NAVIGANT

EVALUATION, MEASUREMENT, AND VERIFICATION OF THE MERCED, TURLOCK, AND MODESTO IRRIGATION DISTRICT'S FY 2012 ENERGY EFFICIENCY PROGRAMS

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

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NAVIGANT

Table of Contents

List of Tables

List of Figures

NAVIGANT

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 85 percent for Modesto, 90 percent, for Turlock, and over 99 percent for Merced.

Given the similarities of type of utility, geographic location, and program offerings, the three joined together in the evaluation of their FY 2012 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 FY2012 EM&V for MTM are all from the non-residential sector. The sampled sites comprised 62% 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 45 percent. Modesto had the lowest share of evaluated to total claimed savings of about 16 percent. This low value reflects the greater diversity of its overall utility portfolio of programs offered; especially with Modesto's new construction programs that represent over 50 percent of their claimed savings. The share for Turlock is about 95 percent and for Merced, nearly 100 percent. These high shares reflect the large percentage of claimed savings from the non-residential existing building sector.

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	15,648,477	2,571,507	16.4%
Turlock	5,713,573	5,422,695	94.9%
Merced	3,259,287	3,246,028	99.6%
Total	**24,621,337**	**11,240,230**	**45.7%**

1.1.1 Portfolio Level Ex-post Gross and Net 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 programs included within each utilities portfolio of program offerings are identified in the tables. The realization rate of 99.7 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 net to gross ratios are taken directly from each utility's E3 filing and represent an average within each program category.

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

Modesto Program	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)
AG-Custom	14,732	99.7%	14,688	80.0%	11,750
BIZ-Cooling	24,423	99.7%	24,349	80.0%	19,479
BIZ-Custom	1,761,896	99.7%	1,756,610	80.0%	1,405,288
BIZ-Lighting	2,315,140	NA	2,315,140	84.8%	1,963,239
BIZ-New Construction	8,430,050	NA	8,430,050	80.0%	6,744,040
BIZ-Refrigeration	715,414	99.7%	713,268	85.0%	606,278
BIZ-Windows	55,043	99.7%	54,878	80.0%	43,902
LIEE-All	1,574,347	NA	1,574,347	100.0%	1,574,347
RES-Appliance	215,093	NA	215,093	66.6%	143,252
RES-Cooling	197,211	NA	197,211	89.2%	175,913
RES-Gen Improvement	1,509	NA	1,509	80.0%	1,207
RES-Lighting	158,400	NA	158,400	80.0%	126,720
RES-Windows	152,206	NA	152,206	55.0%	83,713
RES-New Construction	20,815	NA	20,815	80.0%	16,652
RES-Pool Pump	12,198	NA	12,198	69.0%	8,417
TOTAL	**15,648,477**		**15,640,763**	**82.6%**	**12,924,197**

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

Turlock Program	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 - CFL	33,764	NA	33,764	50.0%	16,882
Res - Clothes Washer	17,284	NA	17,284	80.0%	13,827
Res - Cooling	7,317	NA	7,317	80.0%	5,854
Res - Refrigeration	190,288	NA	190,288	80.0%	152,230
Res - Shell	17,235	NA	17,235	80.0%	13,788
Res - Shade Tree	24,990	NA	24,990	80.0%	19,992
Ag - Lighting	181,079	99.7%	180,536	80.0%	144,429
Ag - Motors	61,950	99.7%	61,764	80.0%	49,411
Ag - Variable Speed Drive	38,795	99.7%	38,679	80.0%	30,943
Com - Lighting	2,681,690	99.7%	2,673,645	80.0%	2,138,916
Com - Refrigeration	189,662	99.7%	189,093	80.0%	151,274
Ind - Lighting	1,954,664	99.7%	1,948,800	80.0%	1,559,040
Ind - Motors	314,855	99.7%	313,910	80.0%	251,128
TOTAL	**5,713,573**		**5,697,305**	**79.8%**	**4,547,715**

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

Merced Program	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)
Commercial Retrofit	3,246,028	99.7%	3,236,290	78.8%	2,550,197
Residential Air Conditioning	419	NA	419	78.3%	328
Residential Appliances	5,953	NA	5,953	78.7%	4,685
Residential Refrigerator Recycle	3,785	NA	3,785	61.4%	2,324
Residential Lighting	3,102	NA	3,102	78.9%	2,447
TOTAL	**3,259,287**		**3,249,549**	**78.8%**	**2,559,981**

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 same realization rate as energy of 99.7 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 E3 filing. Navigant used the California Protocol guidelines for estimating peak demand impact at the basic rigor level.

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

Modesto Program	Gross Ex-ante Coincident Peak Demand (kW)	Energy Savings Realization Rate	Gross Ex-post Coincident Peak Demand (kW)	Net to Gross Ratio	Net Ex-post Coincident Peak Demand (kW)
AG-Custom	0.0	99.7%	0.0	80.0%	0.0
BIZ-Cooling	18.0	99.7%	17.9	80.0%	14.4
BIZ-Custom	183.4	99.7%	182.8	80.0%	146.3
BIZ-Lighting	372.0	NA	372.0	84.8%	315.5
BIZ-New Construction	123.8	NA	123.8	80.0%	99.0
BIZ-Refrigeration	120.5	99.7%	120.1	85.0%	102.1
BIZ-Windows	6.5	99.7%	6.5	80.0%	5.2
LIEE-All	853.7	NA	853.7	100.0%	853.7
RES-Appliance	109.8	NA	109.8	66.6%	73.1
RES-Cooling	40.3	NA	40.3	89.2%	35.9
RES-Gen Improvement	8.4	NA	8.4	80.0%	6.7
RES-Lighting	25.2	NA	25.2	80.0%	20.2
RES-Windows	155.0	NA	155.0	55.0%	85.3
RES-New Construction	0.0	NA	0.0	80.0%	0.0
RES-Pool Pump	3.0	NA	3.0	69.0%	2.1
TOTAL	**2,019.6**		**2,018.6**	**87.2%**	**1,759.4**

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

Turlock Program	Gross Ex-ante Coincident Peak Demand (kW)	Energy Savings Realization Rate	Gross Ex-post Coincident Peak Demand (kW)	Net to Gross Ratio	Net Ex-post Coincident Peak Demand (kW)
Res - CFL	6.3	NA	6.3	50.0%	3.2
Res - Clothes Washer	7.2	NA	7.2	80.0%	5.8
Res - Cooling	8.2	NA	8.2	80.0%	6.6
Res - Refrigeration	51.4	NA	51.4	80.0%	41.1
Res - Shell	15.8	NA	15.8	80.0%	12.6
Res - Shade Tree	6.9	NA	6.9	80.0%	5.5
Ag - Lighting	26.5	99.7%	26.4	80.0%	21.1
Ag - Motors	7.6	99.7%	7.6	80.0%	6.1
Ag - Variable Speed Drive	5.3	99.7%	5.3	80.0%	4.2
Com - Lighting	898.0	99.7%	895.3	80.0%	716.2
Com - Refrigeration	15.4	99.7%	15.4	80.0%	12.3
Ind - Lighting	283.6	99.7%	282.7	80.0%	226.2
Ind - Motors	63.6	99.7%	63.4	80.0%	50.7
TOTAL	**1,395.8**		**1,391.9**	**79.9%**	**1,111.6**

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

Merced Program	Gross Ex-ante Coincident Peak Demand (kW)	Energy Savings Realization Rate	Gross Ex-post Coincident Peak Demand (kW)	Net to Gross Ratio	Net Ex-post Coincident Peak Demand (kW)
Commercial Retrofit	50.3	99.7%	50.1	78.8%	39.5
Residential Air Conditioning	0.7	NA	0.7	78.3%	0.5
Residential Appliances	6.8	NA	6.8	78.7%	5.4
Residential Refrigerator Recycle	0.8	NA	0.8	61.4%	0.5
Residential Lighting	0.5	NA	0.5	78.9%	0.4
TOTAL	**59.1**		**58.9**	**78.5%**	**46.3**

1.1.2 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 1-8, Table 1-9, and Table 1-10 summarize the gross and net ex-post lifecycle energy savings for each program by utility for Modesto, Turlock, and Merced; respectively.

Table 1-8. Gross and Net Ex-post Portfolio Level Lifecycle Energy Savings - Modesto

Modesto Program	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)
AG-Custom	14,688	11,750	15.0	220,317	176,254
BIZ-Cooling	24,349	19,479	15.0	365,240	292,192
BIZ-Custom	1,756,610	1,405,288	15.0	26,349,155	21,079,324
BIZ-Lighting	2,315,140	1,963,239	10.6	24,540,488	20,810,334
BIZ-New Construction	8,430,050	6,744,040	15.0	126,450,750	101,160,600
BIZ-Refrigeration	713,268	606,278	4.5	3,209,705	2,728,249
BIZ-Windows	54,878	43,902	10.0	548,776	439,021
LIEE-All	1,574,347	1,574,347	18.6	29,282,856	29,282,856
RES-Appliance	215,093	143,252	6.2	1,333,577	888,162
RES-Cooling	197,211	175,913	18.1	3,569,527	3,184,018
RES-Gen Improvement	1,509	1,207	25.0	37,728	30,182
RES-Lighting	158,400	126,720	22.0	3,484,800	2,787,840
RES-Windows	152,206	83,713	17.7	2,694,043	1,481,724
RES-New Construction	20,815	16,652	15.0	312,225	249,780
RES-Pool Pump	12,198	8,417	10.0	121,980	84,166
TOTAL	**15,640,763**	**12,924,197**	**14.2**	**222,521,166**	**184,674,702**

Table 1-9. Gross and Net Ex-post Portfolio Level Lifecycle Energy Savings - Turlock

Turlock Program	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 - CFL	33,764	16,882	5.0	168,820	84,410
Res - Clothes Washer	17,284	13,827	10.0	172,840	138,272
Res - Cooling	7,317	5,854	12.7	92,926	74,341
Res - Refrigeration	190,288	152,230	7.6	1,446,189	1,156,951
Res - Shell	17,235	13,788	10.0	172,350	137,880
Res - Shade Tree	24,990	19,992	30.0	749,700	599,760
Ag - Lighting	180,536	144,429	11.0	1,985,893	1,588,715
Ag - Motors	61,764	49,411	15.0	926,462	741,170
Ag - Variable Speed Drive	38,679	30,943	15.0	580,179	464,143
Com - Lighting	2,673,645	2,138,916	6.8	18,180,786	14,544,629
Com - Refrigeration	189,093	151,274	7.7	1,456,016	1,164,813
Ind - Lighting	1,948,800	1,559,040	11.0	21,436,800	17,149,440
Ind - Motors	313,910	251,128	15.0	4,708,657	3,766,925
TOTAL	**5,697,305**	**4,547,715**	**9.1**	**52,077,618**	**41,611,449**

Table 1-10. Gross and Net Ex-post Portfolio Level Lifecycle Energy Savings - Merced

Merced Program	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)
Commercial Retrofit	3,236,290	2,550,197	9.3	30,097,500	23,716,830
Residential Air Conditioning	419	328	14.9	6,239	4,885
Residential Appliances	5,953	4,685	13.1	77,983	61,373
Residential Refrigerator Recycle	3,785	2,324	5.0	18,925	11,620
Residential Lighting	3,102	2,447	5.3	16,441	12,972
TOTAL	**3,249,549**	**2,559,981**	**9.3**	**30,217,087**	**23,807,679**

1.1.3 Recommendations

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

Compare modeled baselines to available billing or sub-meter data to improve accuracy. The sub-meter available for the large HVAC project at site 14 differed substantially from the modeled baseline chiller. It was difficult for Navigant to determine the exact source of the discrepancies without the full EnergyPro model, but it was clear that the claimed baseline chiller efficiency of 1.1 kW/ton would have resulted in substantially higher usage than indicated by the sub-meter.

Provide detailed calculation spreadsheets for large or complicated projects. Navigant obtained spreadsheets listing most of the retrofits at site 12 from the facility contact. However, these data did not include all of the retrofits, or calculations, and the data in the project file indicated only the number of fixtures retrofitted. Without a list of fixtures, locations, and operational hours it is very difficult to accurately confirm savings and determine the reasons for discrepancies in savings between the *ex ante* and *ex post* values. In addition, the project file for site 15, a medium-sized VFD project, included only a scanned version of a calculation spreadsheet. This sheet appeared to contain the calculations for the project but was not legible. Ideally spreadsheets or detailed calculation models should be included with the project files instead of scanned versions.

Verify the baseline assumptions when determining energy savings. At site 6 the baseline hours for a lighting system were mentioned to be 9,038 hours/year, longer than an actual year. This was a calculation mistake, but is a fairly obvious problem. At site 8, the baseline fixtures were listed as HID, but appeared to be actually T12s, reducing the project savings. Navigant recommends additional quality control of projects to filter out such errors from programs.

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[1] should be submitted. This study comports with those guidelines.

1.3 Objectives and Relevant Protocols

The overarching goals of these FY 2012 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, Navigant 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, Navigant 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 1.2.1 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
- » CMUA's E3 Reporting Tool – every March 15

[1] 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.

- » 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.[2]

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 1-11, provide a checklist for submitted POU EM&V reports.

[2]As part of these reporting requirements, Navigant and MTM staff have established a goal of submitting EM&V studies to CEC by February 2015—at or near the same time as the March Report is due.

Table 1-11. 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?

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 offer a number of energy efficiency programs in both the residential and non-residential sectors. Table 1-12 provides a listing of the ex-ante claimed savings by program for the Modesto Irrigation District. The non-residential sector accounts for 85 percent of the claimed gross energy savings. However, the non-residential new construction program was not included in the evaluation. This program was not included because it is not part of either Turlock's or Merced's program portfolio. Taking away the non-residential new construction program leaves 31 percent of the claimed portfolio level savings included in the evaluation.

Table 1-12. Summary of Energy Efficiency Savings for the Modesto Irrigation District at the Program Level, FY 2012

Modesto Program	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
AG-Custom	14,732	0.1%	11,786	0.1%	0.0	0.0%
BIZ-Cooling	24,423	0.2%	19,538	0.2%	14.4	0.7%
BIZ-Custom	1,761,896	11.3%	1,409,517	10.9%	146.7	7.2%
BIZ-Lighting	2,315,140	14.8%	1,963,890	15.2%	315.1	15.4%
BIZ-New Construction	8,430,050	53.9%	6,744,040	52.2%	99.0	4.8%
BIZ-Refrigeration	715,414	4.6%	607,813	4.7%	102.4	5.0%
BIZ-Windows	55,043	0.4%	44,034	0.3%	5.2	0.3%
LIEE-All	1,574,347	10.1%	1,574,347	12.2%	853.7	41.8%
RES-Appliance	215,093	1.4%	143,338	1.1%	84.9	4.2%
RES-Cooling	197,211	1.3%	175,983	1.4%	308.5	15.1%
RES-Gen Improvement	1,509	0.0%	1,207	0.0%	6.7	0.3%
RES-Lighting	158,400	1.0%	126,720	1.0%	20.2	1.0%
RES-Windows	152,206	1.0%	83,713	0.6%	85.2	4.2%
RES-New Construction	20,815	0.1%	16,652	0.1%	0.0	0.0%
RES-Pool Pump	12,198	0.1%	8,417	0.1%	2.1	0.1%
TOTAL	**15,648,477**	**100%**	**12,930,995**	**100%**	**2,044.2**	**100%**

Table 1-13 provides a listing of the ex-ante claimed savings by program for the Turlock Irrigation District. The non-residential sector accounts for 90 percent of the claimed gross energy savings. All of the non-residential claimed portfolio level savings are included in the evaluation.

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Table 1-13. Summary of Energy Efficiency Savings for the Turlock Irrigation District at the Program Level, FY 2012

Turlock Program	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 - CFL	33,764	0.6%	16,882	0.4%	3.1	0.3%
Res - Clothes Washer	17,284	0.3%	13,827	0.3%	5.7	0.5%
Res - Cooling	7,317	0.1%	5,854	0.1%	6.5	0.6%
Res - Refrigeration	190,288	3.3%	152,230	3.3%	41.1	3.7%
Res - Shell	17,235	0.3%	13,788	0.3%	12.6	1.1%
Res - Shade Tree	24,990	0.4%	19,992	0.4%	5.5	0.5%
Ag - Lighting	181,079	3.2%	144,863	3.2%	21.2	1.9%
Ag - Motors	61,950	1.1%	49,560	1.1%	6.1	0.5%
Ag - Variable Speed Drive	38,795	0.7%	31,036	0.7%	4.2	0.4%
Com - Lighting	2,681,690	46.9%	2,145,352	47.0%	718.4	64.4%
Com - Refrigeration	189,662	3.3%	151,730	3.3%	12.3	1.1%
Ind - Lighting	1,954,664	34.2%	1,563,731	34.3%	226.9	20.4%
Ind - Motors	314,855	5.5%	251,884	5.5%	50.9	4.6%
TOTAL	**5,713,573**	**100%**	**4,560,729**	**100%**	**1,114.6**	**100%**

Table 1-14 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 1-14. Summary of Energy Efficiency Savings for the Merced Irrigation District at the Program Level, FY 2012

Merced Program	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
Commercial Retrofit	3,246,028	99.6%	2,558,007	99.6%	42.7	85.7%
Residential Air Conditioning	419	0.0%	328	0.0%	0.6	1.1%
Residential Appliances	5,953	0.2%	4,686	0.2%	5.7	11.3%
Residential Refrigerator Recycle	3,785	0.1%	2,324	0.1%	0.5	1.0%
Residential Lighting	3,102	0.1%	2,448	0.1%	0.4	0.8%
TOTAL	**3,259,287**	**100%**	**2,567,792**	**100%**	**49.9**	**100%**

Table 1-15 summarizes the ex-ante claimed energy savings for the three irrigation districts combined. The largest share comes from non-residential existing. This entire category is included in this evaluation.

Table 1-15. Summary of the Energy Efficiency Savings for the Three Irrigation Districts Combined, FY 2012

Combined Program Summary	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
Non-residential Existing	13,555,371	55.1%	10,952,740	54.6%	1,666.5	51.9%
Non-residential New Construction	8,430,050	34.2%	6,744,040	33.6%	99.0	3.1%
Residential Existing	2,615,101	10.6%	2,346,084	11.7%	1,443.1	45.0%
Residential New Construction	20,815	0.1%	16,652	0.1%	0.0	0.0%
TOTAL	**24,621,337**	**100%**	**20,059,516**	**100%**	**3,208.7**	**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 was drawn with a design to achieve statistical validity of 90 percent, +/- 10 percent. Achieving this level of statistical validity would have been difficult if each had evaluated their programs individually.

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.

Navigant 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. In all cases, on-site verification was performed.

2.2.1 On-Site Inspections

Navigant conducted on-site inspections for most of the FY 2012 program EM&V efforts. 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

Navigant 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. These 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 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 may also utilize 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 2012 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 +/- 10 percent at the project level. With this sampling precision, the sample size is 22 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 29. By combining the three utilities into one EM&V effort, a 25% reduction in sample sites is achieved with corresponding budgetary savings. The specific programs included in the sample universe were from the following E3 identified programs:

- Modesto – Ag-Custom
- Modesto – Biz Cooling
- Modesto – Biz Custom
- Modesto – Biz Refrigeration
- Modesto – Biz Windows
- Turlock - Ag Lighting

- Turlock - Ag Motors
- Turlock - Ag Variable Speed Drive
- Turlock - Com Lighting
- Turlock - Com Refrigeration
- Turlock - Ind Lighting
- Turlock - Ind Motors
- Merced – Commercial Retrofit

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 78 projects. These projects have a very wide range of energy savings extending from 138 kWh to 1,237,517 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 +/- 10 percent at the project level as well as a very high percentage of overall sampled *ex-ante* savings. The final sample consists of 20 projects (26%) and more importantly 62% of the *ex-ante* electric energy savings. Some swapping of sites within stratums was performed to insure each utility was represented. By utility, the *ex-ante* electric energy savings are 56% for Turlock Irrigation District, 83% for Modesto Irrigation District, and 54% for Merced Irrigation District. Table 2-2 identifies by site the ex-ante savings and the project to utility weights.

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Table 2-2. Sample by Stratum with Project to Utility Weights for Ex-ante Savings

Site #	Utility Stratum	Utility Total Ex-ante Savings (kWh)	Project Ex-ante Savings (kWh)	Project to Utility Stratum Weight	Project Based Extrapolated Ex-ante Utility Stratum Savings (kWh)
14	Modesto	2,571,507	578,000	1.20	692,500
18	Modesto	2,571,507	450,858	1.20	540,171
15	Modesto	2,571,507	385,611	1.20	461,999
17	Modesto	2,571,507	379,150	1.20	454,258
19	Modesto	2,571,507	306,720	1.20	367,480
1	Modesto	2,571,507	26,722	1.20	32,016
2	Modesto	2,571,507	15,297	1.20	18,327
3	Modesto	2,571,507	3,969	1.20	4,755
4	Turlock	5,422,695	1,237,517	1.78	2,206,704
13	Turlock	5,422,695	1,123,726	1.78	2,003,795
5	Turlock	5,422,695	307,612	1.78	548,525
6	Turlock	5,422,695	257,785	1.78	459,675
20	Turlock	5,422,695	58,903	1.78	105,034
7	Turlock	5,422,695	32,236	1.78	57,482
8	Turlock	5,422,695	13,557	1.78	24,174
9	Turlock	5,422,695	9,705	1.78	17,306
12	Merced	3,246,028	1,216,551	1.84	2,243,574
10	Merced	3,246,028	379,930	1.84	700,670
16	Merced	3,246,028	148,403	1.84	273,686
11	Merced	3,246,028	15,236	1.84	28,098
TOTAL		11,240,230	6,947,488	1.62	11,240,230

3. Estimating Project Level Ex-post Savings

Navigant conducted site visits to each of the 20 sampled projects. At each site, Navigant visually inspected the measures installed and for some sites, metering equipment was installed.

3.1 Site 1

Site 1 was a medium sized retail furniture store. During the FY 2012 program year, the site retrofitted all 130 of its interior, 75-watt halogen track light fixtures with 16-watt CFL flood track light fixtures on a one-to-one basis. Verification of this project included an on-site inspection and an interview with site personnel. According to the site contact interview, the store operating hours are 68 hours per week, which is one hour higher than the 67 hours per week described in the project documentation.

During the on-site verification, the Navigant team found that only 93 fixtures were in use at the time. The 37 fixtures not in use were track light fixtures that the site personnel move to increase or reduce lighting, depending on the furniture for sale at that time. The existence of these 27 fixtures was also confirmed. For the purposes of this evaluation, Navigant accepts the number of fixture installations described on the application. Because of the operating hours were slightly higher than reported, Navigant estimates that the realization rate was 101%, as shown in Table 3-1.

Table 3-1. Site 1 Summary

Project	Ex-ante **kWh Savings**	Ex-post **kWh Savings**	Realization Rate
Interior Lighting	26,722	27,121	101%

Source: Navigant 2013 impact analysis

3.2 Site 2

The site was a medium-sized government office building. During the FY 2012 program years, the site retrofitted all 88 indoor fluorescent fixtures. The older fixtures included a mixture of 2- and 3-lamp, 4-foot T8 fixtures with standard 32-watt T8 lamps. The site replaced all the lamps with 4-foot, 25-watt high efficiency T8 lamps. The site also replaced the old ballasts with new low ballast factor electronic ballasts. Finally, the site installed occupancy sensors in most of the common areas and closed offices.

Navigant's verification of this project included an on-site inspection and an interview with site personnel. The Navigant team was not able to install lighting loggers at the site due to facility concerns regarding security. The site contact confirmed that the retrofits were in place and that there had been no change in the operating hours. (i.e.: The site was operating 13 hours/day, 5 days/week, as stated in the project file.) The Navigant team verified about 80% of the installed fixtures and the numbers matched the application; the remaining 20% were in areas that the evaluation team could not access during the visit.

For operating hours, the Navigant team found in the project files that the claimed ex-ante post-retrofit operating hours for most of the fixtures were a reduction of 44% from the baseline. However, as stated

above, the site visit the site contact confirmed that the facility is still operating 13 hours/day, every weekday, which is similar to the baseline hours. The site did install occupancy sensors in most of the areas but it is unclear from the project files why a 44% flat reduction in the operating hours was applied. For the purposes of this evaluation, Navigant used the same ex-ante operating hours and multiplied them by the occupancy sensor savings factors for the facility type, as identified in the *Statewide Customized Offering Procedures Manual for Business* for the state of California. Table 3-2 shows the difference between the operating hours in the project files and Navigant's calculation.

Table 3-2. Site 2 Lighting Hours

	Ex-ante			Ex-post		
Location	**Baseline Hours**	**Post retrofit hours**	**Occupancy Sensor Reduction**	**Operating Hours**	**Occupancy Sensor Reduction**	**Final Operating Hours**
Open Office	3,375	1,890	44%	3,375	15%	2,869
Closed Office	3,375	1,890	44%	3,375	30%	2,363
Common Areas	3,375	1,890	44%	3,375	25%	2,531
Rest Rooms	3,375	1,890	44%	3,375	45%	1,856

Source: Navigant 2013 impact analysis

As shown in Table 3-3, Site 2 had a realization rate of 76%. This is due to Navigant's reduction of operating hours from the ex-ante to the ex-post estimates based on the interview with the site contact. The actual savings from these occupancy sensors may be higher than those listed in the *Statewide Customized Offering Manual*. However Navigant was unable to log the equipment and therefore referred to standard savings factors.

Table 3-3. Site 2 Summary

Project	Ex-ante **kWh Savings**	Ex-post **kWh Savings**	**Realization Rate**
Interior Lighting	15,297	11,672	76%

Source: Navigant 2013 impact analysis

3.3 Site 3

Site 3 is a small retail store. During the FY 2012 program year, the site retrofitted a total of 18 of its interior 65-watt halogen lamps with 12-watt LED lamps on a one-to-one basis.
Verification of this project included an on-site inspection and an interview with site personnel. According to the interview with the site contact, the store operating hours are slightly higher than mentioned in the project files (85 hours per week instead of 80 hours per week). Navigant made adjustment for these increased operating hours in the baseline as well as in the ex-post calculations.

During the fixture count, the Navigant team found that only 18 lamps were described on the rebate application, but the site had replaced total of 21 lamps. The rebate application specifies 18 lamps because the site submitted the invoice for only those 18 lamps. The site was aware of this reduction in the number of lamps on the rebate application. For the ex-post energy savings calculation, the Navigant team included all 21 lamps in the baseline as well as in the retrofitted case.

This increase in the number of retrofitted lamps as well as an increase in the annual operating hours resulted in a realization rate of 119%. The realization rate for site 3 is given in Table 3-4.

Table 3-4. Site 3 Summary

Project	Ex-ante **kWh Savings**	Ex-post **kWh Savings**	Realization Rate
Interior Lighting	3,969	4,730	119%

Source: Navigant 2013 impact analysis

3.4 Site 4

Site 4 retrofitted a total of 2,191 HID street light fixtures (ranging from 70 watts to 400 watts) with LED street light fixtures (ranging from 36 watts to 149 watts, respectively) on a one-to-one basis. Verification of this project included random spot checks of street lights and an interview with the project contact. The Navigant team performed spot checks of street lights and confirmed that they were retrofitted with LED fixtures. The project contact confirmed that the city completed the project over a period of eight months during the 2012 (March 2012 – October 2012). For both the baseline and the current installation, all fixtures are operated by photocells.

Using the information gathered during the visit, Navigant determined that the project installed all of the specified fixtures and that the claimed operating hours were correct, resulting in 100% of the claimed energy savings. The savings and realization rate for site 4 are given in Table 3-5.

Table 3-5. Site 4 Summary

Project	Ex-ante **kWh Savings**	Ex-post **kWh Savings**	Realization Rate
Street Lighting Retrofits	1,237,517	1,237,517	100%

Source: Navigant 2013 impact analysis

3.5 Site 5

Site 5 is a large warehouse and a packaging facility. During the FY 2012 program, the site retrofitted a total of 153 interior fixtures (80 linear fluorescents and 73 400-watt metal halide fixtures) in four different areas of the facility with 114 4-foot, 4-lamp T5 high output (T5HO) linear fluorescent fixtures. The site also installed occupancy sensors on 107 of the 114 new fixtures and 44 existing 8-foot, 2-lamp T8 fixtures. Verification of this project included an on-site inspection, a brief interview with site personnel, and lighting logger deployment. The Navigant team counted the retrofitted fixtures, which matched the number of fixtures specified on the application. There was no change in the operating hours of the facility from the stated hours in the project file. The site operates 24/7 for 47 weeks a year and it is closed for 5 weeks. The Navigant team installed thirteen lighting loggers for around four weeks at different

areas of the facility. Navigant's analysis of the logger data shows that occupancy sensors are working as expected, with the controlled fixtures off around half the time.

In calculating ex-ante savings, a 45% standard savings factor for occupancy sensors was used for the project. Navigant's analysis of logged data shows that the fixtures are actually off for about 50% of the operating time. Thus energy savings for this project is higher than predicted. The savings and realization rate for the site are given in Table 3-6.

Table 3-6. Site 5 Summary

Project	Ex-ante **kWh Savings**	Ex-post **kWh Savings**	Realization Rate
Interior Lighting	307,612	341,145	111%

3.6 Site 6

Site 6 is a large refrigerated warehouse. During the FY 2012 program, the site retrofitted a total of 136 interior 320-watt metal halide fixtures in four different areas of the facility with 150-watt LED fixtures on a one-to-one basis. Out of the 136 baseline fixtures, 109 had 50% dimming capability, whereas all of the new LED fixtures can be dimmed to 10% of their maximum output.

Evaluation of this project included an on-site inspection, a brief interview with site personnel, and lighting logger deployment. The Navigant team counted the retrofitted fixtures, which matched the number of fixtures specified on the application. There was no change in operating hours from those given in the project file (24 hours/day, 6 days/week, and 14 hours/day for Saturday). However during the review of the project file, Navigant identified an error in the baseline energy consumption calculation. Total annual operating hours for the 109 dimmable metal halide fixtures are entered in the calculation as 9,038 hours instead of 8,216 hours. The calculations in the project file use 45% standard savings factor for dimmers. Since the baseline metal halide fixtures had dimming capability too, operating hours for those fixtures were reduced to 55%, with the 45% reduction accounting for energy consumption in the baseline for 100% power and dimmed power. Therefore the ex-ante hours should have been 4,519 annually (55% of the facility 8,216 annual operating hours) for the fixtures at 100% power and 3,697 hour/year at reduced power (45% of total annual operating hours). This operating hour error in the ex-ante calculation resulted in an overestimation of ex-ante energy savings.

The Navigant team could not install data loggers during the site visit because production activities were in progress. The site contact suggested that the Navigant team leave the loggers with him and a maintenance employee would install them at the specified locations during the weekly down period. The site contact did install the loggers, but due to logger calibration problems, they did not record properly and the data were not adequate to evaluate sensor energy savings.

To evaluate the sensor based energy savings, Navigant used a standard 45% reduction factor from the *Statewide Customized Offering Procedures Manual for Business* for the state of California. This 45% reduction factor matches the savings factor used in the project file for calculating ex-ante savings. The realization rate for the site is given in Table 3-7.

Table 3-7. Site 6 Summary

Project	Ex-ante **kWh Savings**	Ex-post **kWh Savings**	Realization Rate
Interior Lighting	257,785	237,318	92%

Although there is no change in the operating hours, number of fixtures, or savings factor due to the sensors, overestimation of the ex-ante baseline hours of operation resulted in reduced savings.

3.7 Site 7

The site is a retail store. During the FY 2012 program, the site retrofitted 164 interior 50-watt halogen lamps in track-head fixtures with 15-watt LED lamps on a one-to-one basis.

Verification of this project included an on-site inspection and an interview with site personnel. The Navigant team's count of retrofitted lamps matched the number of lamps on the application, and there were no changes to the store's reported operating hours (108 hours/week), resulting in a 100% realization rate for the project. The savings and realization rate for site 7 are given in Table 3-8.

Table 3-8. Site 7 Summary

Project	Ex-ante **kWh Savings**	Ex-post **kWh Savings**	Realization Rate
Interior Lighting	32,236	32,236	100%

3.8 Site 8

The site is a large warehouse. According to the project file, during the FY 2012 program, the site retrofitted 33 high intensity discharge (HID) fixtures in the dock area with 4-foot, 4-lamp T8 fixtures on a one-to-one basis.

Verification of this project included an on-site inspection and a brief interview with site personnel. The Navigant team's count of retrofitted fixtures matched the number of fixtures on the application. Also, there is no change in the reported operating hours of the warehouse (12 hours/day, 6 days/week), resulting in a 100% realization rate for the project. The savings and realization rate for site 7 are given in Table 3-9.

Table 3-9. Site 8 Summary

Project	Ex-ante **kWh Savings**	Ex-post **kWh Savings**	Realization Rate
Interior Lighting	13,557	13,557	100%

3.9 Site 9

Site 9 is a small industrial metal fabrication shop. During the FY 2012 program, the site retrofitted 15 interior 400-watt metal halide fixtures in the facility shop with 4-foot, 6-lamp T8 fluorescent fixtures on a one-to-one basis.

Verification of this project included an on-site inspection and an interview with site personnel. The Navigant team's count of the retrofitted fixtures matched the number of fixtures on the application and there was no change in operating hours of the facility compared to the hours given in the project file (10.5 hours/day, 5 days/week). The realization rate and savings for the site are given in Table 3-10.

Table 3-10. Site 9 Summary

Project	Ex-ante **kWh Savings**	Ex-post **kWh Savings**	Realization Rate
Interior Lighting	9,705	9,705	100%

3.10 Site 10

The site is a large supermarket. During the FY 2012 program the site retrofitted 183 of its interior 400-watt metal halide fixtures with 4-foot, 6-lamp high bay T8 fixtures on a one-to-one basis.

Verification of this project included an on-site inspection and a brief interview with the site contact. The Navigant team counted the number of high bay T8 fixtures which matched those listed on the project application. The site contact confirmed that the facility was open 24/7 and the lights operated continuously as specified in the project file. The realization rate for site 10 is given in Table 3-11.

Table 3-11. Site 10 Summary

Project	Ex-ante **kWh Savings**	Ex-post **kWh Savings**	Realization Rate
Interior Lighting	379,930	379,930	100%

3.11 Site 11

The site is a small industrial facility. During the FY 2012 program, the site retrofitted 17 of its exterior high intensity discharge (HID) fixtures with 21 outdoor LED fixtures.

Verification of this project included an on-site inspection and a brief interview with site personnel. During the interview, the site contact confirmed that the facility replaced the fixtures as described in the application. The Navigant team confirmed the installation of 21 outdoor LED fixtures as specified in the application. The baseline fixtures as well as the new fixtures are operated using photocells so the Navigant team determined that there was no change to the ex-ante annual hours of operation (4,270 hours/year).

After an analysis of the project file, Navigant team found that the reported wattages of the baseline fixtures were lower than the standard values used by California programs. These differences are outlined in Table 3-12.

Table 3-12. Fixture Wattages

Fixture Description	Claimed Fixture Wattage	Standard Fixture Wattage
HPS 200 Watts	200	250
HPS 100 Watts	100	138
HPS 250 Watts	250	295
HPS 35 Watts	35	46
Metal Halide 400 Watts	400	458

These standard fixture wattages were taken from *Appendix B: Table of Standard Fixture Wattages and Sample Lighting Table* of the California *Statewide Customized Offering Procedures Manual for Business*. Baseline fixture wattages used in Navigant's calculations are taken from the standard fixture wattage table and are therefore higher than the ex-ante baseline fixture wattages. This increase in baseline fixture wattages resulted in increased energy savings for the project. The realization rate for site 11 is given in Table 3-13.

Table 3-13. Site 11 Summary

Project	Ex-ante **kWh Savings**	Ex-post **kWh Savings**	Realization Rate
Interior Lighting	15,235	18,340	120%

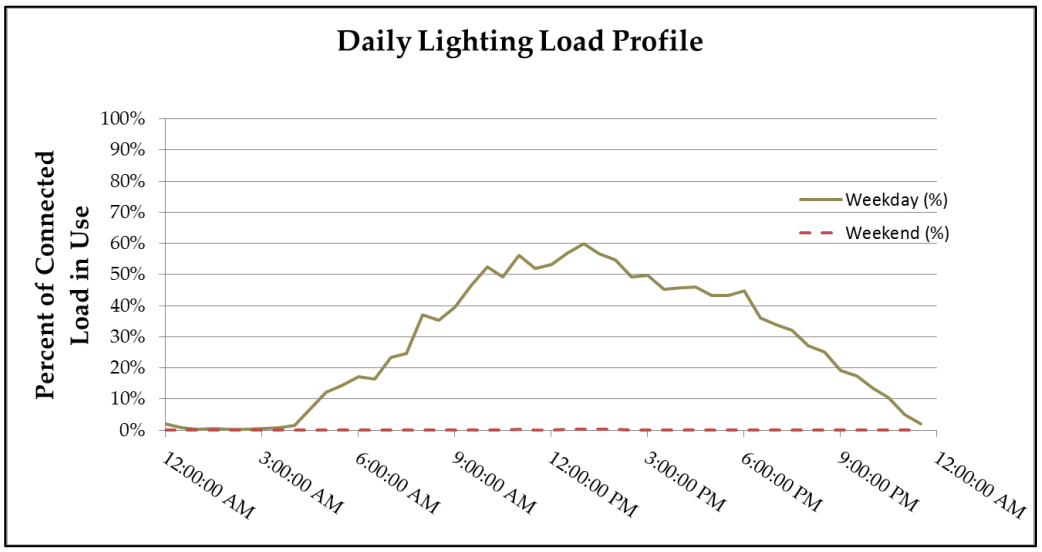
3.12 Site 12

Site 12 is a large educational facility. During the FY 2012 program, the site retrofitted about 8,000 indoor and outdoor light fixtures (mostly 32-watt standard T8 fixtures and incandescent fixtures) with new, efficient fixtures and lamps (mostly a combination 28-watt T8 lamp fluorescent fixtures and LED fixtures). These fixtures have operating hours ranging between 30 hours/week to 70 hours/week. About 16% of the fixtures are operated using occupancy or daylight sensors.

Verification of this project included an on-site inspection, an interview with site personnel, and lighting logger deployment. During the interview, the site contact confirmed that the facility replaced the fixtures as described in the application. Since it was a very large project, the Navigant team performed verification at representative locations within the facility. The project application file did not contain details of the fixtures installed, but the facility contact provided Navigant with spreadsheets detailing most of the fixture replacements. In the locations checked, the number and type of retrofitted fixtures matched the spreadsheet provided by the facility. Thus, Navigant determined that the overall retrofitted fixtures matched the application.

To evaluate the savings due to sensors, the Navigant team deployed lighting loggers randomly at thirteen representative spaces in the facility. These loggers collected data for a period of five weeks. The analysis of the logger data confirms that the sensors are operating as expected. The daily average load for the spaces where lighting loggers were deployed can be seen in the following graph:

Figure 3-1. Site 12 Lighting Load Profile



For the fixtures with sensors installed to control them, the Navigant team extrapolated the savings realization rate from the analysis of lighting logger data. For the fixtures without sensors on them, Navigant determined that they had achieved 100% of the claimed energy savings. The overall realization rate for site 12 is given Table 3-14.

Table 3-14. Site 12 Summary

Project	Ex-ante **kWh Savings**	Ex-post **kWh Savings**	Realization Rate
Lighting retrofits	1,216,551	1,292,376	106%

The slightly higher ex-post savings are due to the extra savings achieved by the sensors. Ex-ante savings are often estimated with standard savings factors according to the space types. Navigant calculated the ex-post energy savings based on the data collected by the installed lighting loggers. The collected data suggest that the fixtures were turned off for more than originally estimated.

3.13 Site 13

Site 13 is a school district. During the FY 2012 program the site completed 13 energy efficiency sub-projects at different school campuses. Navigant randomly selected two campuses for site visits in order to evaluate the project.

The first campus was an elementary school. The site had installed four HVAC units, which have efficiency ratings exceeding the Title 24 code compliance rating for this building type. The second project encompassed part of a junior high school. The site had installed eight HVAC units and 114 4-foot, 3-lamp fluorescent lighting fixtures with occupancy sensors which have efficiency ratings exceeding the Title 24 code required for this building type. The project file provided energy savings calculated with a baseline of Title 24 compliance using EnergyPro 4.4 software.

Verification of these projects included an on-site inspection and an interview with the site contact. During the field visit, the Navigant team confirmed that the HVAC units and the light fixtures were installed at the sites. These sites have variable operating hours since they are educational facilities and after school programs vary. Navigant team did not install loggers because, due to variable hours of the classrooms, it was not practical to extrapolate the energy savings from data loggers over a period of only a month. The Navigant team confirmed that the site has an energy management system with tight control over the HVAC operation. The Navigant team was able to obtain reports from the EMS at the site, but the EMS outputs give only the total energy consumption for the whole campuses, whereas the projects were implemented in a single building in each of the campuses. Thus, it was difficult to crosscheck the savings using these high level results.

Since all the HVAC and lighting equipment matched the application and the schools were operating according to their normal schedules, the EnergyPro 4.4 model provided an acceptable calculation of savings. Navigant determined that projects at both the buildings have achieved 100% of the realization rate for this project. The realization rates for the buildings are given in Table 3-15.
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Table 3-15. Site 13 Sample Summary

Project	Ex-ante **kWh Savings**	Ex-post **kWh Savings**	Realization Rate
Facility 1: High efficiency HVAC units	39,891	39,891	100%
Facility 2: Interior Lighting and High efficiency HVAC units	198,130	198,130	100%
Total	238,021	238,021	100%

Since both the buildings have achieved 100% realization rate, Navigant determined that site 13 as a whole achieved a 100% realization rate. The realization rate for the project is given in Table 3-16.

Table 3-16. Site 13 Summary

Project	Ex-ante **kWh Savings**	Ex-post **kWh Savings**	Realization Rate
High efficiency HVAC and lighting	1,123,726	1,123,726	100%

3.14 Site 14

Site 14 was a large industrial facility that upgraded the HVAC system at one building. This system served one 170,000 square foot building, which was part of a multi-building complex. The building consisted of 66,000 square feet of office space on two floors and 104,000 square feet of windowless production space. The baseline HVAC system for the building consisted of:

- A 1,500 MBH boiler
- A 410-ton chiller
- A 600-ton cooling tower with a VFD controlled fan and single speed water pumping with 3-way valves
- Two dual-duct 130-ton air handlers with fans operating at constant speed and zone-level mixing boxes controlled by local thermostats, serving the offices without economizers
- Five 30-ton air handlers with single speed fans, no economizers, and single zone control consisting of on/off switches, serving the manufacturing operation.

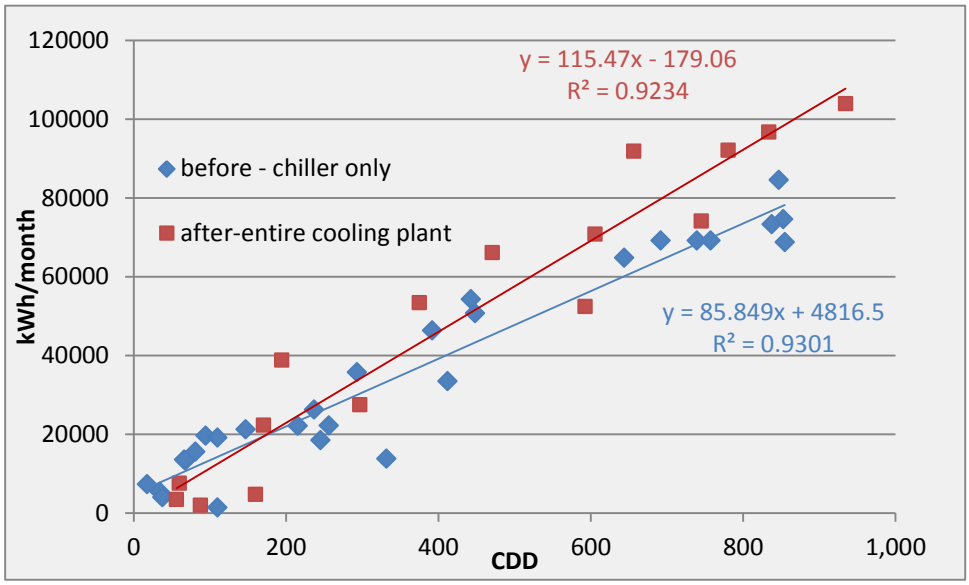
The boiler and cooling tower were not affected by the retrofit. The facility replaced their 400 ton HVAC chiller with two 200 ton chillers and installed variable air and water flow functionality in the system.

EnergyPro 5 was used to model the energy savings for the ex-ante calculations. The baseline system was adjusted to use a chiller efficiency of 0.79 kW/ton per Title 24 instead of the 1.1 kW/ton for which the

actual system was originally rated. Based on the values given in the project report, the calculations appear to use 0.73 kW/ton for the new chillers.

The entire site shares a utility meter so, although the ex-ante project savings calculations used a model of building use, the utility bills cannot be directly compared to the model. Navigant was able to obtain two weeks of hourly readings from the facility EMS for the chillers and the two air handlers serving the office areas. The EMS does not track operation of the five production area air handlers. In addition Navigant obtained monthly sub-meter data for the facility. This consisted of only the chiller prior to the retrofit, but included the cooling tower, new chillers, and pumps after the retrofit. No metered data were available for the production area air handlers, however spot readings and trend data for the office area air handlers provided reasonable loading values. The sub-meter data are shown as a function of cooling degree days, based on 50 °F, in Figure 3-2. The values before and after the retrofit cannot be directly compared because the water pumps and cooling tower were added to the sub-meter at the time of the retrofit.

Figure 3-2. Site 14 Sub-meter Data



Navigant used the monthly sub-meter data and trend data for the pumps and air handlers to calculate savings for the project. Notably the original chiller sub-meter data, normalized to TMY3 weather data, show annual usage very close to what is calculated from the current chillers at 0.73 kW/ton converted to a Title 24 baseline of 0.79 kW/ton, indicating that either the old chiller was substantially more efficient than the claimed 1.1 kW/ton, or building cooling usage has increased since the project was implemented. Facility staff confirmed the sizing and operational hours (24 hours a day, 6 months/year) of the production line air handlers. Based on these values, the baseline use of the production line air handlers would be about 80,000 kWh/year. Although facility staff confirmed the installation of VFDs on these air handlers, they could not provide any data on their actual operation. Because of the limited trend data available, Navigant has rounded the savings to one significant figure, but remains confident that savings exceed the ex-ante value, as savings calculations showed savings between 585,000 and 610,000 kWh

depending on the assumptions made about the process air handlers and the baseline chiller efficiency. The realization rate for the project is given in Table 3-17.

Table 3-17. Site 14 Summary

Project	Ex-ante **kWh Savings**	Ex-post **kWh Savings**	Realization Rate
HVAC upgrades	578,000	600,000	104%

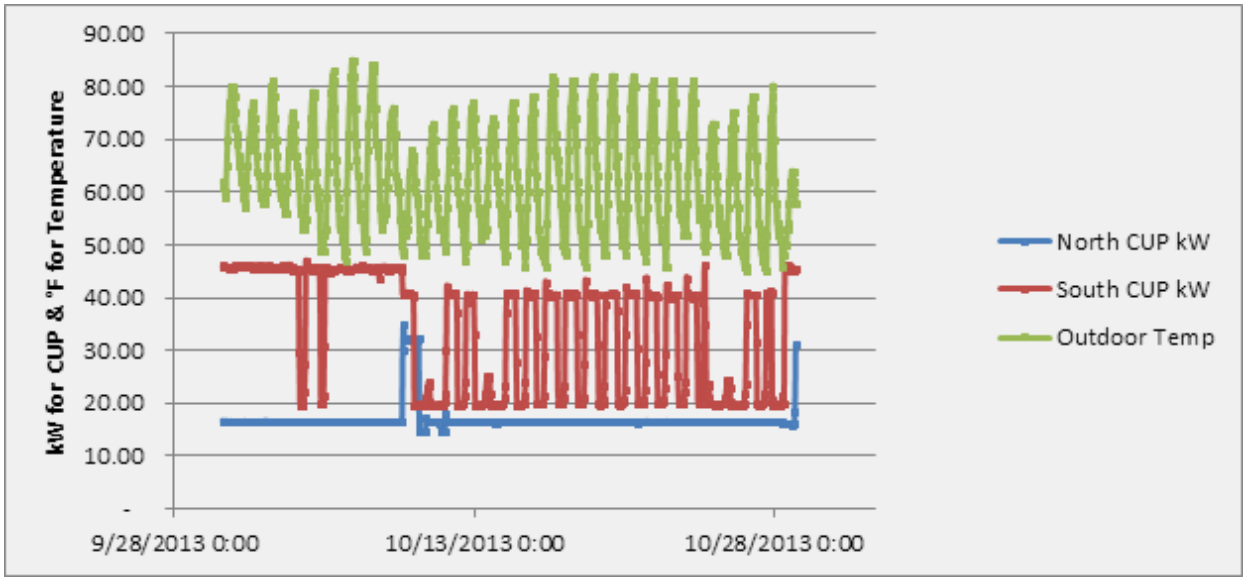
3.15 Site 15

Site 15 is a large medical facility. During the FY 2012 program the site retrofitted six cooling water pumps (ranging from 25 HP to 60 HP in capacity) with variable frequency drives (VFD). The site has two cooling plants that each includes a chiller, a set of chilled water pumps, a cooling tower, and three cooling water pumps.

Verification of this project included an on-site inspection, a brief interview with site personnel, and current (ampere) logger deployment. The Navigant team confirmed that the VFD's are installed as per the application. The Navigant team took spot measurements of power and installed data loggers on each of the six pumps for a period of four weeks to monitor current draw to the pumps.
The analysis of the logged data revealed that most of the pumps were operating at a constant part-load level instead of a continuously varying frequency. Since the pumps were operating at full load in the baseline, the part-load operation of the pumps still provides energy savings relative to the baseline. Navigant's analysis shows that only one 40 HP pump at the south chiller plant is operating on a varying frequency.

The following graph shows how the cooling pump motors for south and north chiller utility plants (CUPs) operate with respect to the outdoor air temperature.

Figure 3-3. Site 15 Pump Load Profile



It is evident from the logged data that the north CUP cooling water pumps run irrespective of changes in the outdoor temperature whereas the south CUP cooling water pumps follow closely with the outdoor temperature.

In calculating energy savings for both of these plants the Navigant team made the following extrapolations:

1. The north CUP cooling water pumps will run throughout the year with similar loads to that observed during the monitoring period.
2. The south CUP cooling water pumps' energy consumption will vary according to the outdoor air temperature.

The project file mentioned that the chiller plants run throughout the year and that these pumps were expected to be running continuously. However, during the site visit, the 25 HP and 60 HP pumps at the north CUP were off. Still, according to the data collected during the site visit, all the pumps from North CUP were expected to run 24/7 and the pumps from south CUP runs on as needed basis. Thus, Navigant made adjustment to the baseline to determine the energy savings for the pumps. Navigant calculated that these pumps would be running at full speed in the baseline for the same hours (8,760 hours for the north CUP and one 40 HP pump from south CUP, and 4,380 hours for remaining two motors from south CUP since these motors were on for about 1/2 of the time during the monitoring period) that they were running during the monitoring period.

The Navigant team used TMY3 temperature data to normalize the operation of the south CUP cooling water pumps to outside air temperature for a typical year. This analysis also uses one pump running all the time, with the two remaining pump motors running for about 4,380 hours each annually. The energy savings and realization rate for the site are given in Table 3-18.

Table 3-18. Site 15 Summary

Project	Ex-ante **kWh Savings**	Ex-post **kWh Savings**	Realization Rate
Cooling Pump with VFDs	385,611	328,855	85%

The realization rate is less than 100% because in the ex-ante case, it was expected that all cooling water pumps would be running all the time. For the ex-post savings Navigant revised the operating hours of the pumps according to the data logged during the monitoring period.

3.16 Site 16

Site 16 is a large retail store. During the FY 2012 program years, the site retrofitted 209 shaded-pole evaporator motors in refrigerated cases, walk-in coolers, and walk-in freezers with electrically commutated motors (ECMs). The site replaced 103 motors in open display coolers, 102 motors in walk-in coolers, and 4 motors in walk-in freezers on a one-to-one basis.

During the site visit the Navigant team was not able to verify the motors visually as they were not accessible. However the Navigant team confirmed project implementation with the site contact and located some of the labels on open cases specifying the date of retrofit for those cases. It appeared that the remaining labels had come off due to cleaning.

Based on the interview with the site contact and the site visit findings, Navigant determined that the site had replaced all the claimed evaporator motors as specified in the application. As claimed in the project file the motors operate continuously (8,760 hours/year) since the cases are never shut off. Hence the Navigant team determined that the site has achieved 100% of the claimed energy savings for this project. The savings and realization rate for site 16 are given in Table 3-19.

Table 3-19. Site 16 Summary

Project	Ex-ante **kWh Savings**	Ex-post **kWh Savings**	Realization Rate
High efficiency motors	148,403	148,403	100%

3.17 Site 17

The site is a winery that insulated three existing, previously uninsulated 120,000 gallon wine storage tanks. These tanks are typically filled once a year and maintained at 40° F for roughly 310 days, and then kept empty for the remaining 55 days annually. Verification of this project included an on-site inspection and an interview with the site contact. The Navigant team confirmed that the tanks are insulated and operating as expected. The Navigant team reviewed the calculation provided for the claimed energy savings and found it reasonable.

Since there are no changes in the operating hours, the operating temperature, or the insulation, the Navigant team determined that the site has achieved 100% of the estimated energy savings for this project as shown in Table 3-20.

Table 3-20. Site 17 Summary

Project	Ex-ante **kWh Savings**	Ex-post **kWh Savings**	Realization Rate
Insulation	379,150	379,150	100%

3.18 Site 18

Site 18 is a large industrial facility. During the FY 2012 program the site replaced an old 200 HP air compressor with a new 200 HP variable frequency air compressor. Prior to the project the site operated two 200 HP air compressors on an alternating basis. The site replaced one of the old 200 HP air compressors with a new 200 HP variable frequency drive (VFD) air compressor. This new VFD air compressor is now used around the clock, and the remaining old 200 HP compressor is kept as a back-up. The site also replaced a non-cycling refrigerated air dryer with a new, cycling refrigerated air dryer and removed an after-cooler which was no longer needed. The compressed air system at the site operates 24 hours a day, 365 days a year.

Navigant's verification of this project included an on-site inspection, a spot measurement of air compressor power, a brief interview with site personnel, and installation of current (ampere) loggers to monitor the compressor and dryer operation for several weeks. The Navigant team confirmed that the installed compressor and dryer matched the application and that the system continues to operate continuously. Navigant's spot measurement and logged data confirmed that the air compressor and dryer are operating as expected.

Navigant used the logged data to determine air flow for the air compressor using the manufacturer's specifications and converted this to energy use for the baseline air compressor, also using manufacturer's specifications. The analysis of these logged data revealed that the compressor was operating at a higher load than claimed in the project files. The ex-ante energy savings for this project had been calculated based on the compressed air system operating at an average demand of 600 cfm. Navigant's analysis of the logged data revealed for the monitoring period showed that the compressed air system was operating at an average of around 700 cfm. This could be due to changes in operations at the facility, but it was not possible to determine if this was the case. The Navigant team adjusted the baseline energy consumption to reflect the higher cfm load on the compressed air system. This increase in load resulted in a reduced energy savings. The realization rate for the site is given in Table 3-21.

Table 3-21. Site 18 Summary

Project	Ex-ante **kWh Savings**	Ex-post **kWh Savings**	Realization Rate
Compressor Replacement	450,858	354,424	79%

3.19 Site 19

Site 19 is a large industrial facility. During the FY 2012 program the site replaced a 75 HP air compressor with a new 50 HP variable frequency drive (VFD) air compressor and 500 gallons of additional compressed air storage capacity.

Navigant's verification of this project included an on-site inspection, a spot measurement of air compressor power, a brief interview with site personnel, and installation of a current (ampere) logger on the air compressor. The Navigant team confirmed that the installed compressor matched the description in the project application. The compressed air system operates 24 hours/day, 6 days/week, which means there is no change to the ex-ante operating hours. Also, Navigant's spot measurement and the logged data confirmed that the compressor is operating as expected.

The Navigant team logged current for the compressor for a period of three weeks, calculated power using the spot measurement and logged data, and converted this to airflow using the manufacturer's specifications for the unit. Using manufacturer's specifications for the baseline compressor, Navigant calculated baseline energy use from the airflow data. The analysis revealed that the compressor was operating at an average load of 8.1 kW, slightly less than the claimed average load of 9.7 kW in the project file. The baseline system energy use was not affected as much by the decreased flow so this decrease in an average load resulted in slightly increased energy savings. The realization rate for site 19 is given in Table 3-22.

Table 3-22. Site 19 Summary

Project	Ex-ante **kWh Savings**	Ex-post **kWh Savings**	Realization Rate
VFD Air Compressor	306,720	320,305	104%

3.20 Site 20

Site 20 is a small dairy that replaced a 15 HP air compressor with a new variable speed air compressor of the same size. Verification of this project included an on-site inspection, a brief interview with site personnel, and installation of a current (ampere) logger on the air compressor. The Navigant team could not perform a spot measurement due to the design of the system, but the team installed a current (ampere) data logger on the compressor for a period of six weeks and used a typical power factor and the rated voltage for the unit to calculate power from the logged data. The team also confirmed that there was no change in the operating hours of the compressor compared to the ex-ante calculations (the compressor operates 8,760 hours annually).

Navigant's analysis of the logged data confirmed that the variable frequency drive is operating as expected. The analysis of the logged data revealed that the compressor was operating at an average load of 3.83 kW, which is slightly less than the claimed average load of 4.75 kW specified in the project file. Navigant used manufacturer's specifications for the new and baseline compressors to calculate airflow and baseline energy consumption. The decrease in average load resulted in increased energy savings as shown in Table 3-23.

Table 3-23. Site 20 Summary

Project	Ex-ante **kWh Savings**	Ex-post **kWh Savings**	Realization Rate
VFD Compressor	58,903	68,599	116%

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 99.7 percent.

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

Site #	Utility Stratum	Project Ex-ante Savings (kWh)	Project Realization Rate	Project Ex-post Savings (kWh)	Project to Utility Stratum Weight	Project Based Extrapolated Ex-ante Savings (kWh)	Project Based Extrapolated Ex-post Savings (kWh)
14	Modesto	578,000	103.8%	600,000	1.20	692,500	718,858
18	Modesto	450,858	78.6%	354,424	1.20	540,171	424,634
15	Modesto	385,611	85.3%	328,855	1.20	461,999	394,000
17	Modesto	379,150	100.0%	379,150	1.20	454,258	454,258
19	Modesto	306,720	104.4%	320,305	1.20	367,480	383,756
1	Modesto	26,722	101.5%	27,121	1.20	32,016	32,494
2	Modesto	15,297	76.3%	11,672	1.20	18,327	13,984
3	Modesto	3,969	119.2%	4,730	1.20	4,755	5,667
4	Turlock	1,237,517	100.0%	1,237,517	1.78	2,206,704	2,206,704
13	Turlock	1,123,726	100.0%	1,123,726	1.78	2,003,795	2,003,795
5	Turlock	307,612	110.9%	341,145	1.78	548,525	608,320
6	Turlock	257,785	92.1%	237,318	1.78	459,675	423,178
20	Turlock	58,903	116.5%	68,599	1.78	105,034	122,324
7	Turlock	32,236	100.0%	32,236	1.78	57,482	57,482
8	Turlock	13,557	100.0%	13,557	1.78	24,174	24,174
9	Turlock	9,705	100.0%	9,705	1.78	17,306	17,306
12	Merced	1,216,551	106.2%	1,292,376	1.84	2,243,574	2,383,411
10	Merced	379,930	100.0%	379,930	1.84	700,670	700,670
16	Merced	148,403	100.0%	148,403	1.84	273,686	273,686
11	Merced	15,235	120.4%	18,340	1.84	28,097	33,823
TOTAL		6,947,487	99.7%	6,929,109	1.62	11,240,228	11,282,525

The overall realization of 99.7 percent is used to estimate the ex-post savings by utility. Table 4-2 outlines by utility the ex-ante and ex-post energy and coincident peak demand estimates. For the analysis of peak demand, Navigant used the California Protocol guidelines for estimating peak demand impact at the basic rigor level. The basic rigor prescribes, at a minimum, an on-peak demand savings estimate based on the allocation of gross energy savings through the use of allocation factors, end-use load shapes or end-use savings load shapes. These secondary data can come from DEER, the CEC forecasting model, utility end-use load shape data, or other prior studies. The time frame and budget available for the impact evaluation precluded direct measurement of peak demand impacts. Rather, Navigant, following the protocol basic rigor level, utilized the peak demand estimates already included in the E3 model.

Table 4-2. Program Level Electric Gross Energy and Demand Ex-post Savings

Utility	Gross Program Ex-ante Savings (kWh)	Gross Program Ex-ante Coincident Demand Savings (kW)	Combined Realization Rate	Gross Program Ex-post Savings (kWh)	Gross Program Ex-post Coincident Demand Savings (kW)
Modesto	2,571,507	328.3	99.7%	2,563,104	327.2
Turlock	5,422,695	1,300.0	99.7%	5,404,975	1,295.8
Merced	3,246,026	0	99.7%	3,235,419	0.0
Total	**11,240,228**	**1,628.3**	**99.7%**	**11,203,499**	**1,623.0**

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

Navigant 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 4-3 identifies the estimates of net impacts for the evaluated programs by utility.

Table 4-3. Program Level Electric 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	2,563,104	327.2	81.4%	2,086,367	266.4
Turlock	5,404,975	1295.8	80.0%	4,323,980	1,036.6
Merced	3,235,419	50.1	78.8%	2,549,510	39.5
Total	**11,203,499**	**1,673.1**	**80.0%**	**8,959,858**	**1,342.5**

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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. 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	2,563,104	2,086,367	11.8	30,244,630	24,619,128
Turlock	5,404,975	4,323,980	9.1	49,185,276	39,348,221
Merced	3,235,419	2,549,510	9.3	30,089,399	23,710,446
Total	**11,203,499**	**8,959,858**	**9.8**	**109,519,305**	**87,677,796**

6. Program Recommendations

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

Compare modeled baselines to available billing or sub-meter data to improve accuracy. The sub-meter available for the large HVAC project at site 14 differed substantially from the modeled baseline chiller. It was difficult for Navigant to determine the exact source of the discrepancies without the full EnergyPro model, but it was clear that the claimed baseline chiller efficiency of 1.1 kW/ton would have resulted in substantially higher usage than indicated by the sub-meter.

Provide detailed calculation spreadsheets for large or complicated projects. Navigant obtained spreadsheets listing most of the retrofits at site 12 from the facility contact. However, these data did not include all of the retrofits, or calculations, and the data in the project file indicated only the number of fixtures retrofitted. Without a list of fixtures, locations, and operational hours it is very difficult to accurately confirm savings and determine the reasons for discrepancies in savings between the *ex ante* and *ex post* values. In addition, the project file for site 15, a medium-sized VFD project, included only a scanned version of a calculation spreadsheet. This sheet appeared to contain the calculations for the project but was not legible. Ideally spreadsheets or detailed calculation models should be included with the project files instead of scanned versions.

Verify the baseline assumptions when determining energy savings. At site 6 the baseline hours for a lighting system were mentioned to be 9,038 hours/year, longer than an actual year. This was a calculation mistake, but is a fairly obvious problem. At site 8, the baseline fixtures were listed as HID, but appeared to be actually T12s, reducing the project savings. Navigant recommends additional quality control of projects to filter out such errors from programs.

7. Portfolio Summary of Impacts

The combined programs included in the FY2012 EM&V for MTM are all from the non-residential sector. The sampled sites comprised 62% 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 45 percent. Modesto had the lowest share of evaluated to total claimed savings of about 16 percent. This low value reflects the greater diversity of its overall utility portfolio of programs offered; especially with Modesto's new construction programs that represent over 50 percent of their claimed savings. The share for Turlock is about 95 percent and for Merced, nearly 100 percent. These high shares reflect the large percentage of claimed savings from the non-residential existing building sector.

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	15,648,477	2,571,507	16.4%
Turlock	5,713,573	5,422,695	94.9%
Merced	3,259,287	3,246,028	99.6%
Total	**24,621,337**	**11,240,230**	**45.7%**

7.1 Portfolio Level Ex-post Gross and Net 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 programs included within each utilities portfolio of program offerings are identified in the tables. The realization rate of 99.7 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 net to gross ratios are taken directly from each utility's E3 filing and represent an average within each program category.

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

Modesto Program	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)
AG-Custom	14,732	99.7%	14,688	80.0%	11,750
BIZ-Cooling	24,423	99.7%	24,349	80.0%	19,479
BIZ-Custom	1,761,896	99.7%	1,756,610	80.0%	1,405,288
BIZ-Lighting	2,315,140	NA	2,315,140	84.8%	1,963,239
BIZ-New Construction	8,430,050	NA	8,430,050	80.0%	6,744,040
BIZ-Refrigeration	715,414	99.7%	713,268	85.0%	606,278
BIZ-Windows	55,043	99.7%	54,878	80.0%	43,902
LIEE-All	1,574,347	NA	1,574,347	100.0%	1,574,347
RES-Appliance	215,093	NA	215,093	66.6%	143,252
RES-Cooling	197,211	NA	197,211	89.2%	175,913
RES-Gen Improvement	1,509	NA	1,509	80.0%	1,207
RES-Lighting	158,400	NA	158,400	80.0%	126,720
RES-Windows	152,206	NA	152,206	55.0%	83,713
RES-New Construction	20,815	NA	20,815	80.0%	16,652
RES-Pool Pump	12,198	NA	12,198	69.0%	8,417
TOTAL	**15,648,477**		**15,640,763**	**82.6%**	**12,924,197**

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

Turlock Program	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 - CFL	33,764	NA	33,764	50.0%	16,882
Res - Clothes Washer	17,284	NA	17,284	80.0%	13,827
Res - Cooling	7,317	NA	7,317	80.0%	5,854
Res - Refrigeration	190,288	NA	190,288	80.0%	152,230
Res - Shell	17,235	NA	17,235	80.0%	13,788
Res - Shade Tree	24,990	NA	24,990	80.0%	19,992
Ag - Lighting	181,079	99.7%	180,536	80.0%	144,429
Ag - Motors	61,950	99.7%	61,764	80.0%	49,411
Ag - Variable Speed Drive	38,795	99.7%	38,679	80.0%	30,943
Com - Lighting	2,681,690	99.7%	2,673,645	80.0%	2,138,916
Com - Refrigeration	189,662	99.7%	189,093	80.0%	151,274
Ind - Lighting	1,954,664	99.7%	1,948,800	80.0%	1,559,040
Ind - Motors	314,855	99.7%	313,910	80.0%	251,128
TOTAL	**5,713,573**		**5,697,305**	**79.8%**	**4,547,715**

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

Merced Program	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)
Commercial Retrofit	3,246,028	99.7%	3,236,290	78.8%	2,550,197
Residential Air Conditioning	419	NA	419	78.3%	328
Residential Appliances	5,953	NA	5,953	78.7%	4,685
Residential Refrigerator Recycle	3,785	NA	3,785	61.4%	2,324
Residential Lighting	3,102	NA	3,102	78.9%	2,447
TOTAL	**3,259,287**		**3,249,549**	**78.8%**	**2,559,981**

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 same realization rate as energy of 99.7 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 E3 filing. As mentioned earlier, Navigant used the California Protocol guidelines for estimating peak demand impact at the basic rigor level.

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

Modesto Program	Gross Ex-ante Coincident Peak Demand (kW)	Energy Savings Realization Rate	Gross Ex-post Coincident Peak Demand (kW)	Net to Gross Ratio	Net Ex-post Coincident Peak Demand (kW)
AG-Custom	0.0	99.7%	0.0	80.0%	0.0
BIZ-Cooling	18.0	99.7%	17.9	80.0%	14.4
BIZ-Custom	183.4	99.7%	182.8	80.0%	146.3
BIZ-Lighting	372.0	NA	372.0	84.8%	315.5
BIZ-New Construction	123.8	NA	123.8	80.0%	99.0
BIZ-Refrigeration	120.5	99.7%	120.1	85.0%	102.1
BIZ-Windows	6.5	99.7%	6.5	80.0%	5.2
LIEE-All	853.7	NA	853.7	100.0%	853.7
RES-Appliance	109.8	NA	109.8	66.6%	73.1
RES-Cooling	40.3	NA	40.3	89.2%	35.9
RES-Gen Improvement	8.4	NA	8.4	80.0%	6.7
RES-Lighting	25.2	NA	25.2	80.0%	20.2
RES-Windows	155.0	NA	155.0	55.0%	85.3
RES-New Construction	0.0	NA	0.0	80.0%	0.0
RES-Pool Pump	3.0	NA	3.0	69.0%	2.1
TOTAL	**2,019.6**		**2,018.6**	**87.2%**	**1,759.4**

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

Turlock Program	Gross Ex-ante Coincident Peak Demand (kW)	Energy Savings Realization Rate	Gross Ex-post Coincident Peak Demand (kW)	Net to Gross Ratio	Net Ex-post Coincident Peak Demand (kW)
Res - CFL	6.3	NA	6.3	50.0%	3.2
Res - Clothes Washer	7.2	NA	7.2	80.0%	5.8
Res - Cooling	8.2	NA	8.2	80.0%	6.6
Res - Refrigeration	51.4	NA	51.4	80.0%	41.1
Res - Shell	15.8	NA	15.8	80.0%	12.6
Res - Shade Tree	6.9	NA	6.9	80.0%	5.5
Ag - Lighting	26.5	99.7%	26.4	80.0%	21.1
Ag - Motors	7.6	99.7%	7.6	80.0%	6.1
Ag - Variable Speed Drive	5.3	99.7%	5.3	80.0%	4.2
Com - Lighting	898.0	99.7%	895.3	80.0%	716.2
Com - Refrigeration	15.4	99.7%	15.4	80.0%	12.3
Ind - Lighting	283.6	99.7%	282.7	80.0%	226.2
Ind - Motors	63.6	99.7%	63.4	80.0%	50.7
TOTAL	**1,395.8**		**1,391.9**	**79.9%**	**1,111.6**

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

Merced Program	Gross Ex-ante Coincident Peak Demand (kW)	Energy Savings Realization Rate	Gross Ex-post Coincident Peak Demand (kW)	Net to Gross Ratio	Net Ex-post Coincident Peak Demand (kW)
Commercial Retrofit	50.3	99.7%	50.1	78.8%	39.5
Residential Air Conditioning	0.7	NA	0.7	78.3%	0.5
Residential Appliances	6.8	NA	6.8	78.7%	5.4
Residential Refrigerator Recycle	0.8	NA	0.8	61.4%	0.5
Residential Lighting	0.5	NA	0.5	78.9%	0.4
TOTAL	**59.1**		**58.9**	**78.5%**	**46.3**

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 summarize 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 Program	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)
AG-Custom	14,688	11,750	15.0	220,317	176,254
BIZ-Cooling	24,349	19,479	15.0	365,240	292,192
BIZ-Custom	1,756,610	1,405,288	15.0	26,349,155	21,079,324
BIZ-Lighting	2,315,140	1,963,239	10.6	24,540,488	20,810,334
BIZ-New Construction	8,430,050	6,744,040	15.0	126,450,750	101,160,600
BIZ-Refrigeration	713,268	606,278	4.5	3,209,705	2,728,249
BIZ-Windows	54,878	43,902	10.0	548,776	439,021
LIEE-All	1,574,347	1,574,347	18.6	29,282,856	29,282,856
RES-Appliance	215,093	143,252	6.2	1,333,577	888,162
RES-Cooling	197,211	175,913	18.1	3,569,527	3,184,018
RES-Gen Improvement	1,509	1,207	25.0	37,728	30,182
RES-Lighting	158,400	126,720	22.0	3,484,800	2,787,840
RES-Windows	152,206	83,713	17.7	2,694,043	1,481,724
RES-New Construction	20,815	16,652	15.0	312,225	249,780
RES-Pool Pump	12,198	8,417	10.0	121,980	84,166
TOTAL	**15,640,763**	**12,924,197**	**14.2**	**222,521,166**	**184,674,702**

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

Turlock Program	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 - CFL	33,764	16,882	5.0	168,820	84,410
Res - Clothes Washer	17,284	13,827	10.0	172,840	138,272
Res - Cooling	7,317	5,854	12.7	92,926	74,341
Res - Refrigeration	190,288	152,230	7.6	1,446,189	1,156,951
Res - Shell	17,235	13,788	10.0	172,350	137,880
Res - Shade Tree	24,990	19,992	30.0	749,700	599,760
Ag - Lighting	180,536	144,429	11.0	1,985,893	1,588,715
Ag - Motors	61,764	49,411	15.0	926,462	741,170
Ag - Variable Speed Drive	38,679	30,943	15.0	580,179	464,143
Com - Lighting	2,673,645	2,138,916	6.8	18,180,786	14,544,629
Com - Refrigeration	189,093	151,274	7.7	1,456,016	1,164,813
Ind - Lighting	1,948,800	1,559,040	11.0	21,436,800	17,149,440
Ind - Motors	313,910	251,128	15.0	4,708,657	3,766,925
TOTAL	**5,697,305**	**4,547,715**	**9.1**	**52,077,618**	**41,611,449**

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

Merced Program	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)
Commercial Retrofit	3,236,290	2,550,197	9.3	30,097,500	23,716,830
Residential Air Conditioning	419	328	14.9	6,239	4,885
Residential Appliances	5,953	4,685	13.1	77,983	61,373
Residential Refrigerator Recycle	3,785	2,324	5.0	18,925	11,620
Residential Lighting	3,102	2,447	5.3	16,441	12,972
TOTAL	**3,249,549**	**2,559,981**	**9.3**	**30,217,087**	**23,807,679**