NAVIGANT

EVALUATION, MEASUREMENT, AND VERIFICATION OF THE MODESTO, TURLOCK, AND MERCED IRRIGATION DISTRICT'S FY 2013 ENERGY EFFICIENCY PROGRAMS

Final

Prepared for:
Modesto Irrigation District
Turlock Irrigation District
Merced Irrigation District

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1. Introduction

The three Irrigation Districts of Modesto, Turlock, and Merced (MTM) are located in California's central valley near one another and each offer similar DSM programs. The similarity of DSM program offerings is especially true for each utility's non-residential sectors. The non-residential sector programs are the largest providers of claimed energy savings for each utility with 92 percent for Modesto, 97 percent, for Turlock, and over 99 percent for Merced. In addition, these three utilities use the calendar year as their fiscal year.

Given the similarities of type of utility, geographic location, and program offerings, the three joined together in the evaluation of their FY 2013 non-residential programs. The population of program participants from each was pooled together for the evaluation sample draw. By combining into one evaluation effort, the statistical reliability of results was improved for the amount of evaluation expenditure made.

1.1 *Executive Summary*

The combined programs included in the FY2013 EM&V for MTM are all from the non-residential sector. The sampled sites comprised 40 percent of the evaluated *ex-ante* electric energy savings.

As shown in Table 1-1, the share of evaluated claimed savings to total claimed savings is about 69 percent. Turlock had the lowest share of evaluated to total claimed savings of about 49 percent. The share for Modesto is about 87 percent and for Merced, nearly 100 percent.

Table 1-1. Share of Evaluated Claimed Savings to Total Claimed Savings by Utility

Utility	Total Gross Annual Ex-ante Energy Savings (kWh)	Evaluated Gross Annual Ex-ante Energy Savings (kWh)	Percent of the Total Energy Savings Evaluated
Modesto	11,061,683	9,582,306	86.6%
Turlock	13,052,240	6,453,348	49.4%
Merced	2,295,325	2,275,412	99.1%
Total	26,409,247	18,311,065	69.3%

1.1.1 Portfolio Level Ex-post Gross and Net Energy Savings by Utility

Table 1-2, Table 1-3, and Table 1-4 summarize the gross and net ex-post electricity savings for Modesto, Turlock, and Merced; respectively. All Categories included within each utilities portfolio of program offerings are identified in the tables. The realization rate of 100.6 percent is applied to each of the categories included in the EM&V combined sample. No realization rate is applied to any of the remaining categories. The net to gross ratios are taken directly from each utility's SB 1037 filing and represent an average within each category.

Table 1-2. Gross and Net Ex-post Portfolio Level Electric Savings - Modesto

Modesto Category	Gross Annual Ex-ante Energy Savings (kWh)	Energy Savings Realization Rate	Gross Annual Ex-post Energy Savings (kWh)	Net to Gross Ratio	Net Annual Ex-post Energy Savings (kWh)
Res Clothes Washers	24,924	NA	24,924	85.0%	21,185
Res Cooling	84,496	NA	84,496	83.3%	70,400
Res Dishwashers	0	NA	0	0.0%	0
Res Electronics	10,050	NA	10,050	100.0%	10,050
Res Heating	0	NA	0	0.0%	0
Res Lighting	133,601	NA	133,601	100.0%	133,601
Res Pool Pump	26,001	NA	26,001	69.0%	17,941
Res Refrigeration	267,055	NA	267,055	77.6%	207,148
Res Shell	162,202	NA	162,202	66.3%	107,523
Res Water Heating	9,978	NA	9,978	87.8%	8,758
Res Comprehensive	183,547	NA	183,547	80.0%	146,838
Non-Res Cooling	794,590	100.6%	799,164	80.0%	639,331
Non-Res Heating	0	NA	0	0.0%	0
Non-Res Lighting	5,019,350	100.6%	5,048,245	84.8%	4,278,951
Non-Res Motors	0	NA	0	0.0%	0
Non-Res Pumps	37,200	100.6%	37,414	80.0%	29,931
Non-Res Refrigeration	3,209,924	100.6%	3,228,403	84.3%	2,720,069
Non-Res Shell	195,727	100.6%	196,854	80.0%	157,483
Non Res Process	903,038	100.6%	908,237	80.0%	726,589
TOTAL	11,061,683		11,120,171	83.41%	9,275,798

Table 1-3. Gross and Net Ex-post Portfolio Level Electric Savings - Turlock

Turlock Category	Gross Annual Ex-ante Energy Savings (kWh)	Energy Savings Realization Rate	Gross Annual Ex-post Energy Savings (kWh)	Net to Gross Ratio	Net Annual Ex-post Energy Savings (kWh)
Res Clothes Washers	15,167	NA	15,167	80.0%	12,134
Res Cooling	151,117	NA	151,117	80.0%	120,894
Res Dishwashers	0	NA	0	0.0%	0
Res Electronics	0	NA	0	0.0%	0
Res Heating	0	NA	0	0.0%	0
Res Lighting	40,304	NA	40,304	50.0%	20,152
Res Pool Pump	0	NA	0	0.0%	0
Res Refrigeration	116,648	NA	116,648	66.7%	77,784
Res Shell	12,634	NA	12,634	55.7%	7,043
Res Water Heating	0	NA	0	0.0%	0
Res Comprehensive	23,179	NA	23,179	80.0%	18,543
Non-Res Cooling	0	NA	0	0.0%	0
Non-Res Heating	0	NA	0	0.0%	0
Non-Res Lighting	11,244,421	100.6%	11,309,152	80.0%	9,047,322
Non-Res Motors	229,245	100.6%	230,565	78.6%	181,128
Non-Res Pumps	282,866	100.6%	284,494	80.0%	227,596
Non-Res Refrigeration	490,059	100.6%	492,880	80.3%	396,001
Non-Res Shell	138,380	100.6%	139,177	80.0%	111,341
Non Res Process	308,220	100.6%	309,994	82.0%	254,102
TOTAL	13,052,240		13,125,311	79.80%	10,474,040

Table 1-4. Gross and Net Ex-post Portfolio Level Electric Savings - Merced

Merced Category	Gross Annual Ex-ante Energy Savings (kWh)	Energy Savings Realization Rate	Gross Annual Ex-post Energy Savings (kWh)	Net to Gross Ratio	Net Annual Ex-post Energy Savings (kWh)
Res Clothes Washers	3,596	NA	3,596	85.0%	3,057
Res Cooling	257	NA	257	67.8%	174
Res Dishwashers	368	NA	368	80.0%	295
Res Electronics	0	NA	0	0.0%	0
Res Heating	0	NA	0	0.0%	0
Res Lighting	2,662	NA	2,662	62.1%	1,654
Res Pool Pump	0	NA	0	0.0%	0
Res Refrigeration	5,687	NA	5,687	75.0%	4,265
Res Shell	0	NA	0	0.0%	0
Res Water Heating	0	NA	0	0.0%	0
Res Comprehensive	0	NA	0	0.0%	0
Non-Res Cooling	766,557	100.6%	770,970	78.1%	601,810
Non-Res Heating	0	NA	0	0.0%	0
Non-Res Lighting	1,497,363	100.6%	1,505,983	78.0%	1,174,667
Non-Res Motors	0	NA	0	0.0%	0
Non-Res Pumps	0	NA	0	0.0%	0
Non-Res Refrigeration	7,394	100.6%	7,437	85.0%	6,321
Non-Res Shell	0	NA	0	0.0%	0
Non Res Process	11,440	100.6%	11,506	78.0%	8,975
TOTAL	2,295,325		2,308,466	78.03%	1,801,218

Table 1-5, Table 1-6, and Table 1-7 summarize the gross and net ex-post coincident peak demand savings for Modesto, Turlock, and Merced; respectively. The demand realization rate as energy of 95.2 percent is applied to each of the programs included in the EM&V combined sample. No realization rate is applied to any of the remaining programs. The ex-ante gross coincident peak demand savings are taken directly from each utility's SB 1037 filing.

Table 1-5. Gross and Net Ex-post Portfolio Level Coincident Peak Demand Savings - Modesto

Modesto Category	Gross Ex-ante Coincident Peak Demand (kW)	Demand Realization Rate	Gross Ex-post Coincident Peak Demand (kW)	Net to Gross Ratio	Net Ex-post Coincident Peak Demand (kW)
Res Clothes Washers	63.9	NA	63.9	85.0%	54.3
Res Cooling	80.3	NA	80.3	83.3%	66.9
Res Dishwashers	0.0	NA	0.0	0.0%	0.0
Res Electronics	0.0	NA	0.0	0.0%	0.0
Res Heating	0.0	NA	0.0	0.0%	0.0
Res Lighting	19.0	NA	19.0	100.0%	19.0
Res Pool Pump	6.4	NA	6.4	69.0%	4.4
Res Refrigeration	29.6	NA	29.6	77.6%	22.9
Res Shell	156.6	NA	156.6	66.3%	103.8
Res Water Heating	0.2	NA	0.2	87.8%	0.1
Res Comprehensive	0.0	NA	0.0	0.0%	0.0
Non-Res Cooling	140.1	95.2%	133.4	80.0%	106.7
Non-Res Heating	0.0	NA	0.0	0.0%	0.0
Non-Res Lighting	737.7	95.2%	702.2	84.8%	595.2
Non-Res Motors	0.0	NA	0.0	0.0%	0.0
Non-Res Pumps	18.6	95.2%	17.7	80.0%	14.2
Non-Res Refrigeration	326.7	95.2%	311.0	84.3%	262.0
Non-Res Shell	3.6	95.2%	3.4	80.0%	2.7
Non Res Process	135.5	95.2%	129.0	80.0%	103.2
TOTAL	1,718.2		1,652.7	82.02%	1,355.6

Table 1-6. Gross and Net Ex-post Portfolio Level Coincident Peak Demand Savings - Turlock

Turlock Category	Gross Ex-ante Coincident Peak Demand (kW)	Demand Realization Rate	Gross Ex-post Coincident Peak Demand (kW)	Net to Gross Ratio	Net Ex-post Coincident Peak Demand (kW)
Res Clothes Washers	6.3	NA	6.3	80.0%	5
Res Cooling	34.9	NA	34.9	80.0%	28
Res Dishwashers	0.0	NA	0.0	0.0%	0
Res Electronics	0.0	NA	0.0	0.0%	0
Res Heating	0.0	NA	0.0	0.0%	0
Res Lighting	7.5	NA	7.5	50.0%	4
Res Pool Pump	0.0	NA	0.0	0.0%	0
Res Refrigeration	29.2	NA	29.2	66.7%	19
Res Shell	12.1	NA	12.1	55.7%	7
Res Water Heating	0.0	NA	0.0	0.0%	0
Res Comprehensive	0.0	NA	0.0	0.0%	0
Non-Res Cooling	0.0	NA	0.0	0.0%	0
Non-Res Heating	0.0	NA	0.0	0.0%	0
Non-Res Lighting	1,363.0	95.2%	1,297.4	80.0%	1,038
Non-Res Motors	52.8	95.2%	50.2	78.6%	39
Non-Res Pumps	84.0	95.2%	80.0	80.0%	64
Non-Res Refrigeration	76.6	95.2%	72.9	80.3%	59
Non-Res Shell	125.1	95.2%	119.1	80.0%	95
Non Res Process	149.7	95.2%	142.5	82.0%	117
TOTAL	1,941.1		1,852	79.64%	1,475

Table 1-7. Gross and Net Ex-post Portfolio Level Coincident Peak Demand Savings – Merced

Merced Category	Gross Ex-ante Coincident Peak Demand (kW)	Demand Realization Rate	Gross Ex-post Coincident Peak Demand (kW)	Net to Gross Ratio	Net Ex-post Coincident Peak Demand (kW)
Res Clothes Washers	9.2	NA	9.2	85.0%	7.8
Res Cooling	0.0	NA	0.0	0.0%	0.0
Res Dishwashers	1.3	NA	1.3	80.0%	1.0
Res Electronics	0.0	NA	0.0	0.0%	0.0
Res Heating	0.0	NA	0.0	0.0%	0.0
Res Lighting	0.5	NA	0.5	62.1%	0.3
Res Pool Pump	0.0	NA	0.0	0.0%	0.0
Res Refrigeration	1.0	NA	1.0	75.0%	0.7
Res Shell	0.0	NA	0.0	0.0%	0.0
Res Water Heating	0.0	NA	0.0	0.0%	0.0
Res Comprehensive	0.0	NA	0.0	0.0%	0.0
Non-Res Cooling	0.0	NA	0.0	0.0%	0.0
Non-Res Heating	0.0	NA	0.0	0.0%	0.0
Non-Res Lighting	0.6	95.2%	0.6	78.0%	0.5
Non-Res Motors	0.0	NA	0.0	0.0%	0.0
Non-Res Pumps	0.0	NA	0.0	0.0%	0.0
Non-Res Refrigeration	1.7	95.2%	1.6	85.0%	1.4
Non-Res Shell	0.0	NA	0.0	0.0%	0.0
Non Res Process	0.1	95.2%	0.1	78.0%	0.1
TOTAL	14.4		14.2	82.72%	11.8

1.1.2 Recommendations

Include the Coincident Demand Diversity Factor and HVAC Interactive Factors while calculating the energy and the demand savings for the custom lighting projects. The Navigant team recommends that the Coincident Demand Diversity Factor and the DEER Interactive Effects Factors should be used while calculating the energy and the demand savings for the custom lighting projects implemented in the conditioned spaces. These factors are outlined in the Customized Calculated Savings Guidelines for Non Residential Programs, Version 6.0[1]. The Coincident Demand Diversity Factor provides a probability that the light affected by the project will be on during the facility's peak demand period. Coincident Diversity Factor for peak demand is based on the project's technology (CFL, Non-CFL, or LED Exit Sign), building

[1] More information is available at: http://www.aesc-inc.com/download/spc/2013SPCDocs/PGE/Customized%202.0%20Energy%20Savings.pdf, page 84.

type and climate zone. These factors are documented in the Database for Energy Efficiency Resources and are only applicable for the indoor lighting. Also, by reducing the lighting load in the air-conditioned areas, the load on the HVAC system is lowered and this effect must be quantified using the HVAC Interactive Factors.

Provide additional quality control for the ex-ante savings calculations. At site 15, the ex-ante calculations listed the efficient lighting system correctly as '4-foot 6-lamp T8 fixture' in the "Proposed Lighting" table for three fixtures but listed the wattage for the baseline metal halide fixture in the 'Proposed Lighting' table. This resulted in slightly less claimed ex-ante savings for the site 15. The Navigant team recommends additional quality control of projects to filter out such errors from programs.

Contact program participants who received new door gaskets and insure the material being installed is of high quality. At the two sites we visited with door gasket installation, the Navigant staff found that the gaskets appeared to be of poor quality. Though still providing a seal, they were beginning to deteriorate. The gasket measure has a rated measure life of 4 years but the condition of the gaskets did not look promising to last for the rated measure life.

1.2 Regulatory Context

Two legislative bills regulate the energy efficiency conservation programs for California's Publicly-Owned Utilities (POU). These include the Senate Bill 1037 (SB 1037) and Assembly Bill 2021 (AB 2021), which were signed into law a year apart. SB 1037 requires that, similar to the states' Investor-Owned Utilities (IOU), California's ~40 POUs must place cost- effective, reliable, and feasible energy efficiency and demand reduction resources at the top of the utility resource loading order. The intention if this Bill is to give priority to the efficiency resource in utility operating plans. Additionally, SB 1037 (signed September 29, 2005) requires that POUs submit an annual report describing utility programs, expenditures, expected energy savings, and actual energy savings.

Assembly Bill 2021, signed by the governor a year later (September 29, 2006), reiterates the loading order and annual report stated in SB1037 and expands on the annual report requirements. The expanded report requires inclusion of investment funding and cost-effectiveness methodologies. It also requires the inclusion of an independent evaluation that measures and verifies both the energy efficiency savings and reductions in energy demand that are achieved through utilities' energy efficiency and demand reduction programs. Additionally, AB 2021 requires a report every three years that highlights cost-effective potential electric savings from energy efficiency, and establishes annual targets for electricity energy efficiency and demand reduction over ten years. However, Assembly Bill 2227 (Bradford, 2012) amended this requirement to a quadrennial basis.

The California Energy Commission (CEC) is mandated by the legislature to oversee POU SB 1037 and AB 1021 energy efficiency program and evaluation, measurement, and verification (EM&V) efforts, with the following requirements for the CEC:

» Monitor POUs' annual efficiency progress.

» Review POU independent evaluation studies, reporting results, and, if necessary, recommend improvements.
» Ensure that savings verification increases the reliability of savings and contributes to better program design.

The CEC also was mandated to provide the POUs EM&V Guidelines under which plans[2] should be submitted. This study comports with those guidelines.

1.3 Objectives and Relevant Protocols

The overarching goals of these FY 2013 EM&V activities are to provide MTM with unbiased, objective, and independent program evaluations by giving the following:

» Useful recommendations and feedback to improve MTM program operation, tracking, and measure offerings.
» Assessment of the quality of the program tracking data and supporting project application data for impact evaluation purposes.
» Increased level of confidence in conservation program results.

To achieve these goals, the Navigant team undertook impact evaluations of the MTM non-residential programs using the following guidelines for Navigant team activities:

» CEC POU EM&V Guidelines
» California Energy Efficiency Evaluation Protocols
» California Evaluation Framework

As a basic component of program impact evaluations, the Navigant team referred to International Performance Measurement and Verification Protocols (IPMVP) to determine the best options for evaluating energy efficiency measures (EEMs). These protocols are discussed in detail in Section 2. . In Section 1.3.1 below, we provide a detailed discussion of relevant CEC POU EM&V Guidelines and Criteria required for MTM evaluations.

1.3.1 CEC EM&V Guidelines

CEC Guidelines include both *POU reporting schedules* as well as a set of *CEC EM&V Framework of Criteria* Guidelines by which POU EM&V reporting materials are to be evaluated.

Specific EM&V reporting materials and CEC feedback reports are required to meet the following schedules:

» CMUA's annual Report – every March 15.

[2] SB 1037 and AB 1021 did not require energy efficiency reporting to the CEC for smaller POUs with loads equal to or less than 500,000 megawatt-hours (MWh)/year.

- CMUA's E3 Reporting Tool – every March 15.
- EM&V Portfolio-level Evaluation Plans – For POUs that do formal portfolio-level evaluation plans, reports should be submitted to the CEC as they are completed.
- EM&V Evaluation (Impact) Studies - Submit to the CEC as they are completed.
- The CEC will provide feedback on the EM&V report directly to the POU staff contact within 60 days of receiving the report. The Commission will generally base its evaluation of the report on the *Framework of Criteria*; however, feedback on and evaluation of the report will be interactive between Commission staff and POU staff.[3]

For EM&V evaluation impact studies, the CEC guidelines require use of the CEC *Framework of Criteria* to guide the development and execution of EM&V impact studies through the following stages:

- Gross savings methods, including both engineering and billing analysis
- NTG methods
- Sampling and statistical precision
- EM&V reporting requirements

The CEC *Framework of Criteria* guidelines (Part D), as identified in Table 1-8, provide a checklist for submitted POU EM&V reports.

[3]As part of these reporting requirements, Navigant and MTM staff have established a goal of submitting EM&V studies to CEC by February of each year—at or near the same time as the March Report is due.

Table 1-8. CEC *Framework of Criteria* Guidelines (Part D)

Contextual Reporting

- ☐ Does the EM&V report clearly state savings values consistent with the associated SB 1037 annual report?
- ☐ Does the evaluation cover a significant portion of the POUs portfolio and clearly describe the programs or savings not evaluated?
- ☐ Does the evaluation assess risk or uncertainly in selecting the components of the portfolio to evaluate?

Overview and Documentation of Specific Evaluation Effort

- ☐ Does the report clearly identify what is being evaluated in the study (part of a program; an entire program; the entire portfolio)?
- ☐ Does the evaluation include an assessment of EUL and lifecycle savings?
- ☐ Does the evaluation report provide documentation of all engineering and billing analysis algorithms, assumptions, survey instruments and explanation of methods?
- ☐ Does the report describe the methodology in sufficient detail that another evaluator could replicate the study and achieve similar results?
- ☐ Are all data collection instruments included, typically in an appendix?
- ☐ Does the report adequately describe metering equipment and protocols, if any, typically in an appendix?

Gross Savings

- ☐ Does the report review the program's choice of baseline?
- ☐ Does the report clearly characterize the population of participants?
- ☐ Does the report clearly discuss its sampling approach and sample design?
- ☐ Does the report state the sampling precision targets and achieved precision?
- ☐ Does the report clearly present ex-post savings?
- ☐ Are the results expanded to the program population? If not, the report should state why not and clearly indicate where ex-ante savings are being passed through.
- ☐ Does the study clearly explain any differences between ex-ante and ex-post savings?

Net Savings

- ☐ Does the evaluation include a quantitative assessment of net-to-gross? If not, does the evaluator clearly indicate the source of the assumed net-to-gross value?
- ☐ Does the report clearly discuss its sampling approach and sample design?
- ☐ If a self-report method is used, does the approach account for free-ridership?

EM&V Summary and Conclusions

- ☐ Does the report provide clear recommendations for improving program processes to achieve measurable and cost-effective energy savings?
- ☐ Does the evaluation assess the reliability of the verified savings and areas of uncertainty?

Source: California Energy Commission EM&V Guidelines, POU Energy Efficiency Programs, January 2011

1.4 Modesto, Turlock, and Merced Energy Efficiency Program Offerings

The MTM irrigation districts currently offers a number of energy efficiency programs in both the residential and non-residential sectors. Table 1-9 provides a listing of the ex-ante claimed savings by program for the Modesto Irrigation District. The non-residential sector accounts for 92 percent of the claimed gross energy savings.

Table 1-9. Summary of Energy Efficiency Savings for the Modesto Irrigation District at the Program Level, FY 2013

Modesto Category	Gross Annual Energy Savings (kWh)	Percent of Total Gross Annual Energy Savings	Net Annual Energy Savings (kWh)	Percent of Total Net Annual Energy Savings	Net Coincident Peak Savings (kW)	Percent of Net Coincident Peak Demand Savings
Res Clothes Washers	24,924	0.23%	21,185	0.23%	54.3	3.85%
Res Cooling	84,496	0.76%	70,400	0.76%	66.9	4.75%
Res Dishwashers	0	0.00%	0	0.00%	0.0	0.00%
Res Electronics	10,050	0.09%	10,050	0.11%	0.0	0.00%
Res Heating	0	0.00%	0	0.00%	0.0	0.00%
Res Lighting	133,601	1.21%	133,601	1.45%	19.0	1.35%
Res Pool Pump	26,001	0.24%	17,941	0.19%	4.4	0.31%
Res Refrigeration	267,055	2.41%	207,148	2.25%	22.9	1.63%
Res Shell	162,202	1.47%	107,523	1.17%	103.8	7.36%
Res Water Heating	9,978	0.09%	8,758	0.09%	0.1	0.01%
Res Comprehensive	183,547	1.66%	146,838	1.59%	0.0	0.00%
Non-Res Cooling	794,590	7.18%	635,672	6.89%	112.1	7.95%
Non-Res Heating	0	0.00%	0	0.00%	0.0	0.00%
Non-Res Lighting	5,019,350	45.38%	4,254,459	46.11%	625.3	44.33%
Non-Res Motors	0	0.00%	0	0.00%	0.0	0.00%
Non-Res Pumps	37,200	0.34%	29,760	0.32%	14.9	1.06%
Non-Res Refrigeration	3,209,924	29.02%	2,704,500	29.31%	275.3	19.52%
Non-Res Shell	195,727	1.77%	156,582	1.70%	2.9	0.20%
Non Res Process	903,038	8.16%	722,430	7.83%	108.4	7.69%
TOTAL	11,061,683	100%	9,226,846	100%	1,410.4	100%

Table 1-10 provides a listing of the ex-ante claimed savings by program for the Turlock Irrigation District. The non-residential sector accounts for 97 percent of the claimed gross energy savings.

Table 1-10. Summary of Energy Efficiency Savings for the Turlock Irrigation District at the Program Level, FY 2013

Turlock Category	Gross Annual Energy Savings (kWh)	Percent of Total Gross Annual Energy Savings	Net Annual Energy Savings (kWh)	Percent of Total Net Annual Energy Savings	Net Coincident Peak Savings (kW)	Percent of Net Coincident Peak Demand Savings
Res Clothes Washers	15,167	0.12%	12,134	0.12%	5.0	0.33%
Res Cooling	151,117	1.16%	120,894	1.16%	27.9	1.85%
Res Dishwashers	0	0.00%	0	0.00%	0.0	0.00%
Res Electronics	0	0.00%	0	0.00%	0.0	0.00%
Res Heating	0	0.00%	0	0.00%	0.0	0.00%
Res Lighting	40,304	0.31%	20,152	0.19%	3.7	0.25%
Res Pool Pump	0	0.00%	0	0.00%	0.0	0.00%
Res Refrigeration	116,648	0.89%	77,784	0.75%	19.5	1.30%
Res Shell	12,634	0.10%	7,043	0.07%	6.7	0.45%
Res Water Heating	0	0.00%	0	0.00%	0.0	0.00%
Res Comprehensive	23,179	0.18%	18,543	0.18%	0.0	0.00%
Non-Res Cooling	0	0.00%	0	0.00%	0.0	0.00%
Non-Res Heating	0	0.00%	0	0.00%	0.0	0.00%
Non-Res Lighting	11,244,421	86.15%	8,995,537	86.37%	1090.4	72.46%
Non-Res Motors	229,245	1.76%	180,091	1.73%	0.0	0.00%
Non-Res Pumps	282,866	2.17%	226,293	2.17%	67.2	4.47%
Non-Res Refrigeration	490,059	3.75%	393,734	3.78%	61.5	4.09%
Non-Res Shell	138,380	1.06%	110,704	1.06%	100.1	6.65%
Non Res Process	308,220	2.36%	252,648	2.43%	122.7	8.16%
TOTAL	13,052,240	100%	10,415,557	100%	1,504.8	100%

Table 1-11 provides a listing of the ex-ante claimed savings by program for the Merced Irrigation District. The non-residential sector accounts over 99 percent of the claimed gross energy savings. All of the non-residential claimed portfolio level savings are included in the evaluation.

Table 1-11. Summary of Energy Efficiency Savings for the Merced Irrigation District at the Program Level, FY 2013

Merced Category	Gross Annual Energy Savings (kWh)	Percent of Total Gross Annual Energy Savings	Net Annual Energy Savings (kWh)	Percent of Total Net Annual Energy Savings	Net Coincident Peak Savings (kW)	Percent of Net Coincident Peak Demand Savings
Res Clothes Washers	3,596	0.16%	3,057	0.17%	7.8	58.42%
Res Cooling	257	0.01%	174	0.01%	0.0	0.18%
Res Dishwashers	368	0.02%	295	0.02%	1.0	7.51%
Res Electronics	0	0.00%	0	0.00%	0.0	0.00%
Res Heating	0	0.00%	0	0.00%	0.0	0.00%
Res Lighting	2,662	0.12%	1,654	0.09%	2.0	14.54%
Res Pool Pump	0	0.00%	0	0.00%	0.0	0.00%
Res Refrigeration	5,687	0.25%	4,265	0.24%	0.7	5.52%
Res Shell	0	0.00%	0	0.00%	0.0	0.00%
Res Water Heating	0	0.00%	0	0.00%	0.0	0.00%
Res Comprehensive	0	0.00%	0	0.00%	0.0	0.00%
Non-Res Cooling	766,557	33.40%	598,366	33.41%	0.2	1.55%
Non-Res Heating	0	0.00%	0	0.00%	0.0	0.00%
Non-Res Lighting	1,497,363	65.24%	1,167,943	65.21%	0.5	3.55%
Non-Res Motors	0	0.00%	0	0.00%	0.0	0.00%
Non-Res Pumps	0	0.00%	0	0.00%	0.0	0.00%
Non-Res Refrigeration	7,394	0.32%	6,285	0.35%	1.1	8.11%
Non-Res Shell	0	0.00%	0	0.00%	0.0	0.00%
Non Res Process	11,440	0.50%	8,923	0.50%	0.1	0.64%
TOTAL	2,295,325	100%	1,790,962	100%	13.4	100%

1.5 *Evaluation Priorities*

Although Modesto and Turlock are among the top 15 publically owned utilities in California, these three irrigation districts have limited evaluation budgets compared to the state's investor owned utilities or the largest of the publically owned utilities. However each wish to evaluate the programs providing their greatest claimed savings. By combining their evaluation effort, they conserve on their evaluation budget while still evaluating the programs that, as a group, provide the greatest amount of claimed energy savings. The existing non-residential measures included in this evaluation study also have a high degree of uncertainty; especially compared to the measures offered through their residential programs. A high level of statistical validity is achieved as well as the sample that was drawn with a design to achieve statistical validity of 90 percent, +/- 15 percent. Achieving this level of statistical validity would have been difficult if each had evaluated their programs individually.

If each of the utilities had independently evaluated their non-residential programs with the same sampling precision, the number of sample sites across the three utilities would be much higher. By combining the three utilities into one EM&V effort, a 66 percent reduction in sample sites is achieved with corresponding budgetary savings.

2. Overview of Approach and Sampling

2.1 Key Issues

The key issues for this impact evaluation included sample selection and the selection of the appropriate level of rigor with which to evaluate gross energy savings and peak demand impacts. The purpose of conducting ex-post savings analysis is to develop more precise and more accurate (i.e., less biased) estimates of both individual measure savings and overall program savings.

The Navigant team used the International Performance Measurement and Verification Protocol (IPMVP) to guide the evaluation strategy for each program. Table 2-1 provides an overview of these IPMVP options.

Table 2-1. Overview of IPMVP M&V Options

IPMVP M&V Option	Measure Performance Characteristics	Data Requirements
Option A: Engineering calculations using spot or short-term measurements, and/or historical data	Constant performance	» Verified installation » Nameplate or stipulated performance parameters » Spot measurements » Run-time hour measurements
Option B: Engineering calculations using metered data	Constant or variable performance	» Verified installation » Nameplate or stipulated performance parameters » End-use metered data
Option C: Analysis of utility meter (or sub-meter) data using techniques from simple comparison to multivariate regression analysis	Variable performance	» Verified installation » Utility metered or end-use metered data » Engineering estimate of savings input to model
Option D: Calibrated energy simulation/modeling; calibrated with hourly or monthly utility billing data and/or end-use metering	Variable performance	» Verified installation » Spot measurements, run-time hour monitoring, and/or end-use metering to prepare inputs to models » Utility billing records, end-use metering, or other indices to calibrate models

Source: International Performance Measurement & Verification Protocol; http://www.nrel.gov/docs/fy02osti/31505.pdf

IPMVP option A is frequently used for lighting and high performance motor installations, where operational power does not vary significantly. Commercial/industrial electrical efficiency measures are most commonly suited to analysis using option B, with the installation of metering equipment for a few weeks on the end-use measures. Gas efficiency measures are often analyzed using option C, particularly if the gas measure affects a significant portion of the facility's gas usage. Electrical measures may also be analyzed using option C if they have a relatively isolated utility feed with minimal loads other than the affected end use. Option D is generally used only for new construction, which has a package of measures and no history of usage.

2.2 *General M&V Approaches*

The Navigant team considered many issues when matching M&V approaches to different programs, including the following:

- » Size and proportion of the expected impact
- » Degree of site-by-site variation in per-unit savings
- » Aggregate size of the measure's impact at the program and portfolio levels
- » Cost of applying the savings estimation method
- » Sampling size and associated sampling error
- » Reliability of the measured data

The IPMVP evaluation option primarily used for this evaluation is Option A but Options B and C were also utilized. In all cases, on-site verification was performed.

2.2.1 On-Site Inspections

The Navigant team conducted on-site inspections for most of the sample group selected for the FY 2013 program EM&V. The inspections encompass a range of activities, including the following:

- » Simple verification of measure installations
- » Confirmation of measure counts, capacities, and efficiencies
- » Observation of the quality of installation of the technology
- » Collection of nameplate and other performance data
- » Observation of control systems and schedules
- » Confirmation of baseline conditions (as possible)
- » Discussions with building operators about building construction features, occupancy schedules, and energy systems characteristics and operation

In addition to these on-site inspection and verification activities, on-site performance measurement activities fall into the following three broad categories:

- » **Spot measurements** – Spot measurements are the first and simplest level of on-site performance measurement and include one-time instantaneous measurements of technology, system, or environmental factors including temperature, volts, amperes, true power, power factor, light levels, and other variables. As a general guide, these measures are used to quantify single operating parameters that do not vary significantly over time or are intended to provide a snapshot in time. They are not intended to capture seasonal or longer term effects. Another way of looking at this approach is that it is useful in assessing the savings of constant performance measures.

- **Run-time hour data logging –** Run-time hour monitoring represents the second level of performance measurement and is used to record run-time profiles over a given time period or operating hour totals. Run-time hour monitoring is particularly useful for estimating long-term energy consumption from short-term measurements, particularly for technologies which exhibit constant performance characteristics. For example, this method is used extensively for assessing the operating hours of lighting systems and constant load motor systems. Monitoring is conducted with small, portable, simple-to-use monitors, which typically hold two weeks' to one month's worth of data.
- **Interval metering –** Interval metering is the most sophisticated level of on-site performance measurement and involves real-time monitoring of the energy use of specific end uses over a specified time period. This may involve recording true energy use or "proxy" values such as voltage and amperes from which energy used is computed. Interval metering is often used to measure pre- and post-installation performance to obtain accurate data on measure performance. Typically, this strategy is not deployed over long enough time periods to gauge seasonal effects, so the results of the measurements must be integrated into an analysis model to compute annual and seasonal impacts.

2.3 Peak Demand Estimation

The Navigant team used the California Protocol guidelines to estimate peak demand impact at the basic rigor level. The basic rigor prescribes that at a minimum, an on-peak demand savings estimate is based on allocation of gross energy savings through the use of allocation factors, end-use load shapes or end-use savings load shapes. This secondary data can be from DEER, the CEC forecasting model, utility end-use load shape data or other prior studies.

2.4 Sampling

For each program evaluation, the Navigant team defines the population based on the program tracking databases provided by each utility. Information on installed measures, installation dates, key customer characteristics, and estimated savings are the primary data components that are reviewed for programs when developing the sample design. Where appropriate, the Navigant team also utilized other key program characteristics in determining an appropriate sampling design, such as the distribution of customer or business types, the number of measures or projects per participant, implementation contractors, and geography.

Statisticians have developed many approaches to sample design. Each of these approaches may be best suited for a particular evaluation based on the objectives of each program and the availability of the population data. The Navigant team utilizes a variety of sampling approaches depending on the nature of the program and the key areas of interest for evaluation. The specific sampling approach used for each program evaluated is discussed in their respective chapters. Some of the sampling approaches that are commonly used are listed below:

- ***Simple Random Sampling.*** Simple random sampling is a method of selecting sample cases out of the population such that every one of the distinct population cases has an equal chance of being selected.
- ***Systematic Sampling.*** In systematic sampling, each sample unit is chosen at a prescribed interval. Often this approach is used to ensure that the sample draw achieves a representative distribution of a particular characteristic, such as ex-ante project savings.
- ***Stratified Random Sampling.*** In this method, the sample population is divided into subgroups (i.e., strata) based on a known characteristic such as savings level or energy usage. Stratified random samples can produce estimates with smaller coefficients of variation than simple random samples. A sample is then randomly chosen from each stratum in one of three ways: proportional stratification, optimal stratification, or disproportionate stratification.
- ***Cluster Sampling or Snowball Sampling.*** Cluster sampling can be used to reduce the geographic distribution of the sample. The technique is employed where appropriate in sample selection or the scheduling of site visits to reduce travel times and more efficiently utilize field staff.
- ***Ratio Estimation*** is a sampling method that can achieve increased precision and reliability by taking advantage of a relatively stable correlation between an auxiliary variable and the variable of interest. For the evaluation of energy efficiency programs, the most frequency utilized ratio is the realization rate between ex- ante savings and ex- post savings.

For nearly all sampling methodologies, one of the key variables that influence the sample size is the coefficient of variation (CV). The CV is a measure of the variability of the key data point(s) being measured: the higher the variability, the higher the CV, and the larger the sample size needed to achieve the same confidence and precision. The CV can be assigned for an entire program or for an individual stratum. The Navigant team adhered to industry standards and CEC Protocols in determining an appropriate, but conservative CV to use for each program evaluation

2.4.1 Sampling for Modesto, Turlock, and Merced

As a means to reduce Evaluation, Measurement, and Verification (EM&V) costs while at the same time maintaining a high level of statistical confidence, the three Irrigation Districts of Turlock, Modesto, and Merced implemented a joint EM&V of their non-residential programs. The three sets of non-residential programs are similar in scope and the three Irrigation Districts have similar customers. Additionally, the three are geographically close to each other.

The population universe for the EM&V sample is all the calendar year 2013 participants in their non-residential existing buildings programs. Stratified ratio estimation sampling was employed. The sample was drawn with the goal of achieving a sampling precision of 90 percent +/- 15 percent at the project level. With this sampling precision, the sample size is 18 sites. If each of the utilities had independently evaluated their non-residential programs with the same sampling precision, the combined number of sample sites is 53. By combining the three utilities into one EM&V effort, a 66 percent reduction in sample sites is achieved with corresponding budgetary savings.

Table 2-2 provides a breakout by utility of claimed ex-ante savings, number of projects completed in 2013, and the sample of projects drawn from each utility.

Table 2-2. Claimed Ex-ante Savings, Completed Projects, and Sampled Projects by Utility

Utility	Ex-ante Kwh	Share	Projects	Share	Sample	Share
Modesto	9,582,306	52%	165	77%	9	50%
Turlock	6,453,348	35%	40	19%	7	39%
Merced	2,275,412	12%	10	5%	2	11%
Total	18,311,065	100%	215	100%	18	100%

2.4.1.1 Stratified Ratio Estimation Sampling

Stratified ratio estimation combines a stratified sample design with a ratio estimator. Both stratification and ratio estimation take advantage of supporting information available for each project in the population. In the case of the non-residential programs, the supporting information is ex-ante energy savings per project.

By using the ex-ante energy savings per project as the stratification variable, the coefficient of variation in each stratum is reduced thereby improving the statistical precision. Moreover, the sampling fraction can be varied from stratum to stratum to further improve the statistical precision. In particular, a relatively smaller sample is selected from the accounts with small energy savings, but the sample is forced to include a higher proportion of the projects with larger levels of energy savings.

2.4.1.2 Non-Residential Projects Sampled

The population of accounts for the non-residential existing buildings programs consists of a total of 215 projects. These projects have a very wide range of energy savings extending from 52 kWh to 1,638,499 kWh with the median being 20,161 kWh. The population coefficient of variation of the energy savings is large and stratified ratio estimation sampling provides the best methodology to attain both a sampling precision of 90 percent +/- 15 percent at the project level as well as a very high percentage of overall sampled *ex-ante* savings. The final sample consists of 18 projects (8 percent) and more importantly 40 percent of the *ex-ante* electric energy savings. Some swapping of sites within stratums was performed to insure each utility was represented. Table 2-3 identifies each sampled site with utility, project type, ex-ante savings, sample strata, and sample weight.

Table 2-3. Sample with Utility, Project Type, Ex-ante Savings, Sample Strata, and Sample Weight

Site #	Utility	Project Type	Ex-ante Savings (kWh)	Sample Strata	Stratum Weight
13	Turlock	Lighting	1,638,499	Stratum 1	1.37
1	Merced	Lighting	1,015,266	Stratum 1	1.37
3	Modesto	Refrigeration Controls	937,583	Stratum 1	1.37
14	Turlock	Lighting	897,869	Stratum 1	1.37
5	Modesto	Refrigeration	868,320	Stratum 1	1.37
6	Modesto	Lighting	397,837	Stratum 1	1.37
4	Modesto	Compressor	357,974	Stratum 2	4.71
7	Modesto	Lighting	294,177	Stratum 2	4.71
17	Turlock	Lighting	199,729	Stratum 2	4.71
18	Turlock	Lighting	174,981	Stratum 2	4.71
2	Merced	Lighting	143,506	Stratum 2	4.71
9	Modesto	Lighting	138,106	Stratum 2	4.71
8	Modesto	Lighting	82,197	Stratum 3	19.59
15	Turlock	Lighting	73,937	Stratum 3	19.59
16	Turlock	Lighting	28,467	Stratum 3	19.59
10	Modesto	Refrigeration	20,148	Stratum 3	19.59
12	Modesto	Refrigeration & Lighting	8,338	Stratum 3	19.59
11	Modesto	Refrigeration	4,249	Stratum 3	19.59
	TOTAL		7,281,183		

3. Estimating Project Level Ex-post Savings

The Navigant team conducted site visits to each of the 18 sampled projects. At each site, the Navigant team visually inspected the measures installed and for some of the sites, installed metering equipment to capture the measure operation.

3.1 Site 1

3.1.1 Project Summary

The site is a food processing facility in Livingston, CA.

The site replaced 347 400-Watt metal halide high bay fixtures with 146-Watt Durosite high bay LED fixtures on one-to-one basis in its refrigerated cooler area. The lighting system at the site operates 24 by 7 (8,760 hours annually).

The energy savings realization rate for the project is on a higher side because the Navigant team used HVAC interactive factor from the DEER 2011 database for the energy savings calculations. The ex-ante calculations did not use any HVAC interactive factors in the calculations.

Table 3-1. First Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	1,015,266	1,407,846	139 %
Demand Savings (kW)	-	136.2	NA

Source: Project Documentation, Navigant Analysis

3.1.2 Project Description

3.1.2.1 Description of the Baseline and the Installed Efficient Equipment and Operation

The baseline condition included a total of 347 400-Watt metal halide fixtures in the cooler area. These fixtures had 8,760 annual operating hours (24 by 7 schedule).

The site installed 347 146-Watt Durosite high bay LED fixtures on one-to-one basis. The efficient case system also operates on a 24 by 7 schedule.

3.1.2.2 Comments on Ex-Ante Calculations

The ex-ante calculations used a standard lighting algorithm for the energy savings. The algorithm is listed as follows:

Energy Savings:

ΔkWh = ((WattsBASE – WattsEE) / 1000) x Annual Operating Hours

Where:

ΔkWh	= Annual energy saved (in kWh)
WattsBASE	= Connected load of the baseline fixtures
WattsEE	= Connected load of energy efficient fixtures

The ex-ante calculations do not include DEER Interactive Effects Factor as outlined in the Customized Calculated Savings Guidelines for Non Residential Programs, Version 6.0[4].

The Navigant team's review of the 2013 E3 submitted by Merced Irrigation District also shows that there are no demand savings claimed for this project.

3.1.3 On-Site Visit

3.1.3.1 M&V Method

The Navigant team collected the following data during the on-site visit:

» Confirmed the wattage, quantity and schedules of the fixtures
» Confirmed the lamp wattage
» Installed one lighting logger in the cooler area of the site.

This approach is in-line with the IPMVP Option A.

3.1.3.2 Summary of Site Visit

During the onsite visit, Navigant site visit engineers confirmed that the new fixtures are in place and are operating as expected. It was found that actual installed fixtures have a higher wattage rating (163 watts/fixture) than the claimed efficient case fixture wattage (146 watts/fixture).

The Navigant team installed six lighting loggers to capture the operating hours of the lighting fixtures.

3.1.3.3 Ex-Post Calculations and Assumptions

The Navigant team revised the algorithms used in the ex-ante calculations to reflect the energy and demand savings algorithms provided in the Customized Calculated Savings Guidelines for Non Residential Programs (Version 6.0).

The Navigant team used the following algorithms to calculate demand and energy savings:

[4] More information is available at: http://www.aesc-inc.com/download/spc/2013SPCDocs/PGE/Customized%202.0%20Energy%20Savings.pdf, page 84.

Annual Energy Savings Algorithm:

$\Delta kWh = ((kW_{Baseline} – kW_{EE}) / 1000) \times HOURS \times DIE_{Energy}$

Where:

$kW_{Baseline}$	= Connected load of baseline fixtures
kW_{EE}	= Connected load of energy efficient fixtures
HOURS	= Average hours of use per year
DIE_{Energy}	= DEER Interactive Effects Factor for energy savings

Summer Coincident Peak kW Savings Algorithm:

$\Delta kW = ((kW_{Baseline} – kW_{EE}) / 1000) \times DIE_{Demand} \times CDF$

Where:

DIE_{Demand}	= DEER Interactive Effects Factor for energy savings
CDF	= Coincident Diversity Factor for peak demand

The energy savings realization rate for the project is on a higher side because the Navigant team used HVAC interactive factor from the DEER 2011 database for the energy savings calculations.

The Navigant team did revise the baseline and efficient case fixture wattages from the ex-ante calculations as follows:

Table 3-2. Revised Fixture Wattages

Fixture	Ex-Ante Wattage	Revised Ex-Post Wattage
Baseline: 400 Watt Metal Halide	480	458
Efficient Case: High Bay LED Fixture	146	163

The demand savings realization rate for the project is 'NA' (Not Applicable) as the ex-ante savings do not claim any demand savings for this project. For the ex-post demand savings calculations, the Navigant team used HVAC interactive factor and coincident demand factor for the demand savings calculations.

The Navigant team did install lighting loggers at the site to capture the operating hours of the fixtures but were not able to retrieve the loggers from the site. Thus, used the reported operating hours for the fixtures, gathered during the site visit, for the ex-post calculations.

3.2 *Site 2*

3.2.1 Project Summary

The site is a food processing facility in Livingston, CA.

The following measures were installed in two of its freezers in the program year 2013:

» In freezer 1, the site replaced 24 400-Watt metal halide high bay fixtures with 146-Watt Durosite high bay LED fixtures on one-to-one basis, and;
» In freezer 2, the site replaced 47 4-lamp T5HO high bay fixtures with 146-Watt Durosite high bay LED fixtures on one-to-one basis.

The lighting system at the site operates 24 by 7 (8,760 annual operating hours).

The energy savings realization rate for the project is on a lower side due to the following reasons:

» The Navigant team revised the baseline fixture wattages from the ex-ante calculations according to standard rated fixture wattages as shown in Table 3-6. The ex-ante calculations had estimated fixture wattages on a higher side for the baseline fixtures.
» During the site visit, the Navigant team found that the efficient case fixtures have slightly higher wattage rating than estimated in the ex-ante calculations, this has further reduced the realization rate for the energy savings.

Table 3-3. First Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	143,506	97,373	68 %
Demand Savings (kW)	-	9.4	NA

Source: Project Documentation, Navigant Analysis

3.2.2 Project Description

3.2.2.1 Description of the Baseline and the Installed Efficient Equipment and Operation

The site had the following lighting system in the baseline.

Table 3-4. Baseline Lighting System

Location	Fixture Description	Quantity	Annual Op. Hours
NCDC Freezer 1	400-Watt Metal Halide High Bay	24	8,760
NCDC Freezer 2	324-Watt 4-lamp T5HO High Bay	47	8,760

These fixtures had 8,760 annual operating hours (24 by 7 schedule).

The site installed the following lighting system in the efficient case.

Table 3-5. Efficient Case Lighting System

Location	Fixture Description	Quantity	Annual Op. Hours
NCDC Freezer 1	146-Watt LED High Bay	24	8,760
NCDC Freezer 2	146-Watt LED High Bay	47	8,760

The efficient case system also operates on 24 by 7 schedule.

3.2.2.2 *Comments on Ex-Ante Calculations*

The ex-ante calculations use a standard lighting algorithm for the energy. The algorithm is listed as follows:

Energy Savings:

$$\Delta kWh = ((WattsBASE - WattsEE) / 1000) \times \text{Annual Operating Hours}$$

Where:

ΔkWh	= Annual energy saved (in kWh)
WattsBASE	= Connected load of the baseline fixtures
WattsEE	= Connected load of energy efficient fixtures

The ex-ante calculations do not include coincident Diversity Factor and DEER Interactive Effects Factor as outlined in the Customized Calculated Savings Guidelines for Non Residential Programs, Version 6.0[5].

The Navigant team's review of the 2013 E3 model submitted by Merced Irrigation District also shows that there are no demand savings claimed for this project.

3.2.3 On-Site Visit

3.2.3.1 *M&V Method*

The Navigant team collected the following data during the on-site visit:

- Confirmed the wattage, quantity and schedules of the fixtures
- Confirmed the lamp wattage

[5] More information is available at: http://www.aesc-inc.com/download/spc/2013SPCDocs/PGE/Customized%202.0%20Energy%20Savings.pdf, page 84.

» Installed four lighting loggers in various areas of the site which would represent the lighting fixtures spread.

This approach is in-line with the IPMVP Option A.

3.2.3.2 Summary of Site Visit

During the onsite visit, Navigant site visit engineers confirmed that the new fixtures are in place and are operating as expected. It was found that actual installed fixtures have a higher wattage rating (163 watts/fixture) than the claimed efficient case fixture wattage (146 watts/fixture).

The Navigant team installed six lighting loggers to capture the operating hours of the lighting fixtures.

3.2.3.3 Ex-Post Calculations and Assumptions

The Navigant team revised the algorithms used in the ex-ante calculations to reflect the energy and demand savings algorithms provided in the Customized Calculated Savings Guidelines for Non Residential Programs (Version 6.0).

The Navigant team used the following algorithms to calculate demand and energy savings:

Annual Energy Savings Algorithm

$$\Delta kWh = ((kW_{Baseline} - kW_{EE}) / 1000) \times HOURS \times DIE_{Energy}$$

Where:

$kW_{Baseline}$	= Connected load of baseline fixtures
kW_{EE}	= Connected load of energy efficient fixtures
HOURS	= Average hours of use per year
DIE_{Energy}	= DEER Interactive Effects Factor for energy savings

Summer Coincident Peak kW Savings Algorithm

$$\Delta kW = ((kW_{Baseline} - kW_{EE}) / 1000) \times DIE_{Demand} \times CDF$$

Where:

DIE_{Demand}	= DEER Interactive Effects Factor for energy savings
CDF	= Coincident Diversity Factor for peak demand

The Navigant team did revise the baseline and efficient case fixture wattages from the ex-ante calculations as follows:

Table 3-6. Revised Fixture Wattages

Fixture	Ex-Ante Wattage	Revised Ex-Post Wattage[6]
Baseline: 400 Watt Metal Halide	480	458
Baseline: 4-lamp T5HO High Bay	326	234
Efficient Case: High Bay LED Fixture	146	163

The energy savings realization rate for the project is on a lower side due to the following reasons:

» The Navigant team revised the baseline fixture wattages from the ex-ante calculations according to standard rated fixture wattages as shown in Table 3-6. The ex-ante calculations had estimated fixture wattages on a higher side for the baseline fixtures.

» During the site visit, the Navigant team found that the efficient case fixtures have slightly higher wattage rating than estimated in the ex-ante calculations, this has further reduced the realization rate for the energy savings.

The demand savings realization rate for the project is 'NA' (Not Applicable) as the ex-ante savings do not claim any demand savings for this project. For the ex-post demand savings calculations, the Navigant team used HVAC interactive factor and coincident demand factor for the demand savings calculations.

The Navigant team did install lighting loggers at the site to capture the operating hours of the fixtures but were not able to retrieve the loggers from the site in time for this evaluation. Thus, the Navigant team used the reported operating hours for the fixtures, gathered during the site visit, for the ex-post calculations.

3.3 Site 3

3.3.1 Project Summary

The site is a large refrigerated warehousing facility in Modesto, CA. There are two different warehouses at the same physical address.

The site installed intelligent refrigeration controls in the cooler and freezer areas at the site.

[6] Navigant revised ex-ante wattage estimates of the baseline fixtures according to table of standard fixture wattages found here "http://www.aesc-inc.com/download/spc/2013SPCDocs/PGE/App%20B%20Standard%20Fixture%20Watts.pdf ".
For the efficient case fixture wattage revision, Navigant used the data gathered during the site visit.

The energy and demand savings realization rates for this project are on a higher side because the ex-ante calculations only used 7 days of the evaporator trending data. Whereas, the Navigant team used 18 months of the baseline interval billing data and 16 months of the efficient case interval billing data to calculate the energy and demand savings.

Table 3-7. First Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	937,583	1,387,704	148 %
Demand Savings (kW)	44.6	68.3	153 %

Source: Project Documentation, Navigant Analysis

3.3.2 Project Description

3.3.2.1 Description of the Baseline and the Installed Efficient Equipment and Operation

The site has two different warehouses at the same physical address. The large warehouse has a dry storage and a cooler area. The smaller warehouse, south of the large warehouse, is the freezer section. In the baseline, the refrigeration system at the site did not have an intelligent control system. The evaporator fans ran at 100 percent at all times according to the project documents.

The site installed an intelligent control system for the refrigeration system serving the cooler and the freezer area. The new control system provides following:

» Effective and predictive thermostatic control,
» "Demand" or smart defrost schedules, and;
» Evaporator fan motor management/cycling.

3.3.2.2 Comments on Ex-Ante Calculations

The ex-ante calculations were performed using the trend data acquired from the control system for the cooler and freezer fans. For the baseline case, the ex-ante calculation assume that the fans would be running at 100 percent of the time.

For the efficient case energy consumption, trend data on the evaporator fans was collected for a period of seven days. The ex-ante calculations assume that the fans would have a similar load throughout the year which is unlikely. Typically, the load on the evaporator fans for a refrigerated space varies according to the outside air temperature.

3.3.3 On-Site Visit

3.3.3.1 M&V Method

During the onsite visit, the Navigant team confirmed the implementation of the project. The Modesto Irrigation District has the 15-minute interval data available for this facility at a whole facility meter level. The Navigant team used this interval billing data and the data collected during the site visit to calculate the energy and demand savings using the whole building analysis by normalizing the interval data to the outside air temperature.

This approach is in line with IPMVP option C.

3.3.3.2 Summary of Site Visit

During the site visit, the Navigant site visit engineer confirmed that the project has been implemented and is working as expected. The Navigant site visit engineer was not able to obtain the trend data for the fans in a useable format. The Navigant site visit engineer was able to obtain the trend data summaries for the evaporator fans from the control system in the form of screen-shots but it was not possible to use the summaries to normalize the evaporator fan operation to the outside air temperature.

The Navigant site visit engineer confirmed that the refrigeration load on the facility is fairly constant throughout the year.

3.3.3.3 Ex-Post Calculations and Assumptions

The Navigant team used the following steps for the ex-post calculations:

- » The Navigant team obtained 15-minute interval data for the energy consumption (kWh) at the facility meter level for a period of 52 months (from January 2011 to April 2015).
- » The Navigant team used the baseline data for an 18-months period (January 2011 to June 2012).
- » Though the Navigant team received the efficient case interval data for a period of 33 months (August 2012 to April 2015), 16 months of the recent data was used for the efficient case calculations (January 2014 to April 2015).
- » The Navigant team used this 15-minute kWh data to calculate hourly demand (kW) for the baseline and EE case period.
- » The Navigant team obtained outdoor air temperature (OAT) data for the Modesto city county airport weather station. The Navigant team used this OAT data to normalize the hourly kW consumption of the facility.
- » The Navigant team derived linear regression equations for the baseline and the efficient case period.
- » The Navigant team obtained the TMY3[7] weather data for the city of Modesto. The Navigant team then used this TMY3 data and the linear regressions developed from the billing data to calculate the baseline and EE case energy consumption for the facility.

[7] TMY3 is the third, and most recent, edition of typical meteorological year weather data.

- The difference between the baseline and EE case consumption is the ex-post energy savings for this project.
- The demand savings is the difference between the baseline and the efficient case kW consumption at the maximum outdoor air temperature in the typical meteorological year data (TMY3).

3.4 Site 4

3.4.1 Project Summary

The site is a large industrial facility in Modesto, CA.

The site replaced an old 200-HP air-cooled modulating compressor with a new 200-HP water-cooled compressor with a variable frequency drive (VFD).

The site has achieved lower realization rate for the energy and demand savings. From the ex-post logger data, it is visible that the load (CFM) on the compressor is lower than estimated in the ex-ante calculations. The Navigant team tried to obtain the production data to normalize the savings with the production but was not able to obtain the data from the facility.

Table 3-8. First Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	357,974	267,115	75 %
Demand Savings (kW)	41.0	13.3	32 %

Source: Project Documentation, Navigant Analysis

3.4.2 Project Description

3.4.2.1 Description of the Baseline and the Installed Efficient Equipment and Operation

The baseline condition included an old 200-HP air-cooled modulating Quincy compressor. The baseline compressor had 8,760 annual operating hours.

The site installed a new 200-HP water-cooled air compressor from Atlas-Copco with a variable frequency drive (VFD). This compressor has similar operating hours to the baseline compressor.

3.4.2.2 Comments on Ex-Ante Calculations

The ex-ante calculations were performed using Air Master + model. The Navigant team was not able to obtain the model to review the energy savings calculations but from past experience, the Airmaster+ models provide reasonable energy savings estimates.

3.4.3 On-Site Visit

3.4.3.1 M&V Method

The Navigant team took the following approach for M&V of this project:

- Confirmed the compressor installation,
- Collected the nameplate data and overall operating characteristics of the compressed air system (System pressure, CFM requirement, service area),
- Performed the spot measurements for power for the compressor, and;
- Logged the compressor operation for an eight week period using the current loggers.

This approach is in line with IPMVP Option B. The Navigant team would use the logged data and the data collected during the site visit to calculate the energy and demand savings.

3.4.3.2 Summary of Site Visit

During the onsite visit, the Navigant team confirmed that the new Atlas Copco compressor is installed and is working as expected. The site contact confirmed that the compressed air system operates 24 by 7.

The Navigant team installed a current logger on the compressor and obtained the logged data for a period of eight weeks. The Navigant team was not able to obtain the production data from the site.

3.4.3.3 Ex-Post Calculations and Assumptions

The Navigant team calculated the ex-post energy and demand savings using the following steps:

- The Navigant team logged the compressor for a period of eight weeks (May 1st 2015 to July 7th 2015) for five minute interval data. The Navigant team used the logged current trend data and the spot measurements to determine the ex-post energy use using the following equation:

  $$kW = V * A * PF * \sqrt{3}$$

  Where:

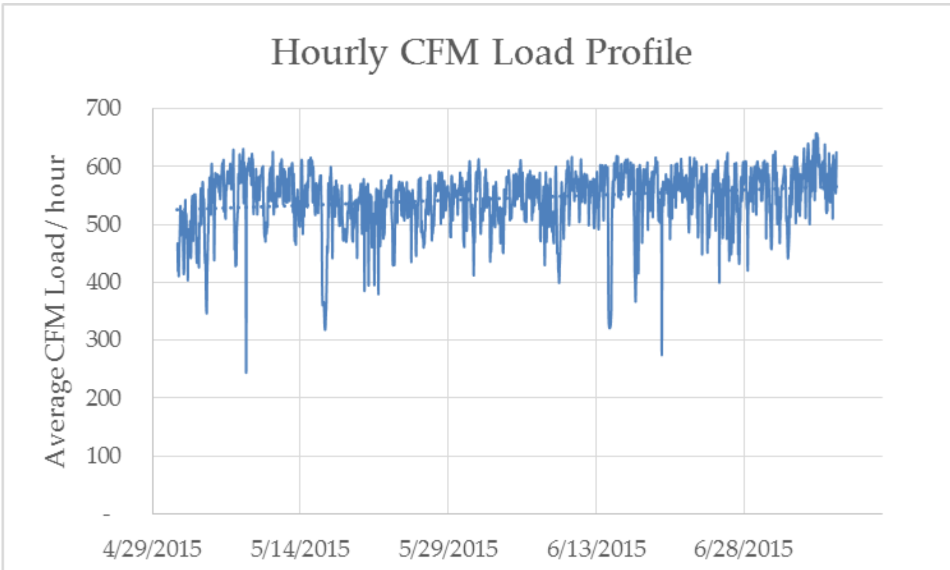
kW	= Instantaneous energy use
V	= Voltage, from the spot measurements
A	= Instantaneous current from the logger data
PF	= Power factor, from the spot measurements

- The Navigant team used this kW value to calculate instantaneous cfm requirement from the compressor curve for the new compressor.
- The Navigant team then calculated baseline kW for the baseline compressor using the cfm requirement value and the old compressor performance curve.
- Energy savings for the compressor is the difference between total baseline energy consumption and ex-post energy consumption for the whole year.

» The Navigant team used hourly average calculated demand to calculate the peak demand savings.

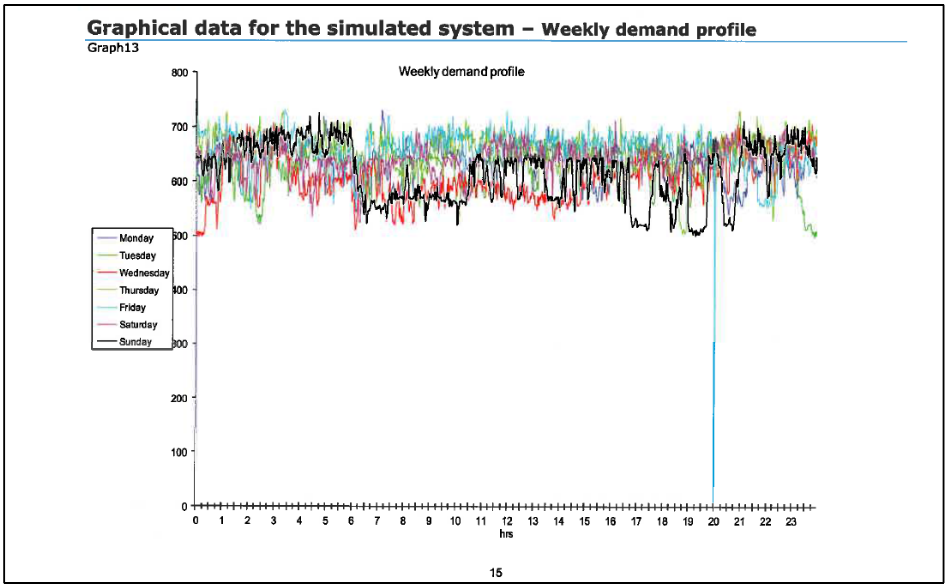
Analysis of the logger data shows that the compressor operating an average load of 550 cfm.

Figure 3-1. The Average CFM Demand – New Compressor



The project files show that the estimated CFM load for the new compressor is about 650 cfm on an average.

Figure 3-2. The Estimated CFM Demand from the Ex-ante Calculations



This is the primary reason behind the lower realization rate for the energy and demand savings. The Navigant team was not able to obtain the production data from the site to normalize the energy savings with the production data.

3.5 Site 5

3.5.1 Project Summary

The site is a medium sized refrigerated warehouse in Modesto, CA.

The site consolidated 40 percent of the old warehouse area with the newer warehouse area and converted the forty years old Freon refrigeration system to an ammonia system.

The ex-post energy savings for the project are on a higher side because the ex-ante energy savings were calculated by using only six months of the post-installation utility billing data. The Navigant team calculated the ex-post energy savings using linear regressions obtained from 15 months of the baseline and 19 months of the efficient case utility data at a 15-minute interval level. This data was normalized for the outdoor air temperature. Navigant was not able to obtain the production data from the site to normalize the energy savings to the production.

Table 3-9. First Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	868,320[8]	1,073,886	124 %
Demand Savings (kW)	0	0	NA

Source: Project Documentation, Navigant Analysis

3.5.2 Project Description

3.5.2.1 Description of the Baseline and the Installed Efficient Equipment and Operation

The site is a medium-sized refrigerated warehouse in Modesto, CA. In the baseline, the site had following refrigeration system:

Table 3-10. Baseline Equipment

Description	% Area	Refrigeration System
Newer warehouse (9 years old)	60%	Ammonia
Original warehouse (40 years old)	40%	Freon

The old warehouse is about 40 percent of the total warehouse area at the site. Old Freon system servicing 36,000 sq. ft. of the old warehouse area was built in mid-1970s. This system had two, old 500-HP compressors which are oversized for the application.

The ammonia refrigeration system at the site includes two 235-HP compressors. These two compressors are sufficient to service the whole facility once the old refrigeration system is converted to ammonia refrigeration system.

The site consolidated old and new warehouses to run on the ammonia refrigeration system. The whole facility runs on Ammonia system for about 46 weeks per year. The old Freon system is operated only 4-6 weeks in a year when the old warehouse has a seasonal load.

3.5.2.2 Comments on Ex-Ante Calculations

The ex-ante calculations were performed using the following steps:

[8] Total ex-ante savings claimed for this project for year 2013 are 1,157,760 kWh. 75% of the savings were claimed in the year 2013 because the utility wanted to revise the savings based on the actual post-implementation billing data.

Year 2013 Ex-Ante Calculations:

» Instantaneous loads for the old and new warehouse were obtained from the utility meter for a single, 90-minute period.
» These loads were divided by the respective warehouse areas to get the energy intensity values (kW/sq. ft.).
» The average demand savings (kW) was calculated using the following formula:

- $\text{kW savings} = (EI_{\text{Old Warehouse}} - EI_{\text{New Warehouse}}) \times (\text{Old Warehouse Area})$

  Where:
  - EI = Energy Intensity in kW/sq. ft.

» The ex-ante calculations assume that the site will operate at this average load throughout the year. Thus, energy savings were derived by multiplying kW savings by 8,760 annual operating hours.

The ex-ante energy savings for the program year 2013 (PY 2013) were calculated using the above steps since there was no post-implementation billing data. The total ex-ante energy savings calculated in the PY 2013 were 1,157,760 kWh. The Modesto Irrigation District (MID) claimed 75% of the total ex-ante savings in PY 2013 because more detailed analysis with the post-implementation billing data was required to calculate precise ex-ante savings for this project.

Year 2014 Ex-Ante Calculations:

In PY 2014, MID revised the ex-ante estimate for the project based on the six months of post-implementation billing data. MID normalized the billing data with the outside weather to calculate the ex-ante energy savings. The site operates in two different modes in a typical year which is as follows:

» Storage mode: Runs throughout the year where the chilled produce is stored in the warehouse rooms, and;
» Production mode: Runs in addition to the storage mode for five months/year (mid-June to mid-November).

The old Freon refrigeration system is used as required during the production mode to blast-freeze the fresh produce arriving during the production period. Useful production data was not available to normalize the energy consumption during these months to the production. The storage mode is consistent throughout the year so the ex-ante calculations used only storage mode energy consumption to form the regression equations for the baseline and energy efficient case. These equations were used with annual weather data to calculate the ex-ante energy savings associated with the storage mode at the site. Total annual energy savings estimate in PY 2014 was 1,898,484 kWh. MID applied 95% savings factor to calculate the energy savings on a conservative side. The PY 2014 claimed ex-ante savings for the project are 1,803,560 kWh. There are no demand savings for the project.

The Navigant team believes that this approach is reasonable to calculate the energy and demand savings.

3.5.3 On-Site Visit

3.5.3.1 M&V Method

During the onsite visit, the Navigant team confirmed the implementation of the project. The Modesto Irrigation District has the 15-minute interval data available for this facility at a whole facility meter level. The Navigant team used this interval billing data and the data collected during the site visit to calculate the energy and demand savings using the whole building analysis.

This approach is in line with IPMVP Option C.

3.5.3.2 Summary of Site Visit

During the site visit, the Navigant site visit engineer confirmed that the project has been implemented and working as expected. The old warehouse is looped into a newer ammonia system. The site contact mentioned that for about 7-8 months in a year, the whole refrigeration load is satisfied by only one 235-HP ammonia compressor. For the remaining months, both the ammonia compressors run to satisfy the total refrigeration load of the facility. The site contacts were very satisfied with the project and the amount of energy savings achieved through it.

The site operates in two different modes in a typical year. These modes are as follows:

Table 3-11. Facility Operating Modes

Months	Description
Storage Mode	Throughout the year. Low production period. Only the base refrigeration load.
Production Mode	Mid-June to mid-November. Blast freezing of the seasonal produce.

3.5.3.3 Ex-Post Calculations and Assumptions

Navigant used the following steps for the ex-post calculations:

- The Navigant team received 15-minute interval data for the energy consumption (kWh) at the facility meter level for a period of 40 months (from January 1st 2012 to April 30th 2015).
- The Navigant team divided this data into the baseline period (January 1st 2012 to March 30th 2013) and the efficient case period (October 1st 2013 to April 30th 2015).
- The Navigant team used this 15-minute kWh data to calculate hourly demand (kW) for the baseline and EE case period.
- The Navigant team obtained outdoor air temperature (OAT) data for the Modesto city county airport weather station. The Navigant team used this OAT data to normalize the hourly kW consumption of the facility.

- The Navigant team divided the baseline and EE case data according to the Table 3-11 and formed the linear regression equations for the storage mode for both the baseline and EE case periods. Navigant used the interval data excluding production period for the facility.
- The Navigant team obtained the TMY3[9] weather data for the city of Modesto. The Navigant team then used this TMY3 data and the linear regressions developed from the billing data to calculate the baseline and EE case energy consumption for the facility.
- The difference between the baseline and EE case consumption is the ex-post energy savings for this project.
- The Navigant team used the same methodology used to calculate the PY 2014 ex-ante savings in the section 3.5.2.2 as the storage mode savings for the site are expected to occur throughout the year.

The ex-post energy savings are on a higher side because the ex-ante energy savings were calculated by using only six months of the post-installation utility billing data. The Navigant team calculated the ex-post energy savings using linear regressions obtained from 15 months of the baseline and 19 months of the efficient case utility data at a 15-minute interval level. This data was normalized for the outdoor air temperature. Navigant was not able to obtain the production data from the site to normalize the energy savings to the production.

3.6 Site 6

3.6.1 Project Summary

The site is a large retail store in Riverbank, CA.

The site replaced 433 4-foot, 6-lamp T5HO (T5 high output) fixtures (54 watt/lamp) with 4-foot, 4-lamp T5HO fixtures (44 watt/lamp) on a one-to-one basis.

The overall energy and demand savings realization rates for site 6 are on a higher side due to the following reasons:

- The Navigant team included HVAC interactive factors in the ex-post calculations. The ex-ante calculations didn't include the interactive factors, and;
- The fixtures are operating at a lower load (25 percent) during the unoccupied period than estimated (50 percent) in the ex-ante calculations.

Table 3-12. First Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	397,837	497, 508	125 %
Demand Savings (kW)	54.6	65.5	120 %

[9] TMY3 is the third, and most recent, edition of typical meteorological year weather data.

Source: Project Documentation, Navigant Analysis

3.6.2 Project Description

3.6.2.1 Description of the Baseline and the Installed Efficient Equipment and Operation

The baseline condition included 433 4-foot, 6-lamp T5HO fixtures. These fixtures had 54 watt T5HO lamps. All the fixtures operated on a 24 by 7 schedule as per the following table. These fixtures are located in main sales area, computer room, break room, tool room and garden area.

Table 3-13. Lighting Schedule

Schedule	% Power
6 AM to 10 PM	100%
10 PM to 6 AM	50%

The site installed 433 4-foot, 4-lamp T5HO fixtures. These new fixtures have 44 watt T5HO lamps. The new lighting system also operates on a similar schedule as the baseline.

3.6.2.2 Comments on Ex-Ante Calculations

The ex-ante calculations use standard lighting algorithms for the energy and demand calculations. These algorithms are listed as follows:

Energy Savings:

$$\Delta kWh = ((kW_{Baseline} - kW_{EE}) / 1000) \times \text{Annual Operating Hours}$$

Where:

ΔkWh	= Annual energy saved (in kWh)
$kW_{Baseline}$	= Connected load of baseline fixtures
kW_{EE}	= Connected load of energy efficient fixtures

Demand Savings:

$$\Delta kW = ((kW_{Baseline} - kW_{EE}) / 1000)$$

Where:

ΔkW	= Peak demand saved (in kW)
$kW_{Baseline}$	= Connected load of baseline fixtures
kW_{EE}	= Connected load of energy efficient fixtures

The ex-ante calculations do not include Coincident Diversity Factor and DEER HVAC Interactive Effects Factor as outlined in the Customized Calculated Savings Guidelines for Non Residential Programs, Version 6.0[10].

3.6.3 On-Site Visit

3.6.3.1 M&V Method

The Navigant team collected the following data during the on-site visit:

» Confirmed the wattage, quantity and schedules of the fixtures
» Confirmed the lamp wattage
» Installed 13-15 lighting loggers in various areas of the site which would represent the lighting fixtures spread, or, if the store has lights on timer or an EMS system, get the schedules from the site.

This approach is in-line with the IPMVP Option A.

3.6.3.2 Summary of Site Visit

The Navigant team verified that all the 433 T5HO fixtures are in place. These fixtures are operated using a timer switch so Navigant did not install any lighting loggers at the site. These fixtures are operated as per the following schedule:

Table 3-14. Ex-post Lighting Schedule

Schedule	% Power
6 AM to 10 PM	100%
10 PM to 6 AM	25%

Thus, the new fixtures are operating on a lower load during the non-occupied hours. This will result in more energy savings than estimated in the ex-ante calculations.

3.6.3.3 Ex-Post Calculations and Assumptions

The Navigant team revised the algorithms used in the ex-ante calculations to reflect the energy and demand saving algorithms provided in the Customized Calculated Savings Guidelines for Non Residential Programs (Version 6.0).

The Navigant team used the following algorithms to calculate demand and energy savings:

Annual Energy Savings Algorithm

[10] More information is available at: http://www.aesc-inc.com/download/spc/2013SPCDocs/PGE/Customized%202.0%20Energy%20Savings.pdf , page 84.

$\Delta kWh = ((kW_{Baseline} - kW_{EE}) / 1000) \times HOURS \times DIE_{Energy}$

Where:

$kW_{Baseline}$	= Connected load of baseline fixtures
kW_{EE}	= Connected load of energy efficient fixtures
HOURS	= Average hours of use per year
DIE_{Energy}	= DEER Interactive Effects Factor for energy savings = 1.06

Summer Coincident Peak kW Savings Algorithm

$\Delta kW = ((kW_{Baseline} - kW_{EE}) / 1000) \times DIE_{Demand} \times CDF$

Where:

DIE_{Demand}	= DEER Interactive Effects Factor for energy savings = 1.2
CDF	= Coincident Diversity Factor for peak demand (1.00 in this case as the fixtures are on during the peak demand period)

The energy and demand savings realization rate for the site 6 is on a higher side due to the following reasons:

» The Navigant team included DEER HVAC interactive factors in the calculations, and;
» The fixtures are operating at a lower load (25%) during the unoccupied period than estimated (50%) in the ex-ante calculations.

3.7 Site 7

3.7.1 Project Summary

This site is a large office building located in Modesto, CA.

This site replaced a total of 3,081 32-watt T8 lamps with 28-watt T8 lamps on a one-to-one basis.

The energy savings realization rate for the project is on a lower side because the ex-ante energy savings were calculated using the deemed savings numbers whereas the Navigant team calculated the ex-post savings using the actual light count and actual operating hours.

Table 3-15. First Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	294,177	251,106	85 %
Demand Savings (kW)	-	8.9	NA

Source: Project Documentation, Navigant Analysis

3.7.2 Project Description

3.7.2.1 Description of the Baseline and the Installed Efficient Equipment and Operation

This site had a total of 3,081 32-watt T8 lamps throughout the interior of the building. These lamps were in various 2, 3, 4 and 8 lamp fixtures. These fixtures were operated using the manual switches.

This site replaced all of the 32-watt T8 lamps with 28-watt T8 lamps on a one-to-one basis in the interior of the building.

3.7.2.2 Comments on Ex-Ante Calculations

The ex-ante calculations used the deemed energy savings. The deemed measures installed in this project are shown in the following table:

Table 3-16. Deemed Measures Installed at the Site

Description	Deemed Annual kWh Savings / Unit
T8 or T5 Linear Fluorescent 4-ft lamp installed	67.5
28 Watt 4-Foot T8 Fluorescent (used in place of 32 Watt Fluorescent T8)	20.0

3.7.3 On-Site Visit

3.7.3.1 M&V Method

The Navigant team collected the following data during the on-site visit:

» Confirmed the wattage, quantity and schedules of the fixtures.
» Confirmed the lamp wattage.
» Installed seven lighting loggers in various areas of the site which would represent the lighting fixtures spread.

This approach is in-line with the IPMVP Option A.

3.7.3.2 Summary of Site Visit

The Navigant team verified that all the 28-watt T8 lamps are in place and operating as expected. The Navigant team installed seven lighting data loggers at different locations to capture the operating hours of the fixtures.

3.7.3.3 Ex-Post Calculations and Assumptions

The Navigant team used the lighting energy and demand savings algorithms provided in the Customized Calculated Savings Guidelines for Non Residential Programs (Version 6.0)[11].

The Navigant team used the following algorithms to calculate demand and energy savings:

Annual Energy Savings Algorithm

$\Delta kWh = ((kW_{Baseline} - kW_{EE}) / 1000) \times HOURS \times DIE_{Energy}$

Where:

$kW_{Baseline}$	= Connected load of baseline fixtures
kW_{EE}	= Connected load of energy efficient fixtures
HOURS	= Average hours of use per year
DIE_{Energy}	= DEER Interactive Effects Factor for energy savings = 1.32

Summer Coincident Peak kW Savings Algorithm

$\Delta kW = ((kW_{Baseline} - kW_{EE}) / 1000) \times DIE_{Demand} \times CDF$

Where:

DIE_{Demand}	= DEER Interactive Effects Factor for energy savings = 1.11
CDF	= Coincident Diversity Factor for peak demand (0.625 in this case as the fixtures are on during the peak demand period)

The energy savings realization rate for the project is on a lower side because the ex-ante energy savings were calculated using the deemed savings numbers whereas the Navigant team included the DEER HVAC interactive factors and actual operating hours of the fixtures in the ex-post calculations.

3.8 Site 8

3.8.1 Project Summary

This site is a warehouse located in Modesto, CA.

This site retrofitted 33 1,000-watt metal halide fixtures with 33 8-lamp T5HO fluorescent fixtures.

The energy savings is on a very low side due to the following reasons:

» The ex-ante energy savings were calculated using the deemed energy savings.

[11] More information is available at: http://www.aesc-inc.com/download/spc/2013SPCDocs/PGE/Customized%202.0%20Energy%20Savings.pdf, page 84.

» The Navigant team calculated the ex-post energy savings using the actual operating hours of the fixtures which are very low (456 hours/year). These fixtures operate only five hours/day, two times a month and two weeks of 24 by 7 operation for maintenance.

Table 3-17. First Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	82,197	9,578	12 %
Demand Savings (kW)	-	-	N/A

Source: Project Documentation, Navigant Analysis

3.8.2 Project Description

3.8.2.1 Description of the Baseline and the Installed Efficient Equipment and Operation

This site had 33 1,000-watt metal halide fixtures in the baseline. These fixtures operated only five hours/day, two times a month and two weeks of 24 by 7 operation for maintenance.

This site installed 33 new, 8-lamp T5HO fluorescent fixtures. The new fixtures have similar operating hours as the baseline.

3.8.2.2 Comments on Ex-Ante Calculations

The ex-ante calculations were calculated using the deemed energy savings. The deemed measure installed in this project is shown in the following table:

Table 3-18. Deemed Measures Installed at the Site

Description	Deemed Annual kWh Savings / Unit
Interior Linear Fluorescent > 400 Watt Base case: 360 - 600 Watts Replacement	2,784.6

3.8.3 On-Site Visit

3.8.3.1 M&V Method

The Navigant team collected the following data during the on-site visit:

- » Confirmed the wattage, quantity and schedules of the fixtures
- » Confirmed the lamp wattage

This approach is in-line with the IPMVP Option A.

3.8.3.2 Summary of Site Visit

The Navigant team verified that all the 33 1000-watt metal halide fixtures had been replaced with 8-lamp T5HO fixtures. The Navigant team was not able to install any lighting loggers at the site due to the accessibility issue. During the onsite visit, the Navigant team found that the fixtures are off all year except for five hours a day, twice a month and two weeks of 24 by 7 usage during a maintenance period.

3.8.3.3 Ex-Post Calculations and Assumptions

The Navigant team used the lighting energy and demand savings algorithms provided in the Customized Calculated Savings Guidelines for Non Residential Programs (Version 6.0)[12].

The Navigant team used the following algorithms to calculate the energy savings:

Annual Energy Savings Algorithm

$$\Delta kWh = ((kW_{Baseline} - kW_{EE}) / 1000) \times HOURS \times DIE_{Energy}$$

Where:

$kW_{Baseline}$ = Connected load of baseline fixtures
kW_{EE} = Connected load of energy efficient fixtures
HOURS = Average hours of use per year
DIE_{Energy} = DEER Interactive Effects Factor for energy savings = 1.04

[12] More information is available at: http://www.aesc-inc.com/download/spc/2013SPCDocs/PGE/Customized%202.0%20Energy%20Savings.pdf , page 84.

The Navigant team assigned 0 demand savings to this project since the lights are rarely on.

The energy savings is on a very low side due to the following reasons:

» The ex-ante energy savings were calculated using the deemed energy savings.
» The Navigant team calculated the ex-post energy savings using the actual operating hours of the fixtures which are very low (456 hours/year). These fixtures operate only five hours/day, two times a month and two weeks of 24 by 7 operation for maintenance.

3.9 Site 9

3.9.1 Project Summary

This site is a school located in Salida, CA.

This site completed the following measures in the program year 2013:

» De-lamped 696 4-foot T8 lamps,
» Retrofitted 3,253 32-watt T8 lamps with 25-watt T8 lamps on one-to-one basis in the fluorescent fixtures throughout the facility, and;
» Retrofitted 20 250-watt metal halide pole fixtures by 90-watt LED fixtures on one-to-one basis.

Table 3-19. First Year Project Savings Summary

	Ex-ante	Ex-post -	Realization Rate
Energy Savings (kWh/Year)	138,106	163,803	119 %
Demand Savings (kW)	-	0.2	N/A

Source: Project Documentation, Navigant Analysis

3.9.2 Project Description – De-lamping

3.9.2.1 Description of the Baseline and the Installed Efficient Equipment and Operation

In the baseline, the site had the following lighting system:

» This site had 696 32-watt T8 lamps in various fluorescent fixtures throughout the facility.

The site de-lamped 696 4-foot lamps from the interior of the building.

3.9.2.2 Comments on Ex-Ante Calculations

The ex-ante calculations were calculated using the deemed energy savings. The deemed savings for the de-lamping measure are shown in the following table:

Table 3-20. Deemed Savings for De-lamping

Description	Deemed Annual kWh Savings / Unit
De-lamp: 4 foot lamp	97.3

3.9.3 Project Description - Lighting Retrofits

3.9.3.1 Description of the Baseline and the Installed Efficient Equipment and Operation

This site had the following lighting system in the baseline:

- 3,253 32-watt T8 lamps in the fluorescent fixtures throughout the facility, and;
- 20 250-watt metal halide pole fixtures in the parking lot.

This site completed the following measures:

- Retrofitted 3,253 32-watt T8 lamps with 25-watt T8 lamps on one-to-one basis, and;
- Retrofitted 20 250-watt metal halide pole fixtures by 90-watt LED fixtures on one-to-one basis.

3.9.3.2 Comments on Ex-Ante Calculations

The ex-ante calculations were calculated using the deemed energy savings. The deemed measures installed in this project are shown in the following table:

Table 3-21. Deemed Measures Installed at the Site

Description	Deemed Annual kWh Savings / Unit
25 Watt 4-Foot T8 Fluorescent (used in place of 32 Watt Fluorescent T8)	25.0
Exterior Linear Fluorescent 400W Base case: <=244 Watts Replacement	1,260.1

For the exterior pole fixture replacement, incorrect deemed measure savings were used to calculate the ex-ante energy savings. The correct deemed measure savings which should have been used are shown in the following table:

Table 3-22. Correct Deemed Measure for the Exterior Fixtures at the Site

Description	Deemed Annual kWh Savings / Unit
Pulse-Start Metal Halide Fixtures - Hardwired Exterior 176 - 399W Base case: <=275W Replacement	523.16

3.9.4 On-Site Visit

3.9.4.1 M&V Method

The Navigant team collected the following data during the on-site visit:

- » Confirmed the wattage, quantity and schedules of the fixtures
- » Confirmed the lamp wattage
- » Installed nine lighting loggers in various areas of the site which would represent the lighting fixtures spread.

This approach is in-line with the IPMVP option A.

3.9.4.2 Summary of Site Visit

The Navigant team verified that all the measures detailed in the project file are implanted and are working as expected. 32W lamps had been replaced with 25W T8's. The Navigant team installed nine lighting loggers in various locations at the site.

3.9.4.3 Ex-Post Calculations and Assumptions

The Navigant team used the lighting energy and demand savings algorithms provided in the Customized Calculated Savings Guidelines for Non Residential Programs (Version 6.0)[13].

The Navigant team used the following algorithms to calculate demand and energy savings:

Annual Energy Savings Algorithm

$$\Delta kWh = ((kW_{Baseline} - kW_{EE}) / 1000) \times HOURS \times DIE_{Energy}$$

Where:

$kW_{Baseline}$ = Connected load of baseline fixtures
kW_{EE} = Connected load of LED fixtures
HOURS = Average hours of use per year

[13] More information is available at: http://www.aesc-inc.com/download/spc/2013SPCDocs/PGE/Customized%202.0%20Energy%20Savings.pdf, page 84.

DIE_{Energy} = DEER Interactive Effects Factor for energy savings = 1.6

Summer Coincident Peak kW Savings Algorithm

$\Delta kW = ((kW_{Baseline} - kW_{EE}) / 1000) \times DIE_{Demand} \times CDF$

Where:

DIE_{Demand} = DEER Interactive Effects Factor for energy savings = 1.0

CDF = Coincident Diversity Factor for peak demand (0.02 in this case as the fixtures are on during the peak demand period)

The energy savings realization rate for this project is on a higher side because the ex-ante energy savings were calculated using the deemed savings numbers whereas the Navigant team included the DEER HVAC interactive factors and actual operating hours of the fixtures in the ex-post calculations.

3.10 Site 10

3.10.1 Project Summary

The site is a restaurant in Modesto, CA.

The site installed gaskets on the cooling cases throughout the restaurant. The site also installed one strip curtain on a walk-in storage door.

The overall energy savings realization rate for this project is on a lower side since the Navigant team assigned zero savings to the strip curtain measure as described in the section 3.10.3.3 .

Table 3-23. First Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	20,148	16,087	80 %
Demand Savings (kW)	-	3.7	NA

Source: Project Documentation, Navigant Analysis

3.10.2 Project Description

3.10.2.1 Description of the Baseline and the Installed Efficient Equipment and Operation

In the baseline, the site had old gaskets on the coolers, refrigerators and beverage cases. The site did not have a strip curtain on a walk-in storage door.

The site installed total 310 linear ft. of gaskets on the doors of all the cooling cases throughout the restaurant. The site also installed a strip curtain on a walk-in storage door which is about 20 sq. ft. (8′ X 2.5′).

3.10.2.2 Comments on Ex-Ante Calculations

The ex-ante savings were calculated using deemed numbers. The deemed measures installed in this project are shown in the following table:

Table 3-24. Deemed Measures Installed at the Site

Description	Deemed Annual kWh Savings	Deemed Coincident Peak Demand Savings
Door Gaskets	52 kWh / Linear Ft.	0.012 kW/Linear Ft.
Strip-Curtains for Walk-in Enclosures	151 kWh / Sq. Ft.	0.010 kW/ Sq. Ft.

3.10.3 On-Site Visit

3.10.3.1 M&V Method

The Navigant team collected the following data during the on-site visit:

» The baseline conditions
» Linear feet of the gaskets installed in the restaurant
» Verified the installation of the strip curtain
» Strip curtain size

3.10.3.2 Summary of Site Visit

During the site visit, the Navigant team verified the installation of the gaskets visually. The Navigant team also verified that the quantity and length of the installed gasket matches the reported quantity on the application. Following figure shows the installed gaskets at the site:

Figure 3-3. Installed Gaskets at Site 10

The Navigant team found that the gaskets appeared to be of poor quality. Though still providing a seal, they were beginning to deteriorate. According to the site contact, these gaskets would last for about one more year which is about half the rated measure life for the gaskets (four years). However, the site contact was very happy with the performance of the new gaskets and he mentioned that he would participate again in the rebate program in the future.

During the site visit, the Navigant site visit engineer found that the installed strip curtain was not in good shape. The following figure shows the strip curtain condition at the site:

Figure 3-4. Strip Curtain at Site 10

3.10.3.3 Ex-Post Calculations and Assumptions

The Navigant team used the deemed savings numbers and the site visit findings to calculate the energy and demand savings for the installed measures. For the strip curtain measure, the Navigant team assigned zero savings as the strip curtain is almost gone.

3.11 Site 11

3.11.1 Project Summary

The site is a restaurant in Modesto, CA.

The site installed gaskets on the cooling cases in the restaurant. The site also installed one strip curtain on the walk-in cooler door.

The overall energy savings realization rate for this project is on a lower side since the Navigant team assigned zero savings to the strip curtain measure and the gasket on the freezer case as described in the section 3.10.3.3 .

Table 3-25. First Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	4,249	1,985	47%
Demand Savings (kW)	-	0.5	NA

Source: Project Documentation, Navigant Analysis

3.11.2 Project Description

3.11.2.1 Description of the Baseline and the Installed Efficient Equipment and Operation

In the baseline, the site did not have gaskets on the prep station, the cooler, or the freezer. The site did not have a strip curtain on the walk-in cooler door.

The site installed a total of 52.5 linear ft. of gaskets on the doors of the prep station, the cooler and the freezer case in the restaurant. The site also installed a strip curtain on the walk-in cooler door.

3.11.2.2 Comments on Ex-Ante Calculations

The ex-ante savings were calculated using deemed numbers. The deemed measures installed in this project are shown in the following table:

Table 3-26. Deemed Measures Installed at the Site

Description	Deemed Annual kWh Savings	Deemed Coincident Peak Demand Savings
Door Gaskets	52 kWh / Linear Ft.	0.012 kW/Linear Ft.
Strip-Curtains for Walk-in Enclosures	151 kWh / Sq. Ft.	0.010 kW/ Sq. Ft.

3.11.3 On-Site Visit

3.11.3.1 M&V Method

The Navigant team collected the following data during the on-site visit:

» The baseline conditions
» Linear feet of the gaskets installed in the restaurant
» Verified the installation of the strip curtain
» Strip curtain size

3.11.3.2 *Summary of Site Visit*

During the site visit, the Navigant team verified the installation of the gaskets on the prep case and the cooler case visually. The freezer on which the gasket was installed as part of the project is no longer in use.

The Navigant team also verified that the quantity and length of the installed gaskets match with the reported quantity on the application. Following figure shows the installed gaskets at the site:

Figure 3-5. Installed Gaskets at Site 11

The Navigant team found that the gaskets appeared to be of poor quality. Though still providing a seal, they were beginning to deteriorate. The gasket measure has a rated measure life of four years but the condition of the gaskets did not look promising to last for the rated measure life.

During the site visit, The Navigant site visit engineer found that the site removed the installed strip curtain due to condensation issues.

3.11.3.3 *Ex-Post Calculations and Assumptions*

The Navigant team used the deemed savings numbers and the site visit findings to calculate the energy and the demand savings for these measures. For the strip curtain on the walk-in cooler door, the Navigant team assigned no savings as the site removed the curtain. For the gasket on the freezer case, the Navigant team assigned zero savings as well as the freezer was no longer in use. This has resulted in a lower realization rate for this project.

3.12 *Site 12*

3.12.1 Project Summary

The site is a small retail store in Waterford, CA.

In the program year 2013, the site installed the following measures under the Modesto Irrigation District's Direct Install Program:

- Installed two 1/15 HP and two 1/20 HP ECM[14] fans in the walk-in refrigerator,
- Retrofitted a neon "OPEN" sign with a LED sign, and;
- Installed 22 4-foot, 2-lamp, T8 fixtures with NLO (Normal Light Output) ballasts.

The overall energy and demand savings realization rate for this site is 100 percent.

Table 3-27. First Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	8,338	8,338	100 %
Demand Savings (kW)	1.3	1.3	100 %

Source: Project Documentation, Navigant Analysis

3.12.2 Project Description

3.12.2.1 Description of the Baseline and the Installed Efficient Equipment and Operation

In the baseline, the site had non-ECM motors in the walk-in cooler. The site also had a neon "OPEN" sign in the baseline. The Navigant team was not able to verify the baseline condition for the new T8 fixtures.

The site installed the following equipment in the efficient case:

- Two 1/15 HP and two 1/20 HP ECM[15] fans in the walk-in refrigerator,
- A LED "OPEN" sign, and;
- 22 4-foot, 2-lamp, T8 fixtures with NLO (Normal Light Output) ballasts throughout the store.

[14] Electronically Commutated Motor
[15] Electronically Commutated Motor

3.12.2.2 Comments on Ex-Ante Calculations

The ex-ante savings were calculated using deemed energy savings as shown in the following table:

Table 3-28. Deemed Energy Savings

Measure Description	Energy Savings (kWh/unit/year)	Demand Savings (kW/unit)
<1 HP ECM fans	1,068	0.12
LED sign	550	0.15
2 lamp T8 fixture, NLO	160	0.03

3.12.3 On-Site Visit

3.12.3.1 M&V Method

During the onsite visit, the Navigant team confirmed the installation and quantity of the measures at the site.

3.12.3.2 Summary of Site Visit

During the site visit, the Navigant team verified that all the measures have been implemented at the site and are working as expected. The Navigant team also verified that the quantity of the installed units matches with the reported quantity on the application.

3.12.3.3 Ex-Post Calculations and Assumptions

The Navigant team used the deemed savings numbers and the site visit findings to calculate the energy and demand savings for these measures. The overall energy and demand savings realization rate for the site 12 is 100 percent.

3.13 Site 13

3.13.1 Project Summary

This site is a large distributing center located in Patterson, CA.

This site completed the following lighting measures in the program year 2013:

- Retrofitted 484 4-foot, 32-watt T8 fixtures by 4-foot, 25-watt T8 fixtures on a one-to-one basis,
- Retrofitted 50 23-watt CFL lamps by 11-watt LED lamps on a one-to-one basis, and;
- Retrofitted 1,509 4-foot, 6-lamp, 54-watt T5 fixtures by 4-foot, 6-lamp, 32-watt T8 fixtures on a one-to-one basis.

The energy savings realization rate for the project is on a higher side due to the following reasons:

- The Navigant team used the actual operating hours for the fixtures based on the lighting logger data for a period of three weeks, and;
- The Navigant team used the HVAC interactive factor from the DEER 2011 database for the energy savings calculations.

The demand savings realization rate for the project is on a lower side because the Navigant team used the HVAC interactive factor and the coincident demand factor from the DEER 2011 database for the demand savings calculations.

Table 3-29. First Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	1,638,499	1,942,033	119 %
Demand Savings (kW)	228.5	147.6	65 %

Source: Project Documentation, Navigant Analysis

3.13.2 Project Description

3.13.2.1 Description of the Baseline and the Installed Efficient Equipment and Operation

In the baseline, the site had the following lighting system:

Table 3-30. The Baseline Lighting System

No.	Fixture Description	Fixture Quantity	Control
1	4-foot 2-lamp 32-watt T8	284	Manual
2	4-foot 3-lamp 32-watt T8	190	Manual
3	4-foot 4-lamp 32-watt T8	10	Manual
4	23-watt CFL fixture	50	Manual
5	4-foot 6-lamp 54-watt T5	1,509	Manual
	Total	2,043	

The office fixtures had 2,730 annual operating hours (10.5 hours/day, 5 days/week) and all of the remaining fixtures had 4,420 annual operating hours (17 hours/day, 5 days/week). All of the fixtures were controlled using manual switches.

Table 3-31 shows the efficient case lighting system installed at the site.

Table 3-31. The Efficient Case Lighting System

No.	Fixture Description	Fixture Quantity	Control
1	4-foot 2-lamp 25-watt T8	284	Manual
2	4-foot 3-lamp 25-watt T8	190	Manual
3	4-foot 4-lamp 25-watt T8	10	Manual
4	11-watt LED fixture	50	Manual
5	4-foot 6-lamp 32-watt T8	1,509	Occupancy Sensors
	Total	2,043	

The site installed occupancy sensors on the 6-lamp T8 fixtures. All the remaining fixtures have similar operating hours as the baseline.

3.13.2.2 Comments on Ex-Ante Calculations

The ex-ante calculations use a standard lighting algorithm for the energy and the demand calculations. These algorithms are listed as follows:

Energy Savings:

$$\Delta kWh = ((kW_{Baseline} - kW_{EE}) / 1000) \times \text{Annual Operating Hours}$$

Where:

ΔkWh = Annual energy saved (in kWh)
$kW_{Baseline}$ = Connected load of baseline fixtures
kW_{EE} = Connected load of energy efficient fixtures

Demand Savings:

$$\Delta kW = ((kW_{Baseline} - kW_{EE}) / 1000)$$

Where

ΔkW: = Peak demand saved (in kW)
$kW_{Baseline}$: = Connected load of baseline fixtures
kW_{EE}: = Connected load of energy efficient fixtures

The ex-ante calculations do not include the Coincident Diversity Factor and the DEER HVAC Interactive Effects Factors as outlined in the Customized Calculated Savings Guidelines for the Non Residential Programs, Version 6.0[16].

3.13.3 On-Site Visit

3.13.3.1 M&V Method

The Navigant team collected the following data during the on-site visit:

- Confirmed the wattage, quantity and schedules of the fixtures
- Confirmed the lamp wattage
- Installed 14 lighting loggers in various areas of the site which would represent the lighting fixtures spread.

This approach is in-line with the IPMVP Option A.

3.13.3.2 Summary of Site Visit

During the onsite visit, the Navigant site visit engineer confirmed that the new fixtures are in place and are operating as expected. The Navigant site visit engineer installed 14 lighting loggers to capture the operating hours of the lighting fixtures.

3.13.3.3 Ex-Post Calculations and Assumptions

The Navigant team revised the algorithms used in the ex-ante calculations to reflect the energy and demand savings algorithms provided in the Customized Calculated Savings Guidelines for the Non Residential Programs (Version 6.0).

The Navigant team used the following algorithms to calculate demand and energy savings:

Annual Energy Savings Algorithm

$$\Delta kWh = ((kW_{Baseline} - kW_{EE}) / 1000) \times HOURS \times DIE_{Energy}$$

Where:

$kW_{Baseline}$	= Connected load of baseline fixtures
kW_{EE}	= Connected load of energy efficient fixtures
HOURS	= Average hours of use per year
DIE_{Energy}	= DEER Interactive Effects Factor for energy savings

[16] More information is available at: http://www.aesc-inc.com/download/spc/2013SPCDocs/PGE/Customized%202.0%20Energy%20Savings.pdf , page 84.

Summer Coincident Peak kW Savings Algorithm

$\Delta kW = ((kW_{Baseline} - kW_{EE}) / 1000) \times DIE_{Demand} \times CDF$

Where:

DIE_{Demand} = DEER Interactive Effects Factor for energy savings

CDF = Coincident Diversity Factor for peak demand

The energy savings realization rate for the project is on a higher side due to the following reasons:

» The Navigant team used the actual operating hours for the fixtures based on the lighting logger data for a period of three weeks, and;
» The Navigant team used the HVAC interactive factor from the DEER 2011 database for the energy savings calculations.

The demand savings realization rate for the project is on a lower side because the Navigant team used the HVAC interactive factor and the coincident demand factor for the demand savings calculations.

3.14 Site 14

3.14.1 Project Summary

This is a refrigerated warehouse located in Turlock, CA.

This site completed the following lighting measures in the program year 2013:

» Retrofitted 284 400-watt metal halide fixtures with 160 LED fixtures (164 watts each),
» Retrofitted 20 100-watt metal halide fixtures with 15 LED fixtures (mix of 60-watt and 26-watt LED fixtures), and;
» Retrofitted 57 4-foot 2-lamp T8 fixtures with 34 LED fixtures (26 watts each).

The energy savings realization rate for the project is on a higher side due to the following reasons:

» The Navigant team used the reported operating hours for the fixtures based on the data collected during the site visit, and;
» The Navigant team used HVAC interactive factor from the DEER 2011 database for the energy savings calculations.

The demand savings realization rate for the project is on a lower side because the Navigant team used HVAC interactive factor and coincident demand factor from the DEER 2011 database for the demand savings calculations.

Table 3-32. First Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	897,869	1,272,303	142 %
Demand Savings (kW)	87.2	60.1	69 %

Source: Project Documentation, Navigant Analysis

3.14.2 Project Description

3.14.2.1 Description of the Baseline and the Installed Efficient Equipment and Operation

This site had the following lighting system in the baseline:

» 284 400-watt metal halide fixtures in the freezer areas,
» 20 100-watt metal halide fixtures in the penthouse,
» 49 4-foot 2-lamp T8 fixtures in the freezer drive path area, and;
» 8 4-foot 2-lamp T8 fixtures in the penthouse area.

The freezer area fixtures had 24 by 7 schedule in the baseline. The project file shows that the penthouse area fixtures had 3,389 annual operating hours (65 hours per week).

The site installed the following efficient case system:

» 160 LED fixtures (164 watts each) in the freezer areas,
» 26 LED fixtures (26 watts each) in the freezer drive path area,
» 23 LED fixtures (26 watts each) in the penthouse, and;
» 4 60-watt LED fixtures in the penthouse area.

The project file shows that the freezer fixtures will have reduced hours of operation in the efficient case (1,752 hours/year) due to the occupancy sensor installation. The penthouse fixtures will have similar operating hours as the baseline.

3.14.2.2 Comments on Ex-Ante Calculations

The ex-ante calculations use standard lighting algorithm for the energy and demand calculations. These algorithms are listed as follows:

Energy Savings:

ΔkWh = ((WattsBASE – WattsEE) / 1000) x Annual Operating Hours

Where:

ΔkWh	= Annual energy saved (in kWh)
WattsBASE	= Connected load of baseline fixtures
WattsEE	= Connected load of energy efficient fixtures

Demand Savings:

ΔkW = ((WattsBASE – WattsEE) / 1000)

Where:

ΔkW	= Peak demand saved (in kW)
WattsBASE	= Connected load of baseline fixtures
WattsEE	= Connected load of energy efficient fixtures

The ex-ante calculations do not include coincident Diversity Factor and DEER Interactive Effects Factor as outlined in the Customized Calculated Savings Guidelines for Non Residential Programs, Version 6.0[17].

3.14.3 On-Site Visit

3.14.3.1 M&V Method

The Navigant team collected the following data during the on-site visit:

» Confirmed the wattage, quantity and schedules of the fixtures
» Confirmed the lamp wattage

This approach is in-line with the IPMVP Option A.

3.14.3.2 Summary of Site Visit

During the onsite visit, the Navigant site visit engineer confirmed that the new fixtures are in place and are operating as expected. The Navigant site visit engineer was not able to install the lighting loggers at the site. The Navigant site visit engineer found that the penthouse fixtures have lower operating hours (About 2 hours a day, 7 days a week) than estimated in the ex-ante calculations. Also, the freezer area fixtures have longer operating hours (on an average 12 hours a day, 7 days a week) than estimated in the ex-ante calculations.

3.14.3.3 Ex-Post Calculations and Assumptions

The Navigant team revised the algorithms used in the ex-ante calculations to reflect the energy and demand savings algorithms provided in the Customized Calculated Savings Guidelines for Non Residential Programs (Version 6.0).

[17] More information is available at: http://www.aesc-inc.com/download/spc/2013SPCDocs/PGE/Customized%202.0%20Energy%20Savings.pdf, page 84.

The Navigant team used the following algorithms to calculate demand and energy savings:

Annual Energy Savings Algorithm

$\Delta kWh = ((kW_{Baseline} - kW_{EE}) / 1000) \times HOURS \times DIE_{Energy}$

Where:

$kW_{Baseline}$	= Connected load of baseline fixtures
kW_{EE}	= Connected load of energy efficient fixtures
HOURS	= Average hours of use per year
DIE_{Energy}	= DEER Interactive Effects Factor for energy savings = 1.57

Summer Coincident Peak kW Savings Algorithm

$\Delta kW = ((kW_{Baseline} - kW_{EE}) / 1000) \times DIE_{Demand} \times CDF$

Where:

DIE_{Demand}	= DEER Interactive Effects Factor for energy savings = 1.33
CDF	= Coincident Diversity Factor for peak demand (0.556 in this case as the fixtures are on during the peak demand period)

The Navigant team revised the operating hours of the lights according to the data collected during the site visit.

The energy savings realization rate for the project is on a higher side due to the following reasons:

» The Navigant team used the reported operating hours for the fixtures based on the data collected during the site visit, and;
» The Navigant team used HVAC interactive factor from the DEER 2011 database for the energy savings calculations.

The demand savings realization rate for the project is on a lower side because the Navigant team used HVAC interactive factor and coincident demand factor from the DEER 2011 database for the demand savings calculations.

3.15 Site 15

3.15.1 Project Summary

The site is a large warehouse located in Modesto, CA.

The site replaced 78 400-watt metal halide fixtures with 78 4-foot 6-lamp T8 fixtures on a one-to-one basis.

The realization rate for the energy savings is on a lower side because the verified hours of use for some of the fixtures are higher than estimated in the ex-ante calculations.

The demand savings realization rate for the project is on a higher side because the Navigant team used the HVAC interactive factor and the coincident demand factor for the demand savings calculations.

Table 3-33. First Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	73,937	71,078	96 %
Demand Savings (kW)	17.8	20.7	116 %

Source: Project Documentation, Navigant Analysis

3.15.2 Project Description

3.15.2.1 Description of the Baseline and the Installed Efficient Equipment and Operation

In the baseline, the site had 78 400-watt metal halide fixtures. These fixtures had 2,860 annual operating hours in the baseline (11 hours a day, 5 days a week).

The site installed 78 4-foot 6-lamp T8 fixtures. The expected operating hours for the new fixtures were 1,573 annual operating hours (45 percent occupancy control savings).

3.15.2.2 Comments on Ex-Ante Calculations

The ex-ante calculations use standard lighting algorithm for the energy and demand calculations. These algorithms are listed as follows:

Energy Savings:

$$\Delta kWh = ((WattsBASE - WattsEE) / 1000) \times Annual\ Operating\ Hours$$

Where:

ΔkWh = Annual energy saved (in kWh)
WattsBASE = Connected load of the baseline fixtures
WattsEE = Connected load of energy efficient fixtures

Demand Savings:

$$\Delta kW = ((WattsBASE - WattsEE) / 1000)$$

Where:

ΔkW	= Peak demand saved (in kW)
WattsBASE	= Connected load of the baseline fixtures
WattsEE	= Connected load of energy efficient fixtures

The ex-ante calculations do not include coincident Diversity Factor and DEER Interactive Effects Factor as outlined in the Customized Calculated Savings Guidelines for Non Residential Programs, Version 6.0[18].

3.15.3 On-Site Visit

3.15.3.1 M&V Method

The Navigant team collected the following data during the on-site visit:

- Confirmed the wattage, quantity and schedules of the fixtures
- Confirmed the lamp wattage
- Installed six lighting loggers in various areas of the site which would represent the lighting fixtures spread.

This approach is in-line with the IPMVP Option A.

3.15.3.2 Summary of Site Visit

The Navigant team verified that the new T8 fixtures have been installed at the site and are operating as expected. The Navigant team installed six lighting loggers at the site to capture the operating hours of the fixtures.

3.15.3.3 Ex-Post Calculations and Assumptions

The Navigant team revised the algorithms used in the ex-ante calculations to reflect the energy and demand savings algorithms provided in the Customized Calculated Savings Guidelines for Non Residential Programs (Version 6.0).

The Navigant team used the following algorithms to calculate demand and energy savings:
Annual Energy Savings Algorithm

$$\Delta kWh = ((kW_{Baseline} - kW_{EE}) / 1000) \text{ x HOURS x } DIE_{Energy}$$

Where:

$kW_{Baseline}$	= Connected load of baseline fixtures
kW_{EE}	= Connected load of LED fixtures

[18] More information is available at: http://www.aesc-inc.com/download/spc/2013SPCDocs/PGE/Customized%202.0%20Energy%20Savings.pdf, page 84.

HOURS	= Average hours of use per year
DIE_{Energy}	= DEER Interactive Effects Factor for energy savings = 1.04

Summer Coincident Peak kW Savings Algorithm

$$\Delta kW = ((kW_{Baseline} - kW_{EE}) / 1000) \times DIE_{Demand} \times CDF$$

Where:

DIE_{Demand}	= DEER Interactive Effects Factor for energy savings = 1.17
CDF	= Coincident Diversity Factor for peak demand (0.924 in this case as the fixtures are on during the peak demand period)

The realization rate for the energy savings is on a lower side because the verified hours of use for some of the fixtures are higher than estimated in the ex-ante calculations.

The demand savings realization rate for the project is on a higher side because the Navigant team used the HVAC interactive factor and the coincident demand factor for the demand savings calculations.

3.16 Site 16

3.16.1 Project Summary

The site is a warehouse located in Modesto, CA.

The site had a mix of T12 and metal halide fixtures (total 80) in the baseline. The site retrofitted these fixtures with new, energy efficient T8 and T5 fixtures (total 97).

The realization rate for the energy savings is on a lower side because the verified hours of use for some of the fixtures are higher than estimated in the ex-ante calculations.

The demand savings realization rate for the project is on a higher side because the Navigant team used the HVAC interactive factor and the coincident demand factor for the demand savings calculations.

Table 3-34. First Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	28,467	20,941	74 %
Demand Savings (kW)	4.4	4.7	108 %

Source: Project Documentation, Navigant Analysis

3.16.2 Project Description

3.16.2.1 Description of the Baseline and the Installed Efficient Equipment and Operation

The site had following lighting system in the baseline:

Table 3-35. Baseline Equipment

Fixture Description	Quantity	Wattage	Annual Operating Hours
4-foot 4-lamp T12	13	148	2,340
2-lamp U shape T12	2	74	2,340
4-foot 2-lamp T12	4	74	2,340
8-foot 2-lamp T12	17	227	2,340
400 W metal halide	39	458	2,340
400 W metal halide	4	458	4,380
100 W metal halide	1	128	4,380

The site installed the following lighting system in the efficient case:

Table 3-36. Efficient Equipment

Fixture Description	Quantity	Wattage	Annual Operating Hours
4-foot 2-lamp T8	37	56	2,340
4-foot 2-lamp T8	4	56	1,287
4-foot 6-lamp T5	19	351	2,340
4-foot 6-lamp T5	36	351	1,287
70 W metal halide	1	95	4,380

The site added several occupancy sensors which resulted in the reduced operating hours for several interior fixtures.

3.16.2.2 Comments on Ex-Ante Calculations

The ex-ante calculations use standard lighting algorithm for the energy and demand calculations. These algorithms are listed as follows:

Energy Savings:

$$\Delta kWh = ((WattsBASE - WattsEE) / 1000) \times \text{Annual Operating Hours}$$

Where:

ΔkWh = Annual energy saved (in kWh)
WattsBASE = Connected load of baseline fixtures

WattsEE = Connected load of energy efficient fixtures

Demand Savings:

$\Delta kW = ((WattsBASE - WattsEE) / 1000)$

Where:

ΔkW	= Peak demand saved (in kW)
WattsBASE	= Connected load of baseline fixtures
WattsEE	= Connected load of energy efficient fixtures

The ex-ante calculations do not include coincident Diversity Factor and DEER Interactive Effects Factor as outlined in the Customized Calculated Savings Guidelines for Non Residential Programs, Version 6.0[19].

3.16.3 On-Site Visit

3.16.3.1 M&V Method

The Navigant team collected the following data during the on-site visit:

» Confirmed the wattage, quantity and schedules of the fixtures
» Confirmed the lamp wattage
» Installed six lighting loggers in various areas of the site which would represent the lighting fixtures spread.

This approach is in-line with the IPMVP Option A.

3.16.3.2 Summary of Site Visit

The Navigant team verified that the new T8 fixtures have been installed at the site and are operating as expected. The Navigant team installed six lighting loggers at the site to capture the operating hours of the fixtures.

3.16.3.3 Ex-Post Calculations and Assumptions

The Navigant team revised the algorithms used in the ex-ante calculations to reflect the energy and demand savings algorithms provided in the Customized Calculated Savings Guidelines for Non Residential Programs (Version 6.0).

The Navigant team used the following algorithms to calculate demand and energy savings:

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[19] More information is available at: http://www.aesc-inc.com/download/spc/2013SPCDocs/PGE/Customized%202.0%20Energy%20Savings.pdf, page 84.

Annual Energy Savings Algorithm

$\Delta kWh = ((kW_{Baseline} - kW_{EE}) / 1000) \times HOURS \times DIE_{Energy}$

Where:

$kW_{Baseline}$	= Connected load of baseline fixtures
kW_{EE}	= Connected load of energy efficient fixtures
HOURS	= Average hours of use per year
DIE_{Energy}	= DEER Interactive Effects Factor for energy savings = 1.04

Summer Coincident Peak kW Savings Algorithm

$\Delta kW = ((kW_{Baseline} - kW_{EE}) / 1000) \times DIE_{Demand} \times CDF$

Where:

DIE_{Demand}	= DEER Interactive Effects Factor for energy savings = 1.17
CDF	= Coincident Diversity Factor for peak demand (0.924 in this case as the fixtures are on during the peak demand period)

The realization rate for the energy savings is on a lower side because the verified hours of use for some of the fixtures are higher than estimated in the ex-ante calculations.

The demand savings realization rate for the project is on a higher side because the Navigant team used the HVAC interactive factor and the coincident demand factor for the demand savings calculations.

3.17 Site 17

3.17.1 Project Summary

The site is a warehouse in Turlock, CA.

The site replaced 28 1,000-watt metal halide fixtures with 22 4-foot 32-watt T8 fixtures.

The realization rate for the energy savings is on a higher side because the verified hours of use for most of the fixtures are lower than estimated in the ex-ante calculations.

The demand savings realization rate for the project is on a lower side because the Navigant team used the HVAC interactive factor and the coincident demand factor for the demand savings calculations.

Table 3-37. First Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	199,729	205,455	103 %
Demand Savings (kW)	21.6	18.8	87 %

Source: Project Documentation, Navigant Analysis

3.17.2 Project Description

3.17.2.1 Description of the Baseline and the Installed Efficient Equipment and Operation

The baseline condition included a total of 28 1,000-watt metal halide fixtures in the Warehouse. The baseline lighting system had 8,400 annual operating (24 by 7, 50 weeks a year).

The site installed 17 4-foot 12-lamp T8 fixtures and five 4-foot 8-lamp T8 fixtures. All the fixtures have occupancy sensor controls on them.

3.17.2.2 Comments on Ex-Ante Calculations

The ex-ante calculations use standard lighting algorithm for the energy and demand calculations. These algorithms are listed as follows:

Energy Savings:

$$\Delta kWh = ((WattsBASE - WattsEE) / 1000) \times Annual\ Operating\ Hours$$

Where:

ΔkWh	= Annual energy saved (in kWh)
WattsBASE	= Connected load of baseline fixtures
WattsEE	= Connected load of energy efficient fixtures

Demand Savings:

$$\Delta kW = ((WattsBASE - WattsEE) / 1000)$$

Where:

ΔkW	= Peak demand saved (in kW)
WattsBASE	= Connected load of baseline fixtures
WattsEE	= Connected load of energy efficient fixtures

The ex-ante calculations do not include the Coincident Diversity Factor and the DEER Interactive Effects Factor as outlined in the Customized Calculated Savings Guidelines for Non Residential Programs, Version 6.0[20].

3.17.3 On-Site Visit

3.17.3.1 M&V Method

The Navigant team collected the following data during the on-site visit:

- Confirmed the wattage, quantity and schedules of the fixtures
- Confirmed the lamp wattage
- Installed five lighting loggers in various areas of the site which would represent the lighting fixtures spread.

This approach is in-line with the IPMVP Option A.

3.17.3.2 Summary of Site Visit

The Navigant team verified that the new T8 fixtures have been installed at the site and are operating as expected. The Navigant team installed five lighting loggers at the site to capture the operating hours of the fixtures.

3.17.3.3 Ex-Post Calculations and Assumptions

The Navigant team revised the algorithms used in the ex-ante calculations to reflect the energy and demand savings algorithms provided in the Customized Calculated Savings Guidelines for Non Residential Programs (Version 6.0).

The Navigant team used the following algorithms to calculate demand and energy savings:

Annual Energy Savings Algorithm

$$\Delta kWh = ((kW_{Baseline} - kW_{EE}) / 1000) \times HOURS \times DIE_{Energy}$$

Where:

$kW_{Baseline}$	= Connected load of baseline fixtures
kW_{EE}	= Connected load of energy efficient fixtures
HOURS	= Average hours of use per year
DIE_{Energy}	= DEER Interactive Effects Factor for energy savings = 0.982

Summer Coincident Peak kW Savings Algorithm

[20] More information is available at: http://www.aesc-inc.com/download/spc/2013SPCDocs/PGE/Customized%202.0%20Energy%20Savings.pdf, page 84.

$\Delta kW = ((kW_{Baseline} - kW_{EE}) / 1000) \times DIE_{Demand} \times CDF$

Where:

DIE_{Demand}	= DEER Interactive Effects Factor for energy savings = 1.24
CDF	= Coincident Diversity Factor for peak demand (0.7 for the warehouse with air-conditioning)

The realization rate for the energy savings is on a higher side because the verified hours of use for most of the fixtures are lower than estimated in the ex-ante calculations.

The demand savings realization rate for the project is on a lower side because the Navigant team used the HVAC interactive factor and the coincident demand factor for the demand savings calculations.

3.18 Site 18

3.18.1 Project Summary

The site is a retail store in Ceres, CA.

The site retrofitted 170 320-watt metal halide fixtures with 8-foot 6-lamp T5 fixtures on a one-to-one basis.

The realization rate for the energy savings is on a higher side because the Navigant team used the HVAC interactive factor from DEER 2011 database for the ex-post calculations.

The demand savings realization rate for the project is on a higher side because the Navigant team used the HVAC interactive factor and the coincident demand factor from the DEER 2011 database for the demand savings calculations.

Table 3-38. First Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	174,981	185,480	106 %
Demand Savings (kW)	6.0	6.1	102 %

Source: Project Documentation, Navigant Analysis

3.18.2 Project Description

3.18.2.1 Description of the Baseline and the Installed Efficient Equipment and Operation

The baseline condition included a total 170 320-watt metal halide fixtures in the store. The baseline lighting system had 8,760 annual operating (24 by 7 schedule).

The site installed 170 8-foot 6-lamp T5 fixtures. All the fixtures have occupancy sensor controls on them.

3.18.2.2 Comments on Ex-Ante Calculations

The ex-ante calculations use standard lighting algorithms for the energy and demand calculations. These algorithms are listed as follows:

Energy Savings:

$$\Delta kWh = ((WattsBASE - WattsEE) / 1000) \times \text{Annual Operating Hours}$$

Where:

ΔkWh	= Annual energy saved (in kWh)
WattsBASE	= Connected load of baseline fixtures
WattsEE	= Connected load of energy efficient fixtures

Demand Savings:

$$\Delta kW = ((WattsBASE - WattsEE) / 1000)$$

Where:

ΔkW	= Peak demand saved (in kW)
WattsBASE	= Connected load of baseline fixtures
WattsEE	= Connected load of energy efficient fixtures

The ex-ante calculations do not include the Coincident Diversity Factor and the DEER Interactive Effects Factor as outlined in the Customized Calculated Savings Guidelines for Non Residential Programs, Version 6.0[21].

3.18.3 On-Site Visit

3.18.3.1 M&V Method

The Navigant team collected the following data during the on-site visit:

[21] More information is available at: http://www.aesc-inc.com/download/spc/2013SPCDocs/PGE/Customized%202.0%20Energy%20Savings.pdf, page 84.

- » Confirmed the wattage, quantity and schedules of the fixtures
- » Confirmed the lamp wattage
- » Installed eight lighting loggers in various areas of the site which would represent the lighting fixtures spread.

This approach is in-line with the IPMVP Option A.

3.18.3.2 Summary of Site Visit

The Navigant team verified that the new T5 fixtures have been installed at the site and are operating as expected. The Navigant team installed eight lighting loggers at the site to capture the operating hours of the fixtures but the Navigant team was not able to retrieve the lighting loggers from the site.

3.18.3.3 Ex-Post Calculations and Assumptions

The Navigant team revised the algorithms used in the ex-ante calculations to reflect the energy and demand savings algorithms provided in the Customized Calculated Savings Guidelines for Non Residential Programs (Version 6.0).

The Navigant team used the following algorithms to calculate demand and energy savings:

Annual Energy Savings Algorithm

$$\Delta kWh = ((kW_{Baseline} - kW_{EE}) / 1000) \times HOURS \times DIE_{Energy}$$

Where:

$kW_{Baseline}$	= Connected load of baseline fixtures
kW_{EE}	= Connected load of LED fixtures
HOURS	= Average hours of use per year
DIE_{Energy}	= DEER Interactive Effects Factor for energy savings = 1.06

Summer Coincident Peak kW Savings Algorithm

$$\Delta kW = ((kW_{Baseline} - kW_{EE}) / 1000) \times DIE_{Demand} \times CDF$$

Where:

DIE_{Demand}	= DEER Interactive Effects Factor for energy savings = 1.2
CDF	= Coincident Diversity Factor for peak demand (0.848 for a retail store)

The Navigant team was not able to retrieve the lighting loggers installed at the site. The Navigant team used standard 25 percent occupancy control savings factor to calculate the efficient case lighting hours of operation.

The realization rate for the energy savings is on a higher side because the Navigant team used the HVAC interactive factor from DEER 2011 database for the ex-post calculations.

The demand savings realization rate for the project is on a higher side because the Navigant team used the HVAC interactive factor and the coincident demand factor from the DEER 2011 database for the demand savings calculations.

4. Estimating Program Level Ex-post Savings

Each of the ex-ante and ex-post estimates of gross energy savings are part of a sampling stratum. Within each stratum, the share of sampled ex-ante savings to total ex-ante savings is used as the multiplier to develop a total stratum level set of ex-ante and ex-post savings. Each stratum also has a weight that identifies the stratum share of the total ex-ante program savings. These stratum shares are applied to the stratum ex-ante and ex-post savings to develop program level ex-post savings. The program level realization rate is the program level ex-post savings divided by the program level ex-ante savings. Table 4-1 identifies the realization rates by project and the overall program realization rate of 100.6 percent. This overall energy realization rate is used to estimate the ex-post energy savings by utility.

Table 4-1. Combined Program Level Electric Gross Energy Ex-post Savings and Realization Rates

Utility	Ex-ante Savings (kWh)	Project Realization Rate	Ex-post Savings (kWh)	Stratum Weight	Extrapolated Ex-ante Savings (kWh)	Extrapolated Ex-post Savings (kWh)
Turlock	1,638,499	118.5%	1,942,033	1.37	2,247,967	2,664,405
Merced	1,015,266	138.7%	1,407,846	1.37	1,392,912	1,931,518
Modesto	937,583	148.0%	1,387,704	1.37	1,286,333	1,903,884
Turlock	897,869	141.7%	1,272,303	1.37	1,231,847	1,745,558
Modesto	868,320	123.7%	1,073,886	1.37	1,191,307	1,473,336
Modesto	397,837	125.1%	497,508	1.37	545,819	682,565
Modesto	357,974	74.6%	267,115	4.71	1,684,808	1,257,179
Modesto	294,177	85.4%	251,106	4.71	1,384,545	1,181,833
Turlock	199,729	102.9%	205,455	4.71	940,026	966,976
Turlock	174,981	106.0%	185,480	4.71	823,550	872,963
Merced	143,506	67.9%	97,373	4.71	675,412	458,287
Modesto	138,106	118.6%	163,803	4.71	649,997	770,940
Modesto	82,197	11.7%	9,578	19.59	1,609,828	187,586
Turlock	73,937	96.1%	71,078	19.59	1,448,063	1,392,069
Turlock	28,467	73.6%	20,941	19.59	557,529	410,131
Modesto	20,148	79.8%	16,087	19.59	394,608	315,070
Modesto	8,338	100.0%	8,338	19.59	163,300	163,300
Modesto	4,249	46.7%	1,985	19.59	83,215	38,876
TOTAL	7,281,183	100.6%	8,879,619		18,311,065	18,416,478

Estimating the demand impact from the programs is different, due to the fact that only 10 of the 18 sites reported demand impacts whereas the Navigant team estimated demand impacts from all the sites.

Because of this situation, the method the Navigant team utilized to estimate program demand impacts followed these steps:

» A realization rates for the 10 projects with ex-ante demand impacts were estimated. Table 4-2 provides a summary of these realization rates.
» For the 10 projects, calculate the unweighted average realization rate. An unweighted value is used since one project is significantly larger than the others. As shown in Table 4-2, this average realization rate is 95.2 percent.

Table 4-2. Demand Realization Rates by Project

Utility	Ex-ante Demand Savings (kW)	Ex-post Demand Savings (kW)	Project Realization Rate
Turlock	228.5	147.6	64.6%
Modesto	44.6	68.3	153.1%
Turlock	87.2	60.1	68.9%
Modesto	54.6	65.5	120.0%
Modesto	41.0	13.3	32.4%
Turlock	21.6	18.8	86.8%
Turlock	6.0	6.1	101.7%
Turlock	17.8	20.7	116.3%
Turlock	4.4	4.7	108.0%
Modesto	1.3	1.3	100.0%
AVERAGE			95.2%

» This 94.2 percent realization rate cannot be directly applied to the ex-ante demand impact estimates since so many were missing. To work around this issue, a watts/kWh value is calculated from the ex-post demand and energy impacts. Table 4-3 provides the project by project Watts/kWh ratio as well as the stratum weighted value of 0.087 Watts/kWh.

Table 4-3. Calculations for the Watts/kWh Ratio

Utility	Ex-post Energy Savings (kWh)	Ex-post Demand Savings (kW)	Stratum Weight	Extrapolated Ex-post Energy Savings (kWh)	Extrapolated Ex-post Demand Savings (kW)	Watts/kWh Ratio
Turlock	1,942,033	147.6	1.37		202.5	0.076
Merced	1,407,846	136.2	1.37	1,931,518	186.9	0.097
Modesto	1,387,704	68.3	1.37	1,903,884	93.7	0.049
Turlock	1,272,303	60.1	1.37	1,745,558	82.5	0.047
Modesto	1,073,886	0.0	1.37	1,473,336	0.0	0.000
Modesto	497,508	65.5	1.37	682,565	89.9	0.132
Modesto	267,115	9.1	4.71	1,257,179	42.8	0.034
Modesto	251,106	8.9	4.71	1,181,833	41.9	0.035
Turlock	205,455	18.8	4.71	966,976	88.3	0.091
Turlock	185,480	6.1	4.71	872,963	28.5	0.033
Merced	97,373	9.4	4.71	458,287	44.2	0.097
Modesto	163,803	0.2	4.71	770,940	0.9	0.001
Modesto	9,578	0.0	19.59	187,586	0.0	0.000
Turlock	71,078	20.7	19.59	1,392,069	405.4	0.291
Turlock	20,941	4.7	19.59	410,131	92.0	0.224
Modesto	16,087	3.7	19.59	315,070	72.5	0.230
Modesto	8,338	1.3	19.59	163,300	25.5	0.156
Modesto	1,985	0.5	19.59	38,876	9.8	0.252
TOTAL	8,879,619	561.0		18,416,478	1,507	0.082

Table 4-4 outlines by utility the program level ex-ante and ex-post energy and coincident peak demand estimates. For the analysis of peak demand, the Navigant team used the steps outlined above; applying the watts/kWh ratio and peak demand realization rate to the gross program ex-post energy savings.

Table 4-4. Program Level Electric Gross Energy and Demand Ex-post Savings

Utility	Gross Program Ex-ante Savings (kWh)	Energy Realization Rate	Gross Program Ex-post Savings (kWh)	Watts/kWh Ratio	Demand Realization Rate	Gross Program Ex-post Coincident Demand Savings (kW)
Modesto	9,582,306	100.6%	9,637,469	0.082	95.2%	750.8
Turlock	6,453,348	100.6%	6,490,498	0.082	95.2%	505.7
Merced	2,275,412	100.6%	2,288,511	0.082	95.2%	178.3
Total	18,311,065	100.6%	18,416,478	0.082	95.2%	1,434.8

4.1 Ex-Post Gross and Net Energy Savings and Demand Impacts

The Navigant team did not conduct primary research into net-to-gross affects. Rather, the values used by each utility within their respective E3 model submittals are utilized.

Table 4-5. Program Level Gross and Net Energy and Demand Ex-post Savings

Utility	Gross Program Ex-post Savings (kWh)	Gross Program Ex-post Coincident Demand Savings (kW)	Net-to-Gross Ratio	Net Program Ex-post Savings (kWh)	Net Program Ex-post Coincident Demand Savings (kW)
Modesto	9,637,469	750.8	83.75%	8,071,380	628.8
Turlock	6,490,498	505.7	80.00%	5,192,399	404.5
Merced	2,288,511	178.3	78.00%	1,785,039	139.1
Total	18,416,478	1,434.8	81.71%	15,048,817	1,172.41

5. EUL & Lifecycle Savings

Effective Useful Life (EUL) is an estimate of the median number of years that the measures installed under a program are still in place and operable. The DEER database and the E3 model are the sources for estimates of EUL. Lifecycle savings are calculated by multiplying the EUL by the estimate of first year energy savings. Because of the multiple number of different measures included in each utility's program portfolio, the estimated measure life by utility is a weighted average based on the values from each utility's respective E3 submittal. Table 5-1 identifies the gross and net lifecycle energy savings by utility.

Table 5-1. Ex-post Lifecycle Electric Savings

Utility	Gross Program Ex-post Savings (kWh)	Net Program Ex-post Savings (kWh)	Effective Useful Life	Gross Program Lifecycle Ex-post Savings (kWh)	Net Program Lifecycle Ex-post Savings (kWh)
Modesto	9,637,469	8,071,380	9.8	94,447,193	79,099,524
Turlock	6,490,498	5,192,399	11	71,395,480	57,116,384
Merced	2,288,511	1,785,039	11.1	25,402,473	19,813,929
Total	**18,416,478**	**15,048,817**	**10.4**	**191,245,146**	**156,029,837**

6. Program Recommendations

Based on the impact evaluation, the Navigant team has the following recommendations for improving future savings calculations.

Include the Coincident Demand Diversity Factor and HVAC Interactive Factors while calculating the energy and the demand savings for the custom lighting projects. The Navigant team recommends that the Coincident Demand Diversity Factor and the DEER Interactive Effects Factors should be used while calculating the energy and the demand savings for the custom lighting projects implemented in the conditioned spaces. These factors are outlined in the Customized Calculated Savings Guidelines for Non Residential Programs, Version 6.0[22]. The Coincident Demand Diversity Factor provides a probability that the light affected by the project will be on during the facility's peak demand period. Coincident Diversity Factor for peak demand is based on the project's technology (CFL, Non-CFL, or LED Exit Sign), building type and climate zone. These factors are documented in the Database for Energy Efficiency Resources and are only applicable for the indoor lighting. Also, by reducing the lighting load in the air-conditioned areas, the load on the HVAC system is lowered and this effect must be quantified using the HVAC Interactive Factors.

Provide additional quality control for the ex-ante savings calculations. At site 15, the ex-ante calculations listed the efficient lighting system correctly as '4-foot 6-lamp T8 fixture' in the "Proposed Lighting" table for three fixtures but listed the wattage for the baseline metal halide fixture in the 'Proposed Lighting' table. This resulted in slightly less claimed ex-ante savings for the site 15. The Navigant team recommends additional quality control of projects to filter out such errors from programs.

Contact program participants who received new door gaskets and insure the material being installed is of high quality. At the two sites we visited with door gasket installation, Navigant staff found that the gaskets appeared to be of poor quality. Though still providing a seal, they were beginning to deteriorate. The gasket measure has a rated measure life of 4 years but the condition of the gaskets did not look promising to last for the rated measure life.

[22] More information is available at: http://www.aesc-inc.com/download/spc/2013SPCDocs/PGE/Customized%202.0%20Energy%20Savings.pdf, page 84.

7. Portfolio Summary of Impacts

The combined programs included in the FY2013 EM&V for MTM are all from the non-residential sector. The sampled sites comprised 40 percent of the evaluated *ex-ante* electric energy savings.

As shown in Table 7-1, the share of evaluated claimed savings to total claimed savings is about 69 percent. Turlock had the lowest share of evaluated to total claimed savings of about 49 percent. The share for Modesto is about 87 percent and for Merced, nearly 100 percent.

Table 7-1. Share of Evaluated Claimed Savings to Total Claimed Savings by Utility

Utility	Total Gross Annual Ex-ante Energy Savings (kWh)	Evaluated Gross Annual Ex-ante Energy Savings (kWh)	Percent of the Total Energy Savings Evaluated
Modesto	11,061,683	9,582,306	86.6%
Turlock	13,052,240	6,453,348	49.4%
Merced	2,295,325	2,275,412	99.1%
Total	**26,409,247**	**18,311,065**	**69.3%**

7.1 Portfolio Level Ex-post Gross and Net Energy Savings by Utility

Table 7-2, Table 7-3, and Table 7-4 summarize the gross and net ex-post electricity savings for Modesto, Turlock, and Merced; respectively. All Categories included within each utilities portfolio of program offerings are identified in the tables. The realization rate of 100.6 percent is applied to each of the categories included in the EM&V combined sample. No realization rate is applied to any of the remaining categories. The net to gross ratios are taken directly from each utility's SB 1037 filing and represent an average within each category.

Table 7-2. Gross and Net Ex-post Portfolio Level Electric Savings - Modesto

Modesto Category	Gross Annual Ex-ante Energy Savings (kWh)	Energy Savings Realization Rate	Gross Annual Ex-post Energy Savings (kWh)	Net to Gross Ratio	Net Annual Ex-post Energy Savings (kWh)
Res Clothes Washers	24,924	NA	24,924	85.0%	21,185
Res Cooling	84,496	NA	84,496	83.3%	70,400
Res Dishwashers	0	NA	0	0.0%	0
Res Electronics	10,050	NA	10,050	100.0%	10,050
Res Heating	0	NA	0	0.0%	0
Res Lighting	133,601	NA	133,601	100.0%	133,601
Res Pool Pump	26,001	NA	26,001	69.0%	17,941
Res Refrigeration	267,055	NA	267,055	77.6%	207,148
Res Shell	162,202	NA	162,202	66.3%	107,523
Res Water Heating	9,978	NA	9,978	87.8%	8,758
Res Comprehensive	183,547	NA	183,547	80.0%	146,838
Non-Res Cooling	794,590	100.6%	799,164	80.0%	639,331
Non-Res Heating	0	NA	0	0.0%	0
Non-Res Lighting	5,019,350	100.6%	5,048,245	84.8%	4,278,951
Non-Res Motors	0	NA	0	0.0%	0
Non-Res Pumps	37,200	100.6%	37,414	80.0%	29,931
Non-Res Refrigeration	3,209,924	100.6%	3,228,403	84.3%	2,720,069
Non-Res Shell	195,727	100.6%	196,854	80.0%	157,483
Non Res Process	903,038	100.6%	908,237	80.0%	726,589
TOTAL	11,061,683		11,120,171	83.41%	9,275,798

Table 7-3. Gross and Net Ex-post Portfolio Level Electric Savings - Turlock

Turlock Category	Gross Annual Ex-ante Energy Savings (kWh)	Energy Savings Realization Rate	Gross Annual Ex-post Energy Savings (kWh)	Net to Gross Ratio	Net Annual Ex-post Energy Savings (kWh)
Res Clothes Washers	15,167	NA	15,167	80.0%	12,134
Res Cooling	151,117	NA	151,117	80.0%	120,894
Res Dishwashers	0	NA	0	0.0%	0
Res Electronics	0	NA	0	0.0%	0
Res Heating	0	NA	0	0.0%	0
Res Lighting	40,304	NA	40,304	50.0%	20,152
Res Pool Pump	0	NA	0	0.0%	0
Res Refrigeration	116,648	NA	116,648	66.7%	77,784
Res Shell	12,634	NA	12,634	55.7%	7,043
Res Water Heating	0	NA	0	0.0%	0
Res Comprehensive	23,179	NA	23,179	80.0%	18,543
Non-Res Cooling	0	NA	0	0.0%	0
Non-Res Heating	0	NA	0	0.0%	0
Non-Res Lighting	11,244,421	100.6%	11,309,152	80.0%	9,047,322
Non-Res Motors	229,245	100.6%	230,565	78.6%	181,128
Non-Res Pumps	282,866	100.6%	284,494	80.0%	227,596
Non-Res Refrigeration	490,059	100.6%	492,880	80.3%	396,001
Non-Res Shell	138,380	100.6%	139,177	80.0%	111,341
Non Res Process	308,220	100.6%	309,994	82.0%	254,102
TOTAL	13,052,240		13,125,311	79.80%	10,474,040

Table 7-4. Gross and Net Ex-post Portfolio Level Electric Savings - Merced

Merced Category	Gross Annual Ex-ante Energy Savings (kWh)	Energy Savings Realization Rate	Gross Annual Ex-post Energy Savings (kWh)	Net to Gross Ratio	Net Annual Ex-post Energy Savings (kWh)
Res Clothes Washers	3,596	NA	3,596	85.0%	3,057
Res Cooling	257	NA	257	67.8%	174
Res Dishwashers	368	NA	368	80.0%	295
Res Electronics	0	NA	0	0.0%	0
Res Heating	0	NA	0	0.0%	0
Res Lighting	2,662	NA	2,662	62.1%	1,654
Res Pool Pump	0	NA	0	0.0%	0
Res Refrigeration	5,687	NA	5,687	75.0%	4,265
Res Shell	0	NA	0	0.0%	0
Res Water Heating	0	NA	0	0.0%	0
Res Comprehensive	0	NA	0	0.0%	0
Non-Res Cooling	766,557	100.6%	770,970	78.1%	601,810
Non-Res Heating	0	NA	0	0.0%	0
Non-Res Lighting	1,497,363	100.6%	1,505,983	78.0%	1,174,667
Non-Res Motors	0	NA	0	0.0%	0
Non-Res Pumps	0	NA	0	0.0%	0
Non-Res Refrigeration	7,394	100.6%	7,437	85.0%	6,321
Non-Res Shell	0	NA	0	0.0%	0
Non Res Process	11,440	100.6%	11,506	78.0%	8,975
TOTAL	2,295,325		2,308,466	78.03%	1,801,218

Table 7-5, Table 7-6, and Table 7-7 summarize the gross and net ex-post coincident peak demand savings for Modesto, Turlock, and Merced; respectively. The demand realization rate as energy of 95.2 percent is applied to each of the programs included in the EM&V combined sample. No realization rate is applied to any of the remaining programs. The ex-ante gross coincident peak demand savings are taken directly from each utility's SB 1037 filing.

Table 7-5. Gross and Net Ex-post Portfolio Level Coincident Peak Demand Savings - Modesto

Modesto Category	Gross Ex-ante Coincident Peak Demand (kW)	Demand Realization Rate	Gross Ex-post Coincident Peak Demand (kW)	Net to Gross Ratio	Net Ex-post Coincident Peak Demand (kW)
Res Clothes Washers	63.9	NA	63.9	85.0%	54.3
Res Cooling	80.3	NA	80.3	83.3%	66.9
Res Dishwashers	0.0	NA	0.0	0.0%	0.0
Res Electronics	0.0	NA	0.0	0.0%	0.0
Res Heating	0.0	NA	0.0	0.0%	0.0
Res Lighting	19.0	NA	19.0	100.0%	19.0
Res Pool Pump	6.4	NA	6.4	69.0%	4.4
Res Refrigeration	29.6	NA	29.6	77.6%	22.9
Res Shell	156.6	NA	156.6	66.3%	103.8
Res Water Heating	0.2	NA	0.2	87.8%	0.1
Res Comprehensive	0.0	NA	0.0	0.0%	0.0
Non-Res Cooling	140.1	95.2%	133.4	80.0%	106.7
Non-Res Heating	0.0	NA	0.0	0.0%	0.0
Non-Res Lighting	737.7	95.2%	702.2	84.8%	595.2
Non-Res Motors	0.0	NA	0.0	0.0%	0.0
Non-Res Pumps	18.6	95.2%	17.7	80.0%	14.2
Non-Res Refrigeration	326.7	95.2%	311.0	84.3%	262.0
Non-Res Shell	3.6	95.2%	3.4	80.0%	2.7
Non Res Process	135.5	95.2%	129.0	80.0%	103.2
TOTAL	1,718.2		1,652.7	82.02%	1,355.6

Table 7-6. Gross and Net Ex-post Portfolio Level Coincident Peak Demand Savings - Turlock

Turlock Category	Gross Ex-ante Coincident Peak Demand (kW)	Demand Realization Rate	Gross Ex-post Coincident Peak Demand (kW)	Net to Gross Ratio	Net Ex-post Coincident Peak Demand (kW)
Res Clothes Washers	6.3	NA	6.3	80.0%	5
Res Cooling	34.9	NA	34.9	80.0%	28
Res Dishwashers	0.0	NA	0.0	0.0%	0
Res Electronics	0.0	NA	0.0	0.0%	0
Res Heating	0.0	NA	0.0	0.0%	0
Res Lighting	7.5	NA	7.5	50.0%	4
Res Pool Pump	0.0	NA	0.0	0.0%	0
Res Refrigeration	29.2	NA	29.2	66.7%	19
Res Shell	12.1	NA	12.1	55.7%	7
Res Water Heating	0.0	NA	0.0	0.0%	0
Res Comprehensive	0.0	NA	0.0	0.0%	0
Non-Res Cooling	0.0	NA	0.0	0.0%	0
Non-Res Heating	0.0	NA	0.0	0.0%	0
Non-Res Lighting	1,363.0	95.2%	1,297.4	80.0%	1,038
Non-Res Motors	52.8	95.2%	50.2	78.6%	39
Non-Res Pumps	84.0	95.2%	80.0	80.0%	64
Non-Res Refrigeration	76.6	95.2%	72.9	80.3%	59
Non-Res Shell	125.1	95.2%	119.1	80.0%	95
Non Res Process	149.7	95.2%	142.5	82.0%	117
TOTAL	1,941.1		1,852	79.64%	1,475

Table 7-7. Gross and Net Ex-post Portfolio Level Coincident Peak Demand Savings – Merced

Merced Category	Gross Ex-ante Coincident Peak Demand (kW)	Demand Realization Rate	Gross Ex-post Coincident Peak Demand (kW)	Net to Gross Ratio	Net Ex-post Coincident Peak Demand (kW)
Res Clothes Washers	9.2	NA	9.2	85.0%	7.8
Res Cooling	0.0	NA	0.0	0.0%	0.0
Res Dishwashers	1.3	NA	1.3	80.0%	1.0
Res Electronics	0.0	NA	0.0	0.0%	0.0
Res Heating	0.0	NA	0.0	0.0%	0.0
Res Lighting	0.5	NA	0.5	62.1%	0.3
Res Pool Pump	0.0	NA	0.0	0.0%	0.0
Res Refrigeration	1.0	NA	1.0	75.0%	0.7
Res Shell	0.0	NA	0.0	0.0%	0.0
Res Water Heating	0.0	NA	0.0	0.0%	0.0
Res Comprehensive	0.0	NA	0.0	0.0%	0.0
Non-Res Cooling	0.0	NA	0.0	0.0%	0.0
Non-Res Heating	0.0	NA	0.0	0.0%	0.0
Non-Res Lighting	0.6	95.2%	0.6	78.0%	0.5
Non-Res Motors	0.0	NA	0.0	0.0%	0.0
Non-Res Pumps	0.0	NA	0.0	0.0%	0.0
Non-Res Refrigeration	1.7	95.2%	1.6	85.0%	1.4
Non-Res Shell	0.0	NA	0.0	0.0%	0.0
Non Res Process	0.1	95.2%	0.1	78.0%	0.1
TOTAL	14.4		14.2	82.72%	11.8

7.2 *Portfolio Level EUL & Lifecycle Savings by Utility*

Effective Useful Life (EUL) is an estimate of the median number of years that the measures installed under a program are still in place and operable. The DEER database and the E3 model are the sources for estimates of EUL.

The lifecycle savings are calculated by multiplying the EUL by the estimate of first year energy savings. Each program includes many different measures and the lifetimes associated with each program is a weighted average (weighted by energy savings) of the measures included within each program.

Table 7-8, Table 7-9, and

Table 7-10 summarizes the gross and net ex-post lifecycle energy savings for each program by utility for Modesto, Turlock, and Merced; respectively.

Table 7-8. Gross and Net Ex-post Portfolio Level Lifecycle Energy Savings - Modesto

Modesto Category	Gross Annual Ex-post Energy Savings (kWh)	Net Annual Ex-post Energy Savings (kWh)	Average Measure Life	Gross Lifecycle Ex-post Energy Savings (kWh)	Net Lifecycle Ex-post Energy Savings (kWh)
Res Clothes Washers	24,924	21,185	12.0	299,088	254,225
Res Cooling	84,496	70,400	19.3	1,632,254	1,359,954
Res Dishwashers	0	0	0.0	0	0
Res Electronics	10,050	10,050	15.0	150,750	150,750
Res Heating	0	0	0.0	0	0
Res Lighting	133,601	133,601	6.4	854,809	854,809
Res Pool Pump	26,001	17,941	10.0	260,010	179,407
Res Refrigeration	267,055	207,148	11.3	3,029,570	2,349,959
Res Shell	162,202	107,523	14.6	2,367,280	1,569,262
Res Water Heating	9,978	8,758	12.8	127,819	112,196
Res Comprehensive	183,547	146,838	15.0	2,753,205	2,202,564
Non-Res Cooling	799,164	639,331	15.0	11,987,457	9,589,965
Non-Res Heating	0	0	0.0	0	0
Non-Res Lighting	5,048,245	4,278,951	10.5	52,914,753	44,851,153
Non-Res Motors	0	0	0.0	0	0
Non-Res Pumps	37,414	29,931	15.0	561,212	448,970
Non-Res Refrigeration	3,228,403	2,720,069	11.8	38,048,407	32,057,427
Non-Res Shell	196,854	157,483	14.2	2,800,293	2,240,235
Non Res Process	908,237	726,589	15.0	13,623,549	10,898,839
TOTAL	11,120,171	9,275,798	11.8	131,410,456	109,119,715

Table 7-9. Gross and Net Ex-post Portfolio Level Lifecycle Energy Savings - Turlock

Turlock Category	Gross Annual Ex-post Energy Savings (kWh)	Net Annual Ex-post Energy Savings (kWh)	Average Measure Life	Gross Lifecycle Ex-post Energy Savings (kWh)	Net Lifecycle Ex-post Energy Savings (kWh)
Res Clothes Washers	15,167	12,134	10.0	151,670	121,336
Res Cooling	151,117	120,894	29.3	4,430,194	3,544,155
Res Dishwashers	0	0	0.0	0	0
Res Electronics	0	0	0.0	0	0
Res Heating	0	0	0.0	0	0
Res Lighting	40,304	20,152	5.0	201,520	100,760
Res Pool Pump	0	0	0.0	0	0
Res Refrigeration	116,648	77,784	9.7	1,127,348	751,744
Res Shell	12,634	7,043	10.6	134,477	74,968
Res Water Heating	0	0	0.0	0	0
Res Comprehensive	23,179	18,543	30.0	695,371	556,296
Non-Res Cooling	0	0	0.0	0	0
Non-Res Heating	0	0	0.0	0	0
Non-Res Lighting	11,309,152	9,047,322	11.0	124,899,967	99,919,974
Non-Res Motors	230,565	181,128	12.2	2,809,445	2,207,057
Non-Res Pumps	284,494	227,596	15.0	4,267,416	3,413,933
Non-Res Refrigeration	492,880	396,001	10.4	5,121,514	4,114,845
Non-Res Shell	139,177	111,341	11.0	1,530,943	1,224,754
Non Res Process	309,994	254,102	7.3	2,248,098	1,842,766
TOTAL	13,125,311	10,474,040	11.2	147,617,961	117,872,589

Table 7-10. Gross and Net Ex-post Portfolio Level Lifecycle Energy Savings - Merced

Merced Category	Gross Annual Ex-post Energy Savings (kWh)	Net Annual Ex-post Energy Savings (kWh)	Average Measure Life	Gross Lifecycle Ex-post Energy Savings (kWh)	Net Lifecycle Ex-post Energy Savings (kWh)
Res Clothes Washers	3,596	3,057	12.0	43,152	36,679
Res Cooling	257	174	18.1	4,666	3,164
Res Dishwashers	368	295	11.0	4,052	3,242
Res Electronics	0	0	0.0	0	0
Res Heating	0	0	0.0	0	0
Res Lighting	2,662	1,654	6.1	16,155	10,039
Res Pool Pump	0	0	0.0	0	0
Res Refrigeration	5,687	4,265	14.0	79,618	59,714
Res Shell	0	0	0.0	0	0
Res Water Heating	0	0	0.0	0	0
Res Comprehensive	0	0	0.0	0	0
Non-Res Cooling	770,970	601,810	11.4	8,806,183	6,874,006
Non-Res Heating	0	0	0.0	0	0
Non-Res Lighting	1,505,983	1,174,667	11.0	16,565,813	12,921,334
Non-Res Motors	0	0	0.0	0	0
Non-Res Pumps	0	0	0.0	0	0
Non-Res Refrigeration	7,437	6,321	4.0	29,748	25,286
Non-Res Shell	0	0	0.0	0	0
Non Res Process	11,506	8,975	11.0	126,564	98,720
TOTAL	2,308,466	1,801,218	11.1	25,675,952	20,032,183