NAVIGANT

EVALUATION, MEASUREMENT, AND VERIFICATION OF THE MODESTO, TURLOCK, AND MERCED IRRIGATION DISTRICT'S FY 2014 AND FY 2015 NON-RESIDENTIAL ENERGY EFFICIENCY PROGRAMS

FINAL

Prepared for:

Modesto Irrigation District – Water and Power

TID Water & Power – Serving Central California since 1887

Merced Irrigation District – Water & Power

Submitted by:
Navigant Consulting, Inc.
1001 Officers Row
Vancouver, WA 98661

+1.360.828.4000
navigant.com
April 20, 2017

TABLE OF CONTENTS

DISCLAIMER

This report was prepared by Navigant Consulting, Inc. (Navigant) for Modesto, Turlock and Merced Irrigation Districts. The work presented in this report represents Navigant's professional judgment based on the information available at the time this report was prepared. Navigant is not responsible for the reader's use of, or reliance upon, the report, nor any decisions based on the report. NAVIGANT MAKES NO REPRESENTATIONS OR WARRANTIES, EXPRESSED OR IMPLIED. Readers of the report are advised that they assume all liabilities incurred by them, or third parties, as a result of their reliance on the report, or the data, information, findings and opinions contained in the report.

EXECUTIVE SUMMARY

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 demand-side management (DSM) programs. The similarity of DSM program offerings is especially true for each utility's non-residential sector. The non-residential sector programs are the largest providers of claimed energy savings for each utility, with over 90% for each.

Given the similarities in the types of utility, geographic location, and program offerings, the three districts joined together in the evaluation of their fiscal year (FY) 2014 and FY 2015 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.

The combined programs included in the FY 2014 and FY 2015 evaluation, measurement and verification (EM&V) for MTM are all from the non-residential sector. As shown in Table ES-1, the share of evaluated claimed savings to total claimed savings is about 44%.

Table ES-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	24,405,732	11,204,424	45.9%
Turlock	5,731,091	2,895,435	50.5%
Merced	2,760,010	282,706	10.2%
TOTAL	**32,896,833**	**14,382,565**	**43.7%**

Source: Navigant Analysis

Portfolio-Level Ex-Post Gross and Net Energy Savings by Utility

Table ES-2, Table ES-3, and Table ES-4 summarize the gross and net ex-post electricity savings for FY 2014, and Table ES-5, Table ES-6, and Table ES-7 summarize the savings for FY 2015 for Modesto, Turlock, and Merced, respectively. All E3 categories included within each utility's portfolio of program offerings are identified in the tables. The realization rate appropriate for each utility is applied to each of the categories included in the EM&V combined sample. No realization rate is applied to any of the remaining categories. The net-to-gross ratios are taken directly from each utility's E3 filing and represent an average within each E3 category.

Table ES-2. FY 2014 Gross and Net Ex-Post Portfolio-Level Electric Savings – Modesto

Modesto E3 Category	Gross Annual Ex-Ante Energy Savings (kWh)	Energy Savings Realization Rate	Gross Annual Ex-Post Energy Savings (kWh)	Net-to-Gross Ratio	Net Annual Ex-Post Energy Savings (kWh)
Res Clothes Washers	13,640	NA	13,640	0.85	11,594
Res Cooling	87,374	NA	87,374	0.84	73,181
Res Dishwashers	0	NA	0	0.00	0
Res Electronics	6,900	NA	6,900	1.00	6,900
Res Heating	0	NA	0	0.00	0
Res Lighting	126,024	NA	126,024	1.00	126,024
Res Pool Pump	32,421	NA	32,421	0.69	22,370
Res Refrigeration	329,404	NA	329,404	0.75	248,540
Res Shell	171,853	NA	171,853	0.67	115,232
Res Water Heating	6,757	NA	6,757	0.89	5,998
Res Comprehensive	4,220	NA	4,220	0.85	3,572
Non-Res Cooking	0	1.14	0	0.00	0
Non-Res Cooling	346,948	1.14	395,627	0.70	277,558
Non-Res Heating	0	1.14	0	0.00	0
Non-Res Lighting	2,683,603	1.14	3,060,134	0.70	2,149,724
Non-Res Motors	0	1.14	0	0.00	0
Non-Res Pumps	421,004	1.14	480,074	0.70	336,803
Non-Res Refrigeration	1,507,999	1.14	1,719,584	0.72	1,244,451
Non-Res Shell	743,104	1.14	847,367	0.70	594,483
Non-Res Process	1,313,919	1.14	1,498,272	0.70	1,051,135
Non-Res Comprehensive	165,399	1.14	188,606	0.70	132,319
Other	1,166,049	NA	1,166,049	0.80	932,839
TOTAL	**9,126,617**		**10,134,306**	**72.36%**	**7,332,723**

Source: Navigant Analysis

Table ES-3. FY 2014 Gross and Net Ex-Post Portfolio-Level Electric Savings – Turlock

Turlock E3 Category	Gross Annual Ex-Ante Energy Savings (kWh)	Energy Savings Realization Rate	Gross Annual Ex-Post Energy Savings (kWh)	Net-to-Gross Ratio	Net Annual Ex-Post Energy Savings (kWh)
Res Clothes Washers	19,388	NA	19,388	0.31	6,010
Res Cooling	19,726	NA	19,726	0.80	15,781
Res Dishwashers	0	NA	0	0.00	0
Res Electronics	0	NA	0	0.00	0
Res Heating	0	NA	0	0.00	0
Res Lighting	8,742	NA	8,742	0.50	4,371
Res Pool Pump	0	NA	0	0.00	0
Res Refrigeration	144,536	NA	144,536	0.70	101,175
Res Shell	4,615,122	NA	4,615,122	0.79	3,667,203
Res Water Heating	0	NA	0	0.00	0
Res Comprehensive	0	NA	0	0.00	0
Non-Res Cooking	0	1.14	0	0.00	0
Non-Res Cooling	0	1.14	0	0.00	0
Non-Res Heating	0	1.14	0	0.00	0
Non-Res Lighting	943,844	1.14	1,076,273	0.70	755,075
Non-Res Motors	0	1.14	0	0.00	0
Non-Res Pumps	0	1.14	0	0.00	0
Non-Res Refrigeration	1,035,042	1.14	1,180,267	0.70	828,034
Non-Res Shell	0	1.14	0	0.00	0
Non-Res Process	895,630	1.14	1,021,294	0.70	716,504
Non-Res Comprehensive	0	1.14	0	0.00	0
Other	0	NA	0	0.00	0
TOTAL	**7,682,029**		**8,085,347**	**75.37%**	**6,094,153**

Source: Navigant Analysis

Table ES-4. FY 2014 Gross and Net Ex-Post Portfolio-Level Electric Savings – Merced

Merced E3 Category	Gross Annual Ex-Ante Energy Savings (kWh)	Energy Savings Realization Rate	Gross Annual Ex-Post Energy Savings (kWh)	Net-to-Gross Ratio	Net Annual Ex-Post Energy Savings (kWh)
Res Clothes Washers	1,517	NA	1,517	0.31	470
Res Cooling	186	NA	186	0.80	149
Res Dishwashers	272	NA	272	0.60	163
Res Electronics	0	NA	0	0.00	0
Res Heating	0	NA	0	0.00	0
Res Lighting	0	NA	0	0.00	0
Res Pool Pump	0	NA	0	0.00	0
Res Refrigeration	6,488	NA	6,488	0.70	4,542
Res Shell	1,006	NA	1,006	0.00	282
Res Water Heating	0	NA	0	0.00	0
Res Comprehensive	0	NA	0	0.00	0
Non-Res Cooking	0	1.14	0	0.00	0
Non-Res Cooling	0	1.14	0	0.00	0
Non-Res Heating	0	1.14	0	0.00	0
Non-Res Lighting	2,320,408	1.14	2,645,980	0.64	1,693,427
Non-Res Motors	0	1.14	0	0.00	0
Non-Res Pumps	0	1.14	0	0.00	0
Non-Res Refrigeration	252,201	1.14	287,587	0.64	184,056
Non-Res Shell	0	1.14	0	0.00	0
Non-Res Process	0	1.14	0	0.00	0
Non-Res Comprehensive	0	1.14	0	0.00	0
Other	11,440	NA	11,440	0.64	7,322
TOTAL	**2,593,518**		**2,954,476**	**63.98%**	**1,890,410**

Source: Navigant Analysis

Table ES-5. FY 2015 Gross and Net Ex-Post Portfolio-Level Electric Savings – Modesto

Modesto E3 Category	Gross Annual Ex-Ante Energy Savings (kWh)	Energy Savings Realization Rate	Gross Annual Ex-Post Energy Savings (kWh)	Net-to-Gross Ratio	Net Annual Ex-Post Energy Savings (kWh)
Res Clothes Washers	11,470	NA	11,470	0.85	9,750
Res Cooling	107,647	NA	107,647	0.81	87,689
Res Dishwashers	0	NA	0	0.00	0
Res Electronics	6,750	NA	6,750	1.00	6,750
Res Heating	0	NA	0	0.00	0
Res Lighting	110,594	NA	110,594	1.00	110,594
Res Pool Pump	50,397	NA	50,397	0.69	34,774
Res Refrigeration	280,614	NA	280,614	0.73	203,489
Res Shell	184,506	NA	184,506	0.65	119,665
Res Water Heating	6,411	NA	6,411	0.86	5,502
Res Comprehensive	0	NA	0	0.00	0
Non-Res Cooking	0	1.14	0	0.00	0
Non-Res Cooling	1,078,540	1.14	1,229,868	0.70	862,832
Non-Res Heating	0	1.14	0	0.00	0
Non-Res Lighting	3,034,433	1.14	3,460,188	0.70	2,427,538
Non-Res Motors	3,410,406	1.14	3,888,913	0.70	2,728,325
Non-Res Pumps	0	1.14	0	0.00	0
Non-Res Refrigeration	974,092	1.14	1,110,765	0.74	824,338
Non-Res Shell	22,242	1.14	25,363	0.70	17,794
Non-Res Process	8,704,044	1.14	9,925,292	0.70	6,963,235
Non-Res Comprehensive	0	1.14	0	0.00	0
Other	0	NA	0	0.00	0
TOTAL	**17,982,146**		**20,398,778**	**70.60%**	**14,402,274**

Source: Navigant Analysis

Table ES-6. FY 2015 Gross and Net Ex-Post Portfolio-Level Electric Savings – Turlock

Turlock E3 Category	Gross Annual Ex-Ante Energy Savings (kWh)	Energy Savings Realization Rate	Gross Annual Ex-Post Energy Savings (kWh)	Net-to-Gross Ratio	Net Annual Ex-Post Energy Savings (kWh)
Res Clothes Washers	12,913	NA	12,913	0.31	4,003
Res Cooling	49,376	NA	49,376	0.50	24,502
Res Dishwashers	0	NA	0	0.00	0
Res Electronics	0	NA	0	0.00	0
Res Heating	0	NA	0	0.00	0
Res Lighting	57,054	NA	57,054	0.51	29,309
Res Pool Pump	0	NA	0	0.00	0
Res Refrigeration	155,036	NA	155,036	0.70	108,541
Res Shell	0	NA	0	0.00	0
Res Water Heating	0	NA	0	0.00	0
Res Comprehensive	2,965,938	NA	2,965,938	1.00	2,965,463
Non-Res Cooking	0	1.14	0	0.00	0
Non-Res Cooling	0	1.14	0	0.00	0
Non-Res Heating	0	1.14	0	0.00	0
Non-Res Lighting	2,477,929	1.14	2,825,602	0.70	1,982,343
Non-Res Motors	0	1.14	0	0.00	0
Non-Res Pumps	0	1.14	0	0.00	0
Non-Res Refrigeration	0	1.14	0	0.00	0
Non-Res Shell	227,704	1.14	259,653	0.70	182,164
Non-Res Process	150,942	1.14	172,120	0.70	120,753
Non-Res Comprehensive	0	1.14	0	0.00	0
Other	0	NA	0	0.00	0
TOTAL	**6,096,891**		**6,497,692**	**83.37%**	**5,417,078**

Source: Navigant Analysis

Table ES-7. FY 2015 Gross and Net Ex-Post Portfolio-Level Electric Savings – Merced

Merced E3 Category	Gross Annual Ex-Ante Energy Savings (kWh)	Energy Savings Realization Rate	Gross Annual Ex-Post Energy Savings (kWh)	Net-to-Gross Ratio	Net Annual Ex-Post Energy Savings (kWh)
Res Clothes Washers	5,520	NA	5,520	0.31	1,711
Res Cooling	94	NA	94	0.80	75
Res Dishwashers	572	NA	572	0.60	343
Res Electronics	0	NA	0	0.00	0
Res Heating	0	NA	0	0.00	0
Res Lighting	0	NA	0	0.00	0
Res Pool Pump	0	NA	0	0.00	0
Res Refrigeration	5,828	NA	5,828	0.70	4,080
Res Shell	0	NA	0	0.00	0
Res Water Heating	0	NA	0	0.00	0
Res Comprehensive	0	NA	0	0.00	0
Non-Res Cooking	0	1.14	0	0.00	0
Non-Res Cooling	0	1.14	0	0.00	0
Non-Res Heating	0	1.14	0	0.00	0
Non-Res Lighting	19,447	1.14	22,176	0.70	15,558
Non-Res Motors	0	1.14	0	0.00	0
Non-Res Pumps	0	1.14	0	0.00	0
Non-Res Refrigeration	0	1.14	0	0.00	0
Non-Res Shell	0	1.14	0	0.00	0
Non-Res Process	91,908	1.14	104,803	0.70	73,526
Non-Res Comprehensive	76,046	1.14	86,716	0.70	60,837
Other	0	NA	0	0.00	0
TOTAL	**199,415**		**225,709**	**69.17%**	**156,130**

Source: Navigant Analysis

Recommendations

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

Include the Coincident Demand Diversity Factor and HVAC Interactive Factors while calculating the energy and the demand savings for the lighting projects. Consistent with the Navigant team's recommendation from the program year (FY) 2013 evaluation, Navigant recommends that the Coincident Demand Diversity Factor and the Database for Energy Efficiency Resources (DEER) Interactive Effects Factors should be used while calculating the energy and the demand savings for the lighting projects implemented in the conditioned spaces. These factors are outlined in the Customized Calculated Savings Guidelines for Non-Residential Programs, Version 6.0.[1] The Coincident Demand Diversity Factor provides a probability that the light affected by the project will be on during the facility's peak demand period. Coincident Diversity Factor for peak demand is based on the project's technology (CFL, Non-CFL, or LED Exit Sign), building type, and climate zone. These factors are documented in the DEER and are only applicable for the indoor lighting. Also, by reducing the lighting load in the air-conditioned areas, the load on the HVAC system is lowered, and this effect must be quantified using the HVAC Interactive Factors.

Provide additional quality control for the ex-ante savings calculations. At site 16, the ex-ante calculations use the measured airflows (Pre and Post) and a proprietary calculator spreadsheet tool to estimate the energy savings. Navigant's review of the project file shows that there is a discrepancy in the claimed total energy saved from the project. Page 13 in the project files shows a breakdown of the annual energy savings from the occupied and unoccupied period. The total energy savings from the supply fans, exhaust fans, and cooling energy is shown as follows:

Table ES-8. Ex-Ante Aggregate Annual Energy Savings Breakdown

	Energy Savings (kWh)
Cooling Energy	93,752
Supply Fans	122,428
Exhaust Fans	231,231
Total	**447,411**
Claimed Ex-Ante	**549,283**
Difference	**(101,872)**

Source: Project Documentation, Navigant Analysis

Navigant was not able to identify the reason behind this discrepancy. Navigant did attempt to obtain the original calculation spreadsheet from the contractor for the project, but was not able to obtain it.

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

Navigant recommends adding a layer of quality control to filter out such errors. Additionally, if there is indeed a reason to revise the savings from 447,411 kWh to 549,283 kWh, final project files should also reflect these revised savings.

Collect the calculation spreadsheet used to estimate the ex-ante savings. Navigant recommends collecting all the calculation spreadsheets or simulation models used to calculate the ex-ante savings. It is easier for utilities to ask for and collect these documents at the time of the rebate processing. It is difficult for an independent third-party evaluator visiting the site a year or two later to get hold of such documents from the time of the evaluation. Many times, sites where the projects are implemented do not store these files. Sometimes the site contact who was present at the time of the implementation leaves the company and their new counterpart may not necessarily know about the project. These calculation spreadsheets or models aid significantly in understanding all the assumptions that went into the ex-ante calculations. The scanned copies of spreadsheets or model inputs/outputs do not provide that level of insight. However, Navigant does want to acknowledge that the overall collection of these calculation spreadsheets and models has improved in FY2014-15 over past evaluation years.

Regulatory Context

Two legislative bills regulate the energy efficiency conservation programs for California's publicly owned utilities (POUs). These include the Senate Bill 1037 (SB 1037) and Assembly Bill 2021 (AB 2021), which were signed into law a year apart. Similar to regulations for California's investor-owned utilities (IOUs), SB 1037 (signed September 29, 2005) requires that the state'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 of the bill is to give priority to the efficiency resource in utility operating plans. The bill also requires that POUs submit an annual report describing utility programs, expenditures, expected energy savings, and actual energy savings.

AB 2021, signed by the governor on September 29, 2006, reiterates the loading order and annual report stated in SB1037 and expands on the annual report requirements. The expanded report requires the 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 3 years that identifies cost-effective potential electric savings from energy efficiency, and establishes annual targets for electricity energy efficiency and demand reduction over 10 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 EM&V efforts. The CEC must meet the following requirements:

- 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 with EM&V guidelines under which their EM&V reports[2] should be submitted. This study comports with those guidelines.

Objectives and Relevant Protocols

The overarching goals of the FY 2014 and FY 2015 EM&V activities are to provide MTM with unbiased, objective, and independent program evaluations by providing 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 energy efficiency program results.

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

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

As a basic component of program impact evaluations, the Navigant team referred to International Performance Measurement and Verification Protocols (IPMVP) to determine the best options for evaluating energy efficiency measures (EEMs). These protocols are discussed in detail in Section 1. In the section below, we provide a detailed discussion of relevant CEC POU EM&V Guidelines and Criteria required for MTM evaluations.

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.
- 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.

---

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

- EM&V Evaluation (Impact) Studies – Submit to the CEC as they are completed.
- The CEC will provide feedback on the EM&V report directly to the POU staff contact within 60 days of receiving the report. The Commission will generally base its evaluation of the report on the Framework of Criteria; however, feedback on and evaluation of the report will be interactive between Commission staff and POU staff.[3]

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

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

The CEC Framework of Criteria guidelines (Part D), as identified in Table ES-9, provide a checklist for submitted POU EM&V reports.

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

Table ES-9. 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 POU's portfolio and clearly describe the programs or savings not evaluated?
- ☐ Does the evaluation assess risk or uncertainly in selecting the components of the portfolio to evaluate?

Overview and Documentation of Specific Evaluation Effort

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

Gross Savings

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

Net Savings

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

EM&V Summary and Conclusions

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

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

Evaluation Priorities

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

If each of the utilities had independently evaluated their non-residential programs with the same sampling precision, the number of sample sites across the three utilities would be much higher. By combining the three utilities into one EM&V effort, an over 60% reduction in sample sites is achieved with corresponding budgetary savings.

1. OVERVIEW OF APPROACH AND SAMPLING

1.1 Key Issues

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

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

Table 1-1. 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 • Runtime 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, runtime 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[4]

[4] More information is available at 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.

1.2 General M&V Approaches

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

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

The IPMVP evaluation option primarily used for this evaluation is Option A, but Options B and C were also utilized. In all cases except two, onsite verification was performed. Navigant performed phone verification and engineering review for the two sampled projects where onsite verification was not possible due to site contact availability.

1.2.1 Onsite Inspections

The Navigant team conducted onsite inspections of the fiscal year FY 2014 and FY 2015 non-residential program participants. 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 onsite inspection and verification activities, onsite performance measurement activities fall into the following three broad categories:

- **Spot measurements –** Spot measurements are the first and simplest level of onsite 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.
- **Runtime hour data logging –** Runtime hour monitoring represents the second level of performance measurement and is used to record runtime profiles over a given time period or operating hour totals. Runtime hour monitoring is particularly useful for estimating long-term energy consumption from short-term measurements, particularly for technologies that 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 that typically hold 2 weeks to 1 months' worth of data.
- **Interval metering –** Interval metering is the most sophisticated level of onsite 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 use 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.

1.3 Peak Demand Estimation

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

1.4 Sampling

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

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

1.4.1 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 Modesto, Turlock, 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, all three are geographically close to each other.

The population universe for the EM&V sample is all the FY 2014 and FY 2015 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% (+/- 15%) at the project level. With this sampling precision, the sample size is 21 sites. If each of the utilities had independently evaluated their non-residential programs with the same sampling precision, the combined number of sample sites would be over 50. By combining the three utilities into one EM&V effort, an over 60% reduction in sample sites is achieved with corresponding budgetary savings. Table 1-2 provides a breakout by utility of claimed ex-ante savings, the number of projects completed in FY 2014 and FY 2015, and the sample of projects drawn from each utility.

Table 1-2. Claimed Gross Ex-Ante Savings, Completed Projects, and Sampled Projects by Utility

Utility	Gross Ex-ante Kwh	Share	Projects	Share	Sample	Share
Modesto	24,405,732	74%	120	64%	12	57%
Turlock	5,731,091	17%	63	34%	7	33%
Merced	2,760,010	8%	5	3%	2	10%
TOTAL	**32,896,833**	**100%**	**188**	**100%**	**21**	**100%**

Source: Navigant

1.4.1.1 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 CV 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.

1.4.1.2 Non-Residential Projects Sample

The population of accounts for the non-residential existing buildings programs consists of a total of 188 projects. These projects have a very wide range of energy savings extending from 270 kWh to 3,313,000 kWh, with the median being 34,724 kWh. The population CV of the energy savings is large, and stratified ratio estimation sampling provides the best methodology to attain both a sampling precision of 90% (+/-15%) at the project level, as well as a very high percentage of overall sampled ex-ante savings. The final sample consists of 21 projects (11%) and more importantly 54% of the ex-ante electric energy savings. Some swapping of sites within strata was performed to ensure that each utility was represented. Table 1-3 identifies each sampled site with utility, project type, ex-ante savings, sample strata, and sample weight.

Table 1-3. Sample with Utility, Project Type, Ex-ante Savings, Sample Strata, and Sample Weight

Utility - Site	Project Type	Sample Strata	Ex-Ante kWh Savings	Stratum Weight
Modesto -1	Compressed Air System Upgrade	Stratum 1	3,170,159	1.55
Modesto -2	Furnace Upgrade	Stratum 1	2,679,551	1.55
Modesto -3	Energy Management System	Stratum 1	1,166,049	1.55
Modesto -4	Furnace Control System Upgrade	Stratum 2	859,587	1.65
Modesto -5	Screw Compressor Retrofit - Freon to Ammonia	Stratum 2	935,240	1.65
Modesto -6	Variable Speed Drive	Stratum 2	734,136	1.65
Modesto -7	Energy Management System	Stratum 2	627,872	1.65
Modesto -8	Lighting Retrofit - Grocery	Stratum 2	439,500	1.65
Modesto -9	Exterior Lighting Retrofit - Retail	Stratum 2	405,036	1.65
Modesto -10	Pool Control System	Stratum 3	152,949	16.68
Modesto -11	VFD for Ag Irrigation Pump	Stratum 3	18,660	16.68
Modesto -12	Lighting Retrofit - Retail	Stratum 3	15,685	16.68
Turlock -13	Rapid Doors - Refrigeration	Stratum 1	962,128	1.55
Turlock -14	Interior Lighting	Stratum 2	728,184	1.65
Turlock -15	Interior Lighting	Stratum 2	579,308	1.65
Turlock -16	Exhaust Fan VFD	Stratum 2	549,283	1.65
Turlock -17	Exterior Lighting	Stratum 3	38,679	16.68
Turlock -18	New Construction	Stratum 3	27,701	16.68
Turlock -19	Interior Lighting	Stratum 3	10,152	16.68
Merced -20	Compressor Upgrade	Stratum 3	91,908	16.68
Merced -21	Lighting	Stratum 3	190,798	16.68

Source: Navigant

2. ESTIMATING PROJECT LEVEL EX-POST SAVINGS

The Navigant team conducted site visits to each of the 21 sampled projects. At each site, the Navigant team visually inspected the measures installed. Additionally, metering equipment was installed at some of the sites to capture the measure operation. This section outlines the M&V plan for each site and includes the measure descriptions, M&V method, and M&V results.

2.1 Site 1

2.1.1 Project Summary

This site is a beverage manufacturing facility located in Modesto, California. The facility used compressed air for a variety of applications including blowing and vacuum operations to support packaging line. The entire compressed air system, controls, receivers, piping, and end-use applications were upgraded. These upgrades are listed in Section 2.1.2.2.

Navigant used a similar approach as the ex-ante analysis to determine the energy and peak demand savings. The energy and peak demand savings for the project are slightly lower than claimed due to the utilization of different trend data intervals for the respective analyses.

Table 2-1. First-Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	3,170,159	2,939,905	93%
Peak Demand Savings (kW)	361	355	98%

Source: Project Documentation, Navigant Analysis

2.1.2 Compressor System Upgrade

2.1.2.1 Description of Baseline Equipment and Operation

The baseline equipment includes three compressors totaling 1,100 horsepower (hp) of connected load. The compressed air system includes dryers, a dry receiver, and distribution piping. Nozzles used for blowing are the standard orifice type.

2.1.2.2 Description of Efficient Case Equipment and Operation

The compressed air system was completely overhauled and includes the following upgrades:

- Modify compressed air piping
- Install new Programmable Logic Controller (PLC) to three compressors
- Install new air dryer
- Install new air filters

- Install new high-efficiency air receiver water trap drain valves
- Modify compressed air header to bottling lines 16, 17, and 18
- Install temperature control on three venturi blown cabinet coolers
- Replace high pressure blow ports with venturi nozzles that are photo eye controlled
- Replace all existing single-stage venturi vacuum eductors with more efficient multistage eductors
- Install fully automatic air shutoff controls
- Implement comprehensive air leak identification and repair program

2.1.2.3 Comments on Ex-Ante Calculations

The ex-ante calculations are based on 1 month (June 2015) of trending data obtained from the compressed air control system. This data provides hourly energy consumption of the three compressors for loading and unloading. This trending data was used to calculate the efficient case energy consumption.

The baseline energy consumption is pulled from the original scoping audit completed in the 2013. Both of these energy consumptions are linearized to the pre- and post-production level to calculate energy savings. Navigant believes that this is a reasonable approach to calculate the energy savings.

2.1.3 Onsite Visit

2.1.3.1 M&V Method

Navigant used IPMVP Option B: Retrofit Isolation to determine the energy and demand savings for this project.

Navigant performed the following activities for the M&V of this project:

- Confirm the installation of the measures listed in the Section 2.1.2.2. (verbally or physically)
- Collect the nameplate information of the three compressors and the dryer
- Collect the production data for the facility (production in cases/mo) for the last 12 months
    - Also, confirm the future production projections
- Collect the trend data for the compressors for minimum 4 weeks to maximum 12 months; the trend data should include:
    - Hourly load/unload kilowatt-hours for the three compressors
    - Total cfm load in the facility
    - Average PSI for the facility

2.1.3.2 Summary of Site Visit

Navigant performed a site visit in October 2016. Navigant met with representatives from the facility, the compressed air contractor, and utility representative to tour the facility. The measures listed above in

Section 2.1.2.2 were identified as installed and deemed operating as intended. The facility contact confirmed that the system is capable of trending key operational parameters.

2.1.3.3 Ex-Post Calculations and Assumptions

Navigant used 2,112 hours (about 3 months) of trend data from the compressed air system and production records to determine the unit energy (average kilowatt-hours consumed per unit of product) for the system. Navigant compared this to the baseline unit energy to determine the improvement in unit energy. The baseline unit energy was determined in the compressed air audit that led to the compressed air system upgrades.

Navigant used production records from the last 21 months to determine the average monthly production. The average monthly production was multiplied by improvements in unit energy and annualized to determine energy savings.

Demand savings were determined in a similar manner. The average monthly production was used to determine the monthly kilowatt-hours consumed based on the baseline and post-implementation unit energy values. Navigant analyzed the trend data to determine the percent runtime of the lead compressor. The percentage runtime was multiplied by the standard hours in a month (720) to determine a proxy for system runtime. Navigant divided this monthly kilowatt-hour value by the runtime to determine the peak demand for the pre- and post-implementation periods.

2.2 Site 2

2.2.1 Project Summary

This site is a beverage manufacturing facility located in Modesto, California. The site overhauled furnace 2 and included the energy efficiency components. Total estimated ex-ante energy and demand savings for this project are 5,359,102 kWh/year and 611.77 kW. The rebate was paid out in two phases. Thus, the first phase (i.e., this FY 2015 project) claims approximately 50% of the estimated energy and demand savings which are 2,678,572 kWh and 305.9 kW.

The energy and demand savings for the project are on the higher side because the ex-ante calculations underestimated the savings due to the use of a baseline percentage fuel ratio factor. This fuel ratio factor indicates the % of electric boost energy to total consumption of the furnace (Gas plus electric). Navigant used 6 months of recent efficient case data to estimate the ex-post savings.

Table 2-2. Project Savings Summary

	Ex-ante		Ex-post		Realization Rate	
	Total	**First Year (FY2015)**	**Total**	**First Year (FY2015)**	**Total**	**First Year (FY2015)**
Energy Savings (kWh/Year)	5,359,102	2,678,572	10,455,422	5,227,711	195%	195%
Peak Demand Savings (kW)	611.8	305.9	1,279.4	639.7	209%	209%

Source: Project Documentation, Navigant Analysis

2.2.2 Furnace Upgrade

2.2.2.1 Description of Baseline Equipment and Operation

The site had an old glass melting furnace with electric boost. The site had earlier planned on rebuilding the old furnace to the standard components. Baseline daily production of furnace 2 was about 310 tons/day. The furnace operated 354 days a year at a fairly constant load.

2.2.2.2 Description of Efficient Case Equipment and Operation

The site upgraded the furnace 2 to more efficient components in order to reduce energy consumption as well as increase production capacity. After the upgrade, furnace 2 is estimated to run at increased daily production of about 410 tons/day.

2.2.2.3 Comments on Ex-Ante Calculations

The ex-ante calculation estimated energy and demand savings using the following steps:

- The ex-ante calculation uses the baseline production and the annual energy consumption for the baseline period (2012-13) to calculate the total energy consumption/ton of production for the baseline period. This represents natural gas and electric energy consumption/ton of production. The energy consumption is normalized to a 50% cullet ratio.
- The calculation then uses the average percentage fuel ratio of electric energy to total energy (15% in the baseline) to derive the electric energy consumption/ton of production.
- For the efficient case, the ex-ante calculation used improved total energy/ton from the historical upgrade of furnace 4 at the facility. Furnace 4 went through a similar upgrade 2 years ago.
- For the efficient case, the ex-ante calculation still uses the same percentage fuel ratio as the baseline period (15%) to calculate the efficient case electric energy consumption.
- The difference between the baseline and efficient case electric energy consumption scaled to new production level (410 tons/day) represents the energy savings for this project.

- The ex-ante calculation divided the estimated annual electric energy savings by operational days per year (354) to derive the average demand savings.

The ex-ante calculation approach looks reasonable. However, during the ex-post calculations, the Navigant team identified that the percentage fuel ratio had improved to 10% in the efficient case. Navigant confirmed this with the site contact, who mentioned that one of the goals behind this upgrade is to improve the percentage fuel ratio from 15% to 10%. This change should have been included in the ex-ante calculations. Since the ex-ante calculations did not include this change, this resulted in the underestimating of the energy and demand savings. Navigant revised the ex-ante calculations to include this change in the efficient case calculations, which resulted in an about 140% increase in the ex-ante savings. The following table shows the difference between the ex-ante savings and revised ex-ante savings.

Table 2-3. Ex-Ante vs. Revised Ex-Ante, First-Year Savings

	Ex-Ante	Revised Ex-Ante	Revised Ex-Ante / Ex-Ante
Efficient Case % Fuel Ratio	15%	10%	-
Energy Savings (kWh/Year)	2,678,572	6,504,124	242%
Peak Demand Savings (kW)	305.9	766.0	250%

Source: Project Documentation, Navigant Analysis

2.2.3 Onsite Visit

2.2.3.1 M&V Method

The site monitors the energy consumption of furnace 2. During the onsite visit, Navigant confirmed the following details:

- Installation of the new furnace
- Daily production
- Recent post-installation trend data gathering

This method is in line with the IPMVP Option B.

2.2.3.2 Summary of Site Visit

Navigant performed a site visit in October 2016. Navigant's site visit engineer confirmed that the new furnace is installed and is operating as expected. The furnace is running at slightly lower load (386 tons/day) than estimated in the ex-ante calculations (410 tons/year). The site provided 6 months of recent trend data (April 2016 to September 2016), which includes daily production, daily energy consumption (total, Natural Gas and Electric) and percentage cullet ratio.

2.2.3.3 Ex-Post Calculations and Assumptions

Navigant calculated the ex-post energy and demand savings using the following approach:

- Navigant developed a multi-regression equation for the baseline energy consumption using daily production (in tons) and percentage cullet ratio.
- Navigant used this regression equation to estimate the baseline energy consumption for the efficient case daily production and percentage cullet ratio.
- The difference between the efficient case and baseline case energy consumption is the ex-post energy savings. Navigant extrapolated 6 months of data to the whole year to estimate the annual ex-post energy savings.
- Navigant divided this annual energy consumption by the annual hours of operation (354 days/year, 24 hours/day) to estimate the average ex-post demand savings.

The ex-post energy and demand savings have high realization rates due to the following reasons:

- As described in Section 2.2.2.3, the ex-ante calculations underestimated energy and demand savings since it used the baseline fuel ratio. The efficient case fuel ratio is close to 10%, which resulted in a higher realization rate.
- However, the ex-post energy and demand savings are slightly lower than the revised ex-ante savings included in Table 2-3 because the efficient case daily production is slightly lower than estimated in the ex-ante calculations.

Navigant double-checked the ex-post savings by analyzing the utility meter-level electric energy consumption provided by MID. This meter serves furnace 1, 2, and 3 at the site. Navigant's analysis of the meter-level data corroborates the ex-post energy and demand savings for the furnace 2. There is no significant change in the utility meter-level consumption from the baseline period to the efficient case period. However, furnace 2 has improved the production by 30%-40%. Also, the furnace 2 energy consumption data provided by the site shows that energy consumption for furnace 2 has in fact decreased by 33% (18.8 GWh in the baseline to 14.6 GWh in the efficient case).

2.3 Site 3 (& Site 7)

2.3.1 Project Summary

The site is a major food manufacturing company located in Modesto, California. The site installed a new energy management system (EMS) for the processing, packaging, and warehouse areas. As part of the EMS upgrade, the site installed variable frequency drive (VFD) controls on multiple evaporative cooler fans, exhaust fans, and supply fans. The EMS system allows for central control and coordination of the facility's major HVAC equipment. MID paid the rebates for this project in two phases. Both of these phases were selected as a part of the random sample for this evaluation. Site 3 is phase 1 and Site 7 is phase 2.

The small discrepancy in energy savings is due to small differences in assumptions for power factor and operational parameters. For peak demand savings, Navigant updated the analysis with the recent trending data which resulted in slightly lower demand realization rate.

Table 2-4. First-Year Project Savings Summary

		Ex-Ante*	Ex-Post	Realization Rate
Energy Savings (kWh/Year)	Phase 1 (Site 3)	1,166,049	1,213,740	104%
	Phase 2 (Site 7)	627,872	653,552	104%
	Total	**1,793,921**	**1,867,353**	**104%**
Peak Demand Savings (kW)	Phase 1 (Site 3)	132.2	84.5	64%
	Phase 2 (Site 7)	73.8	47.5	64%
	Total	**205.0**	**132.0**	**64%**

Source: Project Documentation, Navigant Analysis

2.3.2 Energy Management System

2.3.2.1 Description of Baseline Equipment and Operation

In the baseline, the cooling system at the site did not have master control system. The scope of this project is limited to evaporation coolers, exhaust fans, and rooftop units (RTUs) serving the processing, packaging, and warehouse areas.

2.3.2.2 Description of Efficient Case Equipment and Operation

The site installed a new EMS for the processing, packaging, and warehouse areas. This included adding VFDs, sensors, and a controller system on the cooling system components at the site. The installed EMS system is capable of trending the individual unit power consumption.

2.3.2.3 Comments on Ex-Ante Calculations

The ex-ante calculations were performed using the bin-hour analysis. This method uses an estimated baseline consumption and calculated efficient consumption. The project file used 3 months of trend data to calculate the efficient case consumption. Navigant believes that the ex-ante calculations are reasonable.

MID paid the rebate for the EMS project at this site in two phases. The first phase was paid out in 2014 and was about 64% of estimated ex-ante savings. The second phase was paid out in 2015 for the remaining energy savings.

2.3.3 Onsite Visit

2.3.3.1 M&V Method

Navigant performed a site visit in October 2016. Navigant collected the following data during the onsite visit:

- Confirmed the installation of the controls system, VFDs, and sensors (random spot check)
- Collected the HVAC equipment nameplate data for the units from the random spot check

- Collected the trend data from the EMS for recent months
- Collected the monthly production of the facility in lbs. of product

This approach is in line with IPMVP Option B.

2.3.3.2 Summary of Site Visit

Navigant met with the facility engineer to tour the facility. Navigant performed spot checks to confirm that the EMS system and VFD controls were installed as expected. The facility was undergoing an EMS software/integration upgrade and was unable to pull a current trend report during the onsite visit.

2.3.3.3 Ex-Post Calculations and Assumptions

Navigant used 75 days of historic trend data spanning from 5/1/12014 to 7/15/204. The trend data included VFD set point and amperage data for each piece of affected equipment in 5-minute intervals, as well as outdoor air temperature (OAT). Navigant used this data to create 1-degree temperature bins and averaged the total HVAC electric load for each bin. Typical meteorological data (TMY3) was used in conjunction with the temperature bins to determine average annual energy consumption for the post-implementation system.

Navigant determined the baseline energy consumption by assuming that the motors in the affected equipment operated at a fixed speed year-round prior to the retrofit. Navigant used spot power measurements of motor kilowatts multiplied by 8,760 to determine annual kilowatt-hours.

The installed controls included maximum set points on the affected equipment leading to a persistent reduction in overall demand. Navigant determined demand savings by taking the difference between the baseline kW, which was established with power measurements prior to the retrofit and the demand in the highest temperature bin (105 °F.) during in post retrofit trend data.

Navigant divided the ex-post energy and demand savings in the same ratio (64%-36%) to calculate the realization rate for phase one and two of the project.

2.4 Site 4

2.4.1 Project Summary

The site is a beverage manufacturing facility located in Modesto, California. The site installed an advanced control system on furnace 1 to increase productivity and save electric energy consumption. This furnace is used to produce glass used to create glass bottles for the facility.

The ex-post energy and peak demand savings for the project are on a slightly lower side because the ex-ante calculations did not adjust for the increase in the cullet ratio from the baseline to the efficient case period. Some portion of the estimated ex-ante savings resulted due to this increase in the cullet ratio, as energy consumption of a glass furnace is reduced as the cullet ratio increases.

Table 2-5. First-Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	859,587	691,939	80%
Peak Demand Savings (kW)	98.0	81.4	83%

Source: Project Documentation, Navigant Analysis

2.4.2 Furnace Control System Upgrade

2.4.2.1 Description of Baseline Equipment and Operation

In the baseline, furnace 1 did not have an advanced control system. Daily production of the furnace was 429 tons/day on an average. Furnace 1 operated 354 days/year, with 11 days of shutdown period toward the end of the calendar year (typically December 22 to January 1).

2.4.2.2 Description of Efficient Case Equipment and Operation

The site installed an online optimization program on furnace 1 to increase productivity and reduce energy usage. This program uses model predictive control, fuzzy logic, neural networks, knowledge systems and advanced optimization to gain better control over the glass melting process.

2.4.2.3 Comments on Ex-Ante Calculations

The ex-ante savings were calculated using the monitored energy consumption (pre and post) and daily production values. The ex-ante calculations developed separate linear regression models for the baseline and efficient case operation of the furnace 1. Daily production (in tons) was the only variable used to develop these regression models. Navigant believes this is a reasonable approach; however, the cullet value should also be used in the regression models as the energy consumption of a typical glass furnaces also depends on the percentage of cullet used in the production. Cullet is a broken and recycled glass that is mixed with the raw input materials in the furnace to create glass. Less energy is required to melt and process cullet than the actual raw materials. Thus, as the amount of cullet increases in the input of a glass furnace, overall energy consumption of the furnace decreases.

2.4.3 Onsite Visit

2.4.3.1 M&V Method

The site monitors the energy consumption of the furnace 1. During the onsite visit, Navigant attempted to gather the following details:

- Confirm daily production of the furnace 1.
- Gather the post-installation trend data for the furnace.

This method is in line with the IPMVP Option C.

2.4.3.2 Summary of Site Visit

Navigant's site visit engineer confirmed that the advanced control system is installed on furnace 1 and it is operating as expected. Production levels for furnace 1 are similar to the baseline period. Navigant requested and received the trend data for the daily production, cullet ratio, and daily energy consumption for the most recent 6 months (June 2016 to November 2016) for furnace 1.

2.4.3.3 Ex-Post Calculations and Assumptions

Navigant used the following steps to estimate the ex-post energy and demand savings. Navigant calculated the ex-post energy and demand savings using the following approach:

- Navigant developed a multi-regression equation for the baseline energy consumption using daily production (in tons) and cullet ratio.
- Navigant used this regression equation to estimate the baseline energy consumption for the efficient case daily production and cullet ratio. For efficient case, Navigant used the existing 10 months of trend data from year 2015 and added the recent 6 months of data from 2016 (June 2016 to November 2016). Average daily production throughout this period as well as the baseline is consistent (close to 427-429 tons/day).
- Navigant calculated average baseline energy/ton and average efficient case energy/ton from the multi-regression model and efficient case data. The difference between these two is the average of the ex-post energy savings/ton.
- Navigant multiplied this value with the annual production to derive ex-post energy savings.
- Navigant divided this annual energy consumption by the annual hours of operation (354 days/year, 24 hours/day) to estimate the average ex-post peak demand savings.

The ex-post energy and peak demand savings are slightly on the lower side because the average cullet ratio in the baseline is slightly lower than average cullet ratio in the efficient case. Since the ex-ante calculations did not adjust for this difference in the cullet ratio, the ex-ante calculations slightly overestimated the energy and demand savings for the project. Since the cullet ratio increased from the baseline to the efficient case, some portion of the estimated ex-ante savings resulted due to this increase in the cullet ratio as energy consumption of a glass furnace reduces as the cullet ratio increases.

2.5 Site 5

2.5.1 Project Summary

The site is a midsize refrigerated warehouse located in Modesto, California. The site consolidated 40% of the old warehouse area with the newer warehouse area and converted the 40-year-old Freon refrigeration system to an ammonia system.

The ex-post energy savings for the project are on the higher side because the ex-ante energy savings were calculated using only 6 months of post-installation utility billing data. The Navigant team calculated the ex-post energy savings using linear regressions obtained from 15 months of the baseline and 19 months of the recent efficient case utility data at a 15-minute interval level. This data was normalized for the OAT. Navigant was not able to obtain the production data from the site to normalize the energy savings to the production.

Table 2-6. First-Year Project Savings Summary

	Ex-ante*	Ex-post	Realization Rate
Energy Savings (kWh/Year)	935,240[5]	1,156,121	124 %
Peak Demand Savings (kW)	0	0	NA

Source: Project Documentation, Navigant Analysis
** There is an average Ex-ante demand savings of 106 kW associated with this project but since there is no reduction in the connected load, Peak Demand savings for the project is 0 kW. During summer months, the site still operates baseline refrigeration system to keep up with the increased refrigeration load.*

2.5.2 Refrigeration System Consolidation

2.5.2.1 Description of Baseline Equipment and Operation

The site is a midsize refrigerated warehouse in Modesto, California. In the baseline, the site had the following refrigeration system:

Table 2-7. Baseline Equipment

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

Source: Onsite data collection

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

The ammonia refrigeration system at the site includes two 235 hp compressors. These two compressors were sufficient to service the whole facility once the old refrigeration system is converted to an ammonia refrigeration system.

[5] Total ex-ante savings claimed for this project for year 2013 are 1,157,760 kWh. 75% of the savings were claimed in the year 2013 because the utility wanted to revise the savings based on the actual post-implementation billing data. MID revised the ex-ante savings for this project in year 2014 based on the six months of post implementation trend data. The revised ex-ante savings for this project were 1,803,560 kWh. Thus, MID reported the remaining 935,240 kWh for this project in year 2014 as Phase 2.

2.5.2.2 Description of Efficient Case Equipment and Operation

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

2.5.2.3 Comments on Ex-Ante Calculations

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

Year 2013 Ex-Ante Calculations:

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

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

  Where:
  EI = Energy Intensity in kW/sq. ft.
- The ex-ante calculations assume that the site will operate at this average load throughout the year. Thus, energy savings were derived by multiplying kilowatt savings by 8,760 annual operating hours.

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

Year 2014 Ex-Ante Calculations:
In FY 2014, MID revised the ex-ante estimate for the project based on 6 months of post-implementation billing data. MID normalized the billing data with the outside weather to calculate the ex-ante energy savings. The site operates in two different modes in a typical year, as described in Table 2-8.

The old Freon refrigeration system is used as required during the production mode to blast-freeze the fresh produce arriving during the production period. Useful production data was not available to normalize the energy consumption during these months to the production. The storage mode is consistent throughout the year, so the ex-ante calculations used only storage mode energy consumption to form the regression equations for the baseline and energy efficient case. These equations were used with annual weather data to calculate the ex-ante energy savings associated with the storage mode at the site. Total annual energy savings estimate in FY 2014 were 1,898,484 kWh. MID applied a 95% savings factor to calculate the energy savings on a conservative side. Thus, MID revised the ex-ante savings for the project to 1,803,560 kWh. In FY 2014, MID claimed 935,240 kWh of energy savings for the project. There are no peak demand savings for the project.

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

2.5.3 Onsite Visit

2.5.3.1 M&V Method

Navigant performed a site visit in October 2016. During the onsite visit, Navigant attempted to verify that the ammonia system is still in place and is working as expected. Navigant requested 15-min interval data for the facility from MID for whole building analysis. This approach is in line with IPMVP Option C.

2.5.3.2 Summary of Site Visit

During the site visit, the Navigant site visit engineer confirmed that the project has been implemented and is working as expected. The old warehouse is looped into a newer ammonia system. The site contact confirmed that for about 7-8 months in a year, the whole refrigeration load is satisfied by only one 235 hp ammonia compressor. For the remaining months, both the ammonia compressors run to satisfy the total refrigeration load of the facility. There are no operational changes in the refrigeration system at the site from last year (2015) when Navigant visited the site for the phase 1 savings claimed for FY 2013.

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

Table 2-8. Facility Operating Modes

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

Source: Discussion with the site contact

2.5.3.3 Ex-Post Calculations and Assumptions

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

- The Navigant team received updated 15-minute interval data for the energy consumption (kWh) at the facility meter level for a period of 16 months (from May 1, 2015 to October 10, 2016).
- The Navigant team used the baseline data received for the phase 1 evaluation of this project in the FY 2013 evaluation to develop the baseline regression equation. The baseline period includes interval data for a period of 15 months (January 1, 2012 to March 30, 2013).
- For the efficient case data, Navigant used the recent 16 months of data received from MID (May 1, 2015 to October 10, 2016).
- The Navigant team used this 15-minute kilowatt-hour data to calculate hourly demand (kW) for the baseline and energy efficient case period.
- The Navigant team obtained OAT data for the Modesto city county airport weather station. The Navigant team used this OAT data to normalize the hourly kilowatt consumption of the facility.

- The Navigant team divided the baseline and energy efficient case data according to Table 2-8 and formed the linear regression equations for the storage mode for both the baseline and energy efficient case periods. Navigant used the interval data excluding production period for the facility.
- The Navigant team obtained the TMY3[6] weather data for the city of Modesto. The Navigant team then used this TMY3 data and the linear regressions developed from the billing data to calculate the baseline and energy efficient case energy consumption for the facility.
- The difference between the baseline and energy efficient case consumption is the ex-post energy savings for this project.
- The Navigant team used the same methodology used to calculate the FY 2014 ex-ante savings in Section 2.5.2.3 as the storage mode savings for the site are expected to occur throughout the year.

The ex-post energy savings are on a higher side because the ex-ante energy savings were calculated by using only 6 months of the post-installation utility billing data. The Navigant team calculated the ex-post energy savings using linear regressions obtained from 15 months of the baseline and 16 months of the efficient case utility data at a 15-minute interval level. This data was normalized for the OAT. Navigant was not able to obtain the production data from the site to normalize the energy savings to the production.

There are no peak demand savings associated with this project as during the peak summer period, the facility still operates the baseline refrigeration system in order to satisfy the higher load.

2.6 Site 6

2.6.1 Project Summary

The site is a large industrial facility located in Modesto, California. The site replaced one of the existing 125 hp air-cooled modulating compressor with a new 175 hp air-cooled compressor with a VFD.

The ex-post energy savings have a lower realization rate as Navigant's calculation reflect the seasonal load on the compressed air system at the site. The ex-ante calculations estimated that the compressed air system would be running at constant high load throughout the year.

Table 2-9. First-Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	734,136	607,445	83%
Peak Demand Savings (kW)	0	0	NA

Source: Project Documentation, Navigant Analysis

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

2.6.2 VFD Compressor

2.6.2.1 Description of Baseline Equipment and Operation

The baseline compressed air system consisted of four compressors (three 125 hp and one 100 hp). The compressed air system runs on a 24/5 basis. On weekends, the system runs for a one 10-hour shift on Saturdays. In the baseline, all four compressors used to run on modulating with unloading controls.

2.6.2.2 Description of Efficient Case Equipment and Operation

The site installed a new 175 hp air-cooled air compressor from Atlas-Copco with a VFD. This compressor has similar operating hours to the baseline compressor. The site also reconfigured the compressor staging. The 100 hp compressor runs at a full load as a base compressor. The new 175 hp VFD compressor operates as a trim compressor. The remaining two compressors are used as a backup.

2.6.2.3 Comments on Ex-Ante Calculations

The ex-ante calculations used the baseline and EE case trending data to calculate the ex-ante savings. The ex-ante calculations used an AirMaster + model to develop average daily load on the compressed air system to calculate the energy savings. Navigant believes that the AirMaster+ model results in a reasonable energy savings. However, the ex-ante calculation assumes a constant load on the compressed air system throughout the year. Navigant verified this assumption during the onsite visit.

2.6.3 Onsite Visit

2.6.3.1 M&V Method

While onsite, Navigant:

1. Interviewed onsite contact about the operation and use of the compressors
2. Confirmed the compressor installation
3. Collected the nameplate data for all four compressors
4. Collected information on:
    a. Overall operating characteristics of the compressed air system
    b. System pressure
    c. Record CFM load (From control panel, if available)
    d. Record Service areas
5. Confirmed seasonality of production at the facility
6. Performed spot measurements for the compressor that include
    a. Volts
    b. Amps
    c. Power Factor

7. Installed a data logger to measure current for a period of 3-4 weeks and logged all operating compressors (100 hp base compressor and new 175 hp)

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

2.6.3.2 Summary of Site Visit

Navigant performed a site visit in October 2016. Navigant met the plant manager to conduct the site visit. The facility manufacturers steel (tin) containers for food products. The plant utilizes compressed air in a variety of its manufacturing processes such as actuators, blowing and Venturi-based vacuums. The compressed air plant is located in a covered area adjacent to the building. Individual compressors are mounted on concrete pads and connected with a common header that directs the compressed air through filtration and refrigeration drying equipment to a dry receiver.

The plant manager indicated output is tied to the harvest and processing of local crops in the area, with output peaking in the summer and tapering off significantly during the fall and winter. This was corroborated with plant activity at the time of the site visit, which was limited enough that the trim compressors only ran for several minutes during the hour-long onsite visit.

Navigant performed spot measurements and installed a logger on the new 175 hp VFD compressor, which operates as a trim compressor. This information is summarized below:

Table 2-10. Spot Measurements During the Onsite Visit

Equipment ID	Motor HP	Speed (RPM) Min/Max	ACFM	kW	Amps	Volts	PF
GA132VSD	175	650/1485	282	59.6	73	486	0.97

Source: Navigant's onsite data collection

The plant manager indicated that the baseload compressor (QSI-500i) does not run during this portion of the year, so Navigant did not install a logger on this piece of equipment. The GA132VSD unit set point is 115 PSI at the compressor outlet.

2.6.3.3 Ex-Post Calculations and Assumptions

The ex-ante calculations estimated that the compressed air system runs at a fairly constant load throughout the year. However, based on the onsite data collection, Navigant found out that the production and hence the load on the compressed air system at the site is fairly seasonal. The load peaks during the harvest season (spring and summer) and tapers off during fall and winter months. Navigant's site visit occurred during the period of low load on the compressed air system, and only the trim compressor was operating during the site visit. Based on the onsite data collection, Navigant estimated three levels of loading on the compressed air system at the site; high load for about 9 months during harvesting and packaging season, low load for about 3 months in the winter, and medium load (average of high and low load) during a 1-month period, which represents tapering off/on period between high and low load.

Navigant used the logger data from the site visit to calculate the energy savings during the low load period. Navigant estimated that the ex-ante energy savings reflect the energy savings during the high load period. For the medium load period, Navigant used the average of the high and low load periods to estimate energy savings.

The ex-post energy savings have a lower realization rate, as Navigant's calculations reflect the seasonal load on the compressed air system at the site. The ex-ante calculations estimated that the compressed air system would be running at a constant high load throughout the year.

There are no demand savings associated with this project as during the high load period, the compressed air system with VFD compressor typically consumes more energy than a constant speed compressor system.

2.7 Site 7

2.7.1 Project Summary

The site is a major food manufacturing company located in Modesto, California. The site installed a new energy management system (EMS) for the processing, packaging, and warehouse areas. As part of the EMS upgrade, the site installed variable frequency drive (VFD) controls on multiple evaporative cooler fans, exhaust fans, and supply fans. The EMS system allows for central control and coordination of the facility's major HVAC equipment. MID paid the rebates for this project in two phases. Both of these phases were selected as a part of the random sample for this evaluation. Site 3 is phase 1 and Site 7 is phase 2.

Refer to Section 2.3 Site 3 (& Site 7) for all information pertaining to Site 7.

2.8 Site 8

2.8.1 Project Summary

The site is a grocery store located in Modesto, California. The site performed a lighting retrofit to replace T12 linear fluorescent fixtures with T8 fixtures and LED fixtures throughout the site.

The difference in the realization rate for the energy and demand savings at the site is due to Navigant's inclusion of DEER 2016 HVAC interactive factors and coincident demand factors.

Table 2-11. First-Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	439,500	419,996	96%
Peak Demand Savings (kW)	40.75	68.50	168%

Source: Project Documentation, Navigant Analysis

2.8.2 LED Lighting Retrofit

2.8.2.1 Description of Baseline Equipment and Operation

The site is a grocery store located in Modesto, California. The site had a total of 413 T12 fixtures in the baseline. The majority of fixtures at the site operate at 16 hours a day, 7 days a week, whereas about 200 total fixtures on the sales floor and refrigerated cases operate on 24/7 basis.

2.8.2.2 Description of Efficient Equipment and Operation

The site replaced 41 fixtures in the refrigerated cases and 9 fixtures in the office area with LED fixtures. The remaining fixtures throughout the site were replace by efficient T8 fixtures. There is no change in the operating hours of the fixtures from the baseline.

2.8.2.3 Comments on Ex-Ante Calculations

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

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

Where,
ΔkWh: Annual energy saved (in kWh),
WattsBASE: Connected load of the baseline fixtures,
WattsEE: Connected load of energy efficient fixtures.
Demand Savings:
ΔkW = ((WattsBASE – WattsEE) / 1000)

Where,
ΔkW: Peak demand saved (in kW),
WattsBASE: Connected load of the baseline fixtures,
WattsEE: Connected load of energy efficient fixtures.

The ex-ante calculations do not include HVAC Interactive Effects Factors as outlined in the Customized Calculated Savings Guidelines for Non Residential Programs, Version 6.0.[7] However, the ex-ante calculations do include a 0.67 coincident demand savings factor in the demand savings calculations.

2.8.3 Onsite Visit

2.8.3.1 M&V Method

Navigant collected following data during the onsite visit:

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

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

- Confirmed the lamp wattage
- Categorized and counted the fixtures as per the space type (air-conditioned or non-conditioned)

2.8.3.2 Summary of Site Visit

Navigant performed a site visit in October, 2016 to verify the installation of efficient lamps and hours of use. Navigant also confirmed that no other energy efficient measures have been installed since the completion of this project. Half of the sales floor and the refrigerated cases keep the lights on 24/7 while the rest of the lights were on during store hours on a 16 hours a day, 7 days a week basis.

2.8.3.3 Ex-Post Calculations and Assumptions

The ex-post calculations used a standard algorithm with onsite findings to get the energy savings. The modified algorithm uses interactive effects to calculate savings.

Annual Energy Savings Algorithm

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

Where:

$kW_{Baseline}$	= Connected load of baseline fixtures
kW_{EE}	= Connected load of LED fixtures
HOURS	= Average hours of use per year
DIE_{Energy}	= DEER Interactive Effects Factor for energy savings found in 2016 DEER factors = 1.29 (refrigerated case) = 1.14 (grocery)

Summer Coincident Peak kW Savings Algorithm

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

Where:

DIE_{Demand}	= DEER Interactive Effects Factor for energy savings found in 2016 DEER factors = 1.29 (refrigerated case) = 1.35 (grocery)
CDF	= Coincident Diversity Factor for peak demand = 0.75 for fixtures not on 8760 hours = 1.0 for fixtures with 8760 hours

The difference in the realization rate for the energy and demand savings at the site is due to Navigant's inclusion of DEER 2016 HVAC interactive factors and coincident demand factors.

2.9 Site 9

2.9.1 Project Summary

The site is an automotive shop located in Modesto, California. The site performed an exterior lighting retrofit and replaced existing pole lighting and wall packs with LED fixtures. Navigant revised the operating hours of the fixtures to match the dusk-to-dawn hours provided by the US Naval Observatory, which resulted in a slightly higher realization rate.

Table 2-12. First-Year Project Savings Summary

	Ex-Ante	Ex-Post	Realization Rate
Energy Savings (kWh/Year)	405,036	423,140	104%
Peak Demand Savings (kW)	0	0	NA

Source: Project Documentation, Navigant Analysis

2.9.2 LED Lighting Retrofit

2.9.2.1 Description of Baseline Equipment and Operation

This site is an automotive dealership located in Modesto, California. In the baseline, the site had total 214 exterior high intensity discharge (HID) fixtures. These exterior fixtures were controlled by a photocell.

2.9.2.2 Description of Efficient Equipment and Operation

The site replaced old 214 exterior HID fixtures with 124 LED fixtures. The new fixtures are also operated using photocells.

2.9.2.3 Comments on Ex-Ante

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

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

Where,
ΔkWh: Annual energy saved (in kWh),
WattsBASE: Connected load of the baseline fixtures,
WattsEE: Connected load of energy efficient fixtures.

There are no demand savings for this site because the fixtures are all exteriors.

2.9.3 Onsite Visit

2.9.3.1 M&V Method

Navigant collected the following data during the onsite visit:

- Confirmed the wattage and quantity of the fixtures
- Confirmed the control type of the fixtures

2.9.3.2 Summary of Site Visit

Navigant performed a site visit in October 2016. Navigant confirmed the number of installed fixtures and was able to get a lighting plan. All fixtures matched the claimed number of fixtures from the project file. The fixtures are controlled using photocells.

2.9.3.3 Ex-Post Calculations and Assumptions

Navigant used the following algorithm similar to the ex-ante calculations.

Annual Energy Savings Algorithm

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

Where:

$kW_{Baseline}$ = Connected load of baseline fixtures
kW_{EE} = Connected load of LED fixtures
HOURS = Average hours of use per year
DIE_{Energy} = 1.00 for exterior spaces

The ex-post savings used annual hours of use found from the US Naval Observatory. Specifically, Navigant used the dusk-to-dawn hours provided by US Naval Observatory to calculate the operating hours of the fixtures. These revised hours of operation resulted in the slightly higher realization rate.

2.10 Site 10

2.10.1 Project Summary

This project included installing VFD control systems on pool pumps at four different school campuses in Modesto, California. Navigant confirmed that the VFD control systems are installed on the pool pumps from this project and they are operating as expected. Navigant has determined that this project has achieved a 100% realization rate for the energy savings.

Table 2-13. First-Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	152,949	152,949	100%
Peak Demand Savings (kW)	0	0	NA

Source: Project Documentation, Navigant Analysis

2.10.2 VFD Control System

2.10.2.1 Description of Baseline Equipment and Operation

This project included installing VFD control systems on pool pumps at four different school campuses located in Modesto, California. Three pool pumps use a 15 hp motor, whereas the fourth pool pump has a 50 hp motor. These pumps run on a 24/7 basis to deliver pool chemicals.

2.10.2.2 Description of Efficient Equipment and Operation

The school district installed VFD on these pumps to operate them efficiently and save energy.

2.10.2.3 Comments on Ex-Ante Calculations

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

Energy Savings:
$\Delta kWh = kWh/yr_{(BASE)} - kWh/yr_{(EE)}$

Where,
ΔkWh: Annual energy saved (in kWh),
$kWh/yr_{(BASE)}$: Average $kW_{(BASE)}$ * Annual Operating Hours
$kW/yr_{(EE)}$: Average $kW_{(EE)}$ * Annual Operating Hours

There are no peak demand savings with this project as on a peak load, a pump with a VFD consumes more energy than a constant speed pump of the same size.

2.10.3 Onsite Visit

2.10.3.1 M&V Method

Navigant collected the following data during the onsite visit:

- Collected nameplate data for pool pumps
- Collected trending data from EMS systems (if possible)
- Confirmed the installation of the VFD control systems

2.10.3.2 Summary of Site Visit

Navigant performed a site visit in October 2016. Navigant's site visit engineer visited one of the schools to confirm the project installation. Navigant confirmed that the VFD control system is installed on the 15 hp pool pump at the school. The pump operated 24/7 throughout the year. There is no trending data available for the pump. Navigant was not able to install the data logger on the pump during the site visit.

2.10.3.3 Ex-Post Calculations and Assumptions

Navigant was not able to install a data logger on the school pump during the site visit. Navigant reviewed the ex-ante calculations provided in the project files for one of the pumps and found them reasonable. Overall claimed ex-ante energy savings from the pumps at these schools is about 22% of the estimated baseline energy consumption. This value is reasonable for a typical VFD application. Thus, Navigant estimates that this project has achieved a 100% realization rate for the energy savings.

2.11 Site 11

2.11.1 Project Summary

The site is an agricultural farm located in Modesto, California. The site installed a VFD on an existing 60-hp river pump. Navigant confirmed that the VFD is installed on the pump and is operating as expected. Navigant determined that this project has achieved a 100% realization rate for the energy savings.

Table 2-14. First-Year Project Savings Summary

	Ex-Ante	Ex-Post	Realization Rate
Energy Savings (kWh/Year)	18,660	18,660	100%
Peak Demand Savings (kW)	0	0	NA

Source: Project Documentation, Navigant Analysis

2.11.2 VFD Pump

2.11.2.1 Description of Baseline Equipment and Operation

This site is an agricultural farm. In the baseline, the site had a 60 hp constant speed pump. In the baseline, this pump used to run at a constant load and site used to bypass the excess water two-thirds of the operating time when the irrigation need for the farm is lower. The pump operates 1,750 hours/year, typically during the summer.

2.11.2.2 Description of Efficient Equipment and Operation

The site installed a VFD on the bypass pump. The VFD allows the pump to operate at a lower load for two-thirds of the operating hours when the irrigation need is lower. This helps save electric energy consumption and also eliminate bypassing of the water.

2.11.2.3 Comments on Ex-Ante

The ex-ante calculations use a standard algorithm to calculate the energy savings as follows:

Energy Savings:

$\Delta kWh = (kW_{BASE} – kW_{EE}) / 1000) \times$ Annual Operating Hours

Where,

ΔkWh: Annual energy saved (in kWh),

kW_{BASE}: Baseline load on the pump,

kW_{EE}: Efficient case load on the pump.

There are no demand savings associated with this project as typically at a full load, a pump with a VFD consumes more energy than a pump without a VFD.

2.11.3 Onsite Visit

2.11.3.1 M&V Method

Navigant collected the following data during the onsite visit:

- Confirmed the installation of the VFD
- Confirmed the pump size
- Confirmed the operating hours and seasonality
- Installed a current logger to monitor the energy consumption of the pump

2.11.3.2 Summary of Site Visit

Navigant confirmed that the VFD was installed on the pump and is operating as expected. The site contact confirmed that about two-thirds of the time, the pump runs on a reduced irrigation load, as estimated in the ex-ante calculations. The site contact also confirmed that the annual operating hours of the pump are 1,750 hours per year. Navigant installed a data logger on the pump; however, the site visit occurred in October 2016, which was outside the operating season of the pump.

2.11.3.3 Ex-Post Calculations and Assumptions

The monitoring data gathered by the logger was not useful, as the pump was rarely operating during the monitoring period. Navigant reviewed the ex-ante calculations, which look reasonable and are in line with Navigant's site visit findings. Navigant determined that this project has achieved a 100% realization rate for the energy savings. There are no peak demand savings associated with this VFD project.

2.12 Site 12

2.12.1 Project Summary

The site is a small drug store located in Modesto, California. The site replaced T12 fixtures with the efficient T8 fixtures. The difference in the realization rate for the energy and demand savings at the site is due to Navigant's inclusion of DEER 2016 HVAC interactive factors and coincident demand factors.

Table 2-15. First-Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	15,685	16,626	106%
Peak Demand Savings (kW)	2.5	2.9	119%

Source: Project Documentation, Navigant Analysis

2.12.2 T8 Lighting Retrofit

2.12.2.1 Description of Baseline and Efficient Equipment and Operation

The site is a small drug store located in Modesto, California. In the baseline, the site had T12 fixtures throughout the store. Most of these fixtures operated on a 24/7 basis.

2.12.2.2 Description of Baseline and Efficient Equipment and Operation

The site installed new, efficient T8 fixtures throughout the store. The new lighting system has the same operating schedule as the baseline fixtures.

2.12.2.3 Comments on Ex-Ante Calculations

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

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

Where,
ΔkWh: Annual energy saved (in kWh),
WattsBASE: Connected load of the baseline fixtures,
WattsEE: Connected load of energy efficient fixtures.

Demand Savings:
ΔkW = ((WattsBASE – WattsEE) / 1000)

Where,
ΔkW: Peak demand saved (in kW),
WattsBASE: Connected load of the baseline fixtures,
WattsEE: Connected load of energy efficient fixtures.

The ex-ante calculations do not include HVAC Interactive Effects Factors, as outlined in the Customized Calculated Savings Guidelines for Non Residential Programs, Version 6.0.[8]

2.12.3 Onsite Visit

2.12.3.1 M&V Method

Navigant collected the following data during the onsite visit:

- Confirmed the wattage and quantity of the fixtures
- Confirmed the operating schedule

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

- Categorized and count the fixtures as per the space type (air-conditioned or non-conditioned)

2.12.3.2 Summary of Site Visit

Navigant performed a site visit in October 2016. Navigant confirmed the number of fixtures installed and the hours of operation.

2.12.3.3 Ex-Post Calculations and Assumptions

The ex-post calculations used a standard algorithm to account for interactive effects and coincident demand savings factor.

Annual Energy Savings Algorithm

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

Where:

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

Summer Coincident Peak kW Savings Algorithm

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

Where:

DIE_{Demand}	= DEER Interactive Effects Factor for energy savings = 1.19
CDF	= Coincident Diversity Factor for peak demand
	= 1.00 in this case as the fixtures are on 24/7

The difference in the realization rate for the energy and demand savings at the site is due to Navigant's inclusion of DEER 2016 HVAC interactive factors and coincident demand factors.

2.13 Site 13

2.13.1 Project Summary

The site is a refrigerated warehouse located in Turlock, California. The site replaced three old rapid speed doors with new, efficient rapid doors.

Navigant confirmed that this rapid door retrofit project is installed at the site and is operating as expected. The Navigant team has estimated that the project has achieved a 100% realization rate for the energy and demand savings.

Table 2-16. First-Year Project Savings Summary

	Ex-Ante	Ex-Post	Realization Rate
Energy Savings (kWh/Year)	962,128	962,128	100%
Peak Demand Savings (kW)	110.0	110.0	100%

Source: Project Documentation, Navigant Analysis

2.13.2 Rapid Close Doors

2.13.2.1 Description of Baseline and Efficient Equipment and Operation

The site is a refrigerated warehouse that replaced three rapid close doors with new, high efficient doors on a one-to-one basis. Each old door had:

- Three 9.5 kW heaters (ran continuously)
- Two 3.65 kW quartz lamps (ran continuously)
- Three 0.25 hp blower motors

The new doors have two 0.2 hp blower motors each. They do not have any heater or high intensity lighting similar to the baseline equipment. Based on the data collected during the project implementation, these doors cycle 15 times/hour on an average. Baseline doors required 6 seconds for opening or closing. New doors require 4 seconds for opening or closing. Thus, for each door operation cycle (opening, movement of forklift/personnel, and closing), new doors are expected to save 4 seconds of refrigerated air loss to the outside, which will result in refrigeration energy savings. Additionally, new doors will save a significant amount of energy due to the absence of the heaters and high intensity lamps compared to the baseline case.

2.13.2.2 Comments on Ex-Ante

The ex-ante calculations used Statewide Customized Offerings tool (Version 2013) to calculate the energy and demand savings for the measure. Navigant reviewed the ex-ante calculations provided in the project file. The ex-ante calculations look reasonable.

2.13.3 Onsite Visit

2.13.3.1 M&V Method

Navigant collected the following data during the onsite visit:

- Confirmed the installation of the measure
- Collected the nameplate information of the doors (if possible)
- Collected the data on door open counts
- Confirmed operating hours of the facility

2.13.3.2 Summary of Site Visit

Navigant performed a site visit in October 2016. Navigant's site visit engineer confirmed the installation of the new doors. The facility operates the doors 24/7. Navigant's engineer confirmed that the door cycles at the similar rate compared to the baseline, approximately 15 times/hour.

2.13.3.3 Ex-Post Calculations and Assumptions

Navigant reviewed the ex-ante energy and demand savings calculated using calculator tool from Customized Statewide Offering program (Version 2013). Navigant's onsite data collection confirmed that the doors are operating as expected and the operating characteristics of the doors are similar to that estimated for ex-ante calculations. Navigant determined that this project has achieved a 100% realization rate for the energy and peak demand savings.

2.14 Site 14

2.14.1 Project Summary

The site is poultry farm located in Turlock, California that upgraded old metal halide and T12 fixtures throughout the facility with new LED fixtures. The difference in the realization rate for the energy and demand savings at the site is due to Navigant's inclusion of DEER 2016 HVAC interactive factors and coincident demand factors.

Table 2-17. First-Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	728,184	781,845	107%
Peak Demand Savings (kW)	83.1	100.4	121%

Source: Project Documentation, Navigant Analysis

2.14.2 LED Lighting Retrofit

2.14.2.1 Description of Baseline Equipment and Operation

This site is a poultry farm. The baseline lighting system at the site included a total of 337 metal halide and T12 fixtures. The fixtures at the site operated on a 24/7 basis.

2.14.2.2 Description of Efficient Equipment and Operation

The site replaced all the baseline fixtures with the efficient LED fixtures. New fixtures also operate on 24/7 basis.

2.14.2.3 Comments on Ex-Ante

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

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

Where,
ΔkWh: Annual energy saved (in kWh),
WattsBASE: Connected load of the baseline fixtures,
WattsEE: Connected load of energy efficient fixtures.

Demand Savings:
$\Delta kW = ((WattsBASE – WattsEE) / 1000)$

Where,

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

The ex-ante calculations do not include HVAC Interactive Effects Factors as outlined in the Customized Calculated Savings Guidelines for Non Residential Programs, Version 6.0.[9]

2.14.3 Onsite Visit

2.14.3.1 M&V Method

Navigant collected the following data during the onsite visit:

- Confirmed the wattage and quantity of the fixtures
- Confirmed the operating schedule
- Categorized and counted the fixtures as per the space type (air-conditioned or non-conditioned)

2.14.3.2 Summary of Site Visit

Navigant performed a site visit in October 2016. Navigant confirmed the measure installation and operating hours of the new fixtures. Navigant also identified that the site installed 16 fewer fixtures than estimated in the project file due to a change of scope in the project.

2.14.3.3 Ex-Post Calculations and Assumptions

The ex-post calculations used a standard algorithm with onsite findings to get the energy savings. The modified algorithm uses interactive effects to calculate savings.

Annual Energy Savings Algorithm

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

Where:

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

Summer Coincident Peak kW Savings Algorithm

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

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

Where:

DIE_{Demand} = DEER Interactive Effects Factor for energy savings = 1.17

CDF = Coincident Diversity Factor for peak demand
= 1.00 in this case as the fixtures are on during the peak demand period.

The difference in the realization rate for the energy and demand savings at the site is due to Navigant's inclusion of DEER 2016 HVAC interactive factors and coincident demand factors. Navigant also revised the number of fixtures installed based on the site visit findings.

2.15 Site 15

2.15.1 Project Summary

The site is a distribution center located in Patterson, California. The site replaced old T8 high bay fixtures with LED fixtures. The difference in the realization rate for the energy and demand savings at the site is due to Navigant's inclusion of DEER 2016 HVAC interactive factors and coincident demand factors.

Table 2-18. First-Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	579,308	572,584	99%
Peak Demand Savings (kW)	151.12	132.2	87%

Source: Project Documentation, Navigant Analysis

2.15.2 LED Lighting Retrofit

2.15.2.1 Description of Baseline and Efficient Equipment and Operation

This site is a distribution center for a retail store chain. In the baseline, the site had a total of 1,174 high bay T8 fixtures. These fixtures operated 5 days a week, 6 a.m. to 11:30 p.m.

2.15.2.2 Description of Baseline and Efficient Equipment and Operation

The site replaced 1,174 baseline T8 fixtures with 709 LED fixtures. The site also installed occupancy sensors in the mezzanine area.

2.15.2.3 Comments on Ex-Ante

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

Energy Savings:

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

Where,
ΔkWh: Annual energy saved (in kWh),
WattsBASE: Connected load of the baseline fixtures,
WattsEE: Connected load of energy efficient fixtures.

Demand Savings:

ΔkW = ((WattsBASE – WattsEE) / 1000)

Where,
ΔkW: Peak demand saved (in kW),
WattsBASE: Connected load of the baseline fixtures,
WattsEE: Connected load of energy efficient fixtures.

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

2.15.3 Phone Verification

2.15.3.1 M&V Method

Navigant collected the following data during the phone verification:

- Confirmed the wattage and quantity of the fixtures
- Confirmed the operating schedule
- Categorized and counted the fixtures as per the space type (air-conditioned or non-conditioned)

2.15.3.2 Summary of Phone Verification

Navigant attempted to visit this site during the October 2016 fieldwork session but was unable to visit the site due to scheduling issues. Navigant performed a phone verification to verify the measure installation, hours of use, and other operational changes. Navigant confirmed that all LED fixtures and occupancy sensors have been installed as claimed in the project files.

2.15.3.3 Ex-Post Calculations and Assumptions

The ex-post calculations use a standard algorithm along with the phone verification findings to calculate the energy and demand savings.

Annual Energy Savings Algorithm

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

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

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

DIE_{Energy} = DEER Interactive Effects Factor for energy savings = 0.98

Summer Coincident Peak kW Savings Algorithm

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

Where:

DIE_{Demand} = DEER Interactive Effects Factor for energy savings = 1.24

CDF = Coincident Diversity Factor for peak demand = 0.7.

The difference in the realization rate for the energy and demand savings at the site was due to Navigant's inclusion of DEER 2016 HVAC interactive factors and coincident demand factors.

2.16 Site 16

2.16.1 Project Summary

The site is a college building with lab areas located in Turlock, California. The project at the site included the installation of VFDs on three exhaust fans. The ex-post realization rate for the energy savings is on the lower side as only two exhaust fans are running at a time with the third fan used as backup. The ex-ante calculations estimated all three fans would be running continuously. The exhaust fans also run for a longer period of time than estimated in the ex-ante calculations.

Table 2-19. First-Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	549,283	235,623	43%
Peak Demand Savings (kW)	0	0	NA

Source: Project Documentation, Navigant Analysis

2.16.2 Exhaust Fan VFDs

2.16.2.1 Description of Baseline Equipment and Operation

The three exhaust fans (LEF-E-7, E-8, and E-9) included in the project serve third floor labs at the site. Project files mention that in the baseline, these fans were running continuously. Baseline air change rate at the site was 14 air changes per hour (ACH), occupied and unoccupied. The labs are occupied 7 days a week, 16 hours a day.

2.16.2.2 Description of Efficient Case Equipment and Operation

The site installed VFDs on all three exhaust fans and modified the control strategy to shut off the bypass damper and possibly an entire fan when the exhaust load is lower. The new air change rate is 9.5 ACH occupied and 7.9 ACH unoccupied. This has resulted in the exhaust fan energy savings as well as energy savings from supply fans and air conditioning. The cooling system at the site operates at a lower load in the efficient case due to reduced cooling demand as a lower volume of outside air is required to be cooled due to lower air changes.

2.16.2.3 Comments on Ex-Ante Calculations

The ex-ante calculations use the measured airflows (pre and post) and a proprietary calculator spreadsheet tool to estimate the energy savings. Navigant's review of the project file shows that there is a discrepancy in the claimed total energy saved from the project. Page 13 in the project files shows a breakdown of the annual energy savings from the occupied and unoccupied period. The total energy savings from the supply fans, exhaust fans, and cooling energy is shown as follows:

Table 2-20. Ex-Ante Aggregate Annual Energy Savings Breakdown

	Energy Savings (kWh)
Cooling Energy	93,752
Supply Fans	122,428
Exhaust Fans	231,231
Total	**447,411**
Claimed Ex-Ante	**549,283**
Difference	**(101,872)**

Source: Project Documentation, Navigant Analysis

Navigant was not able to identify the reason behind this discrepancy. Navigant requested this calculation spreadsheet to confirm the ex-ante calculations.

2.16.3 Onsite Visit

2.16.3.1 M&V Method

Navigant collected the following data during the onsite visit:

- Collected the motor nameplate data for all three exhaust fans
- Collected the spot measurements for power, current, load, and frequency from the VFD control system
- Checked if the site has trending data or can save trending data for the fan energy consumption (or, checked if the site collects the trending data on CFM requirements for the lab)
    - If not, installed the loggers on all three fans and monitor the usage for 2-3 weeks
- Collected the schedule of the labs

2.16.3.2 Summary of Site Visit

Navigant performed a site visit in October 2016. Navigant met with the Director of Facilities and a staff electrician to conduct the site visit. The building consists of a mixture of university science teaching labs, research labs, private offices, and lecture areas. The lab areas have a dedicated exhaust system to withdraw hazardous fumes associated with ongoing experiments. The system operates 24 hours per day. The site contact was unsure if operating parameters such as CFM, differential pressure, etc. are trended.

Project file for this project mention that all three fans were running continuously in the baseline. However, the site contact mentioned that only two of the three exhaust fans run at a time and third fan is kept as a standby in the efficient case as well as in the baseline. Navigant was not able to collect the motor and VFD nameplate data due to accessibility issues. Navigant performed spot measurements and installed loggers on the exhaust fans during the site visit. This information is summarized below:

Table 2-21. Ex-Ante Energy Savings Breakdown

Equipment ID	Drive Status (Auto / Hand)	Speed	Amps	Volts	PF
LEF-E-7	Auto	90.20%	14.1	475	0.99
LEF-E-8	Auto	0	-	475	-
LEF-E-9	Auto	90.20%	14.1	475	0.99

Source: Navigant's onsite data collection

Navigant was not able to access the supply fans for spot measurements or logger installation.

Navigant also tried to obtain the calculation spreadsheet used to estimate the ex-ante energy savings from the site contact and the contractor for the project, but Navigant was not able to obtain the calculation spreadsheet.

2.16.3.3 Ex-Post Calculations and Assumptions

Navigant analyzed the logger data and used the onsite spot measurements to develop the efficient case energy consumption of the exhaust fans. For the baseline energy consumption, Navigant estimated that the exhaust fans would be running at constant peak load in the baseline. Navigant revised the number of fans running from three to two based on the data collected during the site visit. Navigant's analysis of the logger data shows that the exhaust fans are running at a slightly higher load than estimated in the ex-ante calculations. This has resulted in a lower realization rate for the exhaust fans.

Navigant was not able to install loggers on the supply fans during the site visit. However, supply fan energy savings and cooling energy savings for this project are linearly related with the exhaust energy savings as at this site, the amount of air exhausted is equal to the amount of air supplied in to maintain the positive air pressure in the lab areas. Cooling energy savings is also linearly related to the amount of air supplied in the lab areas. Thus, in the absence of the trending data for the supply fans and actual ex-ante calculation spread, Navigant has conservatively applied the realization rate from the exhaust fans to the supply fans and cooling energy savings. The following table shows the breakdown of ex-ante and ex-post energy savings for the project.

Table 2-22. Ex-Post Aggregate Annual Energy Savings Breakdown

	Ex-Ante Energy Savings (kWh)	Ex-Post Energy Savings (kWh)	Realization Rate
Cooling Energy	93,752	49,373	53%
Supply Fans	122,428	64,475	53%
Exhaust Fans	231,231	121,775	53%
Total	**549,283**[11]	**235,623**	**43%**

Source: Navigant analysis

2.17 Site 17

2.17.1 Project Summary

The site is a gas station located in Turlock, California. The site replaced its old outdoor canopy and parking lot metal halide fixtures with energy efficient LED fixtures.

There are no demand savings for this project because the project included only exterior fixtures. Navigant's analysis determined that the project at the site has achieved a 100% realization rate for the energy savings.

Table 2-23. First-Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	38,679	38,635	100%
Peak Demand Savings (kW)	0	0	NA

Source: Project Documentation, Navigant Analysis

2.17.2 LED Lighting Retrofit

2.17.2.1 Description of Baseline Equipment and Operation

This site is a small gas station. In the baseline, the site had 24 exterior metal halide fixtures. These fixtures were controlled by a photocell.

[11] The total claimed ex-ante energy savings for this project includes additional 101,872 kWh savings. Navigant was not able to identify the reason behind this discrepancy as Navigant was not able to obtain the actual calculator spreadsheet used to estimate the ex-ante energy savings.

2.17.2.2 Description of Efficient Equipment and Operation

The site replaced old metal halide fixtures with new LED fixtures on one-on-one basis. New fixtures are also controlled using a photocell.

2.17.2.3 Comments on Ex-Ante Calculations

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

Energy Savings:
$\Delta kWh = ((WattsBASE – WattsEE) / 1000) \times \text{Annual Operating Hours}$

Where,
ΔkWh: Annual energy saved (in kWh),
WattsBASE: Connected load of the baseline fixtures,
WattsEE: Connected load of energy efficient fixtures.

There are no demand savings associated with this project.

2.17.3 Onsite Visit

2.17.3.1 M&V Method

Navigant collected the following data during the onsite visit:

- Confirmed the wattage and quantity of the fixtures
- Confirmed the control type of the fixtures

2.17.3.2 Summary of Site Visit

Navigant performed an onsite visit in October 2016. Navigant verified the installation of LED lamps, wattage, and fixture count. Navigant also verified that the fixtures are controlled using photocells.

2.17.3.3 Ex-Post Calculations and Assumptions

Navigant used the following algorithm similar to the ex-ante calculations.

Annual Energy Savings Algorithm

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

Where:
$kW_{Baseline}$ = Connected load of baseline fixtures
kW_{EE} = Connected load of LED fixtures
HOURS = Average hours of use per year
DIE_{Energy} = 1.00 for exterior spaces

The ex-post savings used annual hours of use found from the US Naval Observatory. Specifically, Navigant used the dusk-to-dawn hours provided by US Naval Observatory to calculate the operating hours of the fixtures. Navigant's analysis determined that the project at the site has achieved a 100% realization rate for the energy savings. There are no demand savings for this project because the project included only exterior fixtures.

2.18 Site 18

2.18.1 Project Summary

The site is a new construction project for a small retail facility located in Turlock, California. The site reported savings over the current California Energy Code (Title 24) with its energy efficient measures.

Based on the site visit finding and the review of the project files, the Navigant team determined that the EEMs installed at the facility resulted in a 100% realization rate for the energy and demand savings.

Table 2-24. First-Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	27,701	27,701	100%
Peak Demand Savings (kW)	4.3	4.3	100%

Source: Project Documentation, Navigant Analysis

2.18.2 New Construction

2.18.2.1 Description of Baseline Equipment and Operation

The site is a new retail store. The baseline for this project is California Energy Code (Title 24).

2.18.2.2 Description of Efficient Case Equipment and Operation

The site is a new construction project for a small retail facility. The area of the facility is 9,100 sq. ft.

Following are the measures completed at the site:

- Installed a water heater with 95% efficiency
- Installed HVAC units with EER 12
- Added 1" R5 insulation to roof and wall
- Installed cool roof
- Installed LED fixtures
- Installed occupancy sensors to receiving and sales area

2.18.2.3 Comments on Ex-Ante Calculations

The ex-ante savings are calculated using an Energy Pro model. Navigant was not able to obtain the simulation model. However, based on Navigant's past experience with the Energy Pro models and a review of the project files, Navigant believes that the ex-ante calculations are reasonable.

2.18.3 Onsite Visit

2.18.3.1 M&V Method

Navigant performed the following activities for the M&V of this project:

- Confirmed the installation of a new water heater
- Confirmed the installation of new HVAC units and collected the nameplate data
- Attempted to confirm thickness of the insulation at roof and wall
- Confirmed that the cool roof is installed
- Confirmed the installed lighting fixtures and hours of use
- Confirmed the installation of the occupancy sensors at following locations:
    - Break room
    - Men's restroom
    - Women's restroom
    - Office

2.18.3.2 Summary of Site Visit

Navigant performed a site visit in October 2016. Navigant's site visit engineer confirmed the installation of new efficient fluorescent lighting and occupancy sensors. Navigant's engineer was not able to access the roof to confirm the installation of high-efficiency HVAC units and the cool roof. However, since the facility is a new construction, Navigant believes that all the EEMs at the facility are implemented.

2.18.3.3 Ex-Post Calculations and Assumptions

Navigant was not able to obtain the Energy Pro model for the facility. However, based on the site visit findings and the review of the project files, which include input parameters and output of the simulation model, the Navigant team has determined that the EEMs installed at the facility have resulted in a 100% realization rate for the energy and peak demand savings.

2.19 Site 19

2.19.1 Project Summary

The site is a new construction of a religious assembly building located in Turlock, California. The site installed over the code efficient lighting system.

The difference in the realization rate for the energy and demand savings at the site is due to Navigant's inclusion of DEER 2016 HVAC interactive factors and coincident demand factors. The DEER coincidence factor for the religious assembly building type is lower, which has resulted in a lower demand savings realization rate.

Table 2-25. First-Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	10,152	12,185	120%
Peak Demand Savings (kW)	9.2	2.6	29%

Source: Project Documentation, Navigant Analysis

2.19.2 LED Lighting Retrofit

2.19.2.1 Description of Efficient Equipment and Operation

The site is a new construction of religious assembly building located in Turlock, California. The site installed T5, T8, and LED lights throughout the building and added occupancy sensors.

2.19.2.2 Comments on Ex-Ante

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

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

Where,
ΔkWh: Annual energy saved (in kWh),
WattsBASE: Title 24 code baseline
WattsEE: Connected load of energy efficient fixtures.

Demand Savings:
ΔkW = ((WattsBASE – WattsEE) / 1000)

Where,
ΔkW: Peak demand saved (in kW),
WattsBASE: Title 24 code baseline
WattsEE: Connected load of energy efficient fixtures.

The ex-ante calculations do not include HVAC Interactive Effects Factors and coincident demand savings factors as outlined in the Customized Calculated Savings Guidelines for Non Residential Programs, Version 6.0.[12]

2.19.3 Phone Verification

2.19.3.1 M&V Method

Navigant collected the following data during the phone verification:

- Confirmed the wattage and quantity of the fixtures
- Confirmed the operating schedule
- Categorized the fixtures as per the space type (air-conditioned or non-conditioned)

2.19.3.2 Summary of Phone Verification

Navigant was not able to schedule an onsite visit at the site during the October 2016 fieldwork. Navigant performed a phone verification to verify the measure installations at this site. The wattages and fixture count were confirmed along with the building characteristics. The telephone interview supported the information found in the project file review.

2.19.3.3 Ex-Post Calculations and Assumptions

The ex-post calculations used a standard algorithm with phone verification findings to get the energy savings. The modified algorithm uses interactive effects to calculate savings.

Annual Energy Savings Algorithm

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

Where:

$kW_{Baseline}$ = Title 24 code baseline
kW_{EE} = Connected load of efficient fixtures
HOURS = Average hours of use per year
DIE_{Energy} = DEER Interactive Effects Factor for energy savings = 1.04

Summer Coincident Peak kW Savings Algorithm

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

Where:

DIE_{Demand} = DEER Interactive Effects Factor for energy savings = 1.17
CDF = Coincident Diversity Factor for peak demand
= 0.264 for the religious assembly building type.

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

The difference in the realization rate for the energy and demand savings at the site is due to Navigant's inclusion of DEER 2016 HVAC interactive factors and coincident demand factors. The DEER coincidence factor for the religious assembly building type is lower, which has resulted in a lower peak demand savings realization rate.

2.20 Site 20

2.20.1 Project Summary

The site is an industrial facility located in Merced, California that upgraded its existing compressor system to a larger system with variable speed controls. The site installed a new 175 hp variable speed compressor to support the increase in production and save energy consumption.

Navigant estimated that the compressor project at the facility has achieved a 100% realization rate for the energy savings. There are no demand savings associated with this project.

Table 2-26. First-Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	91,908	91,908	100%
Peak Demand Savings (kW)	0	0	NA

Source: Project Documentation, Navigant Analysis

2.20.2 Variable Speed Air Compressor

2.20.2.1 Description of Baseline Equipment and Operation

This site is a labeling company that has recently increased its production and upgraded its air compressor system. The original compressor system at the site included a 150 hp constant speed baseload compressor and a 175 hp constant speed trim compressor.

2.20.2.2 Description of Efficient Equipment and Operation

The site replaced the old constant speed trim compressor with 175 hp variable speed compressor. The facility and the compressed air system at the facility operates 24 hours a day, 5 days a week. However, the trim compressor typically runs only 10 hours a day.

2.20.2.3 Comments on Ex-Ante Calculations

The ex-ante energy and demand savings were calculated using AirMaster + simulation software. Navigant was not able to obtain the energy model used for the ex-ante energy savings estimation. However, Navigant reviewed the inputs used to calibrate the AirMaster + model and overall they look reasonable. Based on Navigant's past experience with the AirMaster + software, Navigant determined that the ex-ante savings are reasonable.

2.20.3 Onsite Visit

2.20.3.1 M&V Method

Navigant collected the following data during the onsite visit:

- Confirmed the installation of the compressor
- Collected nameplate data and current load on the compressor system
- Attempted to install the data logger on the new variable speed compressor or requested trend data

2.20.3.2 Summary of Site Visit

Navigant conducted a site visit in October 2016. The Navigant site visit engineer confirmed that the new variable speed compressor is installed at the site and is operating as expected. Navigant was not able to install the data logger on the compressor to monitor the energy consumption. Trend data for the compressor was also not available at the site. The facility and the compressed air system still operates on a 24/5 schedule.

2.20.3.3 Ex-post Calculations and Assumptions

Navigant was not able to obtain monitoring or trend data for the compressor project at this facility. Navigant reviewed the ex-ante calculations provided in the project files. The Navigant team also performed a sanity check on the ex-ante energy savings using the operating parameters collected during the onsite visit, data provided in the project files, and engineering algorithms. Navigant's savings estimate (99,639 kWh) is slightly higher than the ex-ante energy savings estimate from the AirMaster + model (91,908 kWh). Thus, to be on the conservative side, Navigant determined that the project has achieved a 100% realization rate for the energy savings.

Navigant agrees with the peak demand savings estimation of 0 kW for the variable speed compressor project. During a peak load conditions, variable speed compressors typically consume more energy than a constant speed compressor of the equal size.

2.21 Site 21

2.21.1 Project Summary

The site is a food service distribution center located in Merced, California. The site upgraded lighting throughout the freezer, cooler, and docks. The difference in the realization rate for the energy and peak demand savings at the site is due to Navigant's inclusion of DEER 2016 HVAC interactive factors and coincident demand factors.

Table 2-27. First-Year Project Savings Summary

	Ex-ante	Ex-post	Realization Rate
Energy Savings (kWh/Year)	190,798	260,869	137%
Peak Demand Savings (kW)	24	18.3	76%

Source: Project Documentation, Navigant Analysis

2.21.2 LED Upgrade

2.21.2.1 Description of Baseline Equipment and Operation

In the baseline, the site had high output T5 fixtures in the freezer, cooler and loading dock section. Most of these fixtures were running on 24/7 basis.

2.21.2.2 Description of Efficient Equipment and Operation

The site replaced the T5 fixtures by efficient LED fixtures on a one-to-one basis. The operating hours for the new fixtures are similar to the baseline fixtures. The site added occupancy sensors in the freezer and cooler area to control the LED fixtures.

2.21.2.3 Comments on Ex-Ante Calculations

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

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

Where,
ΔkWh: Annual energy saved (in kWh),
WattsBASE: Connected load of the baseline fixtures,
WattsEE: Connected load of energy efficient fixtures.

Demand Savings:
ΔkW = ((WattsBASE – WattsEE) / 1000)

Where,
ΔkW: Peak demand saved (in kW),
WattsBASE: Connected load of the baseline fixtures,
WattsEE: Connected load of energy efficient fixtures.

The ex-ante calculations do not include HVAC Interactive Effects Factors and coincident demand savings factors as outlined in the Customized Calculated Savings Guidelines for Non Residential Programs, Version 6.0.[13]

2.21.3 Onsite Visit

2.21.3.1 M&V Method

Navigant collected following data during the onsite visit:

- Confirmed the wattage and quantity of the fixtures
- Confirmed the operating schedule
- Categorized and counted the fixtures as per the space type (air-conditioned or non-conditioned)
- Confirmed the installation of occupancy sensors

2.21.3.2 Summary of Site Visit

Navigant performed a site visit in October 2016. Navigant verified the lighting count, occupancy sensors, and operational hours. The fixtures on the loading dock run on a 24/7 basis.

2.21.3.3 Ex-post Calculations and Assumptions

The ex-post calculations used a standard algorithm with onsite findings to get the energy savings. The modified algorithm uses interactive effects to calculate savings.

Annual Energy Savings Algorithm

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

Where:

$kW_{Baseline}$ = Connected load of baseline fixtures
kW_{EE} = Connected load of LED fixtures
HOURS = Average hours of use per year
DIE_{Energy} = DEER Interactive Effects Factor for energy savings = 1.07

Summer Coincident Peak kW Savings Algorithm

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

Where:

DIE_{Demand} = DEER Interactive Effects Factor for energy savings = 1.22
CDF = Coincident Diversity Factor for peak demand
= 0.536 for a warehouse.

The difference in the realization rate for the energy and demand savings at the site is due to Navigant's inclusion of DEER 2016 HVAC interactive factors and coincident demand factors.

---

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

3. 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 3-1 identifies the realization rates by project and the overall stratum weighted program realization rate of 114.0%. This overall energy realization rate is used to estimate the ex-post energy savings by utility.

Table 3-1. Combined Program-Level Electric Gross Energy Ex-Post Savings and Realization Rates

Utility	Ex-ante Savings (kWh)	Project Realization Rate	Ex-post Savings (kWh)	Stratum Weight	Extrapolated Ex-Ante Savings (kWh)	Extrapolated Ex-Post Savings (kWh)	Stratum Weighted Realization Rate
Modesto -1	3,170,159	92.7%	2,939,905	1.640	5,198,166	4,820,615	
Modesto -2	2,679,551	195.1%	5,227,711	1.640	4,393,708	8,571,971	
Modesto -3	1,166,049	104.1%	1,213,740	1.640	1,911,991	1,990,192	
Modesto -4	859,587	80.5%	691,939	1.739	1,494,740	1,203,216	
Modesto -5	935,240	123.6%	1,156,121	1.739	1,626,294	2,010,385	
Modesto -6	734,136	82.7%	607,445	1.739	1,276,593	1,056,289	
Modesto -7	627,872	104.1%	653,552	1.739	1,091,810	1,136,465	
Modesto -8	439,500	95.6%	419,996	1.739	764,249	730,333	
Modesto -9	405,036	104.5%	423,140	1.739	704,319	735,800	
Modesto -10	152,949	100.0%	152,949	17.618	2,694,595	2,694,595	
Modesto -11	18,660	100.0%	18,660	17.618	328,745	328,745	
Modesto -12	15,685	106.0%	16,626	17.618	276,332	292,910	
Turlock -13	962,128	100.0%	962,128	1.640	1,577,618	1,577,618	
Turlock -14	728,184	107.4%	781,845	1.739	1,266,243	1,359,554	
Turlock -15	579,308	98.8%	572,584	1.739	1,007,362	995,669	
Turlock -16	549,283	42.9%	235,623	1.739	955,151	409,726	
Turlock -17	38,679	99.9%	38,635	17.618	681,431	680,656	
Turlock -18	27,701	100.0%	27,701	17.618	488,025	488,025	
Turlock -19	10,152	120.0%	12,185	17.618	178,856	214,671	
Merced -20	91,908	100.0%	91,908	17.618	1,619,199	1,619,199	
Merced -21	190,798	136.7%	260,869	17.618	3,361,404	4,595,887	
TOTAL	**14,382,565**	**114.8%**	**16,505,262**		**32,896,833**	**37,512,524**	**114.0%**

Source: Navigant analysis

Demand savings are not claimed for all projects. For those where demand savings are claimed, the project and program realization rates are calculated in the same manner as the energy savings. Table 3-2 provides a summary of these realization rates. The overall program demand stratum weighted realization rate is 112.4%. This overall energy realization rate is used to estimate the ex-post energy savings by utility.

Table 3-2. Demand Realization Rates by Project

Utility	Ex-ante Peak Demand (kW)	Project Realization Rate	Ex-post Peak Demand (kW)	Stratum Weight	Extrapolated Ex-Ante Peak Demand (kW)	Extrapolated Ex-Post Peak Demand (kW)	Stratum Weighted Realization Rate
Modesto -1	361	98.3%	355	1.640	592	582	
Modesto -2	306	209.1%	640	1.640	502	1,049	
Modesto -3	132	63.9%	85	1.640	217	139	
Modesto -4	98	83.0%	81	1.739	171	142	
Modesto -5	0	NA	0	1.739	0	0	
Modesto -6	0	NA	0	1.739	0	0	
Modesto -7	74	64.4%NA	0	1.739	0	0	
Modesto -8	41	168.1%	69	1.739	71	119	
Modesto -9	0	NA	0	1.739	0	0	
Modesto -10	0	NA	0	17.618	0	0	
Modesto -11	0	NA	0	17.618	0	0	
Modesto -12	2	105.0%	3	17.618	44	46	
Turlock -13	110	100.0%	110	1.640	180	180	
Turlock -14	83	111.7%	93	1.739	145	161	
Turlock -15	151	87.5%	132	1.739	263	230	
Turlock -16	0	NA	0	1.739	0	0	
Turlock -17	0	NA	0	17.618	0	0	
Turlock -18	4	100.0%	4	17.618	76	76	
Turlock -19	9	28.1%	3	17.618	163	46	
Merced -20	0	NA	0	17.618	0	0	
Merced -21	24	76.3%	18	17.618	423	322	
TOTAL	**1,396**	**117.4%**	**1,639**		**2,973**	**3,174**	**106.8%**

Source: Navigant analysis

Table 3-3 summarizes the program-level ex-ante and ex-post energy and peak demand estimates for the sites sampled, controlling for stratum weights.

Table 3-3. Program-Level Electric Gross Energy and Demand Ex-Post Savings

Utility	Sample Gross Ex-ante Savings (kWh)	Strata Weighted Energy Realization Rate	Sample Gross Ex-post Savings (kWh)	Sample Gross Ex-ante Peak Demand (kW)	Strata Weighted Peak Demand Realization Rate	Sample Gross Ex-post Peak Demand (kW)
TOTAL	**32,896,833**	**114.0%**	**37,512,524**	**2,973**	**106.8%**	**3,174**

Source: Navigant analysis

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

The Navigant team did not conduct primary research into net-to-gross effects. Rather, the values used by each utility within their respective E3 model submittals are utilized, as presented in Table 3-4.

Table 3-4. Program-Level Gross and Net Energy and Demand Ex-Post Savings

Utility	Gross Program Ex-Post Savings (kWh)	Gross Program Ex-Post Peak Demand (kW)	Net-to-Gross Ratio	Net Program Ex-Post Savings (kWh)	Net Program Ex-Post Peak Demand (kW)
Modesto	27,830,053	3,664	70.5%	19,610,535	2,582
Turlock	6,535,209	1,020	70.2%	4,584,873	716
Merced	3,147,262	0	64.4%	2,027,404	0
TOTAL	**37,512,524**	**4,684**	**69.9%**	**26,222,811**	**3,298**

Source: Navigant analysis

4. EUL AND 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 4-1 identifies the gross and net lifecycle energy savings by utility.

Table 4-1. 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	27,830,053	19,610,535	12.5	347,372,296	278,996,511
Turlock	6,535,209	4,584,873	13.0	84,949,447	67,959,557
Merced	3,147,262	2,027,404	8.8	27,541,759	20,227,363
TOTAL	**37,512,524**	**26,222,811**	**12.3**	**459,863,502**	**367,183,431**

Source: Navigant analysis

5. PROGRAM RECOMMENDATIONS

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

Include the Coincident Demand Diversity Factor and HVAC Interactive Factors while calculating the energy and the demand savings for the lighting projects. Consistent with the Navigant team's recommendation from the program year (FY) 2013 evaluation, Navigant recommends that the Coincident Demand Diversity Factor and the Database for Energy Efficiency Resources (DEER) Interactive Effects Factors should be used while calculating the energy and the demand savings for the lighting projects implemented in the conditioned spaces. These factors are outlined in the Customized Calculated Savings Guidelines for Non-Residential Programs, Version 6.0.[14] The Coincident Demand Diversity Factor provides a probability that the light affected by the project will be on during the facility's peak demand period. Coincident Diversity Factor for peak demand is based on the project's technology (CFL, Non-CFL, or LED Exit Sign), building type, and climate zone. These factors are documented in the Database for Energy Efficiency Resources and are only applicable for indoor lighting. Also, by reducing the lighting load in the air-conditioned areas, the load on the HVAC system is lowered, and this effect must be quantified using the HVAC Interactive Factors.

Provide additional quality control for the ex-ante savings calculations. At site 16, the ex-ante calculations use the measured airflows (pre and post) and a proprietary calculator spreadsheet tool to estimate the energy savings. Navigant's review of the project file shows that there is a discrepancy in the claimed total energy saved from the project. Page 13 in the project files shows a breakdown of the annual energy savings from the occupied and unoccupied period. The total energy savings from the supply fans, exhaust fans, and cooling energy is shown as follows:

Table 5-1. Ex-Ante Aggregate Annual Energy Savings Breakdown

	Energy Savings (kWh)
Cooling Energy	93,752
Supply Fans	122,428
Exhaust Fans	231,231
Total	**447,411**
Claimed Ex-Ante	**549,283**
Difference	**(101,872)**

Source: Project Documentation, Navigant Analysis

Navigant was not able to identify the reason behind this discrepancy. Navigant did attempt to obtain the original calculation spreadsheet from the contractor for the project, but was not able to obtain it.

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

Navigant recommends adding a layer of quality control to filter out such errors. Additionally, if there is indeed a reason to revise the savings from 447,411 kWh to 549,283 kWh, final project files should also reflect these revised savings.

Collect the calculation spreadsheet used to estimate the ex-ante savings. Navigant recommends collecting all the calculation spreadsheet or simulation models used to calculate the ex-ante savings. It is easier for utilities to ask for and collect these documents at the time of the rebate processing. It is difficult for an independent third-party evaluator who is visiting the site a year or two later to get hold of such documents at the time of the evaluation. Many times, sites where the projects are implemented do not store these files. Sometimes the site contact who was present at the time of the implementation leaves the company and their new counterpart may not necessarily know about the project. These calculation spreadsheets or models do aid significantly in understanding all the assumptions that went into the ex-ante calculations. The scanned copies of spreadsheets or model inputs/outputs do not provide that level of insight.

However, Navigant does want to acknowledge that the overall collection of these calculation spreadsheets and models has improved in FY 2014-15 from the past evaluation years.

6. PORTFOLIO SUMMARY OF IMPACTS

The combined programs included in the FY 2014 and FY 2015 EM&V for MTM are all from the non-residential sector. The sampled sites comprised 54% of the evaluated ex-ante electric energy savings.

As shown in Table 6-1, the share of evaluated claimed savings to total claimed savings is about 44%. Merced had the lowest share of evaluated to total claimed savings of about 10%. The share for Modesto is about 46%, and for Turlock, about 50%.

Table 6-1. 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	24,405,732	11,204,424	45.9%
Turlock	5,731,091	2,895,435	50.5%
Merced	2,760,010	282,706	10.2%
TOTAL	**32,896,833**	**14,382,565**	**43.7%**

Source: Navigant analysis

6.1 Portfolio-Level Ex-Post Gross and Net Energy Savings by Utility

Table 6-2, Table 6-3, and Table 6-4 summarize the gross and net ex-post electricity savings for FY 2014, and Table 6-5, Table 6-6, and Table 6-7 savings for FY 2015 for Modesto, Turlock, and Merced, respectively. All E3 categories included within each utilities portfolio of program offerings are identified in the tables. The realization rate appropriate for each utility is applied to each of the categories included in the EM&V combined sample. No realization rate is applied to any of the remaining categories. The net-to-gross ratios are taken directly from each utility's E3 filing and represent an average within each E3 category.

Table 6-2. FY 2014 Gross and Net Ex-Post Portfolio-Level Electric Savings – Modesto

Modesto E3 Category	Gross Annual Ex-Ante Energy Savings (kWh)	Energy Savings Realization Rate	Gross Annual Ex-Post Energy Savings (kWh)	Net-to-Gross Ratio	Net Annual Ex-Post Energy Savings (kWh)
Res Clothes Washers	13,640	NA	13,640	0.85	11,594
Res Cooling	87,374	NA	87,374	0.84	73,181
Res Dishwashers	0	NA	0	0.00	0
Res Electronics	6,900	NA	6,900	1.00	6,900
Res Heating	0	NA	0	0.00	0
Res Lighting	126,024	NA	126,024	1.00	126,024
Res Pool Pump	32,421	NA	32,421	0.69	22,370
Res Refrigeration	329,404	NA	329,404	0.75	248,540
Res Shell	171,853	NA	171,853	0.67	115,232
Res Water Heating	6,757	NA	6,757	0.89	5,998
Res Comprehensive	4,220	NA	4,220	0.85	3,572
Non-Res Cooking	0	1.14	0	0.00	0
Non-Res Cooling	346,948	1.14	395,627	0.70	277,558
Non-Res Heating	0	1.14	0	0.00	0
Non-Res Lighting	2,683,603	1.14	3,060,134	0.70	2,149,724
Non-Res Motors	0	1.14	0	0.00	0
Non-Res Pumps	421,004	1.14	480,074	0.70	336,803
Non-Res Refrigeration	1,507,999	1.14	1,719,584	0.72	1,244,451
Non-Res Shell	743,104	1.14	847,367	0.70	594,483
Non-Res Process	1,313,919	1.14	1,498,272	0.70	1,051,135
Non-Res Comprehensive	165,399	1.14	188,606	0.70	132,319
Other	1,166,049	NA	1,166,049	0.80	932,839
TOTAL	**9,126,617**		**10,134,306**	**72.36%**	**7,332,723**

Source: Navigant analysis

Table 6-3. FY 2014 Gross and Net Ex-Post Portfolio-Level Electric Savings – Turlock

Turlock E3 Category	Gross Annual Ex-Ante Energy Savings (kWh)	Energy Savings Realization Rate	Gross Annual Ex-Post Energy Savings (kWh)	Net-to-Gross Ratio	Net Annual Ex-Post Energy Savings (kWh)
Res Clothes Washers	19,388	NA	19,388	0.31	6,010
Res Cooling	19,726	NA	19,726	0.80	15,781
Res Dishwashers	0	NA	0	0.00	0
Res Electronics	0	NA	0	0.00	0
Res Heating	0	NA	0	0.00	0
Res Lighting	8,742	NA	8,742	0.50	4,371
Res Pool Pump	0	NA	0	0.00	0
Res Refrigeration	144,536	NA	144,536	0.70	101,175
Res Shell	4,615,122	NA	4,615,122	0.79	3,667,203
Res Water Heating	0	NA	0	0.00	0
Res Comprehensive	0	NA	0	0.00	0
Non-Res Cooking	0	1.14	0	0.00	0
Non-Res Cooling	0	1.14	0	0.00	0
Non-Res Heating	0	1.14	0	0.00	0
Non-Res Lighting	943,844	1.14	1,076,273	0.70	755,075
Non-Res Motors	0	1.14	0	0.00	0
Non-Res Pumps	0	1.14	0	0.00	0
Non-Res Refrigeration	1,035,042	1.14	1,180,267	0.70	828,034
Non-Res Shell	0	1.14	0	0.00	0
Non-Res Process	895,630	1.14	1,021,294	0.70	716,504
Non-Res Comprehensive	0	1.14	0	0.00	0
Other	0	NA	0	0.00	0
TOTAL	**7,682,029**		**8,085,347**	**75.37%**	**6,094,153**

Source: Navigant analysis

Table 6-4. FY 2014 Gross and Net Ex-Post Portfolio-Level Electric Savings – Merced

Merced E3 Category	Gross Annual Ex-Ante Energy Savings (kWh)	Energy Savings Realization Rate	Gross Annual Ex-Post Energy Savings (kWh)	Net-to-Gross Ratio	Net Annual Ex-Post Energy Savings (kWh)
Res Clothes Washers	1,517	NA	1,517	0.31	470
Res Cooling	186	NA	186	0.80	149
Res Dishwashers	272	NA	272	0.60	163
Res Electronics	0	NA	0	0.00	0
Res Heating	0	NA	0	0.00	0
Res Lighting	0	NA	0	0.00	0
Res Pool Pump	0	NA	0	0.00	0
Res Refrigeration	6,488	NA	6,488	0.70	4,542
Res Shell	1,006	NA	1,006	0.00	282
Res Water Heating	0	NA	0	0.00	0
Res Comprehensive	0	NA	0	0.00	0
Non-Res Cooking	0	1.14	0	0.00	0
Non-Res Cooling	0	1.14	0	0.00	0
Non-Res Heating	0	1.14	0	0.00	0
Non-Res Lighting	2,320,408	1.14	2,645,980	0.64	1,693,427
Non-Res Motors	0	1.14	0	0.00	0
Non-Res Pumps	0	1.14	0	0.00	0
Non-Res Refrigeration	252,201	1.14	287,587	0.64	184,056
Non-Res Shell	0	1.14	0	0.00	0
Non-Res Process	0	1.14	0	0.00	0
Non-Res Comprehensive	0	1.14	0	0.00	0
Other	11,440	NA	11,440	0.64	7,322
TOTAL	**2,593,518**		**2,954,476**	**63.98%**	**1,890,410**

Source: Navigant analysis

Table 6-5. FY 2015 Gross and Net Ex-Post Portfolio-Level Electric Savings – Modesto

Modesto E3 Category	Gross Annual Ex-Ante Energy Savings (kWh)	Energy Savings Realization Rate	Gross Annual Ex-Post Energy Savings (kWh)	Net-to-Gross Ratio	Net Annual Ex-Post Energy Savings (kWh)
Res Clothes Washers	11,470	NA	11,470	0.85	9,750
Res Cooling	107,647	NA	107,647	0.81	87,689
Res Dishwashers	0	NA	0	0.00	0
Res Electronics	6,750	NA	6,750	1.00	6,750
Res Heating	0	NA	0	0.00	0
Res Lighting	110,594	NA	110,594	1.00	110,594
Res Pool Pump	50,397	NA	50,397	0.69	34,774
Res Refrigeration	280,614	NA	280,614	0.73	203,489
Res Shell	184,506	NA	184,506	0.65	119,665
Res Water Heating	6,411	NA	6,411	0.86	5,502
Res Comprehensive	0	NA	0	0.00	0
Non-Res Cooking	0	1.14	0	0.00	0
Non-Res Cooling	1,078,540	1.14	1,229,868	0.70	862,832
Non-Res Heating	0	1.14	0	0.00	0
Non-Res Lighting	3,034,433	1.14	3,460,188	0.70	2,427,538
Non-Res Motors	3,410,406	1.14	3,888,913	0.70	2,728,325
Non-Res Pumps	0	1.14	0	0.00	0
Non-Res Refrigeration	974,092	1.14	1,110,765	0.74	824,338
Non-Res Shell	22,242	1.14	25,363	0.70	17,794
Non-Res Process	8,704,044	1.14	9,925,292	0.70	6,963,235
Non-Res Comprehensive	0	1.14	0	0.00	0
Other	0	NA	0	0.00	0
TOTAL	**17,982,146**		**20,398,778**	**70.60%**	**14,402,274**

Source: Navigant analysis

Table 6-6. FY 2015 Gross and Net Ex-Post Portfolio-Level Electric Savings – Turlock

Turlock E3 Category	Gross Annual Ex-Ante Energy Savings (kWh)	Energy Savings Realization Rate	Gross Annual Ex-Post Energy Savings (kWh)	Net-to-Gross Ratio	Net Annual Ex-Post Energy Savings (kWh)
Res Clothes Washers	12,913	NA	12,913	0.31	4,003
Res Cooling	49,376	NA	49,376	0.50	24,502
Res Dishwashers	0	NA	0	0.00	0
Res Electronics	0	NA	0	0.00	0
Res Heating	0	NA	0	0.00	0
Res Lighting	57,054	NA	57,054	0.51	29,309
Res Pool Pump	0	NA	0	0.00	0
Res Refrigeration	155,036	NA	155,036	0.70	108,541
Res Shell	0	NA	0	0.00	0
Res Water Heating	0	NA	0	0.00	0
Res Comprehensive	2,965,938	NA	2,965,938	1.00	2,965,463
Non-Res Cooking	0	1.14	0	0.00	0
Non-Res Cooling	0	1.14	0	0.00	0
Non-Res Heating	0	1.14	0	0.00	0
Non-Res Lighting	2,477,929	1.14	2,825,602	0.70	1,982,343
Non-Res Motors	0	1.14	0	0.00	0
Non-Res Pumps	0	1.14	0	0.00	0
Non-Res Refrigeration	0	1.14	0	0.00	0
Non-Res Shell	227,704	1.14	259,653	0.70	182,164
Non-Res Process	150,942	1.14	172,120	0.70	120,753
Non-Res Comprehensive	0	1.14	0	0.00	0
Other	0	NA	0	0.00	0
TOTAL	**6,096,891**		**6,497,692**	**83.37%**	**5,417,078**

Source: Navigant analysis

Table 6-7. FY 2015 Gross and Net Ex-Post Portfolio-Level Electric Savings – Merced

Merced E3 Category	Gross Annual Ex-Ante Energy Savings (kWh)	Energy Savings Realization Rate	Gross Annual Ex-Post Energy Savings (kWh)	Net-to-Gross Ratio	Net Annual Ex-Post Energy Savings (kWh)
Res Clothes Washers	5,520	NA	5,520	0.31	1,711
Res Cooling	94	NA	94	0.80	75
Res Dishwashers	572	NA	572	0.60	343
Res Electronics	0	NA	0	0.00	0
Res Heating	0	NA	0	0.00	0
Res Lighting	0	NA	0	0.00	0
Res Pool Pump	0	NA	0	0.00	0
Res Refrigeration	5,828	NA	5,828	0.70	4,080
Res Shell	0	NA	0	0.00	0
Res Water Heating	0	NA	0	0.00	0
Res Comprehensive	0	NA	0	0.00	0
Non-Res Cooking	0	1.14	0	0.00	0
Non-Res Cooling	0	1.14	0	0.00	0
Non-Res Heating	0	1.14	0	0.00	0
Non-Res Lighting	19,447	1.14	22,176	0.70	15,558
Non-Res Motors	0	1.14	0	0.00	0
Non-Res Pumps	0	1.14	0	0.00	0
Non-Res Refrigeration	0	1.14	0	0.00	0
Non-Res Shell	0	1.14	0	0.00	0
Non-Res Process	91,908	1.14	104,803	0.70	73,526
Non-Res Comprehensive	76,046	1.14	86,716	0.70	60,837
Other	0	NA	0	0.00	0
TOTAL	**199,415**		**225,709**	**69.17%**	**156,130**

Source: Navigant analysis

Table 6-8, Table 6-9, and Table 6-10 summarize FY 2014, and Table 6-11, Table 6-12, and Table 6-13 summarize FY 2015 gross and net ex-post coincident peak demand savings for Modesto, Turlock, and Merced, respectively. The demand realization rate for each utility 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.

Table 6-8. FY 2014 Gross and Net Ex-Post Portfolio-Level Coincident Peak Demand Savings – Modesto

Modesto E3 Category	Gross Ex-Ante Coincident Peak Demand (kW)	Demand Realization Rate	Gross Ex-Post Coincident Peak Demand (kW)	Net-to-Gross Ratio	Net Ex-Post Coincident Peak Demand (kW)
Res Clothes Washers	34.98	NA	34.98	0.85	29.73
Res Cooling	103.32	NA	103.32	0.84	86.54
Res Dishwashers	0.00	NA	0.00	0.00	0.00
Res Electronics	0.00	NA	0.00	1.00	0.00
Res Heating	0.00	NA	0.00	0.00	0.00
Res Lighting	11.73	NA	11.73	1.00	11.73
Res Pool Pump	7.98	NA	7.98	0.69	5.51
Res Refrigeration	39.54	NA	39.54	0.75	29.84
Res Shell	265.50	NA	265.50	0.67	178.03
Res Water Heating	0.18	NA	0.18	0.89	0.16
Res Comprehensive	0.00	NA	0.00	0.85	0.00
Non-Res Cooking	0.00	1.07	0.00	0.00	0.00
Non-Res Cooling	37.76	1.07	40.32	0.70	28.29
Non-Res Heating	0.00	1.07	0.00	0.00	0.00
Non-Res Lighting	388.13	1.07	414.42	0.70	291.13
Non-Res Motors	0.00	1.07	0.00	0.00	0.00
Non-Res Pumps	45.52	1.07	48.60	0.70	34.10
Non-Res Refrigeration	200.09	1.07	213.65	0.72	154.62
Non-Res Shell	82.40	1.07	87.98	0.70	61.73
Non-Res Process	175.75	1.07	187.66	0.70	131.66
Non-Res Comprehensive	355.15	1.07	379.21	0.70	266.04
Other	99.86	NA	99.86	0.80	79.89
TOTAL	**1,847.89**		**1,934.94**	**71.78%**	**1,388.97**

Source: Navigant analysis

Table 6-9. FY 2014 Gross and Net Ex-Post Portfolio-Level Coincident Peak Demand Savings – Turlock

Turlock E3 Category	Gross Ex-Ante Coincident Peak Demand (kW)	Demand Realization Rate	Gross Ex-Post Coincident Peak Demand (kW)	Net-to-Gross Ratio	Net Ex-Post Coincident Peak Demand (kW)
Res Clothes Washers	0.00	NA	0.00	0.31	0.00
Res Cooling	6.80	NA	6.80	0.80	5.44
Res Dishwashers	0.00	NA	0.00	0.00	0.00
Res Electronics	0.00	NA	0.00	0.00	0.00
Res Heating	0.00	NA	0.00	0.00	0.00
Res Lighting	1.62	NA	1.62	0.50	0.81
Res Pool Pump	0.00	NA	0.00	0.00	0.00
Res Refrigeration	13.76	NA	13.76	0.70	9.63
Res Shell	7.18	NA	7.18	0.79	5.71
Res Water Heating	0.00	NA	0.00	0.00	0.00
Res Comprehensive	0.00	NA	0.00	0.00	0.00
Non-Res Cooking	0.00	1.07	0.00	0.00	0.00
Non-Res Cooling	0.00	1.07	0.00	0.00	0.00
Non-Res Heating	0.00	1.07	0.00	0.00	0.00
Non-Res Lighting	218.17	1.07	232.95	0.70	163.43
Non-Res Motors	0.00	1.07	0.00	0.00	0.00
Non-Res Pumps	0.00	1.07	0.00	0.00	0.00
Non-Res Refrigeration	112.24	1.07	119.84	0.70	84.08
Non-Res Shell	0.00	1.07	0.00	0.00	0.00
Non-Res Process	80.30	1.07	85.74	0.70	60.15
Non-Res Comprehensive	0.00	1.07	0.00	0.00	0.00
Other	0.00	NA	0.00	0.00	0.00
TOTAL	**440.08**		**467.91**	**70.37%**	**329.26**

Source: Navigant analysis

Table 6-10. FY 2014 Gross and Net Ex-Post Portfolio-Level Coincident Peak Demand Savings – Merced

Merced E3 Category	Gross Ex-Ante Coincident Peak Demand (kW)	Demand Realization Rate	Gross Ex-Post Coincident Peak Demand (kW)	Net-to-Gross Ratio	Net Ex-Post Coincident Peak Demand (kW)
Res Clothes Washers	0.00	NA	0.00	0.31	0.00
Res Cooling	0.19	NA	0.19	0.80	0.15
Res Dishwashers	0.00	NA	0.00	0.60	0.00
Res Electronics	0.00	NA	0.00	0.00	0.00
Res Heating	0.00	NA	0.00	0.00	0.00
Res Lighting	0.00	NA	0.00	0.00	0.00
Res Pool Pump	0.00	NA	0.00	0.00	0.00
Res Refrigeration	0.37	NA	0.37	0.70	0.26
Res Shell	0.00	NA	0.00	0.00	0.04
Res Water Heating	0.00	NA	0.00	0.00	0.00
Res Comprehensive	0.00	NA	0.00	0.00	0.00
Non-Res Cooking	0.00	1.07	0.00	0.00	0.00
Non-Res Cooling	0.00	1.07	0.00	0.00	0.00
Non-Res Heating	0.00	1.07	0.00	0.00	0.00
Non-Res Lighting	0.00	1.07	0.00	0.64	0.00
Non-Res Motors	0.00	1.07	0.00	0.00	0.00
Non-Res Pumps	0.00	1.07	0.00	0.00	0.00
Non-Res Refrigeration	0.00	1.07	0.00	0.64	0.00
Non-Res Shell	0.00	1.07	0.00	0.00	0.00
Non-Res Process	0.00	1.07	0.00	0.00	0.00
Non-Res Comprehensive	0.00	1.07	0.00	0.00	0.00
Other	0.00	NA	0.00	0.64	0.00
TOTAL	**0.56**		**0.56**	**80.26%**	**0.45**

Source: Navigant analysis

Table 6-11. FY 2015 Gross and Net Ex-Post Portfolio-Level Coincident Peak Demand Savings – Modesto

Modesto E3 Category	Gross Ex-Ante Coincident Peak Demand (kW)	Demand Realization Rate	Gross Ex-Post Coincident Peak Demand (kW)	Net-to-Gross Ratio	Net Ex-Post Coincident Peak Demand (kW)
Res Clothes Washers	29	NA	29.4	0.9	25.0
Res Cooling	129	NA	129.0	0.82	106.1
Res Dishwashers	0	NA	0.0	0.00	0.0
Res Electronics	0	NA	0.0	0.00	0.0
Res Heating	0	NA	0.0	0.00	0.0
Res Lighting	4	NA	4.5	1.00	4.5
Res Pool Pump	12	NA	12.4	0.69	8.6
Res Refrigeration	45	NA	44.7	0.63	28.2
Res Shell	238	NA	237.9	0.67	160.4
Res Water Heating	0	NA	0.2	0.83	0.1
Res Comprehensive	0	NA	0.0	0.00	0.0
Non-Res Cooking	0	1.07	0.0	0.00	0.0
Non-Res Cooling	115	1.07	122.7	0.75	91.9
Non-Res Heating	0	1.07	0.0	0.00	0.0
Non-Res Lighting	560	1.07	597.8	0.75	447.9
Non-Res Motors	689	1.07	735.7	0.75	551.2
Non-Res Pumps	0	1.07	0.0	0.00	0.0
Non-Res Refrigeration	51	1.07	54.1	0.80	43.1
Non-Res Shell	0	1.07	0.0	0.00	0.0
Non-Res Process	732	1.07	782.0	0.75	585.9
Non-Res Comprehensive	0	1.07	0.0	0.00	0.0
Other	0	NA	0	0.00	0
TOTAL	**2,605**		**2,750.3**	**0.75**	**2,052.9**

Source: Navigant analysis

Table 6-12. FY 2015 Gross and Net Ex-Post Portfolio-Level Coincident Peak Demand Savings – Turlock

Turlock E3 Category	Gross Ex-Ante Coincident Peak Demand (kW)	Demand Realization Rate	Gross Ex-Post Coincident Peak Demand (kW)	Net-to-Gross Ratio	Net Ex-Post Coincident Peak Demand (kW)
Res Clothes Washers	0.00	NA	0.00	0.00	0.00
Res Cooling	20.74	NA	20.74	0.46	9.64
Res Dishwashers	0.00	NA	0.00	0.00	0.00
Res Electronics	0.00	NA	0.00	0.00	0.00
Res Heating	0.00	NA	0.00	0.00	0.00
Res Lighting	0.00	NA	0.00	0.00	0.00
Res Pool Pump	0.00	NA	0.00	0.00	0.00
Res Refrigeration	22.20	NA	22.20	0.70	15.54
Res Shell	0.00	NA	0.00	0.00	0.00
Res Water Heating	0.00	NA	0.00	0.00	0.00
Res Comprehensive	0.00	NA	0.00	0.00	0.00
Non-Res Cooking	0.00	1.07	0.00	0.00	0.00
Non-Res Cooling	0.00	1.07	0.00	0.00	0.00
Non-Res Heating	0.00	1.07	0.00	0.00	0.00
Non-Res Lighting	391.90	1.07	418.45	0.80	334.76
Non-Res Motors	0.00	1.07	0.00	0.00	0.00
Non-Res Pumps	0.00	1.07	0.00	0.00	0.00
Non-Res Refrigeration	0.00	1.07	0.00	0.00	0.00
Non-Res Shell	142.40	1.07	152.05	0.80	121.64
Non-Res Process	10.41	1.07	11.12	0.80	8.89
Non-Res Comprehensive	0.00	1.07	0.00	0.00	0.00
Other	0.00	NA	0.00	0.00	0.00
TOTAL	**587.65**		**624.55**	**78.53%**	**490.47**

Source: Navigant analysis

Table 6-13. FY 2015 Gross and Net Ex-Post Portfolio-Level Coincident Peak Demand Savings – Merced

Merced E3 Category	Gross Ex-Ante Coincident Peak Demand (kW)	Demand Realization Rate	Gross Ex-Post Coincident Peak Demand (kW)	Net-to-Gross Ratio	Net Ex-Post Coincident Peak Demand (kW)
Res Clothes Washers	0.00	NA	0.00	0.00	0.00
Res Cooling	0.06	NA	0.06	0.80	0.05
Res Dishwashers	0.00	NA	0.00	0.00	0.00
Res Electronics	0.00	NA	0.00	0.00	0.00
Res Heating	0.00	NA	0.00	0.00	0.00
Res Lighting	0.00	NA	0.00	0.00	0.00
Res Pool Pump	0.00	NA	0.00	0.00	0.00
Res Refrigeration	0.50	NA	0.50	0.70	0.35
Res Shell	0.00	NA	0.00	0.00	0.00
Res Water Heating	0.00	NA	0.00	0.00	0.00
Res Comprehensive	0.00	1.07	0.00	0.00	0.00
Non-Res Cooking	0.00	1.07	0.00	0.00	0.00
Non-Res Cooling	0.00	1.07	0.00	0.00	0.00
Non-Res Heating	0.00	1.07	0.00	0.00	0.00
Non-Res Lighting	0.00	1.07	0.00	0.00	0.00
Non-Res Motors	0.00	1.07	0.00	0.00	0.00
Non-Res Pumps	0.00	1.07	0.00	0.00	0.00
Non-Res Refrigeration	0.00	1.07	0.00	0.00	0.00
Non-Res Shell	0.00	1.07	0.00	0.00	0.00
Non-Res Process	0.00	1.07	0.00	0.00	0.00
Non-Res Comprehensive	0.00	1.07	0.00	0.00	0.00
Other	0	NA	0	0.00	0
TOTAL	**0.56**		**0.56**	**71.08%**	**0.40**

Source: Navigant analysis

6.2 Portfolio-Level EUL and Lifecycle Savings by Utility

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 are a weighted average (weighted by energy savings) of the measures included within each program. Table 6-14, Table 6-15, and Table 6-16 summarize FY 2014 and Table 6-17, Table 6-18, and Table 6-19 summarizes the FY 2015 gross and net ex-post lifecycle energy savings for each program by utility for Modesto, Turlock, and Merced, respectively.

Table 6-14. FY 2014 Gross and Net Ex-Post Portfolio-Level Lifecycle Energy Savings – Modesto

Modesto E3 Category	Gross Annual Ex-Ante Energy Savings (kWh)	Net Annual Ex-Post Energy Savings (kWh)	Average Measure Life	Gross Lifecycle Ex-Post Energy Savings (kWh)	Net Lifecycle Ex-Post Energy Savings (kWh)
Res Clothes Washers	13,640	11,594	12.0	163,680	139,128
Res Cooling	87,374	73,181	17.7	1,547,998	1,296,544
Res Dishwashers	0	0	0.0	0	0
Res Electronics	6,900	6,900	15.0	103,500	103,500
Res Heating	0	0	0.0	0	0
Res Lighting	126,024	126,024	6.6	826,730	826,730
Res Pool Pump	32,421	22,370	10.0	324,210	223,705
Res Refrigeration	329,404	248,540	9.3	3,072,188	2,318,005
Res Shell	171,853	115,232	17.5	3,001,188	2,012,374
Res Water Heating	6,757	5,998	12.2	82,300	73,054
Res Comprehensive	4,220	3,572	15.0	63,300	53,585
Non-Res Cooking	0	0	0.0	0	0
Non-Res Cooling	346,948	277,558	15.0	5,204,213	4,163,370
Non-Res Heating	0	0	0.0	0	0
Non-Res Lighting	2,683,603	2,149,724	12.9	34,586,481	27,705,804
Non-Res Motors	0	0	0.0	0	0
Non-Res Pumps	421,004	336,803	15.0	6,315,060	5,052,048
Non-Res Refrigeration	1,507,999	1,244,451	11.5	17,359,259	14,325,438
Non-Res Shell	743,104	594,483	14.9	11,041,195	8,832,956
Non-Res Process	1,313,919	1,051,135	15.0	19,708,785	15,767,028
Non-Res Comprehensive	165,399	132,319	15.0	2,480,985	1,984,788
Other	1,166,049	932,839	15.0	17,490,735	13,992,588
TOTAL	**9,126,617**	**7,332,723**	**13.5**	**123,371,807**	**98,870,645**

Source: Navigant analysis

Table 6-15. FY 2014 Gross and Net Ex-Post Portfolio-Level Lifecycle Energy Savings – Turlock

Turlock E3 Category	Gross Annual Ex-Ante Energy Savings (kWh))	Net Annual Ex-Post Energy Savings (kWh)	Average Measure Life	Gross Lifecycle Ex-Post Energy Savings (kWh)	Net Lifecycle Ex-Post Energy Savings (kWh)
Res Clothes Washers	19,388	6,010	11.0	213,268	66,113
Res Cooling	19,726	15,781	27.6	543,564	434,851
Res Dishwashers	0	0	0.0	0	0
Res Electronics	0	0	0.0	0	0
Res Heating	0	0	0.0	0	0
Res Lighting	8,742	4,371	5.0	43,710	21,855
Res Pool Pump	0	0	0.0	0	0
Res Refrigeration	144,536	101,175	8.1	1,174,615	822,230
Res Shell	4,615,122	3,667,203	1.1	4,905,647	3,898,056
Res Water Heating	0	0	0.0	0	0
Res Comprehensive	0	0	0.0	0	0
Non-Res Cooking	0	0	0.0	0	0
Non-Res Cooling	0	0	0.0	0	0
Non-Res Heating	0	0	0.0	0	0
Non-Res Lighting	943,844	755,075	16.0	15,101,504	12,081,203
Non-Res Motors	0	0	0.0	0	0
Non-Res Pumps	0	0	0.0	0	0
Non-Res Refrigeration	1,035,042	828,034	14.7	15,236,588	12,189,270
Non-Res Shell	0	0	0.0	0	0
Non-Res Process	895,630	716,504	10.9	9,794,864	7,835,891
Non-Res Comprehensive	0	0	0.0	0	0
Other			0.0		
TOTAL	**7,682,029**	**6,094,153**	**6.1**	**47,013,760**	**37,349,471**

Source: Navigant analysis

Table 6-16. FY 2014 Gross and Net Ex-Post Portfolio-Level Lifecycle Energy Savings – Merced

Merced E3 Category	Gross Annual Ex-Ante Energy Savings (kWh))	Net Annual Ex-Post Energy Savings (kWh)	Average Measure Life	Gross Lifecycle Ex-Post Energy Savings (kWh)	Net Lifecycle Ex-Post Energy Savings (kWh)
Res Clothes Washers	1,517	470	11.0	16,687	5,173
Res Cooling	186	149	15.0	2,790	2,232
Res Dishwashers	272	163	10.0	2,720	1,632
Res Electronics	0	0	0.0	0	0
Res Heating	0	0	0.0	0	0
Res Lighting	0	0	0.0	0	0
Res Pool Pump	0	0	0.0	0	0
Res Refrigeration	6,488	4,542	11.4	74,200	51,940
Res Shell	1,006	282	18.5	18,610	5,211
Res Water Heating	0	0	0.0	0	0
Res Comprehensive	0	0	0.0	0	0
Non-Res Cooking	0	0	0.0	0	0
Non-Res Cooling	0	0	0.0	0	0
Non-Res Heating	0	0	0.0	0	0
Non-Res Lighting	2,320,408	1,693,427	10.0	23,204,080	16,934,272
Non-Res Motors	0	0	0.0	0	0
Non-Res Pumps	0	0	0.0	0	0
Non-Res Refrigeration	252,201	184,056	10.0	2,522,010	1,840,556
Non-Res Shell	0	0	0.0	0	0
Non-Res Process	0	0	0.0	0	0
Non-Res Comprehensive	0	0	0.0	0	0
Other	11,440	7,322	10.0	114,400	73,216
TOTAL	**2,593,518**	**1,890,410**	**10.0**	**25,955,497**	**18,914,231**

Source: Navigant analysis

Table 6-17. FY 2015 Gross and Net Ex-Post Portfolio-Level Lifecycle Energy Savings – Modesto

Modesto E3 Category	Gross Annual Ex-Ante Energy Savings (kWh))	Net Annual Ex-Post Energy Savings (kWh)	Average Measure Life	Gross Lifecycle Ex-Post Energy Savings (kWh)	Net Lifecycle Ex-Post Energy Savings (kWh)
Res Clothes Washers	11,470	9,750	12.0	137,640	116,994
Res Cooling	107,647	87,689	17.5	1,885,908	1,536,264
Res Dishwashers	0	0	0.0	0	0
Res Electronics	6,750	6,750	15.0	101,250	101,250
Res Heating	0	0	0.0	0	0
Res Lighting	110,594	110,594	6.8	756,372	756,372
Res Pool Pump	50,397	34,774	10.0	503,970	347,739
Res Refrigeration	280,614	203,489	9.5	2,660,434	1,929,227
Res Shell	184,506	119,665	16.2	2,995,198	1,942,588
Res Water Heating	6,411	5,502	12.0	77,070	66,148
Res Comprehensive	0	0	0.0	0	0
Non-Res Cooking	0	0	0.0	0	0
Non-Res Cooling	1,078,540	862,832	15.0	16,178,100	12,942,480
Non-Res Heating	0	0	0.0	0	0
Non-Res Lighting	3,034,433	2,427,538	12.9	39,068,169	31,254,431
Non-Res Motors	3,410,406	2,728,325	15.0	51,156,090	40,924,872
Non-Res Pumps	0	0	0.0	0	0
Non-Res Refrigeration	974,092	824,338	13.8	13,490,876	11,416,829
Non-Res Shell	22,242	17,794	10.0	222,423	177,938
Non-Res Process	8,704,044	6,963,235	15.0	130,560,660	104,448,528
Non-Res Comprehensive	0	0	10.0	0	0
Other	0	NA	0	0.00	0
TOTAL	**17,982,146**	**14,402,274**	**14.4**	**259,794,161**	**207,961,661**

Source: Navigant analysis

Table 6-18. FY 2015 Gross and Net Ex-Post Portfolio-Level Lifecycle Energy Savings – Turlock

Turlock E3 Category	Gross Annual Ex-Ante Energy Savings (kWh))	Net Annual Ex-Post Energy Savings (kWh)	Average Measure Life	Gross Lifecycle Ex-Post Energy Savings (kWh)	Net Lifecycle Ex-Post Energy Savings (kWh)
Res Clothes Washers	12,913	4,003	11.0	142,043	44,033
Res Cooling	49,376	24,502	20.8	1,024,706	508,488
Res Dishwashers	0	0	0.0	0	0
Res Electronics	0	0	0.0	0	0
Res Heating	0	0	0.0	0	0
Res Lighting	57,054	29,309	8.4	480,750	246,964
Res Pool Pump	0	0	0.0	0	0
Res Refrigeration	155,036	108,541	7.2	1,111,132	777,904
Res Shell	0	0	0.0	0	0
Res Water Heating	0	0	0.0	0	0
Res Comprehensive	2,965,938	2,965,463	1.0	2,975,429	2,974,952
Non-Res Cooking	0	0	0.0	0	0
Non-Res Cooling	0	0	0.0	0	0
Non-Res Heating	0	0	0.0	0	0
Non-Res Lighting	2,477,929	1,982,343	16.0	39,626,813	31,701,450
Non-Res Motors	0	0	0.0	0	0
Non-Res Pumps	0	0	0.0	0	0
Non-Res Refrigeration	0	0	0.0	0	0
Non-Res Shell	227,704	182,164	15.1	3,433,161	2,746,529
Non-Res Process	150,942	120,753	11.6	1,756,517	1,405,214
Non-Res Comprehensive	0	0	0.0	0	0
Other	0	0	0	0	0
TOTAL	**6,096,891**	**5,417,078**	**8.3**	**50,550,550**	**40,405,534**

Source: Navigant analysis

Table 6-19. FY 2015 Gross and Net Ex-Post Portfolio-Level Lifecycle Energy Savings – Merced

Merced E3 Category	Gross Annual Ex-Ante Energy Savings (kWh)	Net Annual Ex-post Energy Savings (kWh)	Average Measure Life	Gross Lifecycle Ex-post Energy Savings (kWh)	Net Lifecycle Ex-post Energy Savings (kWh)
Res Clothes Washers	5,520	1,711	11.0	60,720	18,823
Res Cooling	94	75	15.0	1,410	1,128
Res Dishwashers	572	343	10.0	5,720	3,432
Res Electronics	0	0	0.0	0	0
Res Heating	0	0	0.0	0	0
Res Lighting	0	0	0.0	0	0
Res Pool Pump	0	0	0.0	0	0
Res Refrigeration	5,828	4,080	10.2	59,416	41,591
Res Shell	0	0	0.0	0	0
Res Water Heating	0	0	0.0	0	0
Res Comprehensive	0	0	0.0	0	0
Non-Res Cooking	0	0	0.0	0	0
Non-Res Cooling	0	0	0.0	0	0
Non-Res Heating	0	0	0.0	0	0
Non-Res Lighting	19,447	15,558	7.0	136,129	108,903
Non-Res Motors	0	0	0.0	0	0
Non-Res Pumps	0	0	0.0	0	0
Non-Res Refrigeration	0	0	0.0	0	0
Non-Res Shell	0	0	0.0	0	0
Non-Res Process	91,908	73,526	10.0	919,080	735,264
Non-Res Comprehensive	76,046	60,837	10.0	760,460	608,368
Other	0	0	10.0	0	0
TOTAL	**199,415**	**156,130**	**9.7**	**1,942,935**	**1,517,510**

Source: Navigant analysis