EVALUATION, VERIFICATION, AND MEASUREMENT STUDY

FY 2008 PROGRAM

For Turlock Irrigation District

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CONSULTING, LLC

Submitted to: Turlock Irrigation District

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1 INTRODUCTION

Two legislative bills (SB1037 and AB2021) were signed into law a year apart. SB1037 requires that the Publically Owned Utilities (POUs), similar to the Investor Owned Utilities (IOUs), place cost effective, reliable, and feasible energy efficiency and demand reduction resources at the top of the loading order. Additionally, SB1037 (signed September 29, 2005) requires an annual report that describes the programs, expenditures, expected energy savings, and actual energy savings.

Assembly Bill 2021, signed by the Governor a year later (September 29, 2006), reiterated the loading order and annual report stated in SB1037 as well as expanding on the annual report requirements. The expanded report must include investment funding, cost-effectiveness methodologies, and an independent evaluation that measures and verifies the energy efficiency savings and reductions in energy demand achieved by the energy efficiency and demand reduction programs. AB2021 additionally requires a report every three years that highlights cost-effective electrical and natural gas potential savings from energy efficiency and established annual targets for energy efficiency and demand reduction over 10 years.

The legislative reports require both an on-going assessment of what is occurring within the programs along with a comparison of how much possible savings are left within the POU service territory. The goal of this 2008 energy efficiency program plan is to assist Turlock Irrigation District (TID) to meet these requirements.

1.1 General Utility Background Information

The District is an irrigation district organized in 1887 under the provisions of the Wright Act (California Water Code §20,500 et seq.). The District supplies water for irrigation use in a 307.5-square-mile irrigation service area lying within portions of Stanislaus and Merced Counties, California. Irrigation service began in March 1900 and the District has provided continuous service ever since.

The District provides electric service in a 650-square-mile service area that includes portions of Stanislaus, Merced, and Tuolumne Counties, California. The District also has the right to serve an additional 12-square-mile area of undeveloped land in Tuolumne and Mariposa Counties (Don Pedro South Shore Zone). To provide electric service, the District owns and operates an electric system that includes generation, transmission, and distribution facilities. The District also purchases power and transmission service from others and participates in other utility power supply and transmission arrangements. .

During 2008, the District experienced an increase in the number of customers, electricity sales, and revenues. At the end of the year, the District served 98,423 retail customers, up 1.0% from 2007. Retail energy sales were 1,980,626 MWh, up 1.5% from 2007. The TID 2008 annual peak demand was 516 MW and occurred during August. The TID peak was down 3.4% from the 2007 peak demand.

Key Customer Markets

TID offers a full slate of energy efficiency programs to each of its customer segments. These programs encourage members to be more energy efficient, decrease their energy demand and costs, and conserve resources.

Although 72% of TID's customers are residential, most of its sales are to the non-residential sector. The residential market is provided a full array of energy efficiency programs, but more than 90% of the savings, both historical and expected, come from the non-residential sector. Most of this savings comes from lighting, air compressor, and motor energy efficiency measures.

1.2 Efficiency Programs Offered

TID offers a variety of energy efficiency programs to encourage its members to reduce energy consumption. These programs include a combination of informational energy audits, rebates, and giveaways as a way to help increase member awareness of energy efficiency and encourage the wise use of electricity.

1.2.1 Residential Program Summaries

There are eight residential program initiatives.

- Residential Energy Audits - TID provides free in-home energy audits to customers who would like to learn how to reduce their energy use.
- Residential Rebate Programs - TID offers customers rebates for purchasing and installing:
    - Energy Star Refrigerator
    - Energy Star Room AC
    - Energy Star Clothes Washer
    - Whole House Fan
    - Shade Screens
- Refrigerator Recycling Program – Financing incentives offered to customers that surrender their old operational refrigerator for recycling.
- Shade Tree Rebate - TID provides rebates for up to three trees per year that are planted to provide shade.
- CFL Rebate Program - TID provides a rebate for the purchase and installation of CFLs.
- New Construction Rebate - TID offers a rebate to homebuilders for exceeding Title 24 energy standards.
- "Energy Wise" Education Program - Provides energy saving education and kits to 6th grade students in the TID service territory.
- Education Specialist - Outreach education provided to schools and community groups.

1.2.2 Non-residential Program Summaries

There are three non-residential program initiatives.

- Automated Energy - TID has implemented an on-line energy management tool for business customers who can log onto a website to monitor their energy usage and utilize that information to more efficiently manage their energy consumption.
- Energy Audits - TID offers free on-site energy audits to commercial, industrial and agricultural customers who have concerns, questions or an interest in implementing measures to manage their energy usage and reduce consumption.
- Commercial, Industrial, Agricultural Energy Efficiency Rebates - TID offers rebates along with comprehensive technical support for all commercial, industrial and agricultural customers to promote the purchase and installation of commercial equipment and systems that support and enhance load reduction.

1.2.3 2008 Program Summary

TID spent a total of $1,144,259 in program costs that led to total demand reductions of 1,710 kW and total annual energy reductions of 10,936,997 kWh. Table 1 summarizes the kW, kWh and program costs for TID's 2008 programs.

Table 1: 2008 Summary of TID's Programs

Program Sector	Net Annual Energy Savings (kWh)	Energy Savings % of Total	Net Peak Demand Savings (KW)	Demand Savings % of Total	Incentives ($)	Mktg, E M & V, and Admin Cost ($)	Total Program Costs ($)
Residential Appliances	12,110	0.1%	5	0.3%	$18,270	$594	$18,864
Residential HVAC	41,761	0.4%	52	3.0%	$15,097	$2,749	$17,846
Residential Lighting	468,106	4.3%	217	12.7%	$56,963	$19,517	$76,480
Residential Refrigeration	128,781	1.2%	17	1.0%	$32,363	$6,628	$38,990
Residential Refrigeration	11,499	0.1%	1	0.1%	$15,539	$1,293	$16,831
TOTAL RESIDENTIAL	662,257	6.1%	292	17.1%	$138,231	$30,780	$169,011
Non-Res Process	1,206,941	11.0%	201	11.7%	$29,673	$87,769	$117,442
Non-Res HVAC	35,908	0.3%	8	0.5%	$1,796	$2,758	$4,553
Non-Res Lighting	8,700,195	79.5%	1,142	66.8%	$344,442	$471,504	$815,947
Non-Res Refrigeration	331,697	3.0%	68	4.0%	$13,710	$23,595	$37,306
TOTAL NON-RES	10,274,741	93.9%	1,418	82.9%	$389,621	$585,627	$975,248
TOTAL	10,936,997		1,710		$527,852	$616,407	$1,144,259

1.3 Evaluation Priorities

As shown in Table 1, nearly 90% of TID's energy savings accrues from its non-residential process and lighting end-uses. Both non-residential lighting and non-residential process savings primarily come from a combination of custom rebates based on the amount of energy saved and fixed rebates based on the installation of specific equipment and measures. Both of these non-residential programs are high evaluation priorities.

Based on these evaluation priorities, two sites were selected for inclusion in the 2008 impact evaluation. These sites together represent claimed energy savings of nearly 5,000,000 kWh, which is nearly 50% of the total claimed non-residential energy savings for 2008. The two sites also have unique applications of measures.

- The first is a very large lighting retrofit project.
- The second is a process air compressor project.

2 IMPACT EVALUATION PLAN

A useful construct for thinking about the range of efficiency measures offered by the TID and M&V options is the International Performance Measurement and Verification Protocol (IPMVP). Table 2 presents a listing of the IPMVP protocols, the nature of the performance characteristics of the measures to which M&V options typically apply, and an overview of the data requirements to support each option. Our approach to selecting M&V strategies followed these guidelines.

Table 2: Overview of M&V Options

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

Most of the measures included in the two sites evaluated are custom installed measures. The claimed savings are based on engineering calculations appropriate for the specific site. Therefore, a form of Option “A” was used for the evaluation. In air compressor instance, short term metering was also employed.

3 IMPACT EVALUATION RESULTS

The methodologies employed to measure and verify energy savings attributed to the Non-Residential Custom Program included the following activities:

1. Verify measure installation.
   a. Developed a sample for field verification activities.
   b. Conducted field verification activities and observations.
2. Review applications and supporting documentation provided to the Turlock Irrigation District.
3. Develop adjusted measure savings values based on field activities and data reviews.

These activities are discussed in detail in the following sections. Additional detailed information may be found in the appendices.

3.1 Measure Installation Verification

The objectives of the verification activities were to complete site visits and collect key energy program performance metrics including:

1. Establishing the presence of energy efficient measures by comparing the number of installations observed with the number of installations recorded in the rebate application.
2. Providing input on the quality of installations observed – including whether or not they were operating correctly.
3. Where observed equipment did not match program reported installations, determine if retrofits/installations were ever present, and/or the reason that the installation plan changed.
4. Recording key facility performance data, such as daily schedules, seasonal variations in schedules, and control strategies.
5. Where appropriate, taking measurements of power consumption and usage directly on equipment.

3.2 Installation Verification Sample

Two of the projects that received rebates in FY 2008 were selected for on-site evaluation. Site 1 changed the controls of its compressed air system and took the old base-load compressor off line. Site 2 performed a complete retrofit of lighting in a number of warehouse and supporting areas.

Table 3 details the verification results of the energy efficient installations and savings sampled that occurred under the Non-Residential Custom Program for the Turlock Irrigation District. For privacy, the customer names are not given, but rather a site number assigned.

Table 3: Verified Program Installations and Savings

Customer	Retrofit Measures	kW	kWh
Site 1	Air compressor controls and load changes	74.0	602,660
Site 2	Lighting retrofit with level reduction and occupancy sensors	366.4	4,251,156
Program Total		440.4	4,853,816

The lighting retrofits at Site 2 involved comprehensive retrofits of warehouse and supporting mechanical and storage areas. The majority of the retrofit consisted of replacing a combination of high bay metal halide and T12 fixtures with high output T5 and T8 units. This was done in combination with a significant reduction in the number of fixtures as the warehouses were initially overlit since the lighting had been designed when the buildings were under different ownership and use. In one area, recessed lensed troffers were retrofitted from magnetically ballasted T12s to electronically ballasted T8 lamps. In addition, occupancy sensors were added in almost all areas.

In evaluating these projects, particular attention was paid to reviewing the program documents and supplementing them with field verifications. The evaluation of the lighting retrofits involved the IPMVP Option A approach by reviewing engineering calculations and performing site interviews. The compressed air evaluation used the IPMVP Option B approach, calculating savings using metered data.

Deemed values were not used in calculating savings for these projects because most of the measures, including high bay retrofits and occupancy sensors as well as the air compressor work, do not have deemed savings available. Of the work done at these two sites, only the T12 to T8 retrofits have available deemed values, and these do not allow for high output units or ceiling mounted occupancy sensors. Although these are considered an acceptable alternative to calculated values for CEC verification, the significant difference in conditions in the only case where any values are available makes their use impractical for these projects.

3.3 Site Verification Activities

Field activities typically involved two components:

1. Evaluators coordinated with the implementation contractor and primary customer contacts to establish field activity dates and identify site level contacts.
2. While on-site, the evaluation team conducted an area-by-area, measure-by-measure audit, noting retrofit count, type, and operating conditions. Interviews were also conducted at the site representative’s convenience.

Field evaluation activities were conducted on February 12, 2009. At the time, it was anticipated that all expected installations were completed and finalized.

3.4 Installation Verification Results

Verification work, discussions with participants subsequent to field verification activities, and an analysis of the verified installations indicated that the installations attributed to the Non-Residential Custom Program were installed, with the savings estimates close to the claimed values.

3.4.1 Site 1

Site 1 is an industrial food products manufacturing facility that made changes to its compressed air system and controls in order to take the former base load 200 HP compressor off line. The Compressed Air Management Program (CAMP) performed an assessment of the system in December of 2007. At the time the compressed air demand was expected to increase by 200 acfm with the addition of a second production line.

The initial CAMP report recommended replacing the 200 HP centrifugal compressor with a new 150 HP rotary screw load-unload unit and adjusting the existing 150 HP Kobelco compressor to operate on a load-unload basis. The CAMP verification noted that the scope of work was changed to take the 200 HP compressor offline and add a sensors and load-unload controls to the existing 150 HP compressor. The on-site visit confirmed that this was still the case.

The on-site verification showed two notable differences from the CAMP report verification. This may in part be due to the fact that the site experiences seasonal variations. According to facility personnel, March through November is the high use season with lighter operation the remainder of the year. The initial CAMP readings were taken in early December with the verification in early March. This puts both measurements on the cusp of the transition in use. However, the on-site verification by Summit Blue was performed in February. Although the week of measurement included President's Day, the facility was open that Monday although the compressed air was not in use. This was the result of seasonal usage rather than the holiday according to personnel. During the week Summit Blue monitored the system, it was turned off for fully 50% of the time, whereas the CAMP verification did not show any full shut down periods during a week of monitoring both pre- and post-installation.

There was, however, a second more notable discrepancy between the Summit Blue and CAMP observations. The CAMP measurements were taken every ten minutes and the report recommended the pressure sensor be set for at least a ten minute load period. Summit Blue recorded closer to a one minute or less load period both during on-site observations and with a 15 second logging interval throughout the week. This may point to a need for retro-commissioning of the controls. It does not appear to be indicative of a measurement problem during the CAMP report as the unload periods are consistent in the measurements; however it does show a significant change in conditions since the initial report.

Although there is no doubt that taking the 200 HP compressor offline has saved a significant amount of energy, there is some question about both the effects of seasonal operation and the current operation of the controls. Based on discussion with facility personnel, assuming that the 50% shut off time is a seasonal effect that would have taken place for three months every year, and that the old 200 HP compressor would also have been shut off, decreases the baseline usage by one-eighth, from 1,404,338 kWh/year to 1,228,796 kWh/year. Assuming that the previously verified usage 783,873 kWh/yr should be pro-rated to apply for only three-quarters of the year and using the low usage values observed by Summit Blue for the remaining quarter of the year, gives a new usage of 626,136 kWh/yr. This corresponds to a savings of 602,660 kWh/year. The observed peaks were too short to contribute to demand charges, so the peak demand was around 78 kW, less than the 111 kW observed during heavy use season, so the 74 kW savings found in the initial verification should be accurate.

Table 4 summarizes both the claimed and adjusted energy savings for Site 1.

Table 4: Site 1 Installation and Savings

	kW Savings	Annual kWh Savings
Claimed Savings	74.0	620,466
Verified Calculated Savings	74.0	602,660

3.4.2 Site 2

Site 2 was a large complex of warehouses. Previously these areas were overlit as they had been designed when the spaces were under different ownership and use patterns. Consequently, all of the high bay retrofits included significant reductions in the number of fixtures. Overall the number of fixtures was reduced from 2,278 to only 751. Thirty exit signs were also retrofitted from incandescent to LED units as part of the upgrade. These operate continuously at 8,760 hours per year. Occupancy sensors were installed in most areas. For most units, individual sensors were used, although some rooms used ceiling area sensors instead. Daylight sensors were also used in some areas. These savings were calculated before occupancy sensor reductions were added.

High bay retrofits made up the majority of the savings at the site. These consisted of both metal halide and high output magnetically ballasted T12 to high output, electronically ballasted T5 and T8 units. The T8 fixtures were used for fixtures with emergency ballasts and T5 units were used elsewhere. The initial expectation was to use six lamp T8 fixtures where four lamps were on a motion sensor with a high output ballast and the remaining two lamps were on a standard output emergency ballast. However, the actual fixtures had two high output three-lamp ballasts, one of which was switched by the motion sensor. In addition these fixtures contained a standard output emergency ballast wired in parallel to two of the lamps. This resulted in some adjustments to savings estimates, however since there were only a small number of these units in the retrofit, this did not have a significant effect on savings.

Open industrial high output and standard T12 fixtures were also replaced with high output T8 units in some of the smaller areas, such as substations, stairwells, and mezzanines. In both these areas and the high bay ones, the old T12 fixtures generally used standard rather than newer more efficient magnetic ballasts. The TID program design is to use the existing equipment as found as the baseline for estimating energy savings. This is an acceptable approach, although it is not current standard evaluation practice. In California among the investor owned utilities and larger municipal utilities, Title 24 is used as the baseline. Summit Blue has calculated realization rates based on the TID program design. However, for comparison, a calculation based on the Title 24 baseline has also been provided for reference.

In one area recessed lensed troffers were retrofitted from T12. This is the only area for which deemed savings might have been appropriate, but even here no values were available for the ceiling mounted occupancy sensors, so the values were not used in calculating savings. Consistent with this expectation, this was the only area in which employees were working rather than just passing through during the on-site verification.

The daylight sensors were all observed to be installed and operating correctly. An occupancy study was performed prior to the retrofit. It showed an average occupancy of only 15% in most areas. The only exception to this was in a portion of the area with recessed lensed troffers, where a 50% reduction was expected due to heavier use. Occupancy sensor operation however, was not as reliable as expected. This appeared to be the result of a lack of commissioning of the sensors rather than higher than expected occupancy levels. Many of the units next to the aisles were triggered by traffic passing in the aisles. A few units also appeared to be so sensitive that they never shut off. The shut off timers on units also appeared to be set inconsistently, so that some fixtures remained on longer than planned. Facility personnel were working to correct all of these problems. However, although the initial logging of occupancy did show only 15% usage in most area, the savings calculations did not take into account the time delay of a few minutes for these fixtures to shut off. Because of this, Summit Blue has estimated savings of only 80% based on this occupancy, rather than the 85% value used in the application. This is still significantly higher than typical NRR-DR values, shown in Appendix A. However, the occupancy study does support using these higher values. The daylight sensors are included in demand savings, while the occupancy sensors are not since their operation is on a more random basis.

Summit Blue examined billing data from the site to see if the predicted savings were realized. This proved surprisingly difficult to observe. This may in part be due to the ongoing nature of the retrofit, which has taken place continuously. A few fixtures in difficult to reach places were still being changed. However, since only three fixtures were still seen in operation during the audit, this should not significantly affect billing. Additionally, the last available bill was for January 2009, allowing only a very short period for comparison. The number of days in the billing cycle was not available, so it is possible that the energy comparison is not entirely appropriate. There were several meters at the site, but overall facility numbers were compared since the retrofits took place in multiple buildings. However, January 2009 showed only a 102.8 kW demand reduction compared to January 2008. December 2008 did exhibit 305.6 kW less demand than December 2007, much closer to the estimated savings. Both months show savings between 103,000 and 104,000 kWh, significantly below the 307,105 kWh that is expected based on calculations. It is difficult to ascertain the reason for this, although facility personnel also expressed disappointment with the billing reductions. This may be due both to the fact that the retrofit was still incomplete until the end of the year and due to problems with occupancy sensor adjustments. However, the billing should be monitored in upcoming months to confirm if this changes.

As shown in Table 5, this site shows verified savings similar, though lower, than the claimed savings that were expected based on the rebate application. The reason for this includes:

- Some occupancy sensors did not appear to be operating as expected and the occupancy study did not account for time required for fixtures to shut off.

- The T8 high bay units with emergency ballast were not designed as expected, and three high output lamps instead of two standard output lamps remained on continuously.

Table 5: Site 2 Installation and Savings

	kW Savings	Annual kWh Savings
Claimed Savings	373.4	4,344,554
Verified Program Rules Savings	366.4	4,251,156
Verified Title 24 Based Savings	307.4	3,685,347

3.5 Site Observations

There were several notable issues with the applications at the two sites:

1. *Operation not consistent with expected conditions.* The lighting sensors at site 2 were not properly adjusted. Site personnel were working on adjusting these, however commissioning of sensors such as these is recommended to prevent this problem.
2. *Operation not consistent with expected conditions.* Site 1 reported seasonal changes in operation which may account for some of the variation seen between the measured operation and that reported in the site verification calculations, however there are a few items of note:
    a. On-site observations showed the compressor cycled on about once every minute, while the earlier measurements were taken only once every ten minutes.
    b. The measured energy use was significantly below the verified values. This may be due to seasonal variations in usage, however the logged data showed the compressor was completely turned off from Saturday morning until Tuesday morning. Contrastingly, the verification never showed a complete shutdown.
3. *Baseline conditions.* The TID program is designed to assume that the baseline consists of the actual fixture wattage found rather than values consistent with Title 24 minimum standards. This practice is acceptable but it does not follow the current common evaluation methods that use Title 24 as the baseline.

3.5.1 Program Record Observations

The final program records submitted by the implementation contractor to the Turlock Irrigation District were analyzed for accuracy and consistency, and to ensure that the underlying assumptions were reasonable. The key documents analyzed included the project applications provided to the program for each site

The primary observation from this review was that the controls were not operating as expected at either site. Based on the review of program documents and on-site verification activities, the following conclusions were reached:

1. The measure savings assumptions were calculated to be representative of the Program installations.

2. The savings attributable to the occupancy controls were adjusted to account for the delay in fixture shutoff.

3. Commissioning of controls is highly recommended. This should help reduce problems with accidentally turning on unnecessary lights.

4. Post-installation verification of occupancy sensor operation should be required if savings in excess of the standard NRR-DR values are used.

4 IMPACT EVALUATION RESULTS

Table 6 provides the savings reported in the final installation review documents submitted for the Program and the verified gross savings. Based on TID program design, which identifies the baseline to be the equipment as found at the participants site, the overall energy measure realization rate is a very good 97.8%. The air compressor site had an energy measure realization rate of 97.1% and the lighting 97.9%.

The recommended adjustments are attributable to revised savings estimates for a combination of occupancy sensor reductions, fixture wattages, and changes in the planned and installed units.

Table 6: Claimed Savings and Verified Gross Savings

	Claimed		Verified		Measure Realization Rate	
Project	**kW Savings**	**Annual kWh Savings**	**kW Savings**	**Annual kWh Savings**	**kW Savings**	**Annual kWh Savings**
Site 1	74.0	620,466	74.0	602,660	100%	97.1%
Site 2	373.4	4,344,554	366.4	4,251,156	98.1%	97.9%
Total	447.4	4,965,020	440.4	4,853,816	98.4%	97.8%

Calculated savings have been used for both of the sites, since deemed values are not available for most of the measures, and where they were available the calculated savings were significantly higher due to the facility operating schedule.

APPENDIX A: NON-RESIDENTIAL CUSTOM SITE DETAILS

Table A-1: Standard Occupancy Sensor Reductions by Area Type

Space Type	% Savings	Space Type	% Savings	Space Type	% Savings
Assembly	45	Industrial	45	Restroom	45
Break room	25	Kitchen	30	Retail	15
Classroom	30	Library	15	Stair	25
Computer Room	35	Lobby	25	Storage	45
Conference	35	Lodging (Guest Rooms)	45	Technical Area	35
Dinning	35	Open Office	15	Warehouses	45
Gymnasium	35	Private Office	30	Other	15
Hallway	25	Process	45	Parking Garage	15
Hospital Room	45	Public Assembly	35		

Source: 2008 NRR-DR Program Procedures Manual, Table 2-1