Would The True Industrial Energy Efficiency Savings Please Stand Up?

Al Lutz, Kris Bradley, and Vishy Tirumalashetty, Itron, Inc.

ABSTRACT

Industrial programs have the potential to provide large energy efficiency savings, but when they don't deliver as expected, the impact on attainment of utility savings goals can be significant. A recent example surrounds the savings claimed through California's IOU-sponsored industrial energy efficiency programs for 2006-2008. Though aggregate savings were still substantial, ex-post evaluation estimates of the program savings were significantly lower than the utility-claimed savings. This paper examines how to bridge this gap and improve program-claimed savings. Findings from a detailed analysis of many individual projects indicated that the savings gap was largely due to a number of factors: improper baseline specification, lack of production adjustments, modest program influence on project decisions, and limited information on certain technologies with involved system interactions. The importance of each of these factors is detailed, considering the achieved results as measured in the impact evaluation. The extent to which industry standards and common practices in an industry govern evolving baselines is highlighted, as is the importance of early and effective program influence. Useful life considerations, natural turnover, and the appropriateness of production level adjustments (particularly when enabled by newer industry-standard processes) are explored. The topic of industrial efficiency is especially relevant as utility energy efficiency goals increase and industries focus on reducing energy costs as a way to increase profits in a tough economic environment.

Importance of Energy Evaluation in the Industrial Sector

The industrial sector accounts for 30% of total annual national energy use (DOE, 2009). Energy use reductions in this sector have been the target of energy savings efforts and program offerings by governments and utilities. The evaluation of any program is important to ascertain the achieved results as compared to the claimed results, and the evaluation of energy programs targeted at the industrial sector is no exception. The diversity of programs across different industries and the variety of projects, along with multiple project drivers, contribute to making the evaluation efforts particularly important and instructive in shaping new programs and approaches as well as in verifying energy savings.

The results and findings of the industrial energy evaluations of two IOU sponsored industrial energy efficiency programs in the program years 2006 – 2008 conducted for the CPUC (Itron et al., 2010; Itron et al., 2009) are examined to explain the approaches and address the areas for improvement in industrial energy savings estimation. Separate reports were generated for each contract group; these are publicly available at www.calmac.org.

When we consider the program induced energy savings, it is important to realize that there are both gross impact and net impact components. These components lead to gross realization rates, net to gross ratios, and net realization rates combining those factors.

The gross impact component of energy savings typically refers to the savings technically possible through the implementation of the measure. These are the savings that an energy end user, or program participant, most commonly associate with energy savings.

The net component of energy savings determination involves participant decision making and the likelihood of energy savings measures or actions being implemented in the absence of and without participation in the program. This can be caused by many factors, such as the desire to implement a measure for non-energy reasons (e.g., production changes, material management, quality improvements, labor productivity), corporate energy saving mandates, decisions to implement a technology corporate wide, a 'green' marketing campaign, etc.

Energy savings can mean different things to different people. What do we mean by the 'true' industrial savings? The utility may claim a level of energy savings, the participant may realize a different level of energy savings, and the evaluator may determine yet another level of energy savings. For evaluators, the energy savings is the savings caused by program participation. The participant is not as concerned – or even may not be at all concerned – that the program caused the savings. They are concerned with the savings they realize and the costs they accrue to realize these savings.

The use of only program induced savings is an important requirement to evaluate the effectiveness of the programs in causing or accelerating actions. Whenever there are utility, state or federal energy efficiency programs – anytime there is a subsidy or monetized (or non-monetized) incentive such as a rebate or an audit – and anytime when transaction costs are borne by other parties, such as all ratepayers or all taxpayers, it is important to know the results of the programs. In these evaluations, then, the programs should claim only program induced savings for cost effectiveness and equity calculations.

Approaches Taken and Research Performed to Determine Program Induced Energy Savings

Gross impacts were determined by application review, project documentation review, site visits, M&V activities, and on-site interviews. Metering/monitoring was accompanied by data collection of pre and post implementation operating conditions. In some cases, a more accurate methodology for energy savings may be used, perhaps involving the knowledge of post installation energy use or other parameters not available during project implementation. The evaluators determine an ex post savings figure, reflecting the gross energy savings found based on actual as found operating conditions. The evaluators attempted to ascertain an accurate baseline condition, reflecting the pre implementation operating conditions which would have prevailed in the absence of the program. Adjustments were included for production, occupancy, baseline, weather or other parameters that changed. Information was collected on the remaining useful life (RUL) of the equipment and the normal replacement schedule for equipment, in order to differentiate retrofits where the program induced early equipment replacement.

The net impacts were determined by primary research – data collection efforts focusing on participating customers, vendors and sometimes manufacturers. Net impact results were estimated using telephone interviews, including both scripted questionnaires administered through a CATI[1] center and in depth interviews which are more fluid and personalized. On-site interviews conducted by the gross impact team also aided the net to gross impact assessment. PG&E carried out a very large and extensive implementation effort in the industrial sector. The impact evaluation results yielded claimed ex ante savings, ex-post energy savings estimates,

---

[1] Computer assisted telephone interview (CATI) centers are useful when administering a survey to a large number of telephone participants.

gross savings realization rates, and the net-of-free-ridership ratio (NTFR). NTFR is commonly used interchangeably with the net to gross ratio (NTG).

For the PGE Fab (PG&E Fabrication, Process and Manufacturing Contract Group) impact evaluation, the overarching objectives and evaluation approach can be summarized as follows:

- Verify installations to validate what was reported.
- Estimate gross savings for participating sites that received incentive payments.
- Estimate savings net of free riders based on approved methodology.
- Estimate net program realization rates for each of the reporting domains.
- Develop impact evaluation results.
- Provide findings and recommendations to improve the industrial programs.

Table 1 below provides a comparison of the evaluation-based net savings with the final program-claimed net savings for the PGE Fab evaluation. Realization rates reflect the ex post evaluated savings based on the first year energy savings.

Table 1: Comparison of Evaluation-Estimated Net Savings with the Final Program-Claimed Net Savings: PG&E Fabrication, Process and Manufacturing Contract Group

	Electric Savings		Gas savings
	kWh/year	Avg. peak kW	Therms/year
Tracking			
a. Claimed Gross Savings	482,574,664	59,333	40,144,380
b. Claimed NTG Ratio	0.79	0.79	0.76
c. Claimed Net Savings (c = a x b)	379,657,050	46,677	30,325,098
Evaluation			
d. Evaluation Gross Realization Rate	0.49	0.46	0.68
e. Evaluated Gross Results (e = a x d)	237,003,506	27,093	27,169,773
f. Evaluation NTG Ratio**	0.53	0.52	0.31
g. Evaluated Net Results (g = e x f)	124,731,778	14,012	8,302,483
h. Evaluation Net Realization Rate (h = d x f)	0.26	0.236	0.21
i. Evaluated Net Savings as a Fraction of Claimed Net Savings (i = g / c)	**0.33**	**0.30**	**0.27**

* Claimed results exclusive of the 58 PGE2004 records that were included in the New Construction Codes and Standards evaluation.

** Consistent with current CPUC policy, the Net-to-Gross ratios in this evaluation reflect the effect of free ridership only and exclude any consideration of spillover.

Source: Itron et al. 2009

Reasons for the Savings Shortfall

The following sections describe in more detail several key areas that contributed to the savings shortfall, i.e., the difference between the savings claimed in the ex ante case and the savings found attributable to the energy efficiency programs in the ex post case.

Improper Baseline Specification and Operating Values

One of the most significant reasons for differences between ex ante and ex post estimates of savings was improper baseline specification (including the use of improper operating values used for calculating energy use or improper baseline system specification). Baselines and baseline specification involves both equipment or systems and operating parameters for that equipment/system. Often times, existing or in situ systems are used as the baseline, although in many instances this will not be an appropriate baseline claim. The correct baseline for energy evaluation purposes would be the operating system that would have been installed without the program. This is typically governed by industry standards and common practices.

Consider a case where standard practice has changed the normal baseline for an energy end use. Commercial lighting has moved from standard electromagnetic ballasts to electronic ballasts and from T12 lamps to T8 lamps, with higher efficiency T5 lamps being a step above the industry standard or standard practice. There are similar examples from industry; for example, for higher hours of use, the norm has changed from a standard thermal oxidizer (TO) to a regenerative thermal oxidizer (RTO). For a new installation, the RTO would typically be an appropriate baseline. For a retrofit application, the RTO would also constitute the baseline if the TO was replaced by an RTO on TO burnout (replace on burnout, or 'ROB'). On the other hand, if the TO had a number of years of remaining useful life, the evaluator would allow credit for an appropriate number of years of savings in the gross impact calculations.

In addition to improper baseline specification, equipment operating schedules and profiles were also considered. The ex ante calculations often utilized overestimated critical parameters such as operating flow or production values; in such cases the ex post savings were significantly reduced. Such instances were found at over 30 of the 160 sites and were one of the major reasons for the gap between ex ante and ex post savings estimates.

As a case in point, at one refinery location (Site ID B026a), the energy and demand savings were estimated assuming that the production for the facility would increase. However, the production did not increase in the period following measure installation.

In another case (site ID B055), a control panel in a non-functioning variable speed drive (VSD) was replaced with a new control panel. There was no discernable difference in how the unit would have operated if properly maintained and how the unit operated under the incentivized retrofit. The ex ante claim implied the baseline was a motor without a VFD. However, the existing VFD should have been repaired and operable. Repairs were ineligible under the program and savings were set at zero.

Another project involved a wood processor (site ID B038) that was forced to change systems due to lack of availability of raw product. However, there was no other feasible baseline for the immediate period – the change could not have been postponed. The realization rate due to these measures was set to zero.

Lack of Functioning Equipment

There were found to be instances where the retrofit failed to work as intended and the existing system condition was reverted to immediately after the retrofit. In one case, a high tech manufacturer did not wish to risk production quality and reverted to HVAC system operation as had existed prior to the EMS control system installation (Site ID B049, B050). In another case, equipment was damaged and not replaced several years after the retrofit due to a voltage spike at the facility (Site ID 73). It was verified that 12 of the 15 installed VSDs were not in operation and therefore, the calculated ex post savings were reduced significantly compared to the ex ante savings. Also, it was verified that, for one site (site ID B075), one of the six injection molding machines that were the basis of the ex ante savings was not installed. Finally, for one oil field project (Site ID B116a), only three of seven progressive cavity pumps with VFDs were installed, and one of these wells was abandoned. The recurrence of equipment that was not installed or did not function as intended highlights the importance of verification efforts.

Lack of Production Adjustments

Ex ante savings caused by industrial energy efficiency programs can be overstated or understated if production is not adjusted, or normalized, to pre retrofit or post retrofit conditions, depending on the nature of the retrofit affecting production or the cause of the production adjustment. In one case at a semiconductor manufacturer (site ID B006), the change in production was due to a technology installed which resulted in an increase in production. The ex ante adjusted savings was based on post production levels. Since the change in production was due to the technology and not due to market conditions, the ex post analysis adjusted savings based on the pre-retrofit production, yielding lower savings. Production adjustments should be performed based on established protocols which would ensure the correct handling of production increases and decreases.

Similar use of increased post retrofit production was a cause of a great overstatement of energy savings for a vapor recovery unit for a gasoline refueling station (site ID C014). Better technology allowed an increased level of gasoline recovery. That level was multiplied by the change in energy intensity to recover the gasoline (in kWh/gallons) in order to yield the claimed energy savings. As the technology allowed the increased recovery, and those gallons were not being recovered before the retrofit, the savings from the retrofit should have been based only on the pre retrofit gasoline recovered. The resulting gross realization rate was 0.21. (This site also showed low program influence, with a net to gross ration of 0.08; the value of gas recovered had an enormous economic benefit, the project has a simple payback of only a few months on this basis, an indication of lack of program importance in the decision to implement this particular measure).

Another complex project involved a large manufacturing facility (Site ID B095) that undertook a large retrofit project. Energy savings were based on energy intensity in kWh per ton. Based on lower production, however, kWh per ton actually increased and there was an energy penalty. Two other sites went completely out of business and ceased operations; however, there were energy savings at the time of the ex post evaluation site visit and the gross realization rates were close to 1.00 for the first year. The impacts of a recessionary and slow economy were a significant cause for low gross realization rates and lower evaluated savings than that which was forecast and claimed by the IOU programs. This is believed to account for about 20% of the overall savings shortfall.

Instructions and procedures documents developed as internal guidelines for California impact evaluations included guidance from publications on production adjustment. For industrial measures, changes in production between the pre-installation and post-installation periods must be considered in a manner consistent across various impact evaluations. Changes in production have a direct impact on total energy usage and energy savings. The procedures followed in this evaluation are believed to be viable and realistic, as they are consistent with established protocols described in Section 3.4 of Appendix J of the Cadmac evaluation protocols (Cadmac, 1998). In order to adjust the baseline, an industrial process application must clearly elaborate how an increase in production between the base case and the improved (or ex post) case is traceable to market conditions and not to production improvements due to the implementation of the incentivized measure(s). If the causes for production increases are not adequately described, then load impacts were calculated using the production prior to the installation of the measures (to prevent subsidization of production equipment). Further, to demonstrate market effects, the baseline equipment and systems must be capable of the increased production levels.

Lack of Information on Complex Technologies and Interactions

There are numerous sites where a complex system was not clearly demonstrated to save energy or in which the system interactions are unable to be documented to show clear defensible and accurate energy savings.

One site (site ID B063) consisted of various operational changes for steam generators, motors, and pumps; these changes affected the entire facility. The energy consumption of the installed systems did not account for all the interactions between the new equipment and existing equipment. Significant electrical savings were claimed. The ex-post analysis performed accounted for the system interactions and determined that the facility in fact had not saved electric energy but incurred an electric penalty. It also is noteworthy that the ex ante analysis did not report any gas savings, but the ex post analysis identified significant gas savings due to the new systems and their interactions. Therefore, for complex situations, the ex ante analysis needs to be more descriptive, detailed and comprehensive.

To further illustrate this point, consider another project involving energy transfers from one site to another site (Site ID B041a). This project involved two facilities four miles apart. A pipeline was installed to transport steam generated by a cogeneration system with excess capacity at one site to a second site, allowing reductions in gas used by that site. The first site performed the energy saving measures which reduced the steam usage and would have reduced coal usage at that site. During the ex post analysis, the project was determined to be a fuel switch project and no savings were credited since this measure uses coal to offset gas use. Verification of the handling of this complex project with the IOUs, the participants, the evaluators, and regulatory bodies could have prevented the claiming and disallowance of savings and reduced the overall gap between program ex ante and ex post savings.

Moderate, Limited or No Program Influence

Program influence was minimal in many cases for a number of different reasons. In some cases, program implementers arrived late in the decision making process and offered incentives for projects that had already been decided upon. Program claims were also made on a number of projects that customers initiated for non-energy savings reasons and for which no alternative was ever considered. Program incentives were offered for measures and technologies that are known to be industry standard practice. Program incentives were also offered for projects that were being implemented by end users in response to mandates from other regulatory agencies, for example, citations from air resource districts.

Measures that are already standard practice and extremely likely to be installed by the vast majority of the market should constitute a new baseline and not qualify for incentives. A number of such measures can be identified through investigation of industry practices (e.g., interviews with manufacturers, distributors, retailers, and designers), analysis of sales data, and review of evaluation results.

Influencing industrial customers to implement energy efficiency projects that go beyond their normal practices and plans is extremely difficult. Increasing program influence requires providing advanced energy efficiency options directly to end users at the earliest stages of their decision making.

For the largest projects and those with significant policy issues, an Early Project NTG and Baseline Screening step could be implemented. This step would involve review of the baseline claim and conducting NTG interviews just after the participant's implementation decision is made. The purpose of this screening is to obtain critical information regarding program influence that may lead to the project being re-defined or dropped.

The case of pump-off controllers, (POCs) [2] is instructive. In addition to energy savings, a very important benefit of POCs is their ability to allow for continuous monitoring and optimization of well pumps. These capabilities continue to be important today. Regardless of that benefit, POCs are not yet standard practice for existing wells in California; POCs are not commonly installed outside of rebate programs, and only one of the 16 companies interviewed acknowledged installing POCs as a standard practice for both its existing and new wells. Two major oil companies are installing POCs on existing wells in Texas and Oklahoma, states without rebate programs, and expect to have POCs on all wells in the next three or four years. However, for new wells, installation of POCs as a standard practice has become more common. The economics of installing a POC on a new well is compelling since the cost of a POC (~$4,000) is insignificant compared to the cost of drilling and completing a new well (~$250,000), while the benefits of a POC are extensive. Three of four major oil companies interviewed indicated they would install POCs on new wells in California even without rebates.

For other industrial projects, the baseline issue is extremely relevant. At one site (Site ID B064), diesel pumps with inherent variable speed capabilities that were required by this application were replaced by electrically driven pumps with variable speed drives. A 0.00 NTG program score was assigned as the customer had no other viable baseline – variable speed capability was required in this application and the customer had already decided to install electric motors with these drives before they applied for the program.

Categorizing the Projects, Programs, Measure Types

The various end use categories in the industrial evaluations were grouped into measure types to determine the extent to which certain types of measures are more liable to have large gaps in ex ante and ex post savings. Table 2 shows the realization rates for PGE Fab and sites evaluated in a Southern California Edison (SCE) industrial energy efficiency program (Program SCE 2509) across various end use categories. The maximum realization rate was achieved for lighting projects. The complexity of calculating savings is greater for the remaining end uses, as there are many uncertainties when values are estimated without measurements and operating conditions are subject to change. As an example, for POCs and VFDs, the gross realization rates are low, and the variables relating to both operating hours and power consumption are uncertain.

[2] POCs are a technology that detects the amount of fluid in an oil well to reduce pump operation.

Table 2: Realization Rates by Measure Categories

End Use	No. of Sites	RR_kW	RR_kWh	NTG	Net RR kW	Net RR kWh
POC	48	0.43	0.41	0.42	0.18	0.18
VFD	21	0.69	0.66	0.66	0.45	0.43
Process Other	18	0.47	0.56	0.50	0.23	0.28
Compressed Air	13	0.43	0.47	0.70	0.30	0.33
Lighting	11	1.03	1.04	0.71	0.73	0.74
IMM	8	0.32	0.31	0.71	0.23	0.22
Smart Wells	6	0.96	0.97	0.44	0.42	0.42
HVAC/Refrigeration	6	0.42	0.62	0.94	0.39	0.58
Total Electric	**131**	**0.59**	**0.63**	**0.63**	0.38	0.40
	No. of Sites	**RR_Therm**		**NTG**	**Net RR therms**	
Total Gas	29	0.82		0.39	0.32	

One category that stands out is smart well installations. These figures are misleading however. There is a wide range in the realization rates, with many of the sites substantially higher or lower than 1.00. The other items of note are the low gas net to gross ratios, but higher gross realization rates than any other category besides lighting and smart wells. The low net realization rates associated with POCs, Injection Molding Machines (IMMs), and gas measures indicate that the program design and evaluation of these technologies might bear special consideration in future program and evaluation planning.

Figure 1: Reasons for Savings Shortfall

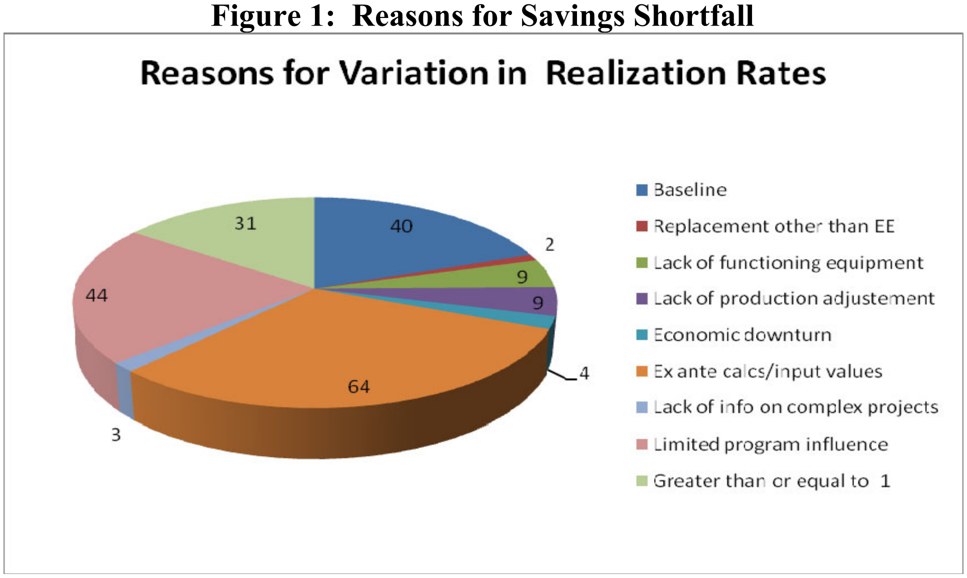

Figure 1 above shows graphically the importance of the reasons for the gross impacts being lower than 1.00. A large reason for the overall shortfall was incorrect input values, while next in importance was limited program influence, followed by baseline issues.

Improvements to Bridge the Gaps

Significant energy efficiency goals (in terms of the physical units of energy saved) for energy efficiency exist for certain programs in California's energy efficiency portfolio. The targets for industrial energy efficiency programs are high. These goals can sometimes cause a hopeful but high estimation of energy savings, which more closely relates to a maximum value verses a realistic expected value. The energy savings claimed may also reflect the realized energy savings but not necessarily the program induced savings.

How do we reduce the size of this discrepancy? There are a number of questions the participants and implementers can ask as savings estimates are prepared.

- What is the program induced savings? What would have happened in the absence of the program? Is there an alternate reasonable baseline?
- What is the production level? How did it change? What is expected in the future?
- Are all interactions accounted for?
- What are the non energy benefits?
- Is the technical basis for each savings claim documented and believable?

The following summary list of recommendations describes baseline and other issues that may assist in closing the gap between claimed and evaluated savings, resulting in the evaluated ex post results being closer to the claimed ex ante savings.

- Improve baseline specifications by explicitly indentifying the project and identify the remaining use life of existing equipment
- Conduct baseline research to establish standard industry practices for key measures
- Conduct analysis of customer incentives and further research on use of incentive caps
- Consider using early project NTG and baseline screening for larger projects and those with policy issues such as fuel switching, self generation, and greenhouse gas impacts
- Reconfigure programs to maximize net not gross program impacts by excluding measures with high naturally occurring adoption levels
- Carefully review qualifying measures for each program and eliminate eligibility for those that are standard practice
- IOU program staff and their implementers should make more conservative assumptions, including values used in savings calculations, based on present and expected operation
- Full descriptions of projects and collection/reporting of baseline parameters should be required, especially for large or complex projects
- Put measures with an inadequate empirical basis for savings estimates in the emerging technologies program
- IOUs should consider a realization rate adjustment in ex ante estimates of custom measure claims until future evaluation results indicate higher gross realization rates.
- Programs should incorporate greater levels of real-time measurement and pre- and post-installation measurement based verification
- Controls should be instituted to ensure compliance with program guidelines and eligibility
- Revisions should be made to the IOU work paper assumptions and ex-ante impact claims

- IOUs should consider reclassifying or segmenting measures to best forecast savings by considering if measures should be treated as prescriptive measures or custom measures
- IOUs should closely monitor the installation of measures to ensure that they are properly installed and operational
- A true up period to confirm operation after savings are claimed may be appropriate if it complies with policy requirements related to timely filing of claimed – and amended - results
- Conduct persistence studies of industrial sector savings
- Improve the capability of program implementation staff to materially influence advanced industrial efficiency improvements
- Enhance the program's capability to become involved with projects at the earliest possible stage
- Provide continuity in account representative assignments, particularly for the largest customers
- Consider limiting or excluding incentive payments to known free riders
- Consider incorporating a payback floor
- Consider tying staff performance to independently verified net results

Importance, Relevance and Magnitude of the Issue

The industrial energy savings potential is a critical component for the utilities to achieve targeted energy savings goals. Industrial energy savings measures do, however, pose a great challenge in estimating the energy savings due to the uncertainties surrounding their application. This paper highlights the reasons for the gap between the ex ante and ex post savings and provides recommendations that can bridge this gap and improve program claimed savings. This paper should guide the energy efficiency community to better understand the areas that need to be addressed and to ensure that the accuracy of the utilities projections for achieved energy savings is improved.

These industrial evaluations are extremely useful for informing future industrial evaluation efforts as well as for identifying improvements to the design and implementation of industrial programs.

Several areas where further work may be fruitful are indicated. First and foremost, it will be beneficial to drill down and perform an analysis within each program and target market segment in order to understand how evaluated savings vary by market. In addition, the analysis of baseline and program influence should also consider compliance requirements imposed by other government units, such as the local air quality boards.

Evolving industrial baselines should be adjusted to reflect common or standard industry practice. Note that the net and gross realization rates are normally calculated based on the first year energy savings in the stream of ex post evaluated savings values. Actual energy savings achieved over the lifetime of the project would result in lower realization rates. There is currently no method to either reflect an adjustment to average savings over equipment lifetime or evolution of codes/standard practice to reflect higher efficiency mandates.

The processes discussed in this paper provide for pre-screening and evaluation of projects in order to reduce free ridership (by discouraging projects that would have been done anyway) and reduce the gap between ex-ante and ex-post gross savings estimates. Use of these procedures will lead to effective program-induced energy efficiency projects incorporating ex ante estimation procedures that are highly accurate and that result in relatively high gross and net realization rates, thereby closing the gap between claimed and evaluated results. This will allow programs to truly meet their goals and to expand their offerings in the future with greater confidence.

References

[DOE] Department of Energy. 2009. **Annual Energy Review 2009; Report No. DOE/EIA-0384**. Washington, D.C.: U.S. Department of Energy.

Itron, Inc., ASW Engineering, Energy and Resources Solutions, Energy Metrics, Helios Resources, Jai J Mitchell Analytics, Michaels Engineering, PWP Inc., Katin Engineering, SDV/ACCI, Warren Energy Engineering. 2010. **2006-2008 Evaluation Report for the Southern California Industrial and Agricultural Contract Group**. CPU0017.01. www.calmac.org. Oakland, CA: Itron, Inc.

Itron, Inc., Energy and Resource Solutions, Energy Metrics, Mad Dash, Inc., Michaels Engineering, PWP, Inc., Katin Engineering. 2009. **2006-2008 Evaluation Report for PG&E Fabrication, Process and Manufacturing Contract Group**. CPU0018.01. www.calmac.org. Oakland, CA: Itron, Inc.

Cadmac. 1998. **Protocols and Procedures for the Verification of Costs, Benefits, and Shareholder Earnings from Demand-Side Management Programs, Appendix J**. http://www.calmac.org/events/APX_J%200698.pdf.