NAVIGANT CONSULTING

ENERGY EFFICIENCY PROGRAM EVALUATION, VERIFICATION, AND MEASUREMENT STUDY

FY 2009 Programs

Prepared for:

Imperial Irrigation District

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Introduction and Executive Summary

Two legislative bills (SB1037 and AB2021) that affect energy efficiency programs offered through Publically Owned Utilities (POUs) were signed into law a year apart. SB1037 requires that the 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 energy efficiency program evaluation plan is to assist Imperial Irrigation District (IID) to meet these requirements.

General Utility Background Information

IID is a customer-owned irrigation district that supplies energy to over 145,000 customers in the Imperial Valley as well as parts of Riverside and San Diego counties. As the sixth largest utility in California, IID controls more than 1,100 megawatts of energy derived from a diverse resource portfolio that includes its own generation and long- and short-term power purchases. IID Energy operates eight hydroelectric generation plants, one generating station, and nine gas turbines.

Objectives

The goals of the EM&V effort at IID are to provide unbiased, objective and independent program evaluations by giving:

- Useful recommendations and feedback to improve IID programs.
- Assessment of conservation program effectiveness.
- Assessment of the quality of the program data for impact evaluation purposes.
- Increased level of confidence in conservation program results through transparent protocols.

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Impact Evaluation Results

Impact evaluations were performed for Custom Energy Solutions Program and the Residential Pool Pump Program. Combined, these two programs account for about 22% of IIDs 2008 claimed savings. The majority of 2009 claimed savings comes from the QACM Program. However, a preliminary review of the program tracking database for the QACM program indicated that the data as it is currently maintained is not ready for a detailed impact evaluation. Therefore, for this fiscal year, the EM&V for the QACM program is a process evaluation that reviews the methodology used by the program implementers, the data reporting process, and the relative reliability of the net energy savings estimate.

A total of 958,079 kWh and 58 peak demand kW were claimed in 2009 from the Residential Pool Pump Program. The measure realization rate was found to be 100% for these claimed savings.

Table EX-1 provides the savings reported in the final installation review documents submitted for the Custom Solutions Program and the verified gross savings. The overall energy measure realization rate is 112%. Sites 4 and 5 saved substantially more than claimed, but sites 1 and 2 both had unreasonably high savings claims due to overestimates of baseline electricity usage.

Table EX1. Claimed Savings and Verified Gross Savings for the Custom Solutions Program

	Claimed		Verified		Measure Realization Rate	
Project	kW Savings	Annual kWh Savings	kW Savings	Annual kWh Savings	kW Savings	Annual kWh Savings
Site 1	0	74,918	0	5,562	NA	7.4%
Site 2	0	133,298	0	46,400	NA	34.8%
Site 3	0	39,442	0	40,220	NA	102%
Site 4	92.9	576,732	91.9	805,368	98.9%	140%
Site 5	22	25,675	0	50,450	0%	196%
Total	**114.9**	**850,065**	**91.9**	**948,000**	**80%**	**112%**

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Program Summaries and FY 2009 *Ex Ante* Gross Energy Savings

Program Summaries

IID offers a variety of energy efficiency programs to both their residential and commercial customers. The programs are funded by a public benefits charge, which is included on all customer electric bills. The programs are not only focused on energy efficiency but also education as to ensure a long-term reach into the future of the community. Listed below are descriptions of the main programs offered by IID.

Residential Program Summaries

- **Home energy analysis** - IID provides tools to help residential customers understand their energy usage. These include an online home energy calculator, home appliance energy fact sheet, and free home energy audits.
- **Energy star rebates** - IID offers residential customer rebates on ENERGY STAR qualified products. The 2010 qualifying product categories include: energy-efficient central air conditioners/heat pumps, qualified room air conditioners, qualified dual pane windows, Variable Speed Pool Pumps, and qualified refrigerators.
- **Quality AC Maintenance** - IID's Quality AC Maintenance program is designed to ensure that both refrigerant charge and airflow through the evaporator coil are properly tested and correctly adjusted and also that duct leakage is detected and properly sealed. The Quality AC Maintenance program also offers enhanced rebates when you replace operational equipment with a qualifying energy efficient system.
- **Solar/PV Solutions -** IID offers rebate incentives of $2.60 per watt ac up to 15 kW for residential customers. All rebate requests must have IID pre-approval before installation.
- **Enhanced Net Metering Program** - IID's net-surplus customers will automatically be enrolled into the Enhanced Net Metering Program on a first-come, first-served basis to receive compensation. NEM customers will also have the opportunity to elect to receive monetary compensation at rates established by the IID Board of Directors for any surplus generation during the preceding 12 months or carry the surplus as a kilowatt credit.

Non-residential Program Summaries

IID provides non-residential efficiency measure assistance through several program initiatives.

- **Energy Rewards Rebate Program -** This program offers rebates to small, medium, and large size non-residential customers for the purchase of qualifying lighting, refrigeration, air conditioning, agricultural, motors and controls equipment that improves the energy efficiency of their businesses.

- **Custom Solutions Program -** The CSP program offers financial incentives in the form of rebates to medium and large non-residential customers who participate in a Detailed Energy Analysis of the their business facilities which result in the customer's purchase and installation of qualifying lighting, refrigeration, air conditioning, food service, agricultural, and/or control equipment.
- **Pump Efficiency Program -** Designed for irrigation, golf course and municipal water pumping needs, the Pump Efficiency program promotes state-of-the art methods for improving irrigation pump efficiency. Trained technicians determine the potential cost-savings opportunities through an equipment analysis. Once the customer completes the recommended retrofits, IID helps offset the costs with a rebate based on anticipated energy savings.
- **New Construction Efficiency –** The New Construction Energy Efficiency program (NCEEP) is a non-residential new construction and renovation energy efficiency program that combines an integrated design process with financial incentives. NCEEP is geared toward assisting customers in moving beyond initial cost considerations and towards the realization of long term energy cost savings as well as avoiding lost opportunities as new non-residential buildings are designed and constructed.

FY 2009 Ex Ante Gross Energy Savings

In fiscal year 2009, IID spent a total of $1,918,650 in program costs that led to total reported demand reductions of 3,025 peak demand kW and total reported annual energy reductions of 11,284,942 net kWh. Table 1 summarizes the kW, kWh and program costs for IID's 2009 programs.

Table 1. 2009 Summary of IID's Programs

Program and Sector		Impact Summary			Cost Summary		
Program Sector	Category	Net Demand Savings (kW)	Net Peak kW Savings	Net Annual kWh Savings	Utility Incentives Cost ($)	Utility Mktg, EM&V, and Admin Cost ($)	Total Utility Cost ($)
Residential							
HVAC	Res Cooling	1,301	1,356	4,897,107	$ 564,965	$ 387,400	$ 952,365
Consumer Electronics	Res Electronics	1	1	8,772	$ 17,340	$ 345	$ 17,685
Lighting	Res Lighting	149	19	106,043	$ 852	$ 3,453	$ 11,628
Pool Pump	Res Pool Pump	59	33	547,630	$ 61,539	$ 25,712	$ 87,251
Refrigeration	Res Refrigeration	31	31	99,900	$ 129,854	$ 7,084	$ 136,938
HVAC	Res Shell	5	5	4,035	$ 388	$ 394	$ 782
Residential Total		**1,546**	**1,445**	**5,663,488**	**$ 774,938**	**$ 424,388**	**$ 1,206,649**
Non-Residential							
HVAC	Non-Res Cooling	1,122	1,126	3,690,276	$ 202,965	$ 181,511	$ 384,476
Lighting	Non-Res Lighting	23	21	79,486	$ 15,120	$ 3,758	$ 18,878
Process	Non-Res Motors	2	2	11,802	$ 350	$ 704	$ 1,054
Process	Non-Res Pumps	48	48	374,777	$ 37,554	$ 18,967	$ 56,521
Other	Other	383	383	1,465,114	$ 146,511	$ 104,561	$ 251,072
Non-Residential Total		**1,578**	**1,580**	**5,621,455**	**$ 402,500**	**$ 309,501**	**$ 712,001**
Total		**3,124**	**3,025**	**11,284,942**	**$ 1,177,438**	**$ 733,889**	**$ 1,918,650**

Evaluation Priorities

The intent of the 2009 EM&V effort is not to evaluate every program offered by IID but rather to focus on those programs with both significant savings and interest to the utility. An initial review of impacts and discussions at the kickoff meeting in mid July indicates that the program of most interest and possible concern is the residential and small commercial QACM program. About 75% of IID claimed savings comes from this program. However, two other programs were also identified to be evaluated for 2009. These include the Custom Energy Solutions Program and the Residential Pool Pump Program.

A preliminary review of the program tracking database for the QACM program indicated that the data as it is currently maintained is not ready for a detailed impact evaluation. Therefore, for this fiscal year, the EM&V for the QACM program is a process evaluation that reviews the methodology used by the program implementers, the data reporting process, and the relative reliability of the net energy savings estimate. Impact evaluations were performed for both the Custom Energy Solutions Program and the Residential Pool Pump Program.

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Impact Evaluation Plan

A useful construct for thinking about the range of efficiency measures offered by Imperial Irrigation District 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

For the Residential Pool Pump Program, IPMVP Option A was followed. The deemed savings are considered representative of the engineering estimates and installation verification was followed.

Each of the five projects evaluated from the Custom Solutions Program include only custom retrofit measures. The claimed savings for these measures are based on engineering calculations appropriate for the specific site. Verifying savings for each of the sites required using three of the options provided in Table 2, options: A, B, and C were used in varying combinations determined by the nature of the retrofit. Option A was primarily to verify billing and logging data in conjunction with options B and C. Option C was used exclusively at sites 1 and 4. Options A, B, and C were all used at sites 2 and 3, and options A and B were used at site 5. For additional details regarding the evaluation methods used, see the section titled: Installation Verification Sample.

Quality AC Maintenance Program Process Evaluation

Navigant reviewed the Quality AC Maintenance (QACM) program not to verify previous program savings, but in order to facilitate that sufficient data is being collected so as to allow for a full EM&V effort in subsequent years. Therefore, the direction of this program analysis was review the methodology used by the program implementers, the data reporting process, and the relative reliability of the net energy savings estimate. Of these aspects of the QACM program, implementation and deemed savings values were found to be fundamentally sound. However, the reporting process shows some need for improvement. Table 3 shows, by building sector, the specific services offered to participants of the Quality AC Maintenance program.

Table 3. Services and Tests Provided Through the Quality AC Maintenance program

Sector	Repair/Test Performed
Commercial	Condenser Coil Cleaning
	Refrigerant Charge Adjustment and Airflow Adjustment
Residential	14 SEER/12.5 EER Upgrade and Quality Install
	Condenser Coil Cleaning
	Duct Test and Repair 23% minimum repair (Bonus Group)
	Refrigerant Charge Adjustment and Airflow Adjustment

A concern with the type of services and repairs listed in Table 3 is the persistence of the savings. Accurate levels of refrigerant should, ideally, be confirmed on an annual or semi-annual basis. Also, the majority of savings from coil cleaning may last only 2-3 years. This would not have an effect on the first year claimed savings, but would have on lifecycle program savings.

It was also noted that a significant number of the sites had more than one repair performed. This raises a strong possibility that interactive impacts from simultaneously applying multiple measures could erode the net savings per project.

Claimed program impacts, as reported to the CEC by IID using the E3 calculator, are shown in Table 4.

Table 4. HVAC Quality Maintenance Program - Claimed Savings

Customer Sector	Annual kWh Savings	Coincident Peak kW Savings
Residential	4,351,154	1,192
Commercial	4,101,161	1,248
Total	**8,452,315**	**2,440**

During the course of this review it was noted that much of the supporting data used to calculate the deemed savings, via work papers, was extracted from DEER 2005. It was also noted that one of the program implementers, Proctor Engineering, has collected a significant amount of primary data on these types of systems through the CheckMe Program. Therefore, it is suggested that the results of pre/post on-site tests be included with the project invoices. This would allow the EM&V provider to compare the deemed savings used in the work papers, to the actual results from the on-site tests or other metered data.

The total count of projects included in this program, shown in Table 5, was established using data[1] provided to Navigant by IID as part of the overall program documentation. The referenced workbook provides an overview of the individual performance tests performed, but contains limited detail on equipment size, etc. To account for overlap of tests/repairs conducted on a single HVAC unit, multiple entries were considered a "unique project" when the following three criteria overlapped: Meter Number, Unit #, and Model Number.

Table 5. Completeness/Comprehensiveness/Relevance of QACM Data Collected by IID

Status of Records	Count of Approved Projects	Percent of Documented Projects
Unique Projects Identified in "2009 QAM Master List"	3,997	100%
Documentation Not Provided	2,637	66%
Insufficient Data Provided	653	16%
Useful for EM&V	**707**	**18%**

[1] It was assumed that the "2009 QAM Master List" file contained a comprehensive list of repairs and tests performed.

The total count of projects shown in the "Unique Projects" row of Table 5 is sub-divided into the other categories based on the following criteria:

- Projects included in the "Documentation Not Provided" category are those that Navigant did not receive details for from IID.
- The "Insufficient Data Provided" category is for projects that a data provided was too limited. This data is likely available but would require an additional request from the program implementer.
- The "Useful for EM&V" category reflects projects attributed to the program implementer Enalasys, their summary data for projects appear sufficient for a detailed evaluation process.

The most important details included in the Enalasys reports that was not included in the Proctor results is the capacity of HVAC equipment (in tons) per individual project. This could be obtained using the unit model numbers, but it would be labor intensive to set up a comprehensive index of model numbers and associated size.

Both implementer reports would be improved if they included a meaningful estimate of the magnitude of charge adjustment or avoided duct leakage that resulted from the site visit.

Because of the previously mentioned prevalence of multiple services provided per piece of equipment, the following are a few key details regarding the overall results reported by Enalasys:

- Total Count of Repairs Performed 707
- Total Sum of Tonnage Serviced 2,202
- Total Deemed kWh Savings 1,333,250

Table 6. Summary of Services Reported Through Enalasys

Sector	Repair/Test Performed	Count of Repairs Performed	Sum of Tonnage Serviced	Avg. Project Savings kWh/ton	Avg. Project Savings kWh/yr	Total Deemed kWh Savings
Comm.	Condenser Coil Cleaning	87	389	242	1,105	96,096
	Refrigerant Charge Adjustment and Airflow Adjustment	87	389	413	1,894	151,556
Res.	14 SEER/12.5 EER Upgrade and Quality Install	1	3	400	1,200	1,200
	Condenser Coil Cleaning	617	1,800	234	681	420,234
	Duct Test and Repair 23% minimum repair (Bonus Group)	2	10	472	2,359	4,719
	Refrigerant Charge Adjustment and Airflow Adjustment	615	1,792	398	1,153	659,446

Summary data from the other program implementer, Proctor Engineering, could not be included in Table 6 because it did not include the capacity for individual HVAC units. The Proctor report provided was also limited to those repairs conducted prior to October 31st, the Enalasys data covers the entire year.

Recommendations for the QACM Program

- To streamline the evaluation process, Navigant recommends that project summaries from multiple implementers be standardized.
- Aside from uniformly providing the rated capacity of maintained equipment, the results of the *in situ* tests should be included with the project invoices.
- The notice on the Enalasys website[2] stating that the Program is closing April 30, 2010 should be removed to reduce the potential for confusion among potential applicants.

[2] http://www.enalasys.com/iid/

Gross Impact Evaluation Results for the Residential Pool Pump Program

The methodology used to measure and verify energy savings for the residential pool pumps program included the following:

1. Identified a sample from the entirety of participants and requested the hard-copy documentation maintained by IID.
2. Verified that the sampled documentation exists and was in good order.
3. Matched the sample documentation information to the records that exist in the IID tracking system to verify that the information was consistent.
4. Reviewed the replacement motor specifications and compared to the IID E3 savings calculator to confirm savings.
5. Created a realization rate for pool pump motor replacements.

Measure Installation Verification

Navigant Consulting requested the complete list of participants in the pool pump replacement program from IID and, from that list, a simple random sample of participants at a 90/10 confidence interval was created. This generated a list of 33 participants. The list of sampled participants was given to IID with the request to provide copies of the hard-copy documentation for each. Proper documentation was produced for each of the sampled 33 participants. Based on these findings, installation verification is considered to be 100%.

Motor Efficiency Verification

The sample of 33 participants all installed Variable Speed Drive motors with 3 speeds or more. In the E3 tool used by IID to report savings for program year 2009, the savings information for pool pumps is defined by 2-speed motors. Since all of the motors in the sample had more than 2-speeds, the calculated savings information in Table 7 below has been verified with a realization rate of 100%.

Table 7. E3 Savings information for Pool Pump Program, PY 2009

	Impact Summary			Cost Summary		
Program	**Net Demand Savings (kW)**	**Net Peak kW Savings**	**Net Annual kWh Savings**	**Utility Incentives Cost ($)**	**Utility Mktg, EM&V, and Admin Cost ($)**	**Total Utility Cost ($)**
Residential Pool Pump	59	33	547,630	$61,539	$25,712	$87,251

Adjustments to Future Program Savings

According to Title 20 of the California Code of Regulations, as of January 2008 all residential pool pumps that are installed due to new construction or remodeling must be either a 2-speed or a variable speed motor. This code did not specify requirements for replacement pumps but an amendment that became effective as of January 2010 now mandates that all replacement pumps must have multi-speed motors and controls. Under this new regulation, the IID residential pool pump program could only claim savings of 321 kWh for energy savings and 0.079 kW for peak savings under its current design.

It may be possible to expand the scope of the residential pool pump program by promoting variable speed pumps not only for new applications and replace on burnout, but also to replace existing, still operational pool pumps. Pumps that meet this requirement could be claimed as "early retirement" installations. The most recent E3 model has energy savings for both program options. The replace on burnout and new pool pumps can claim the afore mentioned 321 kWh. However, under early retirement, a savings of 1,311 kWh can be claimed for variable speed pool pumps.

Insuring proper identification of program participants as to whether 321 kWh or 1,311 kWh can be claimed can be accomplished in two ways. The most rigorous method is to have pre-installation inspections to determine if the existing pool pump is currently fully operational. Those that are can qualify for early retirement status. A less rigorous, but still effective means of determining which savings level to claim is to have the program applicant state on their application form whether the existing pool pump is fully operational or if it is in need of replacement. However, if such an approach is followed, care must be taken not to provide the applicant any kind of incentive to answer one way or the other. The rebate amount should be the same between the two options. The application form should also state that IID reserves the right to inspect, pre or post installation, the pool pump.

Gross Impact Evaluation Results for the Custom Solutions Program

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

1. Verified measure installation by conducting field verification activities and observations. A census of installed projects was evaluated for the program, but only a few of the pumps at site 4 were individually verified, although billing data for all of them was included in the savings analysis.
2. Reviewed applications and supporting documentation provided to Imperial Irrigation District.
3. Developed adjusted measure savings values based on field activities and data reviews.

These activities are discussed in detail in the following sections.

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. Making onsite measurements of equipment power consumption and obtaining data logs from facility personnel.
6. Reviewing available literature and reports to determine savings expected from the installed equipment.
7. In some cases, comparing utility billing data to predicted savings to determine if more accurate savings could be calculated.

Installation Verification Sample

The universe of all five of the projects that received rebates in 2009 was selected for on-site evaluation. Sites 1-3 involved improvements to irrigation pumps for golf courses, site 4 included multi-speed pumps for 54 pools and 54 spas, and site 5 installed variable frequency drives (VFDs) on cooling tower fans.

Table 8 details the verification results of the energy efficient installations and savings sampled that occurred under the non-residential programs for Imperial Irrigation District. For confidentiality, the customer names are not given, but rather a site number assigned.

Table 8. Verified Sampled Installations and Savings

Location	Retrofit Measures	kW	kWh
Site 1	Efficient Well Pump and Motor	0	74,918
Site 2	VFDs on Irrigation Pumps	0	133,298
Site 3	VFDs on Irrigation Pumps	0	39,442
Site 4	Multi-speed Pool Pumps	92.9	576,732
Site 5	VFDs on Cooling Tower Fans	22	25,675
Total		**114.9**	**850,065**

In evaluating these projects, particular attention was paid to reviewing the program documents and supplementing them with field verification work. Measurements of various types were employed at all of the sites except site 1, where savings were based entirely on utility meter data and measurements performed during the project study. For site 5 a combination of logged data and spot measurements was employed. Billing data was used in analysis along with spot measurements at site 4, and sites 2 and 3 used billing data, spot measurements, and logged data. Loggers were installed to monitor equipment operation at sites 2, 3, and 5. The evaluations involved various combinations of IPMVP Options A, B, and C approaches by reviewing engineering calculations, taking onsite measurements, obtaining facility operational and billing data, and performing site interviews.

Site Verification Activities

Field activities typically involved two components:

1. Evaluators coordinated with the utility 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. In some cases measurements of equipment power were taken and data logs of operation obtained. Discussions of the installation details were also conducted at the site representative's convenience.

Field evaluation activities were conducted from January 17-18, 2011. At the time all expected installations were completed and finalized.

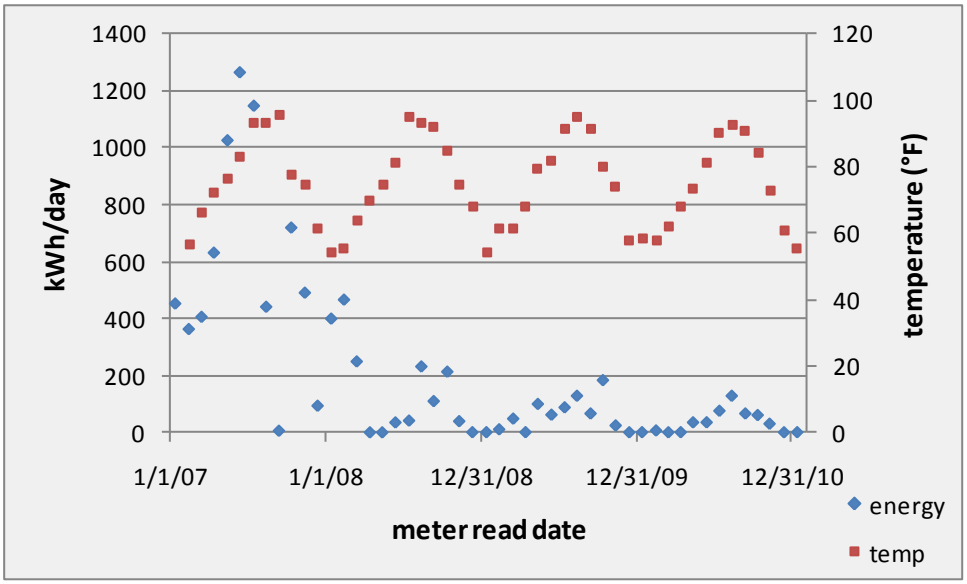
Installation Verification Results

Verification work, discussions with participants subsequent to field verification activities, and an analysis of the verified installations indicated that most of the equipment attributed to the Custom Solutions program was installed as expected, although there were some discrepancies in operational schedules.

Site 1

Site 1 was a well pump station that provides irrigation water to a golf course. In June 2008 the golf course replaced the pump and motor with new, efficient models. The incentive application was not paid until 2009, so this project has been included as part of the 2009 program evaluation. The well pump is on its own electric meter, and the energy consumption for the last four years is shown in Figure 1.

Figure 1. Site 1 Energy Use



Prior to the project in 2008, the golf course shifted a significant portion of its water supply from well water to canal water. This is the reason for the large drop in electricity use seen between 2007 and 2008 in Figure 2. Because of this shift in operation, the earlier data are not a reasonable baseline for evaluating savings for this project.

Recent electric use for the pump averages 21,965 kWh/year, based on billing data. Pump testing during the retrofit estimated pump efficiencies at 58% before replacement and 72% after replacement. The new premium efficiency motor is rated at 95.4% and a standard 100 HP motor would be 94.5% efficient. Based on these values, the baseline energy use without the retrofit is 27,527 kWh/year.

The total verified savings at the site was 5,562 kWh/year, only 7.4% of the claimed savings. This realization rate is so low because on the application baseline energy consumption was estimated at 304,548 kWh/year. From this, calculated savings based on pump and motor efficiencies resulted in a savings estimate that is approximately three times as high as the actual annual energy use of the pump. This overestimate of energy consumption for the site may be due in part to using a baseline which does not account for the shift to canal water. However, in 2007 the pump still only used 214,960 kWh, so the full cause of the overestimate of consumption is unclear.

Table 9. Site 1 Installation and Savings

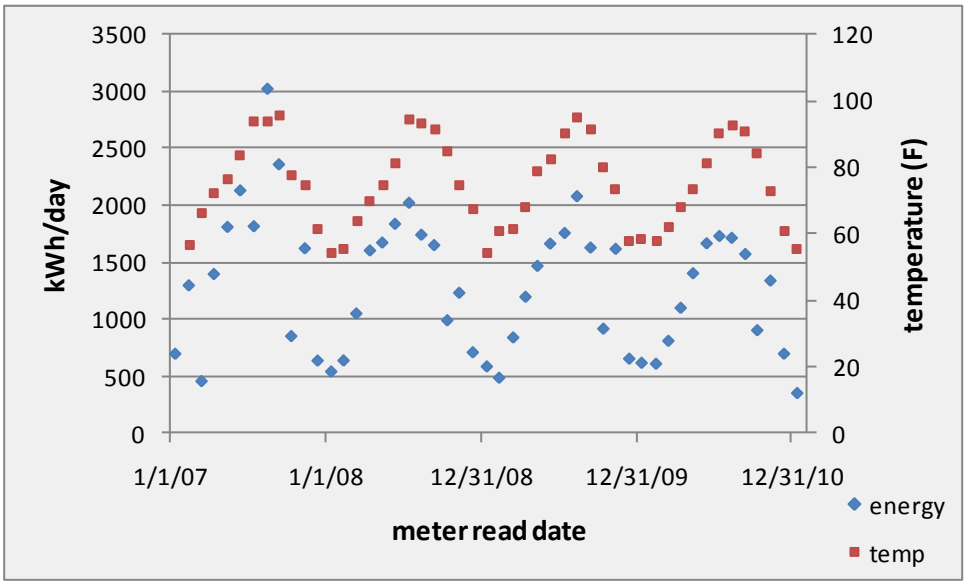
	kW Savings	Annual kWh Savings
Claimed *ex-ante* Savings	0	74,918
Verified ex-ante Savings	0	5,562
Realization Rate	NA	7.4%

Site 2

Site 2 was an irrigation pump station for a golf course. Prior to this project, a bladder controlled water flow from 400 HP of irrigation pumps. The bladder functioned as a sort of pressure controlled throttle for the sprinklers. The site replaced the irrigation pumps and bladder with four new 100 HP pumps controlled by variable speed drives (VFDs).

Navigant took spot measurements of pump power and logged their operation for three weeks. The VFDs were operating properly and the pumps were running significantly below maximum speed most of the time. The pumps are located in a freestanding building which has its own utility meter. The measurements and billing records showed that use is heavier during the summer and pump operation is primarily in the evenings and early mornings, between 5:00 PM and 2:00 AM. Utility billing records for the pump station are shown in Figure 2.

Figure 2. Site 2 Energy Use



The utility billing data in Figure 3 shows that pump use is much heavier during periods of hotter weather. In addition, while the project was implemented in April 2009, a much more significant drop in energy use was seen from 2007 to 2008. The baseline use of 554,200 kWh/year claimed on the application is significantly more than billing records show at any point back through 2007, and this claimed baseline is not supported by the available data. Consequently, Navigant calculated a baseline energy use of 469,400 kWh/year by using the billing data from the year immediately prior to project installation.

Savings at site 2 were 34.6% of claimed savings as demonstrated in Table 10. Current energy use of 423,000 kWh for 2010 is within 0.5% of the predicted VFD usage of 420,902 kWh/year listed in the application. Therefore, the discrepancy between the claimed and verified savings is primarily attributed to the incorrect baseline used for the application.

There are no demand savings associated with this project because the pumps operate almost exclusively in the evenings and at night.

Table 10. Site 2 Installation and Savings

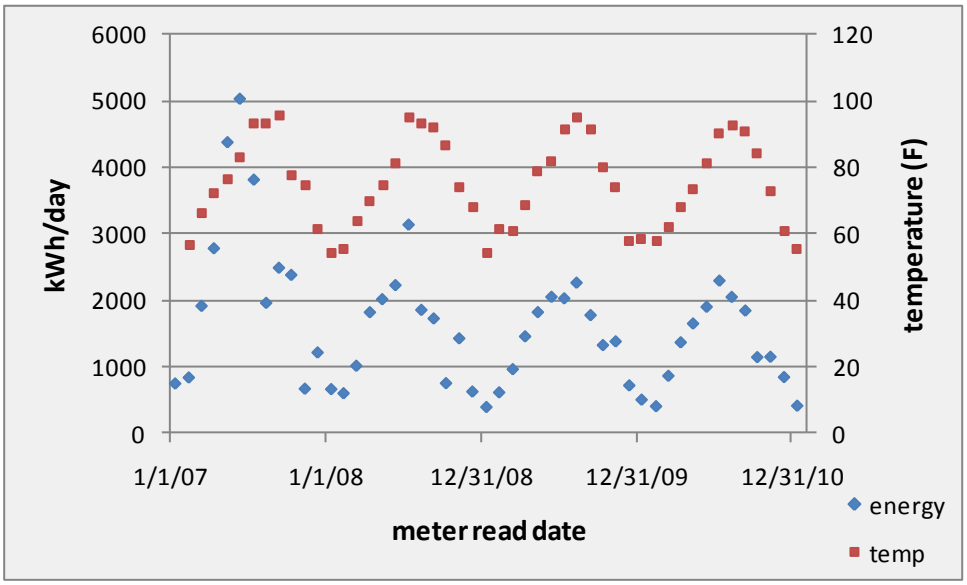
	kW Savings	Annual kWh Savings
Claimed *ex-ante* Savings	0	133,298
Verified ex-ante Savings	0	46,400
Realization Rate	NA	34.8%

Site 3

Site 3 was an irrigation pump station for a golf course with a current set up nearly identical to that at site 2. As with site 2, prior to this project, a bladder controlled water flow from 400 HP of irrigation pumps. This functioned as a throttle for the irrigation system. The site replaced the irrigation pumps and bladder with four new 100 HP pumps controlled by variable speed drives (VFDs).

Navigant took spot measurements of pump power and logged their operation for three weeks. The VFDs were operating properly and the pumps were running significantly below maximum speed most of the time. The pumps are located in a freestanding building which has its own utility meter. The measurements and billing records showed that use is heavier during the summer and pump operation is primarily in the evenings and early mornings, between 5:00 PM and 2:00 AM. Utility billing records for the pump station are shown in Figure 3.

Figure 3. Site 3 Energy Use



The utility billing data in Figure 3 shows that pump use is much heavier during periods of hotter weather. In addition, while the project was implemented in April 2009, a much more significant drop in energy use was seen from 2007 to 2008. The baseline use of 554,200 kWh/year claimed on the application is significantly more than billing records show at any point back through 2007, and this claimed baseline is not supported by the available data. Consequently, Navigant calculated a baseline energy use of 469,400 kWh/year by using the billing data from the year immediately prior to project installation.

Savings at site 3 were 102% of claimed savings as demonstrated in Table 11. Although this project and the one at site 2 were basically identical, with similar verified savings, the discrepancy in their claimed savings results is what leads to the significantly different realization rates between the two sites.

There are no demand savings associated with this project because the pumps operate almost exclusively in the evenings and at night.

Table 11. Site 3 Installation and Savings

	kW Savings	Annual kWh Savings
Claimed *ex-ante* Savings	0	39,442
Verified *ex-post* Savings	0	40,220
	NA	102%

Site 4

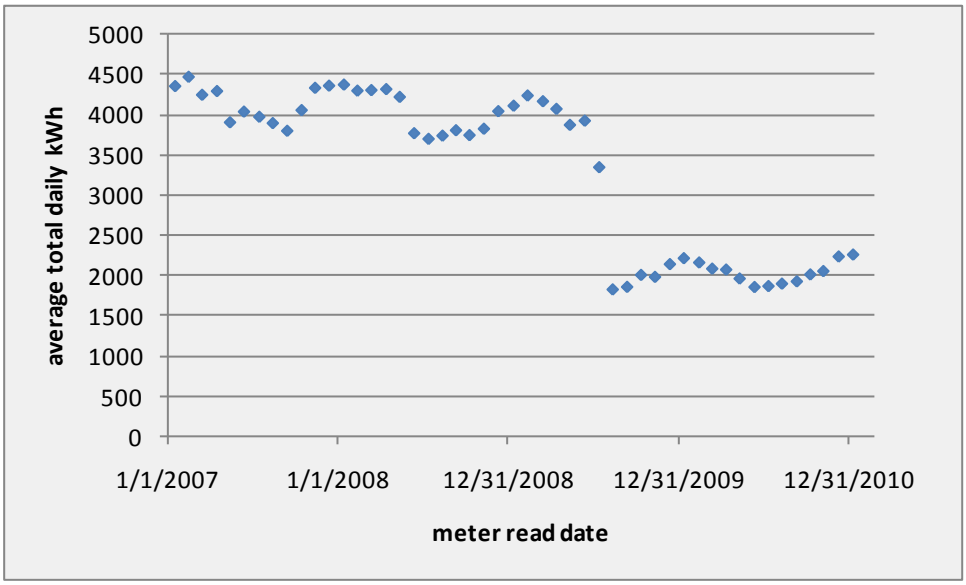
Site 4 was a residential neighborhood that maintains 54 community pools and 54 whirlpool spas. The previously existing single speed circulating pump for each of these pools and spas was replaced by a multi-speed unit, with the final project consisting of 108 pumps. Each pair of pool and spa is shared between 25 residences, and all are open year-round, 24 hours a day. Each pool/spa pair is supplied with power by a dedicated utility meter that also accounts for lighting at the location.

Navigant visited the site and discussed pool operation with facility personnel. During the visit, Navigant took power measurements on pool and spa pumps at two of the locations. There were actually four pumps at each location, but only two had been replaced with multi-speed models. Some of the pumps were cycled off during the visit, but all appeared to be operating correctly, and varying speeds were observed on different pumps. The breakers at the sites included only the four pumps and the pool lights. According to facility personnel, no changes had been made to the remaining single-speed pumps or the lights.

The utility provided Navigant with billing records for 53 of the 54 locations included in the application. Either the 54th pool and spa were sharing a meter with one of the landscaping lakes, or the address on record was not correct.[3] However, there definitely were 54 pools and spas, and 108 pumps were retrofitted. To account for the 54th site, savings are based on the average operation from the 53 available bills. The average daily energy use for the total of the 53 locations is shown in Figure 4.

[3] Billing records could not be located by the utility based on the available information.

Figure 4. Site 4 Average Daily Energy Use



As shown in Figure 4, there a substantial drop in energy use occurred at the time of the retrofit in July 2009. Since these billing records contain only the pumps and pool lights, and the only change made at the site was to replace the 108 circulating pumps, all savings are attributed to this project. Since billing records were only available for 53 of the 54 locations, Navigant adjusted the savings proportionally to account for the additional pool and spa.

Total *ex-post* savings at site 4 are 805,368 kWh/year, 140% of the claimed value. Since the circulating pumps cycle without regard to time of day, and there are 108 of them, demand savings are estimated to be proportional to energy savings. This results in 91.9 kW of demand savings, a 98.9% realization rate.

Table 12. Site 4 Installation and Savings

	kW Savings	Annual kWh Savings
Claimed *ex-ante* Savings	92.9	576,732
Verified *ex-post* Savings	91.9	805,368
Realization Rate	98.9%	140%

Site 5

Site 5 was a produce packing plant. Facility operation was year round, but varies seasonally, as shown in the table below. The plant installed VFDs on four evaporator condenser fans. The south building had a 15 HP fan and a 7.5 HP fan. The north building had a 10 HP fan and a 7.5 HP fan. The energy efficiency opportunity report used to estimate savings for the project based its calculations on only two fans, both 10 HP.

Table 13. Site 5 Operational Schedule

	North Room	South Room
mid-October through mid-April (182)	heavy use; lettuce	heavy use; lettuce
mid-April through mid-May (30)	medium load; green onions	idle
mid-May through mid-June (31)	very heavy load; melons	very heavy load; melons reduced suction pressure
mid-June through late July (40)	very heavy load; grapes	very heavy load; grapes
late July through mid-August (21)	light load; green onions	idle
mid-August through mid-October (61)	down	down

Navigant discussed operation at the plant with site personnel. A typical annual schedule is shown in Table 13. According to facility personnel, fan speed varies according to the wetbulb temperature inside the facility and suction pressure setpoints. During the site visit, Navigant took spot measurements of power consumption on all four condenser fans and installed current loggers on the associated motors. The spot measurements were used in combination with the logged data and motor specifications to estimate fan power and speed. The figures below show the logging results.

Figure 5. North Fan Operation for Site 5

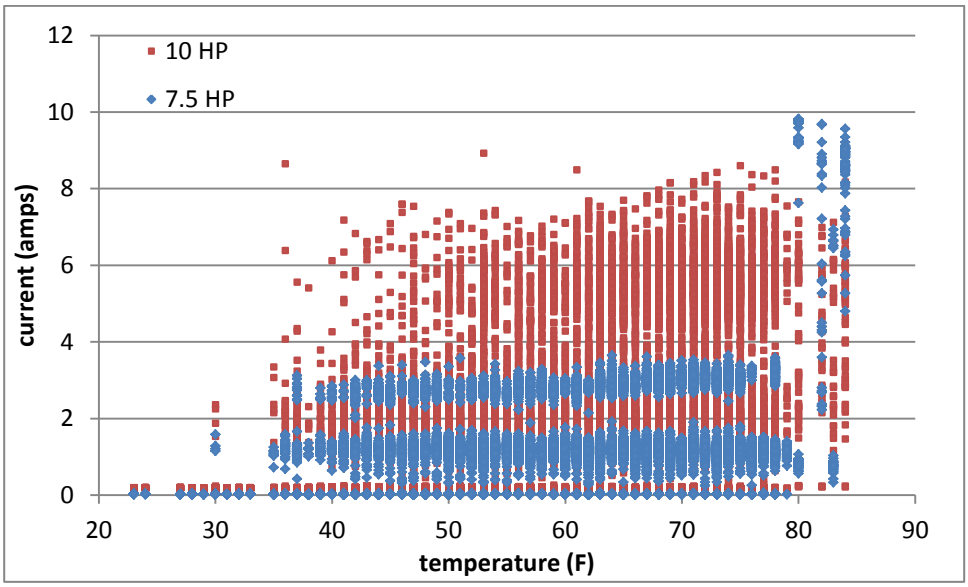
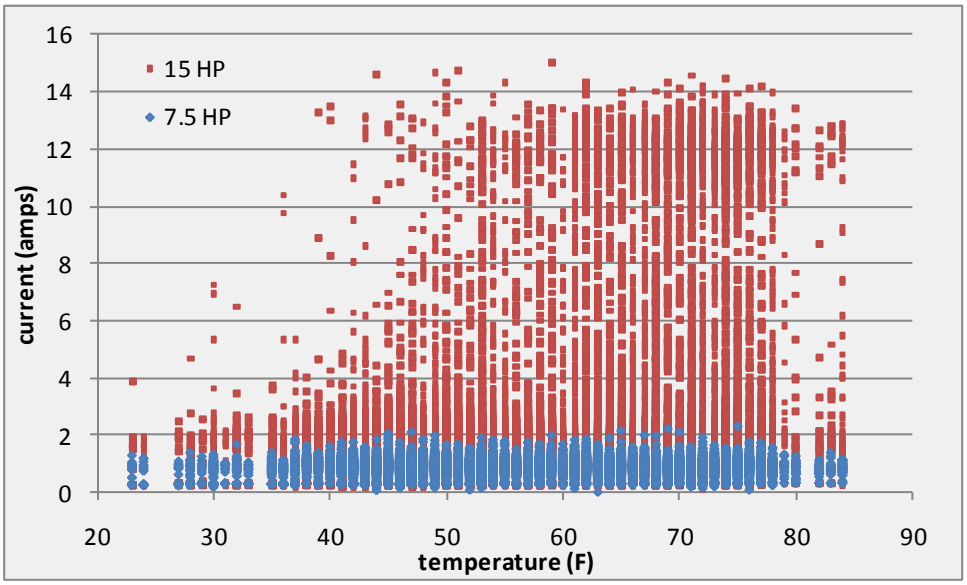


Figure 6. South Fan Operation for Site 5



As shown in Figure 5 and Figure, there is some temperature dependence in fan operation, but it is not strong. Presumably this is because load inside the rooms is the main determining factor on fan speed. The logged data were used to estimate typical fan speeds in plant operation under different conditions.

Without the VFDs, all fans were assumed to run at full speed, but reduced hours when the facility was in use. The percent of fan operational hours was based on facility operation for the baseline. Full fan power was estimated based on the spot readings taken during the site visit. Loading is expected to vary throughout product cycles, although conditions during the site visit represented typical loading for the majority of operational time during the year. During heavy loading times, fans are estimated at full power above 70 °F outside air temperature.

Based on the onsite measurements, savings for this project are 50,450 kWh/year, twice the amount claimed for the incentive. This is partially due to the original estimates only claiming 20 HP of fans for VFDs when the actual project included 40 HP of fans in the retrofit. Since demand savings are based on operation during peak hours on the hottest days of the year, none are attributed to this project.

Table 14. Site 5 Installation and Savings

	kW Savings	Annual kWh Savings
Claimed *ex-ante* Savings	22	25,675
Verified *ex-post* Savings	0	50,450
Realization Rate	0%	196%

Site Observations

There were several notable issues with the applications and implementation for the five projects:

1. *Overestimate of baseline operation for irrigation and well pumps.* Sites 1 and 2 both greatly overestimated savings. This was primarily due to high claims of baseline use.
2. *Incorrect horsepower for fans.* Site 5 had twice the horsepower of VFDs installed as were listed in the project report. A better estimate of savings would be obtained if these values were verified at the time of the application.

Program Record Observations

The final program records submitted by the implementation contractors to Imperial 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 and the available savings spreadsheets.

Based on the review of program documents and on-site verification activities, the following conclusions were reached:

1. *Full savings calculations not included.* Four of the five custom programs included only summaries of savings, but no information on how the savings were calculated. Only site 4 included information on assumptions that went into the calculations. Without more information, it is difficult to determine the reasons for any savings discrepancies between the applications and this evaluation.

2. *Inconsistent documentation.* The program records provided to Navigant for sites 1-3 consisted of incentive application forms with a single attached savings summary table. Sites 4 and 5 did not include application forms, but instead had energy efficiency recommendation reports. In both these latter cases the reports listed several measures, only one of which had been implemented, and no installation information.

Gross Impact Evaluation Results

Impact evaluations were performed for Custom Energy Solutions Program and the Residential Pool Pump Program. Combined, these two programs account for about 22% of IIDs 2008 claimed savings. The majority of 2009 claimed savings comes from the QACM Program. However, a preliminary review of the program tracking database for the QACM program indicated that the data as it is currently maintained is not ready for a detailed impact evaluation. Therefore, for this fiscal year, the EM&V for the QACM program is a process evaluation that reviews the methodology used by the program implementers, the data reporting process, and the relative reliability of the net energy savings estimate.

A total of 958,079 kWh and 58 peak demand kW were claimed in 2009 from the Residential Pool Pump Program. The measure realization rate was found to be 100% for these claimed savings.

Table 15 provides the savings reported in the final installation review documents submitted for the Custom Solutions Program and the verified gross savings. The overall energy measure realization rate is 112%. Sites 4 and 5 saved substantially more than claimed, but sites 1 and 2 both had unreasonably high savings claims due to overestimates of baseline electricity usage.

Table 15. Claimed Savings and Verified Gross Savings for the Custom Solutions Program

	Claimed		Verified		Measure Realization Rate	
Project	kW Savings	Annual kWh Savings	kW Savings	Annual kWh Savings	kW Savings	Annual kWh Savings
Site 1	0	74,918	0	5,562	NA	7.4%
Site 2	0	133,298	0	46,400	NA	34.8%
Site 3	0	39,442	0	40,220	NA	102%
Site 4	92.9	576,732	91.9	805,368	98.9%	140%
Site 5	22	25,675	0	50,450	0%	196%
Total	**114.9**	**850,065**	**91.9**	**948,000**	**80%**	**112%**

Net-to-Gross Assessment

Directly estimating net impacts was not part of the scope for this project. Rather, the approach to identifying possible net-to-gross values is to rely on the extensive number of net-to-gross assessments conducted primarily for the investor owned utilities (IOUs) in California. These IOU studies relied on large sample populations and though the IOU programs differ is some ways from IID's programs, they provide evidence of alternative NTGR values that IID may want to consider. Using these outside studies also allows IID to save valuable budgetary resources.

The on-line searchable database for the California Measurement Advisory Council (CALMAC) was used as the source for the studies included in this NTGR literature review. The alternative estimates for NTGR are drawn from these sources when appropriate

Residential

The residential IID energy efficiency programs include the list of measures that follow. An *ex ante* NTGR of 80% is used for each of these residential measures.

- Central A/C
- HVAC Tune-up
- Windows
- Energy Star refrigerators
- Pool pump
- CFLs
- Home electronics

Two recently completed studies by Cadmus[4] and Itron[5] included NTGR evaluations for three of these residential measures. Included in the evaluation sample were participants from the California Investor Owned Utilities. Table 16 identifies the NTGR values estimated by measure for each of the studies. The table also includes a possible alternative NTGR value for the measures. The alternative values are an average of the findings.

[4] *Residential Retrofit High Impact Measure Evaluation Report,* prepared for the California Public Utilities Commission Energy Division, prepared by Cadmus Group, Inc et.al., February 8, 2010

[5] *2004/2005 Statewide Residential Retrofit Single-Family Energy Efficiency Rebate Evaluation,* prepared for the California Investor Owned Utilities, prepared by Itron, Inc et.al., October 7, 2007

» **Table 16. Current and Possible Alternative NTGRs**

Measure	*Ex* Ante *NTGRs*	*CADMUS Study*	*ITRON Study*	*Alternative NTGRs*
Pool pump	80%	32%	69%	50%
CFLs	80%	NA	58% - 72%	65%
Central A/C	80%	NA	67%	67%

KEMA[6] performed a study published in 2010 that include NTGR assessments for a number of both residential and commercial programs. These included refrigerant charge, airflow, and duct sealing measures. Five different programs offered through PG&E, SCE, and SDG&E were included in the evaluation. NTGR estimates by program varied significantly, ranging from 54% to 96%. A weighted average NTGR, based on achieved savings, is 65% for the residential sector.

A 2003 residential retrofit program EM&V study by Quantum Consulting[7] included an assessment of double pane windows as a program measure. Specific NTGRs were not stated in the study, but a major element of the study was interviews of both program participants and program contractors. The questions asked were the usual for estimating NTGR values. The findings from both participant and contractor surveys indicated that rebates for high-performance dual-pane windows had little influence on the purchase decision. Ninety percent of participants said they would have purchased high performance windows absent the rebate. This provides an inferred NTGR of 10%.

A study conducted for the Northern California Power Agency[8] included evaluating Energy Star refrigerators. The estimated NTGR from this study for Energy Star refrigerators was 80%.

No studies could be found that included a NTGR assessment for home electronics. Therefore, there is no basis to change the current estimate of 80% NTGR. Table 17 lists the alternative NTGR values for residential measures.

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[6] *Evaluation Measurement and Verification of the California Public Utilities Commission HVAC High Impact Measures and Specialized Commercial Contract Group Programs,* prepared for the California Public Utilities Commission Energy Division, prepared by the KEMA Inc et.al., February 10, 2010

[7] *2003 Statewide Residential Retrofit Single-Family Home Energy Efficiency Rebate Program Evaluation,* prepared for the California Investor Owned Utilities, prepared by Quantum Consulting, Inc. et.al., December 29, 2004

[8] *Measurement & Verification Load Impact Study for NCPA SB5X Miscellaneous Rebate Programs*, prepared for the Northern California Power Agency, prepared by Robert Mowris & Associates, June 25, 2005

Table 17. Current and Possible Alternative NTGRs for Residential Measures

Residential Measures	*Ex Ante NTGR*	*Alternative NTGR*
Central A/C	80%	67%
HVAC Tune-up	80%	65%
Windows	80%	10%
Energy Star Refrigerators	80%	80%
Pool Pump	80%	50%
CFLs	80%	65%
Home Electronics	80%	80%

Non-Residential

A large number of measures are included within the non-residential sector. As with residential measures, an *ex ante* NTGR of 80% is used for all non-residential measures. Below is a list of all the non-residential measures for which there are claimed energy savings for FY 2009.

- Linear fluorescent
- High bay lighting
- HVAC
- HVAC Tune-up
- Chillers
- Motors/Pumps/VFDs

A good source for commercial sector lighting measure net-to-gross assessment is the 2010 report "Small Commercial Contract Group Direct Impact Evaluation Report".[9] This report presented the evaluation results for the 2006-2008 nonresidential energy efficiency high impact lighting measures (HIMs) and several non-HIM measures, both lighting and non-lighting. These measures were offered in programs implemented by Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), Southern California Gas (SCG), San Diego Gas and Electric (SDG&E) and third party implementers for the 2006-2008 program cycle.

The net-to-gross analyses are based on a self-report methodology that estimated four separate measurements of free ridership from different inquiry routes and then averaged the values to derive the

[9] *Small Commercial Contract Group Direct Impact Evaluation Report*, CALMAC Study ID: CPU0019:01, prepared for the California Public Utilities Commission Energy Division, prepared by Itron, Inc et. al., February 9, 2010

final free ridership estimate at the measure level. The net-to-gross estimates often varied widely by utility within the same measure classification. No reasons were provided for the variance between the utilities. Below are the estimates of net-to-gross by measure classification by utility and an overall weighted average across the utilities.

- Linear fluorescent lighting:
  - PG&E - 73%
  - SCE – 79%
  - SDG&E – 87%
  - Weighted (by savings) average – 81%
- High bay lighting:
  - PG&E - 68%
  - SCE – 68%
  - SDG&E – 95%
  - Weighted (by savings) average – 74%

Another study that focused specifically on high bay lighting, estimated a similar net-to-gross factor of 69% compared to the Itron study findings that ranged from 68% to 95% with a weighted average of 74%. This 2010 report[10] was conducted by KEMA and Itron and is a market effects study of the PG&E, SCE, and SDG&E 2006-2008 energy efficiency programs on the commercial and industrial high bay lighting products.

A recently completed study by KEMA[11] evaluated HVAC High Impact measures. As with the other studies, the net-to-gross estimates are based on a telephone survey. Included in the evaluation sample were participants from the three largest California IOUs. The results were very similar across the three utilities.

- HVAC A/C Equipment:
  - PG&E - 7394
  - SCE – 96%
  - SDG&E – 94%
  - Weighted (by savings) average – 94%

[10] *High Bay Lighting Market Effects Study*, prepared for the California Public Utilities Commission Energy Division, prepared by KEMA, Inc and Itron, Inc., June 18, 2010

[11] *Evaluation Measurement and Verification of the California Public Utilities Commission HVAC High Impact Measures and Specialized Commercial Contract Group Programs,* prepared for the California Public Utilities Commission Energy Division, prepared by the KEMA Inc et.al., February 10, 2010

As noted under the residential section, KEMA6 performed a study published in 2010 that include NTGR assessments for a number of both residential and commercial programs. These included refrigerant charge, airflow, and duct sealing measures. Four different programs offered through PG&E, SCE, and SDG&E were included in the evaluation. NTGR estimates by program varied significantly, ranging from 54% to 94%. A weighted average NTGR, based on achieved savings, is 75% for the commercial sector.

A study conducted for the Northern California Power Agency evaluated the non-residential custom electric incentive programs for several Northern California publically owned utilities[12]. This study utilized telephone surveys to evaluate net-to-gross ratios. Among the several measures assessed were chillers provided by two different utilities. The estimated NTGR for these two chiller offerings was 99% and 96%, for an average chiller NTGR of 97%.

The motors and pump improvements in the non-residential sector for IID generally included the addition of a VFD to the motors or pump. A 2008 evaluation study by Itron[13] included a NTGR assessment for non-residential HVAC/Motors programs. These programs included both express procurement and upstream procurement efforts. Telephone surveys were utilized to evaluate net-to-gross ratios. Nine different programs were included in the evaluation with the individual program NTGRs ranging from 70% to 76%. The average estimated NTGR for these programs is 73% and we think it is a possible proxy for IID's motors/pumps/VFD measures.

Table 18 lists the alternative NTGR values for non-residential measures.

Table 18. Current and Possible Alternative NTGRs for Non-Residential Measures

Non-Residential Other Measures	*Ex Ante NTGR*	*Alternative NTGR*
Linear Fluorescent	80%	81%
High Bay Lighting	80%	74%
HVAC	80%	94%
HVAC Tune-up	80%	75%
Chillers	80%	97%
Motors/Pumps/VFDs	80%	73%

[12] *Measurement & Verification Load Impact Study for NCPA SB5X Commercial and Industrial HVAC Incentive Programs*, prepared for the Northern California Power Agency, prepared by Robert Mowris & Associates, June 25, 2005

[13] *2004/2005 Statewide Express Efficiency and Upstream HVAC Program Impact Evaluation*, prepared for the California Public Utilities Commission Energy Division, prepared by Itron, Inc. and KEMA, Inc., December 31, 2008