71	0.8	1.9	1.8	20.4	1.4
99	66	49.3	2.1	1.7	1,066.1	1.3
94	61	133.2	2.2	1.6	2,488.6	1.1
89	56	247.4	2.4	1.5	3,956.2	0.9
84	51	322.2	2.6	1.4	4,355.4	0.8
79	46	453.7	2.8	1.3	5,111.4	0.7
74	41	522.7	3.0	1.2	4,825.0	
69	36	566.3	3.3	1.1	4,194.1	
64	31	711.0	3.6	1.0	4,115.3	
59	26	925.5	4.0	0.9	4,046.0	
54	21	1032.3	4.5	0.8	3,252.2	
49	16	1101.4	5.1	0.7	2,332.5	
44	11	743.8	5.9	0.6	942.8	
39	6	321.4	6.9	0.5	190.2	
34	1	63.3	8.2	0.4	5.2	
Subtotal		7,194			40,901	1.03

Ex ante assumptions and gross savings are provided in **Table 5**.

Table 5. Ex Ante Assumptions and Savings for Site #10

Rebate ID	E3 #	Description	E3 Rebate	E3 kWh per unit	E3 kW per unit	E3 EUL	E3 NTGR	Ex ante Qty.	Ex Ante Gross kW	Ex Ante Gross kWh/y	Ex Ante Gross Lifecycle kWh
CNC008	5102	Wine Tank Insulation	\$2500	38,651	0.667	15.0	0.80	12	8.0	463,812	6,957,180
Total								12	8.0	463,812	6,957,180

Findings of the EM&V on-site audit and engineering for site #10 are provided in **Table 6**.

Table 6. Findings of the EM&V On-Site Audits and Engineering Analysis for Site #10

Rebate ID	E3 #	Description	EM&V Rebate	EM&V kWh per unit	EM&V kW per unit	E3 EUL	EM&V NTGR	EM&V Qty.	EM&V Ex Post Gross kW	EM&V Ex Post Gross kWh/y	EM&V Ex Post Gross Lifecycle kWh
CNC008	5102	Wine Tank Insulation	\$2,500	40,901	1.03	15.0	0.56	12	12.4	490,818	7,362,269
Total								12	12.4	490,818	7,362,269

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Data Collection

Temperature bins, UA values, and wine tank insulation are based on the Modesto Irrigation District rebate application and on-site audit information collected at Site #10.

Customer Cost/Benefit Analysis

Cost and Payback based on 2011 Modesto Irrigation District Rates of 0.097 \$/kWh.

- Site #10: (Retrofit Cost \$60,000 - Rebate \$30,000) / (Energy Savings \$47,609) = Simple Payback 0.63 Years.

Appendix D-11: Dairy Vacuum Pump Rebate Site #11

M&V REPORT FOR VACUUM PUMP SITE #11

Prepared for Modesto Irrigation District

Prepared by Robert Mowris & Associates, Inc.

SITE SUMMARY INFORMATION

Company Name: Site #11
Site Name: Site #11
Site Address: 3037 Albers Rd., Modesto, CA 95357
Principal Site Contact Name: N/A **Telephone:** N/A
Utility Representative Name: Peter Govea **Telephone:** (209) 526-7344
Assigned Lead Engineer: Robert Mowris, P.E., Ean Jones, B.S.

Site: MID Site #11

PROJECTS PAID BY PB FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #11	n/a	Dairy Pump	MID	Ag. Custom	12327480	Rebate

MEASURES FOR EACH PROJECT

Item No.	Efficiency Measure	Ex Ante Savings Estimate			Rebate (\$)
		(kW)	(kWh/yr)	(therms)	
Site #11	VFD Vacuum Pump	11.9	120,012	n/a	7,125

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

Item No.	Efficiency Measure	EM&V Gross Savings			Cost (\$)
		(kW)	(kWh/yr)	(therms)	
Site #11	VFD Vacuum Pump	13.79	120,760	n/a	14,802

Spillover

No evidence of spillover was found.

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Modesto Irrigation District, the following efficiency improvements were planned under this project at Site #11. The Modesto Irrigation District rebates are provided in Table 1. For the reported measures the total rebate was \$7,125. The VFD was installed on a new 15 hp vacuum pump for milking, which is downsized from the 25-hp original vacuum pump.

Table 1. Planned Efficiency Improvements at Site #11

Measure	Description	Qty.	Location
1	VFD on 15 hp vacuum pump	1	Dairy Farm
Total		1	

Verified Efficiency Improvement: The EM&V findings are based on installed a VFD on a 15-hp vacuum pump. The study verified the VFD and 15-hp vacuum pump were installed.

Table 2. Verified Efficiency Improvements at Site #11

Measure	Description	Qty.	Location
1	VFD on 15 hp vacuum pump	1	Dairy Farm
Total		1	

Primary Business Descriptions: Site #11 consists of a dairy farm.

Variability in Schedule and Production: The EM&V study reviewed the rebate application and conducted a site visit to verify the installed measures and operational characteristics.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation wattages and hours of operation (obtained from maintenance personnel and data loggers). The general equations for calculating kW and kWh savings are as follows.

$$kW \text{ Savings} = (kW_{pre} - kW_{post})_{peak}$$

$$kWh \text{ Savings} = (kW_{pre} - kW_{post}) \times \text{hours/year}$$

Ex ante assumptions and gross savings are provided in **Table 3**.

Table 3 Ex Ante Assumptions and Savings for Site #11

Rebate ID	E3 #	Description	E3 Rebate	E3 kWh per unit	E3 kW per unit	E3 EUL	E3 NTGR	Ex ante Qty.	Ex Ante Gross kW	Ex Ante Gross kWh/y	Ex Ante Gross Lifecycle kWh
AC010	6416	VFD for Vacuum Pump	\$7,125	120,012	11.9	15.0	0.75	1	11.9	120,012	1,800,180
Total								1	11.9	120,012	1,800,180

Findings of the EM&V on-site audit for site #11 are provided in **Table 4**.

EM&V Report for 2011 MID Energy Efficiency Programs

Table 4. Findings of the EM&V On-Site Audits for Site #11

Rebate ID	Description	Pre W/unit	Post W/unit	Pre h/y	Post h/y	EM&V Qty.	EM&V Ex Post Gross kW	EM&V Ex Post Gross kWh/y	EM&V Ex Post Gross Lifecycle kWh
AC010	VFD for Vacuum Pump	18065	4279	8760	8760	1	13.79	120,760	1,811,403
Total						1	13.79	120,760	1,811,403

Data Collection

Electric power savings and hours of operation are based on data provided by the Modesto Irrigation District and on-site audit information collected at Site #11. Electric power was monitored before and after installation of the new VFD and motor. The pre-monitoring period was approximately 6 days and the post-monitoring period was approximately 10 days. Pre-monitoring data are shown in **Figure 1** and post monitoring data are shown in **Figure 2**.

Cycle(All)

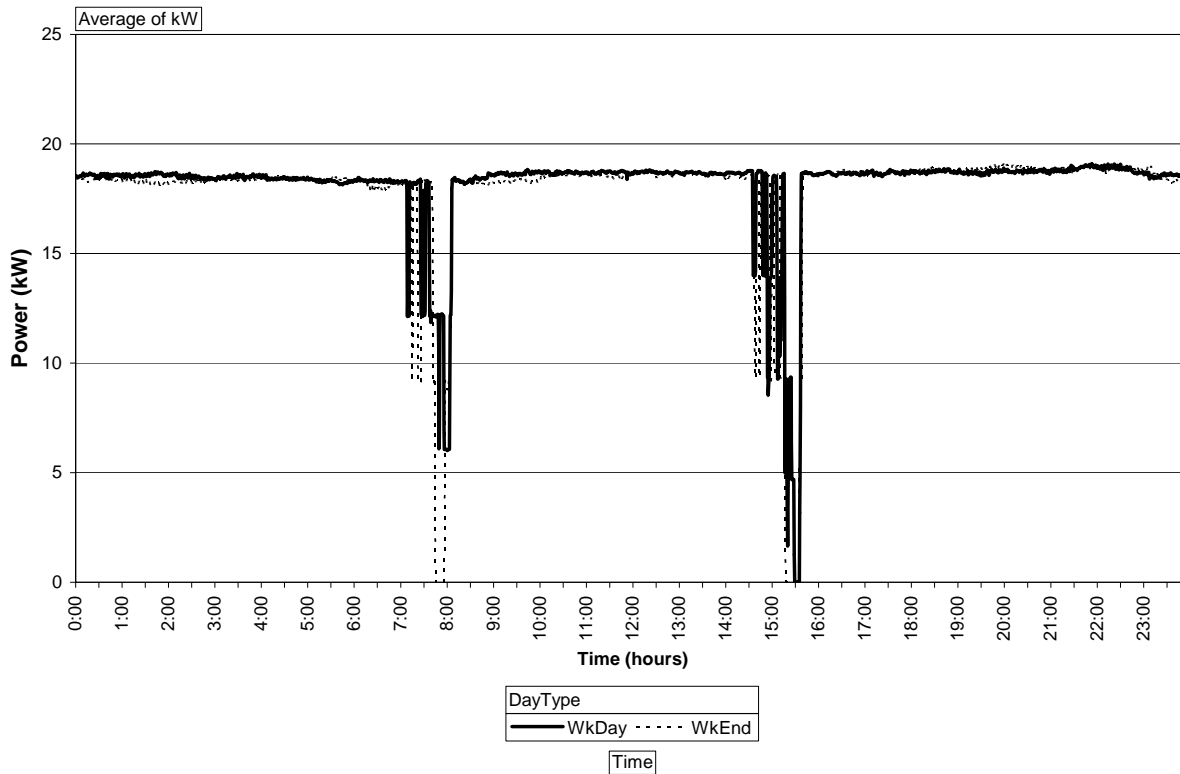


Figure 1. Pre-Monitoring Data for the Constant Speed 25-hp Vacuum Pump

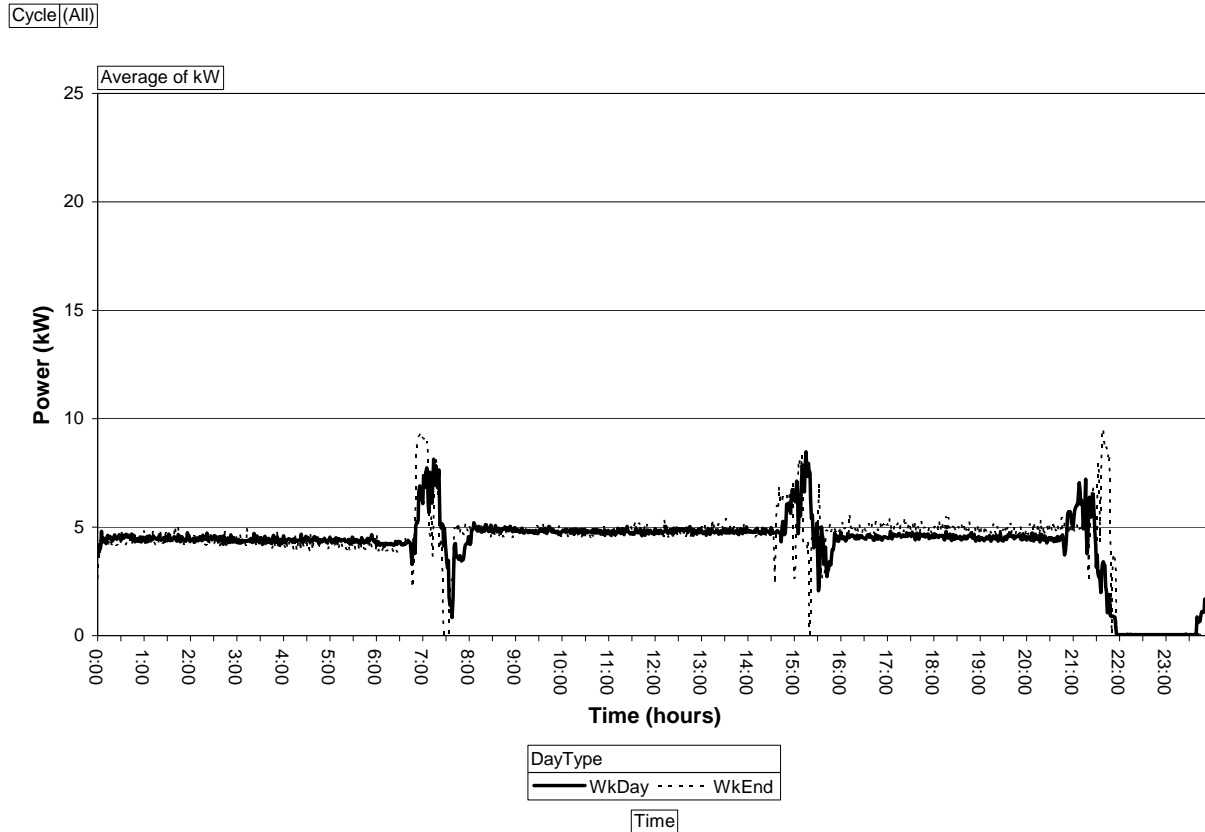


Figure 2. Post-Monitoring Data for the VFD 15-hp Vacuum Pump

Customer Cost/Benefit Analysis

Cost and Payback based on 2011 Modesto Irrigation District Agricultural Rates of 0.135 \$/kWh.

- Site #11: (Retrofit Cost \$14,802 - Rebate \$7,125) / (Energy Savings \$16,303) = Simple Payback 0.47 Years.

Appendix D-12: Commercial Custom Rebate Site #12

EM&V REPORT FOR CUSTOM #12

Prepared for Modesto Irrigation District

Prepared by Robert Mowris & Associates, Inc.

SITE SUMMARY INFORMATION

Company Name: Site #12
Site Name: Site #12
Site Address: 600 Yosemite Blvd., Modesto, CA 95353
Principal Site Contact Name: N/A **Telephone:** N/A
Utility Representative Name: Peter Govea **Telephone:** (209) 526-7344
Assigned Lead Engineer: Robert Mowris, P.E., Ean Jones, B.S.

Site: MID Site #12

PROJECTS PAID BY PB FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #12	n/a	Refrig.	MID	Comm. Custom	2,000,000	Rebate

MEASURES FOR EACH PROJECT

Item No.	Efficiency Measure	Ex Ante Savings Estimate			Rebate (\$)
		(kW)	(kWh/yr)	(therms)	
Site #12	VFD Cooling Tower	5.6	81,641	n/a	5,715

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

Item No.	Efficiency Measure	EM&V Gross Savings			Cost (\$)
		(kW)	(kWh/yr)	(therms)	
Site #12	VFD Cooling Tower	5.6	46,533	n/a	22,445

Spillover

No evidence of spillover was found.

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Modesto Irrigation District, the following efficiency improvements were planned under this project at Site #12. The Modesto Irrigation District rebates are provided in Table 1. The total rebate was \$5,715. The EM&V findings are based on installed fixtures including lamps and ballasts.

Table 1. Planned Efficiency Improvements at Site #12

Measure	Description	Qty.	Location
1	VFD Cooling Tower	1	Warehouse
Total		1	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #12.

Table 2. Verified Efficiency Improvements at Site #12

Measure	Description	Qty.	Location
1	VFD Cooling Tower	1	Warehouse
Total		1	

Primary Business Descriptions: Site #12 consists of wine processing and storage.

Variability in Schedule and Production: The EM&V study reviewed the rebate application and conducted a site visit to verify the installed measures and operational characteristics.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation wattages and hours of operation (obtained from maintenance personnel and data loggers). The general equations for calculating kW and kWh savings are as follows.

$$kW \text{ Savings} = (kW_{pre} - kW_{post})_{peak}$$

$$kWh \text{ Savings} = (kW_{pre} - kW_{post}) \times \text{hours/year}$$

Ex ante assumptions and gross savings are provided in **Table 3**.

Table 3 Ex Ante Assumptions and Savings for Site #12

Rebate ID	E3 #	Description	E3 Rebate	E3 kWh per unit	E3 kW per unit	E3 EUL	E3 NTGR	Ex ante Qty.	Ex Ante Gross kW	Ex Ante Gross kWh/y	Ex Ante Gross Lifecycle kWh
CC075	6394	Cooling Tower VFD	\$5,715	81,641	5.6	15.0	0.80	1	5.6	81,641	1,224,615
Total								1	5.6	81,641	1,224,615

Findings of the EM&V on-site audit for site #12 are provided in **Table 4**.

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Table 4. Findings of the EM&V On-Site Audits for Site #12

Rebate ID	Description	Pre W/unit	Post W/unit	Pre h/y	Post h/y	EM&V Qty.	EM&V Ex Post Gross kW	EM&V Ex Post Gross kWh/y	EM&V Ex Post Gross Lifecycle kWh
CC075	Cooling Tower VFD	29109	21250	5922	5922	1	5.6	46,533	698,000
Total						1	5.6	46,533	698,000

Data Collection

Electric power and hours of operation are based on the data collected by the Modesto Irrigation District and on-site audit information collected at Site #12. Monitoring data with and without the cooling tower VFD operating are shown in **Figure 1**.

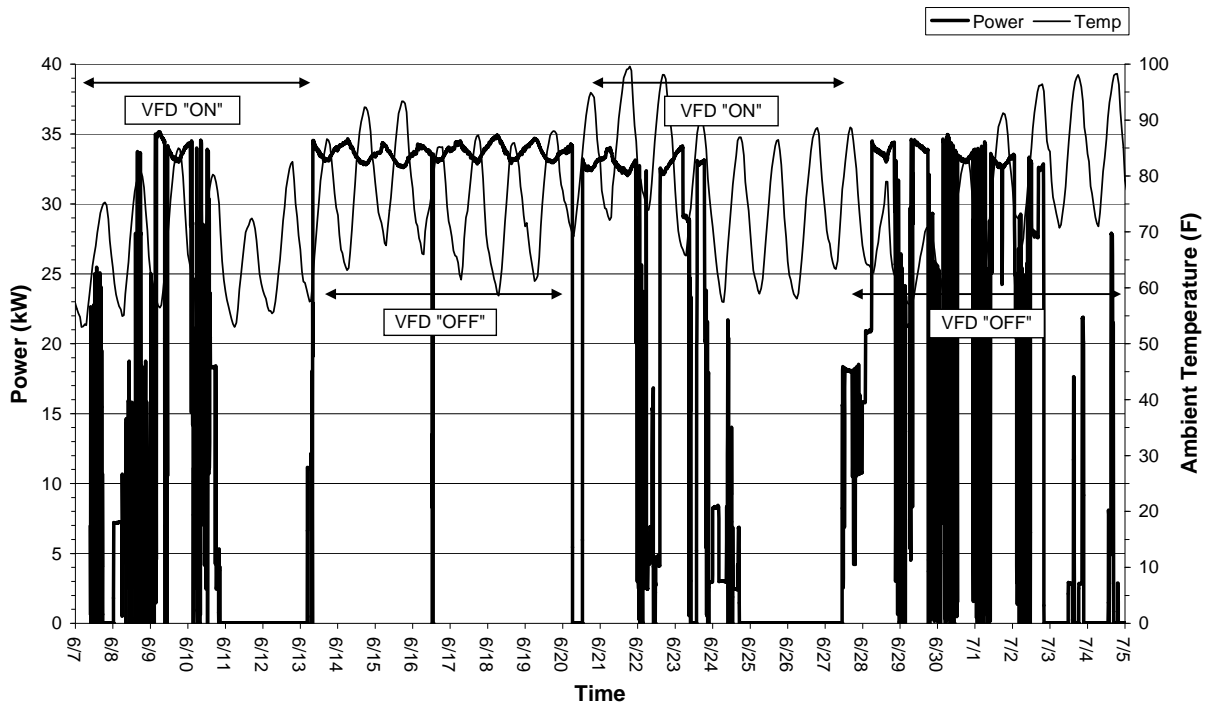


Figure 1. Monitoring Data With and Without Cooling Tower VFD Operating

Customer Cost/Benefit Analysis

Cost and Payback based on 2011 Modesto Irrigation District Rates of 0.097 \$/kWh.

- Site #12: (Retrofit Cost \$22,445 - Rebate \$5,715) / (Energy Savings \$4,514) = Simple Payback 3.71 Years.

Appendix D-13: PC Power Mgmt. Rebate Site #13

EM&V REPORT FOR PC POWER MGMT SITE #13

Prepared for Modesto Irrigation District

Prepared by Robert Mowris & Associates, Inc.

SITE SUMMARY INFORMATION

Company Name: Site #13 (two sites)

Site Name: Site #13 (two sites)

Site Address: 4801 Sisk Rd., Salida, CA 95368, 5201 1st Street, Empire, CA 95357

Principal Site Contact Name: N/A **Telephone:** N/A

Utility Representative Name: Peter Govea **Telephone:** (209) 526-7344

Assigned Lead Engineer: Robert Mowris, P.E., Ean Jones, B.S.

Site: MID Site #13

PROJECTS PAID BY PB FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #13	n/a	Computing	MID	Comm. Computing	11 schools	Rebate

MEASURES FOR EACH PROJECT

Item No.	Efficiency Measure	Ex Ante Savings Estimate			Rebate (\$)
		(kW)	(kWh/yr)	(therms)	
Site #13	PC Power Mgmt	29.48	294,800	n/a	14,740

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

Item No.	Efficiency Measure	EM&V Gross Savings			Cost (\$)
		(kW)	(kWh/yr)	(therms)	
Site #13	PC Power Mgmt	38.5	335,286	n/a	14,740

Spillover

No evidence of spillover was found.

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Modesto Irrigation District, the following efficiency improvements were planned under this project at Site #13. The Modesto Irrigation District rebates are provided in Table 1. Two rebates were paid \$4,260 and \$10,480 for a total of \$14,740. The network PC power management software controls 627 computers at 5 schools and 1193 computers at 6 schools for a total of 1820 computers. The EM&V findings are based on the number of computers verified with the installed power management software and power measurements of a sample of computers and monitors.

Table 1. Planned Efficiency Improvements at Site #13

Measure	Description	Qty.	Location
1	Network PC Power Management	627	5 schools
2	Network PC Power Management	1193	6 schools
Total		1820	11 schools

Verified Efficiency Improvement: The EM&V findings are based on installed software on network personal computers. The study verified 1,820 installed measures.

Table 2. Verified Efficiency Improvements at Site #13

Measure	Description	Qty.	Location
1	Network PC Power Management	627	5 schools
2	Network PC Power Management	1193	6 schools
Total		1820	11 schools

Primary Business Descriptions: Site #13 consists of two school districts with network PC power management software installed on 1820 computers located at 11 schools.

Variability in Schedule and Production: The network PC power management software companies provided pre- and post-data for each computer indicating the number of hours of PC power off, PC standby, and Monitor standby. Data was collected for a random sample of 20 computers in each mode of operation to evaluate the power consumption in each mode of operation.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre- and post-software audit data for each computer indicating the number of hours of PC power off, PC standby, and Monitor standby. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = \sum_{i=1}^n [(kW_{on} - kW_{off}) + (kW_{on} - kW_{sby})]_i$$

$$\text{kWh Savings} = \sum_{i=1}^n [(kW_{on} - kW_{off}) \times hours_{off} + (kW_{on} - kW_{sby}) \times hours_{sby}]_i$$

Where, kW_{on} = kW when on for computer “i,”

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kW_{off} = kW when off for computer “i,”

kW_{sby} = kW when in standby for computer “i,”

$hours_{off}$ = hours of power off operation for computer “i,”

$hours_{sby}$ = hours of power low or standby operation for computer “i.”

Ex ante assumptions and gross savings are provided in **Table 3**.

Table 3 Ex Ante Assumptions and Savings for Site #13

Rebate ID	E3 #	Description	E3 Rebate	E3 kWh per unit	E3 kW per unit	E3 EUL	E3 NTGR	Ex ante Qty.	Ex Ante Gross kW	Ex Ante Gross kWh/y	Ex Ante Gross Lifecycle kWh
CB001	6241	Network PC Power Management Software	\$10	200	0.02	5.0	1.00	1820	29.48	294,800	1,474,000
Total								1820	29.48	294,800	1,474,000

Findings of the EM&V on-site audit for site #13 are provided in **Table 4**.

Table 4. Findings of the EM&V On-Site Audits and Engineering Analysis for Site #13

Rebate ID	E3 #	Description	EM&V Rebate	EM&V kWh per unit	EM&V kW per unit	E3 EUL	EM&V NTGR	EM&V Qty.	EM&V Ex Post Gross kW	EM&V Ex Post Gross kWh/y	EM&V Ex Post Gross Lifecycle kWh
CB001	6241	Network PC Power Management Software	\$10	184.2	0.02	5.0	0.99	1820	38.5	335,286	1,676,428
Total								1820	38.5	335,286	1,676,428

Data Collection

The EM&V study verified the software was installed on each computer based on audit data from school district information systems personnel. The EM&V study measured 20 personal computers and monitors to evaluate power used in power active, power low, and power off modes of operation. EM&V values are compared to previous studies in **Table 5**.

Table 5. Measurements of CPU and Monitor Power for Modes of Operation

Description	CPU PC (W)	CRT Monitor (W)	LCD Monitor (W)	EM&V CPU (W)	EM&V LCD Monitor (W)
Active (Power Active)	70	65	30	55.5	30.8
Low (Power Low)	9	5	2	10.3	1.7
Off (Power Off)	3	1	2	1.7	1.7

Roberson, et al. “Power Levels in Office Equipment: Measurements of New Monitors and Personal Computers.” ACEEE Summer Study, 2002.

Customer Cost/Benefit Analysis

Cost and Payback based on 2011 Modesto Irrigation District Rates of 0.137 \$/kWh.

- Site #13: (Retrofit Cost \$14,740 - Rebate \$14,740) / (Energy Savings \$45,934) = Simple Payback 0 Years.

Appendix D-14: Refrigeration Controls Rebate Site #14

EM&V REPORT FOR REFRIGERATION SITE #14

Prepared for Modesto Irrigation District

Prepared by Robert Mowris & Associates, Inc.

SITE SUMMARY INFORMATION

Company Name: Site #14 (Multiple Sites)

Site Name: Site #14 (Multiple Sites)

Site Address: 2100 Bradford Ave, Modesto, CA 95350, 2601 Oakdale Rd., Suite L, Modesto, CA 95355, 1801 H Street, Modesto, CA 95354, 415 Paradise Rd., Modesto, CA 95351, 801 Oakdale, CA 95355, 2020 W. Briggsmore, Modesto, CA 95350

Principal Site Contact Name: N/A **Telephone:** N/A

Utility Representative Name: Peter Govea **Telephone:** (209) 526-7344

Assigned Lead Engineer: Robert Mowris, P.E., Ean Jones, B.S.

Site: MID Site #14

PROJECTS PAID BY PB FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #14	n/a	Refrigeration	MID	Comm. Custom	300,000	Rebate

MEASURES FOR EACH PROJECT

Item No.	Efficiency Measure	Ex Ante Savings Estimate			
		(kW)	(kWh/yr)	(therms)	Rebate (\$)
Site #14	Refrigeration	55.5	1,118,102	n/a	66,030

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

Item No.	Efficiency Measure	EM&V Gross Savings			
		(kW)	(kWh/yr)	(therms)	Cost (\$)
Site #14	Refrigeration	55.5	1,118,102	n/a	168,768

Spillover

No evidence of spillover was found.

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Modesto Irrigation District, the following efficiency improvements were planned under this project at Site #14 consisting of 6 grocery stores. The Modesto Irrigation District rebates are provided in Table 1. For 18 reported measures the total rebate was \$66,030. The refrigeration controller measures consist of 18 measures. The EM&V findings are based on verification of the rebate application information and DEER savings estimates.

Table 1. Planned Efficiency Improvements at Site #14

Measure	Description	Qty.	Units	Location
1	Refrig. Multiplex Floating Suction Control Condenser	176	hp	Grocery Store 49
2	Refrig. Multiplex Floating Head Pressure Controls	176	hp	Grocery Store 49
3	Anti-Sweat Heater (ASH) Controls	50	ft	Grocery Store 49
4	Refrig. Multiplex Floating Suction Control Condenser	65.5	hp	Grocery Store 61
5	Refrig. Multiplex Floating Head Pressure Controls	65.5	hp	Grocery Store 61
6	Anti-Sweat Heater (ASH) Controls	0	ft	Grocery Store 61
7	Refrig. Multiplex Floating Suction Control Condenser	110	hp	Grocery Store 62
8	Refrig. Multiplex Floating Head Pressure Controls	110	hp	Grocery Store 62
9	Anti-Sweat Heater (ASH) Controls	369	ft	Grocery Store 62
10	Refrig. Multiplex Floating Suction Control Condenser	154.5	hp	Grocery Store 85
11	Refrig. Multiplex Floating Head Pressure Controls	154.5	hp	Grocery Store 85
12	Anti-Sweat Heater (ASH) Controls	132	ft	Grocery Store 85
13	Refrig. Multiplex Floating Suction Control Condenser	236	hp	Grocery Store 86
14	Refrig. Multiplex Floating Head Pressure Controls	236	hp	Grocery Store 86
15	Anti-Sweat Heater (ASH) Controls	308	ft	Grocery Store 86
16	Refrig. Multiplex Floating Suction Control Condenser	152	hp	Grocery Store 410
17	Refrig. Multiplex Floating Head Pressure Controls	152	hp	Grocery Store 410
18	Anti-Sweat Heater (ASH) Controls	83	ft	Grocery Store 410
Total		2,730		

Verified Efficiency Improvement: According to the rebate application, the following energy efficiency improvements were installed at Site #14.

Table 2. Verified Efficiency Improvements at Site #14

Measure	Description	Qty.	Units	Location
1	Refrig. Multiplex Floating Suction Control Condenser	176	hp	Grocery Store 49
2	Refrig. Multiplex Floating Head Pressure Controls	176	hp	Grocery Store 49
3	Anti-Sweat Heater (ASH) Controls	50	ft	Grocery Store 49
4	Refrig. Multiplex Floating Suction Control Condenser	65.5	hp	Grocery Store 61
5	Refrig. Multiplex Floating Head Pressure Controls	65.5	hp	Grocery Store 61
6	Anti-Sweat Heater (ASH) Controls	0	ft	Grocery Store 61
7	Refrig. Multiplex Floating Suction Control Condenser	110	hp	Grocery Store 62
8	Refrig. Multiplex Floating Head Pressure Controls	110	hp	Grocery Store 62
9	Anti-Sweat Heater (ASH) Controls	369	ft	Grocery Store 62
10	Refrig. Multiplex Floating Suction Control Condenser	154.5	hp	Grocery Store 85
11	Refrig. Multiplex Floating Head Pressure Controls	154.5	hp	Grocery Store 85
12	Anti-Sweat Heater (ASH) Controls	132	ft	Grocery Store 85
13	Refrig. Multiplex Floating Suction Control Condenser	236	hp	Grocery Store 86
14	Refrig. Multiplex Floating Head Pressure Controls	236	hp	Grocery Store 86
15	Anti-Sweat Heater (ASH) Controls	308	ft	Grocery Store 86
16	Refrig. Multiplex Floating Suction Control Condenser	152	hp	Grocery Store 410
17	Refrig. Multiplex Floating Head Pressure Controls	152	hp	Grocery Store 410
18	Anti-Sweat Heater (ASH) Controls	83	ft	Grocery Store 410
Total		2,730		

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Primary Business Descriptions: Site #14 consists of multiple grocery store spaces.

Variability in Schedule and Production: The EM&V study evaluated the rebate application information and conducted site visits to determine pre-existing and ex-post operational hours.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on the Database for Energy Efficiency Resources (DEER) and PG&E Work Paper PGEREF108. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{\text{savings/unit}}) \times \text{Number}_{\text{units}}$$

$$\text{kWh Savings} = (kWh_{\text{savings/unit}}) \times \text{Number}_{\text{units}}$$

Insufficient budget was available to perform an engineering evaluation of the DEER and PG&E unit savings estimates. EM&V findings for site #14 are provided in **Table 3**.

Table 3. EM&V Findings for Site #14

Measure	Location	Description	Qty.	Unit	Source	Ex Post kW/Unit	Ex Post kWh/y-unit	EM&V Ex Post kW Savings	Ex Post kWh/y Savings
1	49	Refrig. Multiplex Floating Suction Control Condenser	176	hp	Deer D03-220	0.039	175.96	6.92	30,969
2	49	Refrig. Multiplex Floating Head Pressure Controls	176	hp	Deer D03-224	0.036	834.28	6.25	146,833
3	49	Anti-Sweat Heater (ASH) Controls	50	ft	PG&EREF108	0.008	424	0.42	21,200
4	61	Refrig. Multiplex Floating Suction Control Condenser	65.5	hp	Deer D03-220	0.039	175.96	2.58	11,525
5	61	Refrig. Multiplex Floating Head Pressure Controls	65.5	hp	Deer D03-224	0.036	834.28	2.33	54,645
6	61	Anti-Sweat Heater (ASH) Controls	0	ft	PG&EREF108	0.008	424	0	0
7	62	Refrig. Multiplex Floating Suction Control Condenser	110	hp	Deer D03-220	0.039	175.96	4.33	19,356
8	62	Refrig. Multiplex Floating Head Pressure Controls	110	hp	Deer D03-224	0.036	834.28	3.91	91,771
9	62	Anti-Sweat Heater (ASH) Controls	369	ft	PG&EREF108	0.008	424	3.10	156,456
10	85	Refrig. Multiplex Floating Suction Control Condenser	154.5	hp	Deer D03-220	0.016	141.74	2.49	21,899
11	85	Refrig. Multiplex Floating Head Pressure Controls	154.5	hp	Deer D03-224	0.005	504.11	0.81	77,885
12	85	Anti-Sweat Heater (ASH) Controls	132	ft	PG&EREF108	0.008	424	1.1	55,968
13	86	Refrig. Multiplex Floating Suction Control Condenser	236	hp	Deer D03-220	0.023	123.54	5.31	29,155
14	86	Refrig. Multiplex Floating Head Pressure Controls	236	hp	Deer D03-224	0.006	343.64	1.4	81,099
15	86	Anti-Sweat Heater (ASH) Controls	308	ft	PG&EREF108	0.008	424	2.56	130,592
16	410	Refrig. Multiplex Floating Suction Control Condenser	152	hp	Deer D03-220	0.039	175.96	5.98	26,746
17	410	Refrig. Multiplex Floating Head Pressure Controls	152	hp	Deer D03-224	0.035	834.28	5.39	126,811
18	410	Anti-Sweat Heater (ASH) Controls	83	ft	PG&EREF108	0.008	424	0.69	35,192
Total								55.55	1,118,102

Data Collection

Operational characteristics of the refrigeration controllers were verified at the sites by MID representatives and EM&V site inspections.

Customer Cost/Benefit Analysis

Cost and Payback based on 2011 Modesto Irrigation District Rates of 0.137 \$/kWh.

- Site #14: (Retrofit Cost \$168,768 - Rebate \$66,030) / (Energy Savings \$153,180) = Simple Payback 0.67 Years.