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2006-2008 Evaluation Report for PG&E Fabrication, Process and Manufacturing Contract Group

Report Only

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Abstract

This report presents the evaluation results for the energy efficiency projects and programs within the scope of the California Public Utilities Commission's (CPUC) Pacific Gas and Electric Fabrication, Process, and Manufacturing (PG&E Fab) evaluation contract group. The evaluation addresses program impacts for the 2006-2008 program cycle. PG&E carried out a very large and extensive implementation effort in the industrial sector, which by its nature is a challenging environment, although also one with significant cost effective efficiency opportunities. Based on the magnitude of the claimed savings, the PG&E Fab contract group was divided into three measure groupings for developing and reporting evaluation results. These groupings are: Pump-off controllers (POCs), all other electric measures ("Non-POC Electric") and Gas measures. The impact evaluation results address claimed savings, ex-post energy savings estimates, gross savings realization rates, and the net-of-free-ridership ratio (NTFR).

The evaluation results are based on a combined sample, for all 3 sampling domains, of 133 matched gross and net projects – 41 POC projects, 63 Non-POC Electric projects, and 29 Gas projects. The POC sample represents 42% of the savings associated with the entire population of 656 POC projects; the Non-POC Electric sample represents 34% of the population of 756 projects, and the Gas sample 82% of the population of 152 projects.

The overall net kWh realization rate for all of the industrial programs covered in the scope of this CPUC evaluation contract group is 0.33, with a gross realization rate of 0.49 and net-to-gross ratio of 0.53. The overall net realization rate for gas energy is 0.27, with a gross realization rate of 0.68 and an NTGR of 0.31.

There are a number of specific findings that help to explain why the evaluated ex-post savings estimates are significantly below the ex-ante estimates. These include the following: errors in baseline determination; inadequate basis for claims of how some measures save energy; inadequate enforcement of program and policy rules; inadequate consideration of total system energy analysis; effect of the economic recession; and high free ridership. Program influence was found to be minimal in many cases for a number of reasons. In some cases, the evidence indicates that program implementers arrived late in the decision making process and offered incentives for projects that had already been decided upon. The evidence also indicates that program claims were made on some projects that customers initiated for non-energy savings reasons and for which there was no alternative ever considered. It was also found that program incentives were offered for some measures and technologies that are industry standard practice. Program attribution was also limited when program incentives were 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.

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Executive Summary

This report presents the evaluation results for the energy efficiency projects and programs within the scope of the California Public Utilities Commission's (CPUC) Pacific Gas and Electric Fabrication, Process, and Manufacturing (PG&E Fab) evaluation contract group. The PG&E Fabrication, Process and Manufacturing contract group is comprised of one core PG&E program (PGE2004) and nine third-party programs for the 2006-2008 energy efficiency program cycle. The evaluation addresses program impacts for the 2006-2008 energy efficiency program cycle. PG&E executed a very large and extensive implementation effort in the industrial sector, which by its nature is a challenging environment, although also one with significant cost effective efficiency opportunities.

Based on the magnitude of the claimed savings, the PG&E Fab contract group was divided into three measure groupings for developing and reporting evaluation results. These groupings are: Oil well pump-off controllers (POCs), all other electric measures ("Non-POC Electric") and Gas measures. Impact evaluation results were then developed separately for each of these analysis domains. This report presents evaluation results for all three domains combined, as well as for each separate domain. The impact evaluation results address ex-ante savings, ex-post savings estimates, gross savings realization rates,[1] and the Net-to-Gross-ratio (NTGR).

1.1 Summary of Gross Realization Rate, Net-to-Gross Ratio, and Overall Net Realization Rate Results

The gross impact evaluation results are based on a combined sample, for all three sampling domains, of 133 projects – 41 POC projects, 63 Non-POC Electric projects, and 29 Gas projects. The POC sample represents 41% of the savings associated with the entire population of 656 POC projects; the Non-POC Electric sample represents 35% of the population of 756 projects for this domain, and the Gas sample 82% of the population of 152 projects. In addition, the Net-to-Gross (NTG) sample is much larger than the gross sample since it also includes a number of 'net-only' sites. A large number of NTG surveys were completed, representing very high percentages of the total population and providing for robust results.

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[1] Realization rates are developed for each site and the program as a whole and are defined as the ratio of program ex-post savings estimated by the evaluation team divided by the ex-ante savings.

A site-specific engineering approach was utilized that included measurement and in-depth engineering analyses. The key steps involved in developing the overall savings estimate for the program were to develop site-specific measurement and verification (M&V) plans, independently verify reported measure installation records, develop ex-post estimates of the energy savings for each project in the sample, and statistically apply those findings to the full participant population.

Table 1-1 presents a summary of the program-claimed net savings for each of the analysis domains in this industrial contract group, this evaluation's estimates of net savings for each domain, and the evaluation-based savings as a percentage of program-claimed savings. Program-claimed savings are based on the final PY2006-2008 reports posted by PG&E on the CPUC's Energy Efficiency Groupware Application (EEGA). Evaluated net savings as a percentage of program claimed net savings range from 24% to 41%, depending on the sampling domain and savings metric. These values indicate that evaluation-based net program savings are on the order of one-fourth to less than one-half of claimed savings, significantly below program savings estimates.

Table 1-1: Overall Comparison of Evaluation-Estimated Net Savings with the Final Program-Claimed Net Savings

Evaluation Domain	Electric Savings kWh/year	Avg. peak kW	Gas Savings Therms/year
PG&E Net Savings Claim			
All Electric Measures	379,657,050	46,677	
Pump-Off Controllers (POC)	130,358,878	13,346	
Non-POCs	249,298,171	33,331	
All Gas Measures			30,325,098
Evaluation-Estimated Net Savings			
All Electric Measures	124,731,778	14,012	
Pump-Off Controllers (POC)	33,542,611	3,458	
Non-POCs	100,680,800	12,703	
All Gas Measures			8,302,483
Evaluation-Based Savings as Percent of Program Claims			
All Electric Measures	33%	30%	
Pump-Off Controllers (POC)	26%	26%	
Non-POCs	40%	38%	
All Gas Measures			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.

Table 1-2 through Table 1-5 below provide more detailed comparison of the evaluation-based net savings with the final program-claimed net savings and show the effect of both the estimated gross realization rate and the net-to-gross ratio.

Table 1-2: Comparison of Evaluation-Estimated Net Savings with the Final Program-Claimed Net Savings: All Projects

	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.

Table 1-3: Comparison of Evaluation-Estimated Net Savings with the Final Program-Claimed Net Savings: Pump-Off Controller Projects

	Electric Savings	
	kWh/year	Avg. peak kW
Tracking		
a. Claimed Gross Savings	163,650,384	16,661
b. Claimed NTG Ratio	0.80	0.80
c. Claimed Net Savings (c = a x b)	130,358,878	13,346
Evaluation		
d. Evaluation Gross Realization Rate	0.46	0.47
e. Evaluated Gross Results (e = a x d)	75,349,452	7,842
f. Evaluation NTG Ratio**	0.45	0.44
g. Evaluated Net Results (g = e x f)	33,542,611	3,458
h. Evaluation Net Realization Rate (h = d x f)	0.20	0.21
i. Evaluated Net Savings as a Fraction of Claimed Net Savings (i = g / c)	**0.26**	**0.26**

* 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.

Table 1-4: Comparison of Evaluation-Estimated Net Savings with the Final Program-Claimed Net Savings: Electric Non-POC Projects

	Electric Savings	
	kWh/year	Avg. peak kW
Tracking		
a. Claimed Gross Savings	318,924,279	42,672
b. Claimed NTG Ratio	0.78	0.78
c. Claimed Net Savings (c = a x b)	249,298,171	33,331
Evaluation		
d. Evaluation Gross Realization Rate	0.53	0.51
e. Evaluated Gross Results (e = a x d)	167,824,526	21,583
f. Evaluation NTG Ratio**	0.60	0.59
g. Evaluated Net Results (g = e x f)	100,680,800	12,703
h. Evaluation Net Realization Rate (h = d x f)	0.32	0.30
i. Evaluated Net Savings as a Fraction of Claimed Net Savings (i = g / c)	**0.40**	**0.38**

* 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.

Table 1-5: Comparison of Evaluation-Estimated Net Savings with the Final Program-Claimed Net Savings: Gas Projects

	Gas Savings
	Therms/Year
Tracking	
a. Claimed Gross Savings	40,144,380
b. Claimed NTG Ratio	0.76
c. Claimed Net Savings (c = a x b)	30,325,098
Evaluation	
d. Evaluation Gross Realization Rate	0.68
e. Evaluated Gross Results (e = a x d)	27,169,773
f. Evaluation NTG Ratio**	0.31
g. Evaluated Net Results (g = e x f)	8,302,483
h. Evaluation Net Realization Rate (h = d x f)	0.21
i. Evaluated Net Savings as a Fraction of Claimed Net Savings (i = g / c)	**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.

As indicated in the tables above, PG&E included ex-ante estimates of net-to-gross ratios in their claims but did not include any ex-ante realization rate ratios to adjust the gross impacts in their tracking system for industrial projects. As the tables show, evaluated gross realization rates range from 46% to 68%, depending on the sampling domain. (An evaluated gross realization rate of 100% would indicate evaluated gross savings which are identical to claimed gross savings.) The gross realization rates for the PG&E Fab program are lower than ex post evaluation gross realization rates estimated for the statewide Standard Performance Contract (SPC)[2] program for 2002-2003 (0.89) and 2004-2005 (0.79).

There are fairly significant differences between claimed and evaluated NTGRs; even though the electric NTGRs for this evaluation are very similar to those estimated previously for the SPC program (the gas NTGR is significantly lower than previous SPC program-level NTFRs[3]). The primary source of these differences are that PG&E's ex ante NTGRs are substantially above evaluated values, which average 0.53 (kWh) across all evaluated electric projects and 0.31 across all evaluated gas projects.

Finally, evaluated net savings (inclusive of both gross realization rate and NTGR), as a percentage of program claimed net savings, range from 26% to 40%, depending on the sampling domain. These values indicate that evaluated net program savings are on the order of one-fourth to less than one-half of claimed savings, far below program savings estimates. The specific reasons for these low realization rates are noted below and discussed in more detail in Section 5 – Discussion of Findings and Recommendations.

1.2 Summary of Qualitative Impact-Related Findings

There are a number of specific findings that help to explain why the ex post savings estimates are significantly below the ex-ante. These related key findings are summarized below. A more complete discussion along with references to site examples is provided in Section 5 of this report. The key problem areas pertain to assumed baseline conditions, gross savings estimation, and low program influence (free ridership). A number of these findings, particularly those related to program influence, have been found previously in the SPC program evaluations conducted since 1998. Each of these is discussed below.

1.2.1 Significant Problems with Baselines Used for Claimed Savings

The most common problem in the industrial programs is the use of pre-existing (often referred to as "in situ") equipment as the baseline for estimating program incentives and savings. In many cases, savings were calculated relative to an in situ baseline and then assumed to occur over the entire period of the effective useful life (EUL) of the new equipment. This assumption would only be justifiable in situations where the program induced an early replacement of equipment that would otherwise have had a very high probability of continuing in operation for a period equal to the EUL of the new equipment. Such cases are likely to be extremely rare in practice, yet they are the convention in the

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[2] A statewide energy efficiency program offered by the investor owned utilities (PG&E; Southern California Edison; Southern California Gas; and San Diego Gas and Electric) to their non-residential customers. This program meets customer needs by being open to unlimited wide variety of custom energy efficiency retrofit projects involving commercial, industrial, and agricultural facilities.

[3] Note that this was the first time in recent years that the NTGR was developed separately for gas for large nonresidential SPC-type programs. The observation is based on a comparison of the gas NTGR of 0.31 in this evaluation versus an NTFR for the 2004-05 SPC program of 0.54 (exclusive of adjusters).

program claims. Instead, we find that many of the projects are in fact replace-on-burnout or natural turnover events, or are early replacement events for a period of time (the existing equipment's remaining useful life) that is significantly less than the effective useful life of the measure. That is, the pre-existing equipment was either at the end (or near the end) of its physical life or at the end of its effective life because the customer decided to replace the equipment for reasons other than achieving energy savings (e.g., to improve product quality, respond to regulatory requirements, increase production, etc.).

1.2.2 Some Projects with Inadequate Basis for Claimed Savings

Another related area concerns the basis for the savings claims being made. In some cases there was inadequate engineering or physical basis for claiming savings or little or no reference to empirical information to substantiate the estimate of savings. Measurements were inconclusive for some of these measures and, given the lack of empirical data on the basis for savings estimates, it was difficult both to accept the ex ante claim and to develop an ex post estimate of savings.

1.2.3 Some Projects with Inadequate Enforcement of Program and Policy Rules

There were a few of our sampled sites for which it was concluded that the project for which savings were claimed and incentives paid did not qualify for the program because of violations of the program rules or the CPUC's energy efficiency policy rules.

1.2.4 Some Projects with Unverified and Undocumented Assumptions Used as Inputs for the Savings Calculations for Many Applications

We found a number of cases where the assumptions for the program calculations were unverified and undocumented.

1.2.5 Some Projects with Inadequate Declaration of Fuel Switching, Multi-Fuel Impacts, Distributed Generation

We found that several of our sampled sites involved multiple fuels, or fuel switching, but that the savings claim and ex-ante analyses did not include these impacts. All program-induced changes in fuel use should be included in savings claims and associated analyses.

1.2.6 Some Projects with Inadequate Consideration of Total System Energy Analysis

Energy usage was in some cases only analyzed for a portion of the system that was directly affected by the measure or project even though there were energy interactions with other systems that were also materially affected by the project.

1.2.7 Some Projects with Significant Effects of Recession

For several of our sampled projects, the facility had closed down, resulting in zero savings (since measures have to be operational according to program and policy rules). In other cases, production levels had been reduced, sometimes resulting in corresponding reductions in savings estimates.

1.2.8 High Free Ridership – Limited Program Influence

One important finding is that the programs have a low to moderate percentage of claimed savings that are estimated to be program-induced. Program influence was low in many cases for a number of different reasons. In some cases, the evidence indicates that program implementers arrived late in the decision making process and offered incentives for projects that had already been decided upon. The evidence also indicates that program claims were made on a number of projects that customers initiated for non-energy savings reasons and for which no alternative was ever considered. We also found program incentives were offered for measures and technologies that are industry standard practice (thus significantly increasing the odds of free ridership in any given application). Program attribution was also limited when program incentives were 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.

1.3 Summary of Recommendations

Below are several overarching recommendations aimed at improving the accuracy of savings claims and increasing the degree of program influence on rebated projects. These recommendations are based largely on the above findings and others in Section 5. The recommendations are suggestions for consideration with the end goal being improved gross realization rates and lower levels of free ridership on a percentage basis, while still maintaining high levels of total net savings. We recognize that the utility has ultimate responsibility for program implementation, and the CPUC has responsibility for energy efficiency policy, and each must weigh a variety of different factors, some of which are competing, in developing program requirements, implementation strategies, and policies. The recommendations are not meant to be prescriptive and the utility and CPUC may develop and prefer other approaches to achieve the same overarching goals.

- ***Recommendation: Improve Baseline Specification.***

  End the practice of using in situ baselines over the EUL of the measure as the baseline for estimating savings and paying incentives. Identify projects explicitly in program files as replace-on-burnout, natural turnover, or early replacement. For the replace-on-burnout and natural turnover cases, baselines should be based on the efficiency of alternative new equipment, not the existing in situ equipment. In the case of early replacement, provide evidence and documentation of the remaining useful life of the equipment replaced, the estimated time at which the equipment would have been replaced in the future, and the effect of the program in accelerating early replacement.

- ***Recommendation: Clarify and enforce the definition of "industry standard practice".***

  Industry standard practice should used to set baselines for savings estimates and incentives (such that program savings estimates improve as reflected in improved evaluation gross and net realization rates). It is recommended that, for the next EE program cycle (2010-2012), the CPUC and IOUs should ensure that program and policy references to "industry standard practice" are more precisely defined with respect to program participation requirements, incentive level payments, gross versus net savings attribution, and energy efficiency goal attainment.

- ***Recommendation: Be More Conservative in Estimating Savings.***

  We recommend that the programs make more conservative assumptions for calculated (custom) savings projects in the industrial sector in the next program cycle until ex post realization rates increase.

- ***Recommendation: Use a Gross Realization Rate Adjustment in Savings Claims in Program Tracking Systems.***

  Use of a realization rate adjustment in future program cycle ex ante estimates of custom measure claims should be strongly considered until future evaluation results indicate higher gross realization rates. The size of the adjustment to use for the next cycle is closely related to the extent to which the other recommendations made regarding improving specific aspects of gross savings estimation are addressed.

- ***Recommendation: Aggregate and Approve Fuel Switching and Distributed Generation-Related Projects in One or More Explicit Programs or Clearly Identified Program Elements.***

  If the CPUC approves use of fuel switching, it should require all applications to follow the three-prong test set forth in the CPUC Policy Manual[4] and any other CPUC or other regulatory agency requirements (e.g., those related to GHG reduction goals). If the CPUC approves use of fuel switching, it should investigate whether refinements are needed to the three-prong test to address the state's greenhouse gas reduction policies.

- ***Recommendation: Increase the capability of the program to influence industrial efficiency improvements.***

  To move these customers further along the efficiency spectrum takes time and advanced levels of technical expertise, often requiring expertise in specific

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[4] The Three Prong Test requires that any fuel switching measures: (1) not increase source-BTU consumption; (2) have a TRC benefit-cost ratio of 1.0 or greater; and (3) not adversely affect the environment. Decision 92-10-020, Conclusion of Law 5.

industry production practices and options for improvement. This is a very difficult challenge in this sector. There is already significant industrial expertise available at the utility and third-party contractors and PG&E should be commended for having developed a large and strong industrial efficiency team for 2006-2008. This expertise should be built upon and further increased. Development of the depth of technical expertise required to increase the net effects of the programs is a long term endeavor that requires both utility and regulatory support.

- ***Recommendation: Influence and provide incremental energy efficiency options directly to end users at the earliest decision-making stages of major equipment or facility modifications.***

  Program involvement at an early stage to identify large equipment and facility changes helps ensure efficiency opportunities are appropriately considered and maximize the chances of program influence. Utilization of sales or related tracking systems helps prevent projects from becoming lost opportunities.

- ***Recommendation: Provide Continuity in Account Representative Assignments, Particularly for the Largest Customers.***

  We found many instances where the utility account reps had been reassigned one or more times during the project lifecycle. In some cases, this is unavoidable due to retirements or job changes. However, it should be noted that the likelihood of utility program influence is weakened in such cases, because the assigned representative lacks the long-term relationship and continuity needed to provide a significant influence on the installed project. The utility likely has an internal incentive to maintain continuity in account representative-customer relationships; utilities should seek to provide continuity in these account rep assignments, particularly for their largest customers.

- ***Recommendation: Consider Using Early Project NTG and Baseline Screening Prior to the Incentive Being Approved for the Largest Projects and those with Significant Policy Issues such as Fuel Switching, Self Generation, and Greenhouse Gas Impacts.***

  For the largest projects and those with significant policy issues, we recommend that the CPUC consider implementing an Early Project NTG and Baseline Screening step. This step would involve having the CPUC evaluation team review the baseline claim and conduct NTG interviews during the participant's project implementation and program participation decision process. The purpose of this screening would be to obtain critical information regarding program influence that could lead to the project being re-defined to increase efficiency levels and program influence or dropped for ratepayer-funded rebates if no influence is evident. This approach would also have the advantage of capturing critical information on program influence early in the decision making process, while the information is still fresh in the mind of the decisionmaker(s).

- ***Recommendation: Increase enforcement of program eligibility and policy rule requirements.***

  Some of the evaluated projects were found to have violated program eligibility and policy rules. The CPUC should develop a process for reviewing projects for program eligibility prior to their being approved for a rebate.

- ***Recommendation: Carefully review the list of qualifying measures for each program and eliminate eligibility for those that are standard practice.***

  Measures that are already extremely likely to be installed by the vast majority of the market should in most cases not qualify for incentives. Although identification of such measures can be difficult in practice in the industrial sector, 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. In determining which measures to retain and which to eliminate, a balance must be struck between reducing free ridership and avoiding significant lost opportunities.

- ***Recommendation: Put measures with inadequate empirical basis for savings estimates in the emerging technologies program until more reliable information is developed.***

  The CPUC and IOUs should develop more explicit criteria for determining whether new measures are included under resource programs or the emerging technologies program. Measures with highly uncertain savings in need of detailed research to establish validity, expected savings, and repeatable algorithms and measurement protocols should be included in emerging technologies.

- ***Recommendation: Improve training of program implementation staff in several key areas.***

  These areas are: proper baseline specification, enforcement of program and policy rules, reasonableness of claims, comprehensive facility systems analysis, and increasing program influence on end user's efficiency-related decisions.

- ***Recommendation: Conduct analysis of customer incentives by customer and industry type. Conduct further research on the use of incentive caps.***

  Customer incentive caps have been utilized in various forms for many years. During times of low budgets and low goals, caps were set low to spread incentives to a broad pool of participants. More recently, as goals and budgets have significantly increased, caps have increased greatly as well. We are not aware of any systematic study of the effect of the incentives caps. Similarly, research is needed to explore how much total incentive dollars have been distributed across or concentrated within certain customers to determine whether these patterns are aligned and supportive of efficiency policy goals.

- ***Recommendation: More information is needed on industrial project costs, non-energy costs and benefits, net present value analysis, and associated participant cost-effectiveness analysis.***

  There has been very little analysis conducted of the actual incremental costs of industrial energy efficiency projects. Rules of thumb, such as assuming that incentives represent half of incremental costs, appear to have been used instead as proxies. There is inadequate financial analysis conducted on program projects to determine what portion of the customer's financial investment threshold is associated with the energy savings of particular projects versus non-energy factors such as increases in production and reductions in labor, materials, and regulatory compliance costs. Further research is needed on industrial incremental measure costs in general. Increased financial analysis should be included in industrial project applications, especially for the projects with the largest incentives. Increased review of project financials inclusive of non-energy factors can also help to reduce free ridership.

Recommendations to reduce free ridership. The following are overarching free-ridership-related recommendations that are also relevant to this contract group:

- ***Recommendation: Consider Limiting or Excluding Incentive Payments to Known Free Riders***[5]

  One obvious and simple approach to reducing free ridership is for program administrators to simply exclude projects from the program that they (or possibly the Energy Division) believe have a high probability of being free riders. Administrators in several other jurisdictions have used this approach.[6] In these cases, the administrator has the flexibility to determine total incentive amounts on a case-by-case basis, including zero incentives. We believe consideration should be given to implementation of a process by which projects considered to be very high likelihood free riders are excluded from participation (or, conversely, must go to higher efficiency levels than initially planned in order to participate).[7] Alternatively, or in conjunction with this type of approach, rules could be developed that exclude incentive payments for projects that are driven exclusively

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[5] From the California Public Utilities Commission Energy Efficiency Policy Manual, v. 4.0: "Free riders (Free Ridership) are program participants who would have installed the program measure or equipment in the absence of the program."

[6] Itron, 2005. National Energy Efficiency Best Practices Study. *Volume NR5 – Nonresidential Large Comprehensive Incentive Programs.* www.eebestpractices.com

[7] If necessary, such a process could involve an advisory group that includes staff from the Energy Division (to address any customer concerns). This would offer IOUs appropriate protection from claims that such exclusions were unfounded or unfair.

by non-energy factors that produce energy savings as a by-product, such as some naturally-occurring improvements in certain industrial processes.

- ***Recommendation: Consider Incorporating a Payback Floor***

  The use of a payback floor (minimum payback level based on energy savings alone) can help to reduce free ridership be eliminating projects that have extremely quick paybacks and thus little need for ratepayer-funded incentives. With a payback floor, the program may also avoid incenting projects that are primarily being done for reasons other than energy savings (modernization, production efficiency, environmental compliance, etc.).

- ***Recommendation: Set Incentive Levels to Maximize Net (Not Gross) Program Impacts***

  Free riders dilute the market impact of program dollars. Payback floors and increasing incentives with increasing payback levels are one approach. Another is to tie incentive levels to individual measures or types of measures that are known to have extremely high or low naturally occurring adoption levels.

- ***Recommendation: Consider Tying Staff Performance to Independently Verified Net Results***

  Tying performance reviews of program staff to verified net savings as reported through an independent M&V or impact evaluation process is likely to increase project quality and the accuracy of initial savings estimates. Marketing staff, in particular, should have any financial incentives tied to savings that are independently verified.

Evaluation Related Recommendations. There are also a number of recommendations related to improving the evaluation process.

- ***Recommendation: Involve impact evaluators in large projects and a sample of projects on a real-time basis throughout the program cycle***

  The timing of evaluation processes should be accelerated. Moving the evaluation process forward in time to occur just after the project is installed would ensure the decisionmaker is still available, and that their memory of the basis for the project is still fresh. This can be accomplished through earlier contracting and implementation of the evaluation, combined with improved utility tracking and early reporting of installations (as well as projects in the pipeline), more frequent sampling and evaluation of projects throughout the program plan period.

- ***Recommendation: Evaluation participation requirements should be strengthened***

  In the course of conducting the evaluation, we experienced ‘pushback’ from many participants who either refused to participate in evaluation surveys and on-sites or declined to provide required data and documentation. This made it difficult to conduct the evaluation efficiently and can lead to systematic bias. Requirements for participating in evaluations need to be clearly explained to participants; both at the time they are paid incentives, and later, when evaluation activities commence. Evaluation participation should be clearly and obviously written into program participation and incentive payment agreements.

- ***Recommendation: Conduct a full complement of impact, process, and market evaluations***

  Large customer programs and markets are very dynamic and require regular assessment in order that they may be continuously improved by program managers and policymakers. Most of the effort for the 2006-2008 industrial evaluation focused on impact evaluation, in accordance with Energy Division's evaluation priorities. Future evaluations should consider more integration of process evaluation and market assessment to capture research economies and reduce customer and vendor interview burdens.

- ***Recommendation: Stagger the timing of process and ex post impact tasks so that process evaluations can be conducted and results communicated on a relatively real-time basis***

  If process and impact evaluations are more integrated in future evaluations, care must be taken to schedule activities and deliverables appropriately. Because of the sometimes long project installation lag after commitment in these programs, it is important to schedule process evaluation tasks to be conducted during or just after each program year so that results can be utilized to improve program processes for the subsequent program year (rather than producing results only late in the three-year program cycle for use in the next program cycle).

- ***Recommendation: Conduct baseline research to establish standard industry practices for key measures in important industries***

  Significant research is needed to establish meaningful and defensible data, especially market share, for establishing industry standard practices for measures that are not completely site specific. Improved information on industry standard practices can then inform decisions about which measures to provide incentives for, which could in turn lead to reductions in free ridership.

- ***Recommendation: Conduct a persistence study of industrial sector savings***

  Few studies of the persistence of program savings in the industrial sector have been conducted, particularly within the last decade. As noted previously in this section, there were a number of participants who closed facilities or shut down processes associated with program measures due to economic factors. In addition, in some program years and cycles industrial production levels will be higher or lower depending on economic conditions. Some facilities that do close may stay closed while others may reopen and reutilize efficiency measures. Research is needed to measure the persistence of savings over time under a range of economic conditions. Sufficient time needs to pass in order to maximize the information provided from such persistence studies. We recommend waiting until the recession is completely over and the economy is in full recovery. To accelerate the time at which meaningful results would be obtained, studies can be conducted using earlier program cohorts, for example, going back to the 2002-2003 or 2004-2005 program cycles (or earlier), rather than simple waiting for the 2006-2008 cohort to age.

2

Introduction, Purpose and Objectives of Study

2.1 Introduction

This report presents the evaluation results for the energy efficiency projects and programs within the scope of the California Public Utilities Commission's (CPUC) Pacific Gas and Electric Fabrication, Process, and Manufacturing (PG&E Fab) evaluation contract group. The evaluation addresses program impacts for the 2006-2008 energy efficiency program cycle. This evaluation began in September 2007, midway through the 2006-2008 cycle.

Itron Inc. Consulting and Analysis group is the prime contractor for this evaluation. Itron was assisted by a team of subcontractors as indicated on the title page of this report. This evaluation was managed and directed by the Energy Division (ED) of the CPUC. Assistance was provided to the ED and Itron on study design and quality control by the CPUC's technical support contractors for this evaluation cycle (the Data Management and Quality Control (DMQC) contractor[8], the Master Evaluation Contract Team (MECT)[9], and the Database for Energy Efficiency Resources (DEER) contractor). We refer in this evaluation to the group of Itron, its subcontractors, ED, and ED's support consultants as the evaluation team.

The PG&E Fabrication, Process and Manufacturing contract group is comprised of one core PG&E program (PGE2004) and nine third-party programs for the 2006-2008 energy efficiency program cycle. These programs address industrial and manufacturing facilities, water supply and treatment and wastewater treatment, and oil and gas extraction, refining and production. Each program offers one or more of the following interventions in order to encourage end-users to upgrade to energy efficient measures: site specific facility assessments, feasibility studies, project incentives, facility audits, pump testing, and specialized training.

The PG&E Fab group contains most but not all of the industrial programs in PG&E's 2006-2008 energy efficiency portfolio. Examples of industrial programs and measures addressed in other contract groups include the following: 1) the PG&E Food Processing and Agricultural evaluation contract group address impacts from food processing and agricultural

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[8] A group of consultants with specialized expertise in important aspects of program impact evaluation who are technical advisors to ED staff and MECT on issues related to data management and quality control.

[9] A group of consultants with specialized expertise in important aspects of program impact evaluation who are technical advisors to ED staff and assist the evaluation contractors with development and execution of the verification and evaluation plans.

programs; 2) there were some new construction projects that were included in PG&E's PGE2004 program, however, for the purposes of the CPUC's evaluation, these new construction projects were addressed under the CPUC's New Construction evaluation contract group; 3) some industrial measures that were implemented through prescriptive rather than custom programs and had significant program claims are addressed in the CPUC's Southern California Industrial Programs contract, which includes statewide evaluations of pipe insulation and steam traps inclusive of industrial applications.

A list of the PG&E programs that are included in the PG&E Fab contract evaluation, and their basic program elements, is presented in Table 2-1 below.

Table 2-1: PG&E Fab Programs, Descriptions, and Key Elements

Programs Included in this Evaluation	Program Description	Key Program Elements (Note: As stated in original program filings)
PGE2004, Fabrication, Process and Manufacturing	Core PG&E program. Targets industrial manufacturing; oil and gas extraction and refining; water supply, water treatment and wastewater treatment.	Offers incentives, funds for audits and technical studies, and access to energy analysis tools. Measures: highly varied, site-specific measures; many oil well pump-off controllers (POCs), many industrial process measures, some HVAC and lighting, some gas
PGE2042, Heavy Industry Energy Efficiency Program	Third-party program administered by Lockheed Martin Aspen Systems. Identifies and facilitates the implementation of major process-oriented and other energy-efficiency upgrades for PG&E's very large (>500 kW) heavy industry and water/ wastewater customers.	Offers audits, design assistance, financial incentives, construction oversight, and savings verification. Measures: highly varied, site-specific; mostly electric, some gas
PGE2046, California Wastewater Process Optimization Program	Third-party program administered by QuEST. Focuses on improving the energy efficiency of water and wastewater treatment plants.	Offers facility audits, engineering assistance, project management support and financial incentives. Measures: water/wastewater; electric
PGE2058, Energy Efficiency Services for Oil Production	Third-party program administered by Global Energy Partners (GEP). Targets oil and gas producers with annual usage greater than 1 million kWh. Facilities served include wells, extraction equipment, surface transport, field augmentation, water steam and gas injection, product separation and treatment, storage and distribution, and pipeline transport.	Offers a turnkey custom-measure incentive program. Measures: highly varied, site-specific, including POCs; all electric
PGE2062, Wastewater Process Efficiency Initiative	Third-party program administered by KEMA Services Inc. Focuses on improving the energy efficiency of medium and large wastewater treatment plants.	Offers site-specific energy audits, engineering assistance, process design, project management support and financial incentives. Measures: water/wastewater; all electric

Table 2–1: PG&E Fab Programs, Descriptions, and Key Elements (continued)

Programs Included in this Evaluation	Program Description	Key Program Elements (Note: As stated in original program filings)
PGE2064, Refinery Energy Efficiency Program	Third-party program administered by Nexant. Targets petroleum refining facilities of any size.	Offers audits, training, design assistance, financial incentives and installation assistance. Measures: highly varied, site-specific; all electric
PGE2081, Assessment, Implementation and Monitoring	Third-party program administered by Air Power USA. Focuses on improving the energy efficiency of large compressed air systems over 1,000 horsepower in size. Targets oil refineries, auto manufacturing, food processing and other large manufacturing processes.	Offers audits, training, installation assistance, savings verification and post-project technical support for compressed air systems. Measures: compressed air, site-specific; all electric
PGE2082, VeSM (Value and Energy Stream Mapping) Advantage Plus™	Third-party program administered by California Manufacturing Technology Consulting. Focuses on identifying and quantifying energy efficiency process and equipment improvements.	Was planned to offer a tailored energy savings assessment and action plan prioritizing the process improvements recommended. Measures were to be: highly varied, site-specific; electricity and gas Program cancelled
PGE2084, Energy Efficiency of Compressed Systems	Third-party program administered by Ecos Consulting. Focuses on improving the energy efficiency of compressed air systems 100 to 1,000 horsepower in size.	Offers audits, training and installation assistance. Measures: compressed air, site-specific; all electric
PGE2087, Commercial and Industrial Boiler Efficiency Program	Third-party program administered by Enovity. Targets industrial and manufacturing facilities, food and beverage manufacturing, agriculture and crop production, large institutions, high tech facilities, and large offices with large commercial and industrial fuel-fired boiler systems.	Offers free audits and technical assessment, but also boiler engineering evaluations, technical implementation assistance and financial incentives. Measures: highly varied boiler-related measures, site-specific; mostly gas, some electric

2.2 Programs Goals and Claimed Program Accomplishments

As noted above, this evaluation began in September 2007, midway through the 2006-2008 program cycle. At that time, many of the industrial programs in scope were still early in their program implementation activities. As a result, the evaluation team began its evaluation planning work using the program goals that PG&E submitted to the CPUC at the outset of the program cycle. With so many programs it would not be unexpected to have the actual levels and relative distributions of savings across programs vary significantly from what was originally planned. As discussed in the Methodology section of this report, we anticipated and expected such changes to occur and designed our sampling process accordingly. Beginning the evaluation activities during the program cycle was an important and effective aspect of the study and we recommend that evaluation activities begin even earlier in the next program cycle. At the same time, there are challenges associated with designing and conducting evaluations that are concurrent with program implementation, particularly when there are many programs and it is difficult to predict which programs will end up with more or less of the portfolio impact. This can be seen by considering the differences between the original program goals and the final claimed accomplishments for the programs in this contract group. The savings goals as compared to the claimed accomplishments for the programs in the PG&E Fab Contract Group can be found in Table 2-2 below.

Table 2-2: PG&E Fab Program 2006-2008 Net Goals and PG&E's Reported Net Program Accomplishments

		Goals			PG&E Claimed Accomplishments		
Program	**Program Name**	**kWh**	**kW**	**Therms**	**kWh**	**kW**	**Therms**
PGE2004	Fabrication, Process and Manufacturing	164,935,530	26,390	12,310,200	196,870,975	25,152	23,231,560
PGE2042	Heavy Industry Energy Efficiency (Lockheed)	15,400,000	3,667	1,613,333	51,476,477	7,940	4,632,680
PGE2046	CA Wastewater Process Optimization (QuEST)	3,600,000	360	141,000	11,969,913	1,100	465,020
PGE2058	Energy Efficiency for Oil Production (Global Energy Partners)	104,346,317	11,912	0	97,595,931	9,994	0
PGE2062	Wastewater Plant Efficiency Improvement Initiative (KEMA)	9,114,300	1,040	0	1,495,764	175	0
PGE2064	Refinery Energy Efficiency Program (Nexant)	23,760,000	3,000	0	7,349,989	785	0
PGE2081	AIM (Assessment, Implementation and Monitoring)	28,044,000	3,506	0	10,947,511	1,428	0
PGE2082	VeSM Advantage Plus™	4,469,513	334	417,155	0	0	0
PGE2084	ECO Air (ECOS)	14,710,480	3,664	0	11,181,902	1,657	0
PGE2087	Commercial / Industrial Boiler Efficiency Program (Enovity)	1,162,000	88	1,948,000	1,383,089	327	2,088,401
Total		**369,542,140**	**53,961**	**16,429,688**	**390,271,551**	**48,558**	**30,417,661**

2.3 High Impact Measures (HIMs), Industrial Measure Groupings, and Contribution to PG&E Portfolio

Although the evaluation planning process initially took utility programs as a key organizational element, it was also emphasized by many evaluation team analysts that the portfolio should be examined from the perspective of key measures. In this evaluation, this approach is referred to as the high impact measure (HIM) approach. The philosophy behind the HIM approach is straightforward. Energy and demand impacts are organized by measure group and energy metric (electric energy, electric demand, and gas energy) across programs at the utility level. An advantage of the HIM approach is that it seeks to standardize the analytical methods and data collection approaches for key measures across programs and contract groups to increase consistency and accuracy.

The first step in the HIM process was to identify which measures or like group of measures contributed most to each of the energy metrics for each of the utilities. For much of the portfolio, the measures that contributed most significantly were common pieces of equipment associated with mass market implementation like compact fluorescent lamps and linear fluorescent lamps. The industrial sector was different in this regard due to the intrinsically heterogeneous nature of the sector and efficiency projects. Many of the industrial sector efficiency projects involve complex energy systems and processes that are unique to a particular industry or even individual site. There are, of course, also some efficiency measures and equipment types that do cut across industries and customers such as air compressors, refrigeration compressors, variable-speed drives, and boilers.

ED staff and their consultants developed a preliminary list of HIMs from the E3 calculators delivered by the IOUs covering program savings claims through the end of the second quarter of 2008 (Q2-2008). A single Access database containing the E3 measure line items from the Input tab of the E3 calculator was created. Each of the measures was assigned to a measure name using a consistent measure naming scheme. The savings claims for each IOU were tabulated for each named measure, and the contribution of each measure to the total IOU portfolio savings claim for kWh, kW and Therms was calculated. A list of HIMs was developed by identifying all measures that contributed more than 1% of the portfolio savings by IOU.

Analysis of the PG&E Fab tracking data indicated that only two measure groups represented a significant proportion of the PG&E electric energy, demand, and natural gas metrics. These were oil well pump-off controllers (POCs) for electric and industrial boilers for gas. POCs ultimately accounted for a third of the total energy savings claims for the in-scope PG&E Fab programs. Gas boilers represented approximately two-thirds of the industrial gas claims for PG&E Fab in-scope programs.

It was also recognized that industrial custom projects could collectively be considered a high-impact measure group - one that required a consistent approach to conducting highly complex, site specific measurement and verification (M&V) and savings estimation analyses. Ultimately, the evaluation team determined that only the POC measure would be classified as a HIM in terms of development of a sampling, measurement, and analysis plan that would address all POCs across programs and applications; and that the remaining electric and gas projects would be handled exclusively through site-specific measurement and analysis planning.

Thus, gross impact sampling domains for the PGE Fab contract group were organized into the following three sampling and impact reporting domains:

- Oil well pump-off controllers (electric only measure, referred to as the "POC" electric domain),
- All other electric industrial measures (referred to as the "non-POC" electric domain), and
- All gas industrial measures (referred to as the "Gas" industrial domain).

As shown in Table 2-3, in terms of PG&E's total electric energy claim for the entire 2006-2008 portfolio, this represented 8% of PG&E's reporting as of November 15, 2009. Industrial gas measures, in terms of PG&E's 2006-2008 gas energy savings claims, represented 48% of PG&E's reporting as of the same date.

Table 2-3: PG&E Fab HIM-Related Savings as Percent of Portfolio-Claimed Savings

	PG&E Fab Contract Group*			PG&E Portfolio†			Percent of PG&E Portfolio		
Measure	**Gross kWh**	**Gross kW**	**Gross Therms**	**Gross kWh**	**Gross kW**	**Gross Therms**	**kWh**	**kW**	**Therms**
POC	163,650,384	16,661		6,278,262,259	992,144	83,107,401	3%	2%	
Electric non-POC	318,924,279	42,672					5%	4%	
Gas Measures			40,144,380						48%
Gas Boiler Measures			25,906,233						31%

* Excludes 58 records from program PGE2004 that became part of the New Construction Codes and Standards evaluation

† Best numbers available on 11/15/09

2.4 Measure Groupings for PG&E Fab Contract Group

The PG&E Fab Contract Group was divided into three measure groupings for reporting evaluation results. As noted above, these groupings are: Pump-off Controllers, Non-POC Electric Measures and Gas Measures. Information on these measure groupings and details regarding claimed savings impacts can be found in the following subsections. Additional information related to tracking data analysis and sampling is provided in Section 3 – Methodology.

2.4.1 Pump-off Controllers

Pump off controllers (POCs) are a control device that turns off pump motors used on rotary beam pump oil wells whenever the well is in a "pumped-off" condition, i.e., when there is not enough fluid in the well, causing the pump to "pound" and experience significant strain. When a sensor indicates that enough fluid has accumulated (or after an operator-specified interval) the POC turns the pump on again. By reducing the amount of time a pump is run ineffectively, at relatively low overall pump efficiency, POCs reduce power consumption per unit of fluid pumped without affecting output. Since POCs also reduce the number of instances when a well motor continues to run without an adequate fluid level at the subsurface pump, POCs reduce the number of pump failures, parted rods or tubing leaks. This, in turn, reduces downtime, maintenance costs and repair costs. Thus, there are substantial non-energy benefits from POC installations, in addition to direct energy benefits.

POCs are typically placed on mature wells and also on other wells that are high producers to enable well monitoring. POCs may also be placed on wells that are maintenance intensive and problem prone. The POC acts as a real time monitoring device, and protects the physical well and the investment in that well.

POCs are not a new technology, having been available and installed on a limited scale since the early '90s. However, advances in POC design, networking, telemetry and software over the past decade have reduced the cost of installing and using POCs on a large scale to manage oil field operations.

The PG&E Fabrication, Process and Heavy Industrial Manufacturing program (PGE2004) offered POC rebates for both existing and new well installations. POC rebates were very popular during 2006-2008. As shown in Table 2-4, POCs account for 92,331,461 gross kWh of ex-ante savings, representing 39% of the portion of PGE2004 program claims that was evaluated in the Industrial evaluation.

POCs are also a significant measure in the industrial third party program administered by Global Energy Partners. The Energy Efficiency Services for Oil Production program (PGE2058) offered rebates for both existing and new wells. Table 2-4 shows that through Q4 2008, this program claimed gross savings of 71,818,923 kWh from POCs, and this measure accounted for 29% of the gross kWh savings from PG&E's Industrial Third Party Programs.

Table 2-4: Claimed Electric Savings from POCs for PG&E Fab Contract Group

Program	POC Savings Claims Gross kWh	PG&E Fab Entire Contract Group Savings Gross kWh	POC % of PG&E Fab Gross kWh Savings
PGE2004	92,331,461	236,885,702	39%
Non-PGE 2004	71,318,923	245,688,961	29%
Total	**163,650,384**	**482,574,663**	**34%**

2.4.2 Non-POC Electric Industrial Measures

Non-POC Industrial electric measures include process other and process customized, lighting, air compressors, motors, injection molding machines, space heating and cooling, HVAC controls, adjustable speed drives and pumps.

Table 2-5 shows that gross impact claims for Non-POC electric measures for PGE2004 and the Third Party Programs totaled 318,924,279 kWh or 66% of the portfolio's gross kWh impacts for the PG&E Fab Contract Group. Of this amount, PGE2004 accounted for 144,554,242 kWh, with 174,370,038 kWh coming from the programs administered by third parties. Table 2-5 also indicates that the Non-POC PGE2004 electric measures accounted for 61% of the gross impacts savings for PGE2004. Seventy one percent (71%) of the Third Party program impacts come from the Non-POC electric measures.

Table 2-5: Claimed Electric Savings for Non-POC Industrial Electric Measures

Measure group	Savings Claims Gross kWh	PG&E Fab Entire Contract Group Savings Gross kWh	Non-POC % of PG&E Fab Gross kWh Savings
Non-POC, PGE2004	144,554,242	236,885,702	61%
Non-POC, Non-PGE2004	174,370,038	245,688,961	71%
Total	**318,924,279**	**482,574,663**	**66%**

2.4.3 Gas Industrial Measures

Industrial gas measures include process and non-process boiler measures, boiler upgrades and controls, boiler heat recovery, pipe and duct insulation and packaged HVAC, general process changes, and complex multi-system process changes.

Table 2-6 shows that the majority of gas savings claims (78%) comes from PGE2004 with 22% of the claimed savings from three Third Party Programs: PGE2042 (Heavy Industry Energy Efficiency Program), PGE2046 (California Wastewater Process Optimization Program) and PGE2087 (Commercial and Industrial Boiler Efficiency Program). PGE2004 claimed 31,161,754 gross therm savings from gas measures. The three PG&E Third-Party Programs claimed a combined contribution of 8,982,626 gross therms.

Table 2-6: Claimed Therm Savings for Industrial Gas Measures

Program	Savings Claims Gross Therms	% of Gross Therm Savings
PGE2004	31,161,754	78%
Non-PGE2004	8,982,626	22%
Total	**40,144,380**	**100%**

The gross therm savings impacts from PG&E Third-Party Programs can be found in Table 2-7 below.

Table 2-7: Claimed Therms Savings from PGE Third-Party Programs

Third Party Programs	Gross Claimed Therms Impacts
PGE2042	5,790,850
PGE2046	581,275
PGE2087	2,610,501
Total	**8,982,626**

2.5 Overall Evaluation Objectives

The principal overarching objective of this evaluation was to address the research issues identified in the Research Plan for the PG&E Fab Contract Group.[10] These include the following:

- Verify installations. Verifying reported measure installations to validate what was reported by PG&E. Due to the substantial savings per project and small number of projects in the population of this contract group, the verification sample is nested in the gross impact sample. The verification sample was implemented for program years 2006-2007 and the results were reported in June of 2008. The installation rates developed in the verification report were utilized by ED on an interim basis for the 2006-2007 program cycles, and the cumulative 2006-2008 program cycle, prior to completion of the final evaluation report.

- Estimate gross savings. The Gross Impact Evaluation features an assessment of direct program impact for participating sites that received incentive payments. It involved on-site data collection, monitoring and analysis of a representative sample of PG&E Industrial and Fabrication contract group projects, in order to a) develop ex post estimates and realization rates of the energy and demand savings for each project in the sample, and b) apply those findings to the full participant population to obtain a complete estimate of program impact for each of the sampling and reporting domains (i.e., POCs, non-POC, and therms). For the sampled participant sites, the engineering analysis methods and degree of monitoring varied from project to project, depending on the complexity of the measure, the size of the associated savings, the reliability of engineering input parameters and the availability and reliability of existing data.

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[10] PG&E Fabrication, Process and Manufacturing Evaluation Plan submitted to the CPUC on February 28, 2008; available at http://www.energydataweb.com/cpuc/default.aspx.

- Estimate savings net of free riders.[11] The net-to-gross work was based on the methodology developed by the Large Nonresidential NTGR working group which was composed of ED staff, its consultants, and evaluation contractors and was formed to craft consistent batteries of questions to be used in surveys. Building on lessons learned in past evaluations and the experience of contractors and ED consultants, the group developed batteries of questions and associated scoring algorithms for calculating NTGRs. The non-residential questionnaires and scoring algorithms were submitted for public review and comment prior to finalizing. The net-to-gross samples were significantly larger than the gross impact samples due to the lower cost of conducting net-to-gross interviews. Net-to-gross results were developed for the three reporting domains.

- Estimate overall net program realization rates. The gross and net-to-gross results were combined to produce an overall estimate of the net ex post realization rate for each of the analysis and reporting domains. These results compare the overall ex post savings estimates to PG&E's gross and net savings claims.

- Develop results that will become inputs into ED's final report.

- Provide findings and recommendations to improve programs. The results of the evaluation include findings and recommendations designed to aid the Investor Owned Utilities (IOUs),[12] CPUC, and energy efficiency stakeholders and policy makers to develop programs and policies that will further increase implementation of cost effective energy efficiency improvements in the industrial sector.

2.6 Structure of Report

The overall organizational structure of this report can be found in Table 2-8 below.

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[11] Program participants who would have installed the program measure or equipment in the absence of the program.

[12] They include Pacific Gas and Electric (PG&E), Southern California Edison (SCE), San Diego Gas and Electric (SDG&E), and Southern California Gas (SCG).

Table 2-8: Overall Structure of Report

Section #	Title	Content	Subsections
1	**Executive Summary**		Each report section will first provide the cross cutting information followed by information specific to 1) Pump-Off Controllers, 2) Non-POC Electric Measures, and 3) Non-POC Gas Measures
2	**Introduction, Purpose and Objectives**	Objectives and savings claims	
3	**Methods**	Sampling, on-site surveys, self-report NTG surveys of participants and their vendors	
4	**Results**	Gross impacts and realization rate, net of free ridership ratios and results, spillover results, net realization rates and 20 year impact reporting	
5	**Detailed Findings and Recommendations**	Tracking system, participation, assessment of impact evaluation and ex-ante, ex-post or other data/equipment considerations, free ridership, baseline, program rules, net-to-gross, and evaluation-related recommendations.	

3

Methods

This section presents the methods used to evaluate the programs in the PG&E Fab Contract Group. As discussed in Section 2 of this report, this evaluation was organized around three industrial measure groups: oil well pump-off controllers (POCs), non-POC electric measures and gas measures. With a few exceptions, the same general methods were used to evaluate POCs, non-POC electric measures and gas measures. For each subsection the overall approach is provided first followed by any deviations and more detailed approaches for POCs, non-POC electric and gas, if applicable.

3.1 Overview and Description of Methods

The methods developed and implemented for this evaluation were designed to be compliant with CPUC evaluation protocols and guidance and to produce the most accurate and defensible results possible given project resources and timelines. The approaches followed in this evaluation were guided by the CPUC Evaluation Protocols; however, the CPUC allowed for slight deviations. These variances were consistent with the intent of the Protocols, were expected to produce reliable and robust results, and consisted of:

- A sampling approach that focused on measure group domains, as discussed in Section 2 (POCs, non-POC electric measures, and gas measures), utilized size stratification, and included site-specific measurement and verification plans to address the unique measurement challenges associated with industrial efficiency measures.

- A flexible application of gross energy and demand rigor at the site and measure level, rather than a pre-determined level of rigor by program, given that variation across sites is often more significant than that across programs and that this evaluation utilized only a few sampling domains, within which site complexity and size drove evaluation planning.

- Small deviations from the minimum net-to-gross sample size guidance by program (setting sample sizes at half of the program population or 300, whichever was less).

- Use of site-specific M&V impact methods that were often a hybrid of IPMVP[13] Option A and B to maximize precision in a cost-effective manner. This hybrid method fell between the Basic and Enhanced rigor levels.

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[13] IPMVP refers to the *International Performance Measurement and Verification Protocol*, which specifies alternative measurement and analysis methods that can be used to estimate gross energy and demand savings from a measure installed under a program being evaluated. See www.evo-world.org.

3.2 Protocols and Rigor Levels

3.2.1 Protocols

This evaluation was guided by the *California Energy Efficiency Evaluation Protocols: Technical, Methodological, and Reporting Requirements for Evaluation Professionals.*[14] The following protocols were used:

- Impact Evaluation Protocol
  - Gross Energy Impact Protocol
  - Gross Demand Impact Protocol
  - Participant Net Impact Protocol
- Measurement and Verification Protocol
- Sampling and Uncertainty Protocol
- Evaluation Reporting Protocol

3.2.2 Rigor Levels

As mentioned above, the rigor levels for this evaluation deviated slightly from the Protocols in that specific participant sites and their measure mix were used to drive the evaluation type and rigor assignments rather than each of the ten distinct programs.

Regardless of program, the evaluation type for all sample points used the Protocol Guided Direct Impact for this evaluation. Additionally, the assignment of gross energy and demand rigor was set to a hybrid of Basic and Enhanced for all programs in this contract group. That is, the rigor assignment was included in the site-level analysis planning stage of each sampled project, and those assignments were applied by measure. Based on past experience and the level of certainty required by this evaluation, Itron strongly believed that a blended rigor level between Basic and Enhanced was most appropriate, and that the flexible application of rigor by site/measure ensured that evaluation resources were applied to produce the most reliable results possible given the budgeted resources. The same reasons applied to the NTG rigor assignments, which were made at the sampled project and not the program level.

3.3 Sampling Methodology and Description

This section describes the proposed approach to developing and implementing sampling to support the overall evaluation for the PG&E Fabrication, Process, and Manufacturing contract group. Additional information on our sampling approaches and implementation is provided in Appendix A.

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[14] TecMarket Works, April, 2006, available at http://www.calmac.org/events/EvaluatorsProtocols_Final_AdoptedviaRuling_06-19-2006.pdf

There are several important questions that must be addressed in order to develop any sample design. These include the following:

- What are the sampling design variables and sampling domains?
- Which statistical method will be used to estimate sampling size and precision levels? What type of stratification, if any, will be utilized?
- What is the desired level of statistical confidence and precision? Or conversely, what statistical precision will be achieved for a desired (or affordable) number of sample points?
- What level of variance is expected for the sampling design variables?

Each of these questions is addressed in the remainder of this section.

3.3.1 Gross Impact Sampling Design Variables and Domains

In any sample design, the first question to ask is which sampling variables and research objectives are important enough to be used in defining separate domains of study for the evaluation. As discussed here, a domain of study is a sub-population for which sufficient sample will be allocated to achieve estimates of savings with a pre-assigned precision goal, e.g., 90/10. In general, the total sample size of a study is directly proportional to the number of sampling domains, e.g., doubling the number of domains doubles the overall sample size.

The CPUC ED identified three energy metrics as being at the core of the 2006-2008 impact evaluations. These are: energy savings associated with electric energy (kWh/year), electric demand (peak kW), and natural gas energy (therms).

As discussed in Section 2, with respect to high-impact measure groups and individual measures, the evaluation team determined that only one individual PG&E industrial sector electric measure warranted its own sampling domain. This measure was oil well pump-off controller (POCs), which accounted for 34% of PG&E claimed electric savings for the programs in this contract group. POCs were also selected as a sampling and analysis domain because it was preferred that a consistent engineering and measurement approach be developed and implemented for estimating gross savings for this measure.

We determined that the remaining measures were too numerous and the associated savings too low at the measure level to warrant additional measure-level sampling domains. This was also because of the high cost per site of conducting industrial savings analyses.

When we combined the energy savings metrics with the high-impact measure analysis, we arrived at the three sampling domains for this evaluation: POCs, all other non-POC electric measures, and all natural gas measures.

3.3.2 Sampling and Extrapolation Methods, Confidence and Precision

The PG&E Fabrication Process and Manufacturing ("PG&E Fab") contract group uses the ratio-estimation approach for sample design described in Chapter 13 of the *Evaluation Framework Study*[15] and referenced in the *California Energy Efficiency Evaluation Protocols*.[16] This approach was also used to develop program realization rates for the 2002, 2003 and 2004-2005 Statewide SPC program impact evaluations.

A key input to the ratio-estimation sample planning methodology is the error ratio (*er*) that is expected to result given the evaluation sample size selected (the *error ratio* is defined below). As with the a priori use of the expected coefficient of variation in other sampling methods, the variance in the parameter of interest is not known prior to completing the evaluation work. Instead, analysts must estimate the *er* from other related studies and work or summarize expected sampling results across a range of possible *er* (as is often done with confidence levels).

To more formally investigate the expected precision levels for the 2006-2008 PG&E Fab impact evaluation the precision level achieved for two relevant past evaluations was first reviewed -- for the 2002-2003 and 2004-2005 SPC impact evaluation samples. The precision estimation process was carried out as described for ratio estimation-based samples in Chapter 13 of the *Evaluation Framework Study*. Specifically, the error ratio was calculated and the precision expected was estimated, with alternative sample sizes as described on pages 358 and 365 of the *Study*, respectively, using the results from the 2002-2003 SPC ratio estimation process.[17] From these past studies, we calculated error ratios (*er*) of 0.35 to 0.45 using the following formula:

$$\hat{er} = \frac{\sqrt{\left(\sum_{i=1}^{n} w_i\, e_i^2 / x_i^{\gamma}\right)\left(\sum_{i=1}^{n} w_i\, x_i^{\gamma}\right)}}{\sum_{i=1}^{n} w_i\, y_i}$$

where

$\gamma = 0.8$

$e_i = y_i - \hat{B}\, x_i$

w_i is the case weight,

x is the tracking estimate of savings for each project, and

y is an estimate of the estimated savings from the ex post evaluation.

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[15] http://www.calmac.org/publications/ California_Evaluation_Framework_June_2004.pdf

[16] Chapter 13 – Sampling, page 358, of the TecMarket Works, 2004. *2002 Evaluation Framework Study*, prepared by TecMarket Works for Southern California Edison Company, June.

[17] See Chapter 7 of Quantum Consulting, 2005. *2003 Statewide Nonresidential Standard Performance Contract (SPC) Program Measurement and Evaluation Study*, prepared by Quantum Consulting, Inc. for Southern California Edison Company, SCE Study ID: SCE0206.01, December.

Based again on the 2002-2003 and 2004-2005 SPC results, we used the case weights to calculate the stratified ratio estimator of B, denoted $\hat{B}$, as follows:

$$\hat{B} = \frac{\hat{Y}}{\hat{X}} = \frac{\sum_{i=1}^{n} w_i \, y_i}{\sum_{i=1}^{n} w_i \, x_i}$$

We then estimated relative precision of $\hat{B}$, at the 95 and 90 percent confidence levels, for alternative sample sizes using the equation below (which includes finite population correction):

$$rp = 1.96 \sqrt{1 - \frac{n}{N}} \frac{er}{\sqrt{n}} \quad \text{95\% CL}$$

$$rp = 1.645 \sqrt{1 - \frac{n}{N}} \frac{er}{\sqrt{n}} \quad \text{90\% CL}$$

The resulting precision levels for alternative samples are shown in Figure 3-1 and Figure 3-2 below for the calculated *er* of 0.35 and 0.45 as well as a range of error ratios that might occur in a large (N=5,000) and small (N=100) program population. We took under consideration that error ratios might be somewhat higher for the 2006-2008 impact evaluation than they were for the 2002-2003 SPC and 2004-2005 SPC evaluations because the scope of those impact efforts was much smaller than the expected M&V scope of the 2006-2008 evaluation. The more limited 2002-2003 and 2004-2005 impact scopes may have resulted in a higher fraction of cases in which evaluation engineers defaulted the realization rate to 1.0 because they were not able to conduct a more rigorous analysis than was conducted as part of the program savings estimation process. Conversely, the error ratio expected for the 2006-2007 verification sample and analysis was hypothesized to be possibly lower than 0.35, since verification rates are usually high and variation low for programs with mandatory verification included in the implementation process (as is the case with some of the programs in this contract group).

Figure 3-1: Expected Relative Sampling Precision (at 95% Confidence Level) Versus Sample Size with Stratified Ratio Estimation for Varying Error Ratios and Large Program Population (N=5,000)

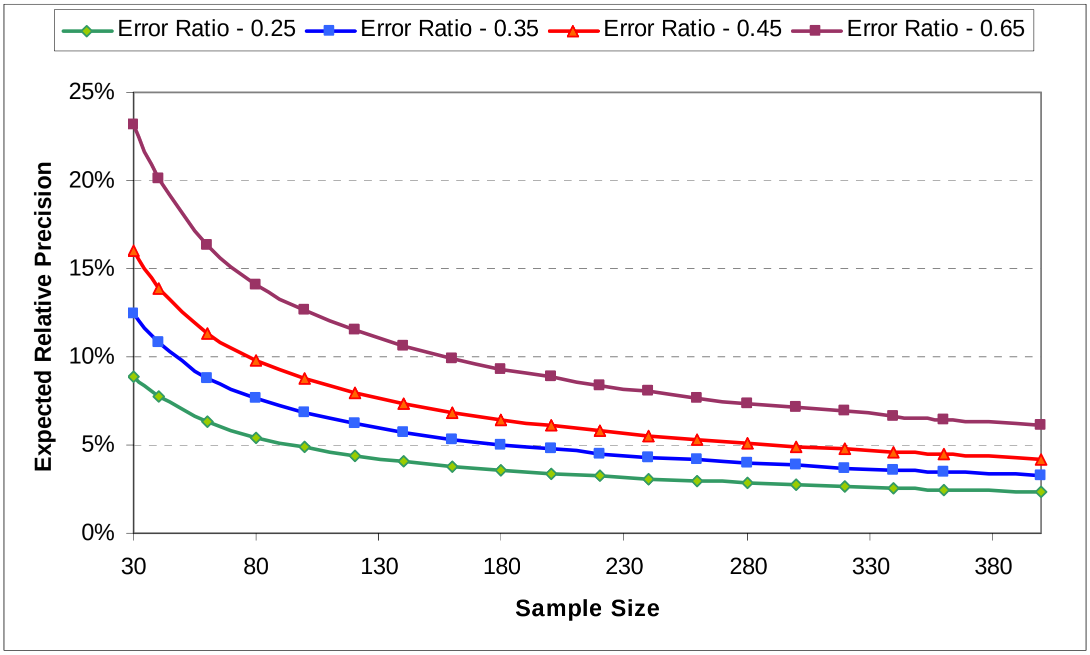
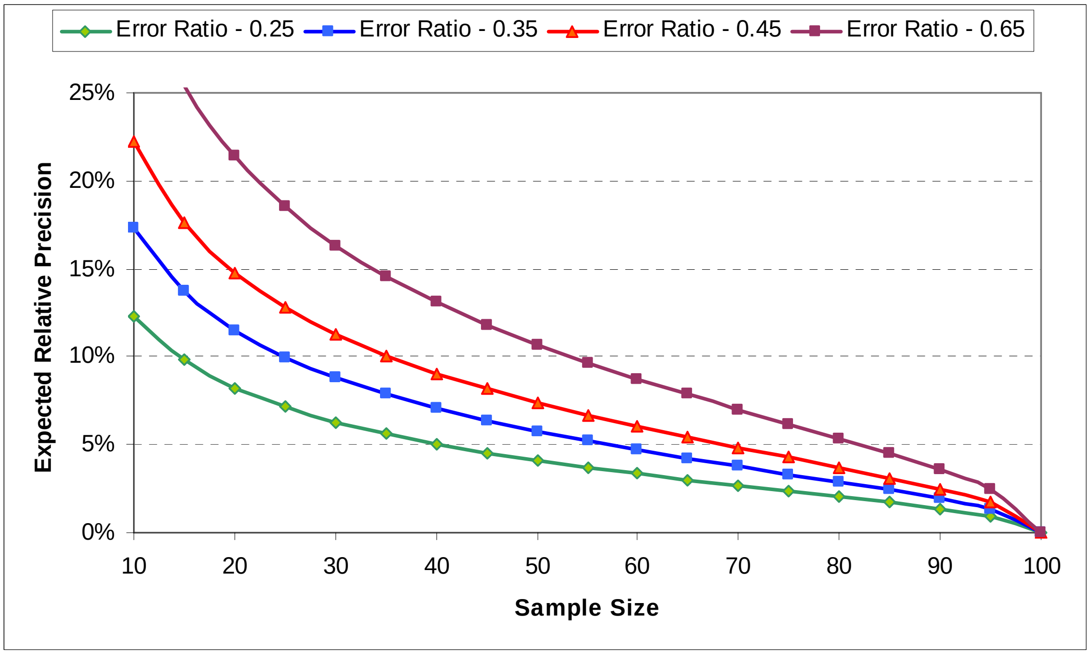


Figure 3-2: Expected Relative Sampling Precision (at 90% Confidence Level) Versus Sample Size with Stratified Ratio Estimation for Varying Error Ratios and Small Program Population (N=100)



The results in the figures are generally consistent with the example given in the *Evaluation Framework Study* (p. 366) and show that precision levels as a function of sample size are highly non-linear.

Perhaps the most important aspect of any sample design for programs that address medium and large nonresidential customers is the use of stratification based on the amount of savings associated with each project. In implementing size stratification, typically projects are grouped into 3 to 5 strata from largest to smallest within which total savings are relatively equal for each stratum. It is not uncommon to find a 100-fold difference in average savings between the stratum with the largest and smallest projects (for example, the difference between strata 1 and 5 for the 2004-2005 SPC Evaluation was 75 fold). The improvement in sampling efficiency that can result from size stratification in the nonresidential sector can often be an order of magnitude decrease in sample sizes that would otherwise be required.

3.3.3 Gross Impact Sample

There were a number of sampling steps carried out on this impact evaluation over a multi-year period beginning in 2007 and ending in 2009. This multi-year sampling was conducted in response to the fact that the evaluation was being conducting during the program implementation cycle (2006-2008) and program-reported projects were changing throughout the period. The multi-stage sampling included an initial sample for the 2006-2007 PG&E Fabrication Contract Group Verification Report. These periodic sampling steps are described in Appendix A. The remainder of this section focuses on summarizing the final evaluation sample.

In March 2009, a HIM Plan Addendum for the PG&E Fabrication, Process and Manufacturing Evaluation Contract Group was submitted to ED. Based on an analysis of program data through Q3, 2008, the Addendum proposed assigning 103 electric sample points and 27 gas points to projects across all PG&E Fab programs.

It is important to note that in Q4, 2008, ED decided that 58 new construction-related project records from program PGE2004, representing 1.15 million kWh and 97 thousand therms gross ex ante savings, would be included in the New Construction Codes and Standards (NCCS) evaluation contract group. Thus, in what follows, the PG&E Fab "population" refers to the PG&E Fab extract as of Q4, 2008 minus the 58 records included in the NCCS evaluation.

Electric Sample

As discussed in greater detail in Appendix A, a size-stratified sample of 30 electric points was drawn from the tracking extract for PGE2004 through Q4, 2007, to support the 2006-2007 Verification Report. Following the release of the Q2, 2008 tracking extract, an additional size-stratified sample of 30 M&V electric points was drawn from program PGE2004. The PG&E Fab third party programs had much lower activity levels at the time, and were therefore not included in the sampling effort. Thus, following the Q2, 2008 tracking extract, a size-stratified sample of 60 points had been selected. The remaining electric sample points (104 targeted minus 60 pulled through Q2 2008 = 44 remaining points) were drawn from the portion of the Q4 2008 program population extract that was incremental to the Q2 2008 population extract.

Table 3-1 compares the program achievements through Q4, 2008 with the final overall sample disposition, by stratum. The overall sample includes nearly a census of stratum 1 (large) projects installed in the PG&E Fab programs and captures almost one-third of claimed savings with a sample of 10 percent of projects.

Table 3-1: Distribution of Electric Projects by Stratum in the PG&E Fab Population and Final Sample Using Program Achievements as of Q4, 2008

	Population				Total Sample			
Strata	N	%N	kWh	% kWh	N	%N	kWh	% kWh
1	34	2%	142,447,707	30%	27	26%	116,620,304	65%
2	28	2%	55,226,868	11%	13	13%	25,784,795	14%
3	201	14%	169,110,120	35%	38	37%	32,816,755	18%
4	260	18%	70,534,548	15%	14	13%	4,065,321	2%
5	889	63%	45,255,421	9%	12	12%	472,578	0%
All	1,412	100%	482,574,664	100%	104	100%	179,759,752	100%

Table 3-2 shows a comparison between the end use disposition in the PG&E Fab population and the end use disposition in the final sample. Since the sample was randomly selected by stratum, the distribution of sample projects by end use is very similar to that in the population. The sample has a slightly higher percentage of POC projects and a slightly lower percentage of lighting and HVAC projects than the program population of projects.

Table 3-2: Distribution of Electric Projects by End Use in the PG&E Fab Population and Final Sample Using Program Achievements as of Q4, 2008

	Population				Total Sample			
End Use	N	%N	kWh	% kWh	N	%N	kWh	% kWh
POC	656	46%	163,650,384	34%	41	39%	67,838,981	38%
Lighting	117	8%	45,832,432	9%	10	10%	13,852,479	8%
HVAC	86	6%	16,585,308	3%	3	3%	4,877,928	3%
Other Electric	553	39%	256,506,539	53%	50	48%	93,190,364	52%
All	1,412	100%	482,574,664	100%	104	100%	179,759,752	100%

As shown in Table 3-3, the estimated confidence and precision for this sample design, at the time of the sample design, was 90/6 if the error ratio was 0.35 and 90/8 if the error ratio was 0.5. If the error ratio was 0.35, the estimated confidence and precision for the 41 POC projects would be 90/9, and for the remaining electric projects 90/7. Assuming the error ratio was no higher than 0.40, the estimated confidence/precision for both POCs and non-POCs would be equal or better than 90/10. The actual error ratios and precision levels that resulted from the evaluation sample are provided in Section 4 of this report.

Table 3-3: Confidence and Precision Estimates, Under Alternate Error Ratio Estimates, for PG&E Fab Electric Sample Using Program Achievements as of Q4, 2008

	N		Precision	
End Use	Population	Sample	ER=0.35	ER=0.5
POC	656	41	90/9	90/12
Other Electric	756	63	90/7	90/10
All	1,412	104	90/6	90/8

Gas Sample

The approach used for electric sampling was employed to isolate the 14 gas sample points drawn through Q2, 2008 and to allocate the balance of 15 gas sample points from the incremental Q4 2008 population by sample stratum to achieve the total targeted sample of 29 points. For consistency with the verification and EM&V work already completed, the number of size strata and the strata boundaries defined in the verification sample design were preserved, and the gross therms savings were used to proportionally assign sample points to each stratum.

Table 3-4 compares the program achievements through Q4, 2008 with the final sample disposition, by stratum. The sample includes a census of projects from strata 1, 2 and 3 (largest three strata). The sample captures 80 percent of the claimed savings with only 27 sample points (representing roughly 20 percent of the number of projects in the population).

Table 3-4: Distribution of Gas Projects by Stratum in the PG&E Fab Population and Final Sample using Program Achievements as of Q4, 2008

	Population				Total Sample			
Strata	N	%N	Therms	% Therms	N	%N	Therms	% Therms
1	8	5%	24,058,701	60%	8	28%	24,058,701	72%
2	1	1%	1,059,000	3%	6	21%	4,878,873	15%
3	6	4%	4,878,873	12%				
4	5	3%	2,720,285	7%	5	17%	2,720,285	8%
5	132	87%	7,427,520	19%	10	34%	1,568,509	5%
All	152	100%	40,144,380	100%	29	100%	33,226,369	100%

Table 3-5 shows a comparison between the gas end use disposition in the PG&E Fab population and the end use disposition in the final gas sample. Since the sample selection was random by stratum, the distribution of sample projects by end use is very similar with the end use distribution in the population. The final sample has a slightly higher percentage of heating boilers and a slightly lower percentage of process boilers than the program population of projects.

Table 3-5: Distribution of Projects by End Use in the PG&E Fab Population and Final Gas Sample using Program Achievements as of Q4, 2008

	Population				Total Sample			
End Use	N	%N	kWh	% kWh	N	%N	kWh	% kWh
Process Boiler	50	33%	8,569,002	21%	10	34%	6,589,545	20%
Heating Boiler	29	19%	17,237,876	43%	7	24%	16,213,895	49%
Boiler Controls	8	5%	99,355	0%	0	0%	0	0%
Other Gas	65	43%	14,238,147	35%	12	41%	10,422,928	31%
All	152	100%	40,144,380	100%	29	100%	33,226,369	100%

As shown in Table 3-6, the estimated confidence and precision levels for the final sample are 90/10, assuming an error ratio of 0.35 and 90/15 assuming an error ratio of 0.5. The actual error ratios and confidence and precision levels that resulted from the evaluation are presented in Section 4.

Table 3-6: Confidence and Precision Estimates, Under Alternate Error Ratio Estimates, for PG&E Fab Gas Sample using Program Achievements as of Q4, 2008

	N		Precision	
End Use	Population	Sample	ER=0.35	ER=0.5
Boiler	87	17	90/15	90/21
Other Gas	65	12	90/14	90/20
All	152	29	90/10	90/15

3.3.4 Net-to-Gross Sample Design

The original research plan submitted to ED for the PG&E Fab contract group included net-to-gross evaluations by program based on “300 sample points or one-half of the program size, whichever is lowest.”

Based on a program tracking database extract for Q3, 2008, a net-to-gross sample of 350 points was drawn for program PGE2004. Similarly, a net-to-gross sample of 164 points was drawn for third-party programs in the PGE Fab contract group. The number of points drawn was higher than 300 or one-half of program size as of Q3, 2008 to allow for backups in case of survey non-response. The M&V sample was nested in the net-to-gross sample.

After the Q4, 2008 tracking database was received and the final M&V sample was finalized, the sample points that were added to the M&V sample in Q4, 2008 were also added to the net-to-gross sample. Since our evaluation approach had shifted focus from program-level to domain level the resulting net-to-gross sample size already exceeded the “300 or one-half of program size” rule. The sample was not further expanded with additional measures installed in Q4, 2008.

Table 3-7 below summarizes the NTG sample design for electric measures installed in the PG&E Fab programs, and Table 3-8 shows the same for the gas measures installed in the PG&E Fab programs.

Overall, extremely high percentages of the claimed electric (69 percent) and gas (87 percent) savings were captured in the net-to-gross samples.

Table 3-7: PG&E Fab Net-to-Gross Sample Design – Electric Measures as of Q4, 2008

	PGE Fab Programs		NTG Sample		NTG Sample Precent	
Strata	N records	Gross kWh	N records	Gross kWh	N records	Gross kWh
1	34	142,447,707	27	116,620,304	79%	82%
2	28	55,226,868	20	39,485,533	71%	71%
3	201	169,110,120	147	122,784,283	73%	73%
4	260	70,534,548	171	44,892,447	66%	64%
5	889	45,255,421	188	8,802,084	21%	19%
Total Electric Measures	1,412	482,574,664	553	332,584,649	39%	69%

Table 3-8: PG&E Fab Net-to-Gross Sample Design – Gas Measures as of Q4, 2008

	PGE Fab Programs		NTG Sample		NTG Sample Precent	
Strata	N records	Gross Therms	N records	Gross Therms	N records	Gross Therms
1	8	24,058,701	8	24,058,701	100%	100%
2	1	1,059,000	1	1,059,000	100%	100%
3	6	4,878,873	6	4,878,873	100%	100%
4	5	2,720,285	5	2,720,285	100%	100%
5	132	7,427,520	34	2,038,612	26%	27%
Total Gas Measures	152	40,144,380	54	34,755,471	36%	87%

3.4 Approach to Estimating Ex-Post Gross Energy Savings

This evaluation used a similar set of approaches to estimating ex-post gross energy savings as used in previous California IOU industrial program evaluations, relying primarily on site-specific measurement and verification for the impact evaluation. The key steps used to develop an overall savings estimate for the contract group were to:

- independently verify reported measure installation records,
- develop ex-post estimates of the energy savings for each project in the sample, and
- apply those findings to the full participant population to obtain a complete estimate of program impacts.

The approach to the impact analysis consists of a distinct set of steps that are listed below and discussed in the subsections that follow. These steps include:

- Developing and implementing the sample design;
- Obtaining the sample of application files and associated documentation;
- Reviewing the applications and preparing the ex-post analysis plans by site;
- Scheduling and conducting the on-site data collection, conducting project verification, and developing the ex-post impact estimates for each site;
- Preparing detailed, site-specific impact evaluation reports;
- Carrying out a quality control review of the ex-post impact estimates and the associated draft site reports and implementing any necessary revisions;
- Estimating a net-of-free-ridership ratio for each site;
- Extrapolating the final ex-post realization and net-of-free ridership estimates for the sample to the remaining applications; and
- Reviewing each of the steps above with Energy Division and its consultants.

For the sampled participant sites, the engineering analysis methods and degree of monitoring varied from project to project, depending on the complexity of the measure, the size of the associated savings, and the availability and reliability of existing data.

To address the wide range in size and complexity across projects, and to maximize the number of sample points for the evaluation, a multi-tiered level of effort for the site-specific engineering work was planned and implemented, from least to most complex and engineering resource intensive. Table 3-9 below provides an overview of the engineering level of effort tiers. The complexity and heterogeneity of expected projects required that enough effort be spent on each site's M&V to produce an accurate and defensible ex post savings estimate. Increasing the reliability of the ex post estimates is as important as increasing the reliability of the sample (which occurs by increasing the number of sample points). In the table below, we summarize the range of M&V efforts that we incorporated into our sample design and site evaluation resource plans.

Table 3-9: Overview of Engineering Level of Effort Tiers

M&V Tier	Description
Level 1	▪ Largest and most complex projects. Detailed application review, on-site verification, collection of data on key parameters, billing/interval data analysis, calibrated simulation models, spot measurements, long-term post monitoring, pre- verification and short-term measurement. ▪ Approximate hours per site: 200
Level 2	▪ Large, complex projects. Detailed application review, on-site verification, collection of data on key parameters, billing/interval data analysis, engineering models, spot measurements, mid-term post monitoring, pre- verification. ▪ Approximate hours per site: 160
Level 3	▪ Large or relatively complex projects. Detailed application review, on-site verification, collection of data on key parameters, billing/interval data analysis, engineering models, spot measurements, short-term post monitoring, pre- verification. ▪ Approximate hours per site: 100
Level 4	▪ Medium size projects requiring monitoring or metering. Detailed application review, on-site verification, collection of data on key parameters, revised engineering calculations, billing data analysis, and spot measurements, possible short term post monitoring. ▪ Approximate hours per site: 60
Level 5	▪ Smaller, simpler projects. Detailed application review, on-site verification, collection of data on key parameters, revised engineering calculations, billing data analysis, and possible spot measurements. ▪ Approximate hours per site: 30

3.4.1 Obtain Sample Application Records

As discussed in Section 3.3, sample was pulled at various points in the evaluation. Once a sample of projects was selected, Itron submitted a formal data request to PG&E for the application records, including site data, verification records, all savings calculations, and all information transactions. Once those documents were received, the individual engineer assigned to each application conducted an initial review to assess the need for additional documentation.

3.4.2 Review Applications and Prepare Analysis Plans

For each selected application, the assigned engineer performed an in-depth application review to assess the engineering methods, parameters and assumptions used to generate all ex-ante impact estimates. Application review served to familiarize the assigned engineer with the gross impact approach applied in the program calculations. This also allowed an assessment of the additional data and monitoring needs that were required to complete each analysis and the likely sources for obtaining those analytic inputs. Data sources were to include interviews on-site personnel, visual inspection of the systems and equipment, EMS data downloads, spot measurements, short-term monitoring (e.g., less than four weeks), and mid-term monitoring (4 to 8 weeks).

A site-specific measurement and verification plan was developed for each site and submitted to ED staff and their consultants for review and approval. This plan outlined the general ex-post impact approach to be used (including monitoring plan), provided an analysis of the current inputs and identified calculations necessary to complete the evaluation. The plan specified what data was required to be collected during the site visit.

3.4.3 Schedule and Conduct On-Site Data Collection

On-site surveys and data collection were completed for each of the 130 PG&E customer projects in the sample. The on-site data collection form can be found in Appendix B. During the site visit, the Itron team engineer met with a facility representative knowledgeable about the equipment and operation, and asked a series of questions regarding operating schedules, location of equipment, and equipment operating practices. During the on-site survey, data identified in the measurement and verification plan was collected, including monitoring records (such as instantaneous spot watt measurements, measured fluid and gas temperatures, data from equipment logs, energy management system (EMS) downloads, and Supervisory Control and Data Acquisition (SCADA) system data); equipment nameplate data; system operation sequences and operating schedules; and a careful description of the baseline condition being modeled. Information related to net-to-gross analysis and baseline specification was also collected, including financial information on project economics, reasons for conducting the project, and remaining useful life of replaced equipment. The net-to-gross information collected from the gross impact site visit is supplemental to the primary net-to-gross (NTG) data collection process which focused on interviewing project decision makers. Section 3.7 describes the NTG interview process.

3.4.4 Conduct Site-Specific Verification and Impact Calculations

After all of the field data was collected, energy and demand savings were developed based on the on-site data, monitoring data, application information, third-party implementer records and, in some cases, billing/interval data.

Energy savings calculations were accomplished using methods that included short-term monitoring, simulation modeling, bin models, application of engineering methods and algorithms, analysis of pre- and post-installation billing and interval data, and other specialized algorithms and models. Short-term monitoring was a priority for all sites, and peak demand savings were also estimated for all projects in the sample. In cases where billing/interval data analysis was used to estimate energy savings, peak demand savings were estimated using principally interval data (if available) and engineering calculations based on estimates of operating profiles and coincident peak diversity factors.

3.4.5 Site-Specific Net-to-Gross Analysis

As discussed in Section 3.7 below, a detailed net-to-gross analysis was conducted for each project in the net-to-gross sample. The primary net-to-gross interviews were conducted with the customer's energy efficiency project decision makers. All of the gross impact sites were included in the net-to-gross sample and most of the associated net-to-gross interviews were completed. Net-to-gross interviews were conducted by both professional consulting staff and by staff in Itron's computer-aided telephone interviewing (CATI) center depending on the rigor level of the sample point. For the higher rigor level interviews, the net-to-gross interviewing team worked with the engineering team to prepare for both NTG and gross impact surveys, share information collected from each survey, and to discuss issues related to determining the final NTG and gross impact estimates. Care was taken to ensure that the results were internally consistent and did not include any double counting of effects between the two samples. Detailed Site-Specific NTG Results can be found in Appendix D.

3.4.6 Site-Specific Analysis Documentation

Detailed documentation is provided in the site report appendix for each site included in the gross impact analysis. The site report documentation includes the following elements:

- Measure Description
- Summary of Program Impact Calculations
- Comments on Program Impact Calculations
- Description of the Impact Evaluation Process
- Impact Evaluation Results
- Supporting Documentation

3.4.7 Quality Control Review and Final Site Reports

The Itron engineering and project management team reviewed and commented on all draft site reports and provided feedback to each assigned engineer for revisions or other improvements. Each assigned engineer then revised the draft reports as necessary to produce the final report as approved by Itron.

The second level of quality control consisted of submitting the draft site reports to ED and its consultants for review and approval. This review provided an important additional level of quality assurance. This review also enabled ED to make final decisions on application of policy-related requirements for project eligibility and baseline specification.

3.4.8 Estimate Verification, Realization, and Impacts for Participant Population

Extrapolation of the site-specific ex-post results to the population was carried out following the statistical procedures for ratio estimation discussed in Section 3.3 and in the *California Evaluation Framework Study*. The population-weighted results are provided in Section 4 of this report.

3.4.9 Engineering Approach for POCs

The general steps for conducting site-specific gross impact analysis for POCs were much the same as for the other industrial measures in this contract group, with exceptions and additional details provided in this subsection. Itron's engineering team and ED consultants worked very closely on various iterations regarding the engineering approach to use for this HIM.

Site characteristics in oil production are variable, including well sizes and depths, equipment sizes, differences in subsurface geologic formation in each reservoir and fluid/oil/water characteristics. The variability of these characteristics influences the on/off state over which the POCs have control. Measurement of the on/off period is difficult in practice; however, it is critical in determining the energy savings for this measure.

POC applications from the same customer were grouped for M&V purposes. For sampling, wells were tiered based on level of expected savings by the size and production levels of each well. Selection was determined using stratified random sampling and generally based on a 90/20 precision target.

Dent Elite Pro kW data loggers were placed on the pump motor conductors for the sampled wells to record kW, kWh, voltage, amps and power factor data every five minutes for a minimum of 4 weeks. Data was also obtained from the facility's Supervisory Control and Data Acquisition (SCADA) system for comparison with the logger data.

Expected baseline or pre-retrofit power draw (kW) was collected by de-energizing the POC and allowing the well to stabilize for 7 days. A well may stabilize to pre-retrofit operation immediately after it is pumped-off; however, the longer period allows for a better reading of the baseline condition. Short-term metering was also conducted during the baseline condition testing. This allowed for a field-specific baseline kW adjustment factor and an average oil field baseline kW adjustment factor to be determined.

With this adjustment to the baseline kW made, the following algorithms were used for all but one large customer to determine the energy and demand impacts as a result of the POC installation. Note that site specific algorithms are provided in the site-specific results which can be found in Appendix D. In addition, a supplementary POC methods and results discussion is provided in Appendix E.

kWh/yr saved = kWh pre-retrofit – kWh (post-retrofit)

where,

kWh (pre-retrofit) = [(kW (post-retrofit) x 81.35%) x (hrs/yr pre-retrofit))]

kWh (post-retrofit)) = [kW (post-retrofit) x hrs/yr post-retrofit (from SCADA data)]

kW (post-retrofit) = Measured true kW (On-period kW average) during the logged duration

Hrs/yr (pre-retrofit) = 8,760 x operating factor (2% for downtime and equipment maintenance)

Hrs/yr (post-retrofit) = SCADA system hours (corroborated by Dent logger findings)

The peak period kW demand reduction was calculated using the pre- and post-retrofit energy use averaged over the entire year (8,760 hours), since controlled and uncontrolled well pump operation is not weather-dependent and equally likely to occur at any time of the year, and since downtime, maintenance or POC de-energization could also occur at any time. This hypothesis was confirmed through analysis of the measured kW and SCADA data, as well as customer interviews.

kW avg (pre-retrofit) = kWh (pre-retrofit) / 8,760 hours per year kW avg (post-retrofit) = kWh (post-retrofit) / 8,760 hours per year

kW saved = kW avg (pre-retrofit) – kW avg (post-retrofit)

For one very large POC customer, we were able to use measured kW for the baseline instead of the adjustment factor used for the other fields. For this customer, the following algorithms were used to calculate energy savings for the wells with simulated pre-retrofit and post-retrofit measurements:

Pre-retrofit energy usage (kWh/yr) = measured pre kW x pre annual operating hours (8760 hours/year x 0.97)

Post—retrofit annual operating hours = % on time from SCADA in normal operation x pre annual operating hours (8760 hours / year x 0.97)

Post-retrofit energy usage (kWh/yr) = measured post kW x post-retrofit annual operating hours (hours/ year)

Energy savings (kWh/yr) = Pre-retrofit energy usage (kWh/yr) - Post-retrofit energy usage (kWh/yr)

Demand savings (kW) = Energy savings (kWh/yr)/ 8760

3.5 Approach to Uncertainty

The consideration of uncertainty was an important part in this evaluation. In addition to the uncertainty that is associated with sampling error, there also uncertainty associated with the estimation and measurement of savings. It is well-known that there is uncertainty in both the ex-ante and the ex-post energy savings estimates. Program level savings estimates are affected by both the number of points sampled (sampling error) and the degree to which the measured site level energy savings estimates reflect the “true” savings (measurement error). The purpose of conducting rigorous site-level evaluation of savings for custom efficiency projects in heterogeneous applications is to estimate savings as reliably as possible (i.e., minimize measurement error) given available resources and the need to maintain a large enough sample to provide adequate sampling precision.

If the component of measurement uncertainty could be directly observed then a mathematical trade-off could be made to optimally reduce the uncertainty of both sampling and measurement error, that is, by sampling more points to decrease the standard error of the mean, or by investing more time and money into each individual site to reduce the individual site measurement error. The dispersion of the sample cannot be characterized directly, but it can be inferred, knowing the total uncertainty and the measurement uncertainty if we assume that the two components to the dispersion (measurement error of the “true” value and variation of “true” values within the population) combine in quadrature to yield the combined dispersion of the sample. Sampling error can be estimated a priori using error ratios and standard errors from similar evaluation efforts conducted previously; however, measurement error cannot be easily estimated as the true savings values are not directly observed. Thus, the trade between the number of sample points and level of effort to reduce measurement uncertainty through increased site-specific evaluation efforts requires judgment. This is a value maximization exercise in which a sample size is specified to meet the study requirements and then the available resources are allocated across the sites based on their size and complexity to minimize the measurement error.

The discussion above concerns tradeoffs between sample error and measurement error for the overall evaluation planning effort. In addition, uncertainty was also addressed in developing the M&V plan for each individual site in this evaluation. Site level energy savings uncertainty was addressed in a two-fold effort. In the first step, in the M&V planning stage, uncertainty analysis was used to understand which variables were likely to have the largest contributions to the overall measurement error in order to focus the site M&V effort on reducing error in the most cost-effective and feasible manner. In the second step, after the M&V work and associated analysis was complete, the ex post results were used to revisit the uncertainty analysis to investigate the levels of uncertainty that remained. This information is useful both to better understand the results of the current study and as input to help characterize measurement uncertainty to improve evaluation and M&V planning for similar future studies.

Because the data collection and savings calculation methods are different for varied industrial sites with different types of measures, an uncertainty analysis could not be done in aggregate for the whole program, but instead was needed at the site level. With over one hundred sites in the sample, it was not possible to perform detailed uncertainty analysis with statistical methods (e.g., Monte Carlo) on every site.

However, in the M&V planning stage for nearly every site, the individual components driving uncertainty – the variables in an energy savings equation – were analyzed to aid in the design of M&V that would result in reduced uncertainty, even if a formal analysis was not performed.

Measurement uncertainty stems from several sources: instruments to monitor variables such as power, flow, or even on/off periods have potential measurement error. Instrument error can be reduced by choice of more accurate equipment and proper training on equipment use. A mean measured value can also be characterized more precisely by monitoring it for a longer time period, as the uncertainty of the mean is inversely proportional to the square root of the number of measurements made. In most cases, we are interested in the mean value of the variables we measure, so monitoring for a longer period is very valuable in reducing measurement error at a site.

For non-measured values, there was an evaluator-determined uncertainty as to the expected range for that variable, informed by observations on site, conversations with on site staff, and familiarity with possible and expected ranges for the type of variable. As an example, hours can range from 0 to 8,760 hours per year, but for a regularly scheduled application, like factory lighting fixtures on an energy management system, the hours may be known fairly well with only a relatively small range of error.

For those cases for which a Monte Carlo analysis was conducted, each of the key variables were described with an expected range, the type of error distribution (e.g., normal, triangular, lognormal, etc.), and either standard deviations or maximum /minimum values. For some sites, detailed uncertainty analysis was performed using Crystal Ball ^{tm} or At Risk^{tm} software to run a Monte Carlo simulation and propagate the uncertainty through the energy savings equation or calculation. Monte Carlo is an appropriate method to use on both simple sites and sites where the calculation is complex and there are multiple parameters of import.

Where uncertainty analysis was conducted in the site planning and ex post analysis, it is discussed in the site reports in Appendix D.

3.6 Approach to Determining Gross Baselines

Over the course of this evaluation, Itron worked through baseline determination and adjustment issues and free ridership in projects with ED and its consultants. Assessment of both full free ridership and partial free ridership is related to the selection of baselines used for gross savings analysis. Free ridership occurs when the program participant would have installed the program-incented or recommended measure in the absence of the program. Partial free-ridership can occur when, in the absence of the program, the participant would have installed something more efficient than the baseline efficiency specified for the gross savings estimation but not as efficient as the item actually installed as a result of the program. For example, in the absence of the program, a participant states that they would have installed 5 VSDs rather than the 10 installed through the program. Or, as another example, in the absence of the program, a participant might have installed an industrial boiler system with an efficiency of 82% (greater than a program-assumed baseline of an existing efficiency code, e.g., efficiency of 80%) rather than the 85% efficiency that was installed through the program.

A challenge that occurs in a number of industrial projects is how to define the evaluation's baseline for gross savings with respect to program requirements that reference "industry standard practice" as the basis for the baseline. In some cases, the availability of efficiency options above the industry standard practice baseline may leave room for further savings adjustment due to partial free ridership. In other cases, there may be few or no efficiency options above the industry standard practice baseline, the result of which may be low or zero gross savings. Evaluators' choices of baselines may differ from those selected by program administrators for a number of reasons as discussed in the remainder of this subsection.

Differences in baseline choices between evaluators and implementers will lead to differences in savings estimates and evaluation realization rates. Documenting these baseline selection differences and explaining the basis for them is an important part of the industrial evaluation process and final evaluation report findings and recommendations.

Below are several principles that Itron used as guidance for determining the appropriate baseline to be used in calculating the gross savings for a project in the PG&E Fab contract group:

Code or market baselines were used for replace-on-burnout and 'natural turnover.'

In situ baselines were only used for the portion of the remaining useful life (RUL) of the pre-existing equipment that was eliminated due to the program. Consideration was given to the specifics of the application with respect to the remaining life, if any, of the pre-existing equipment when selecting the baseline including:

- In-situ equipment was used as the gross baseline only when the existing equipment was not at the end of its useful life and there was compelling evidence that the pre-existing equipment had a remaining useful life.

- Code requirements or industry standard practice baseline were used for replace-on-burnout or natural turnover situations.

- Care was taken in the use of industry standard practice baseline with respect to how much, if any, savings adjustments applied to gross versus net savings.

CPUC policy rules and IOU program eligibility rules governed the baseline.

Careful review of utility and third-party program and CPUC policy rules were made and adjustments were applied to gross savings in some cases, while in others to net savings. The adjustments were applied to gross when there was clear evidence from program or policy rules that savings claims could not be made nor rebates paid for the case in question. Program rules also came into play with respect to gross baseline requirements, e.g., specifying a given efficiency level or percentage above code. In situations where program or policy rules were in question, the case was reviewed by the Itron project management team, ED's consultants, and ED, with ED making the final judgment on whether rules were violated and whether associated corrections were required in the baseline determination or measure qualification.

Minimum production or energy service requirements govern the baseline.

In some situations, a measure for which savings were claimed was determined to be the only acceptable equipment for an application. In such cases, the baseline was set at the minimum needed to meet the requirements. Care was taken to ensure that the changes in production or energy service requirements were not merely preferences but were fundamentally required. An example would be an industrial process where only a variable-speed drive pumping system could meet the production requirements.

For situations where the baseline conditions were changed (such as production levels), the baseline equipment was defined as the minimum equipment needed to meet the revised conditions. This could result in changes in gross savings if claimed savings were set at pre-installation requirements.

Evaluate early replacement RULs and program inducement.

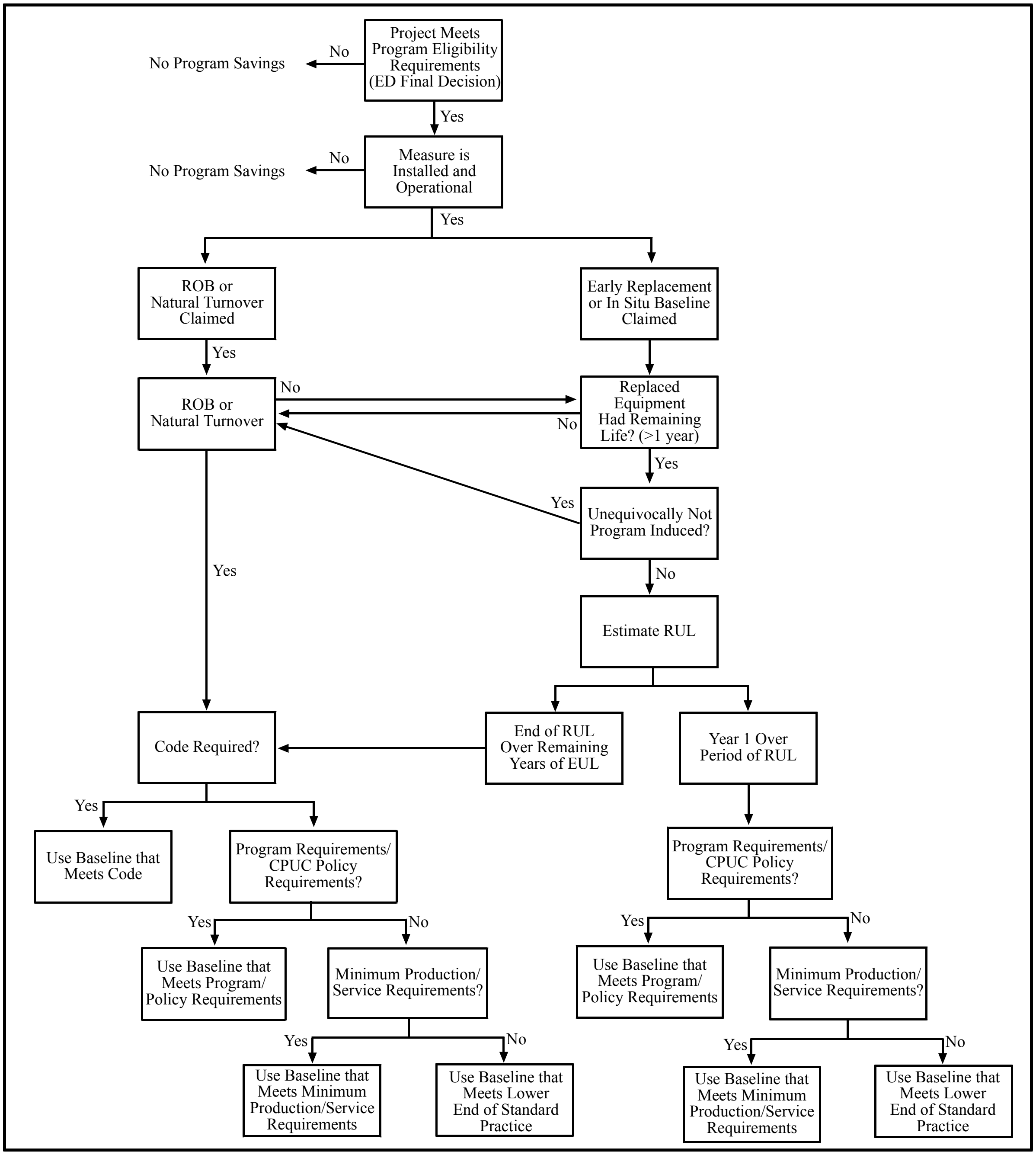
The gross engineering team determined whether there was evidence that early replacement actually occurred, that is, that there was remaining life on the equipment replaced. If so, an estimate was made of the associated RUL. The net team, in consultation with the engineering team, was responsible for determining whether the early replacement was program induced. If the early replacement was not program induced, the gross baseline was set based on the replace on burnout/natural turnover guidelines.

The decision tree used as guidance for determining the baseline for gross savings can be found in Figure 3-3 below. The application of site specific baselines, gross and net baseline approaches were reviewed by ED and its consultants.

Figure 3-3: Baseline Guidance

Guidance for Determination of Baseline for Gross Savings

Take Most Efficient of All Applicable Cases



3.7 Approach to Estimating Freeridership

This section provides a summary of this evaluation's approach to estimating the net-to-gross ratios for the analysis domains in the PG&E Fab contract group. A more extensive discussion of the methods used is provided in Appendix C-1 to this report. As part of the evaluation of the 2006-08 energy efficiency programs designed and implemented by the four investor-owned utilities and third parties, ED formed a nonresidential net-to-gross ratio working group that was composed of experienced evaluation professionals. The main purpose of this group was to develop a standard methodological framework, including decision rules, for integrating in a systematic and consistent manner the findings from both quantitative and qualitative information in estimating net-to-gross ratios.

The methodology described in this section was developed to address the unique needs of Large Nonresidential customer projects developed through energy efficiency programs offered by the four California investor-owned utilities and third-parties. This method relies exclusively on the Self-Report Approach (SRA) to estimate project and domain-level Net-to-Gross Ratios (NTGRs), since other available methods and research designs are not feasible for the types of Large Nonresidential Custom programs that were the subject of this evaluation. For example, in the industrial sector, three barriers are immediately apparent. First, there is an expected very small signal to noise ratio (low statistical power) in a participant/nonparticipant billing analysis i.e., the expected difference in monthly energy use between participants and nonparticipants is too small to detect reliably compared to other sources of variation in kWh that vary greatly across individual industrial sites. In addition, some large industrial customers targeted by the program may have been influenced by participation in energy efficiency programs in prior years, making it very difficult to find true nonparticipants. Finally, even if the first two problems were absent, the large industrial customers targeted by the program are each unique making it unlikely that one could find a group of nonparticipants that could be matched with participants on critical variables.

This SRA methodology provides a standard framework, including decision rules, for integrating findings from both quantitative and qualitative information in the calculation of the net-to-gross ratio in a systematic and consistent manner. This approach was designed to fully comply with the *California Energy Efficiency Evaluation: Protocols: Technical, Methodological, and Reporting Requirements for Evaluation Professionals* (Protocols) and the *Guidelines for Estimating Net-To-Gross Ratios Using the Self-Report Approaches* (Guidelines), as demonstrated in the Nonresidential NTGR Methods Appendix C-1.[18]

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[18] Appendix C-1 contains the detailed *Methodological Framework for Using the Self-Report Approach to Estimating Net-to-Gross Ratios for Nonresidential Customers*, which includes a demonstration of how this methodology complies with the *California Energy Efficiency Evaluation: Protocols: Technical, Methodological, and Reporting Requirements for Evaluation Professionals* (Protocols) and the *Guidelines for Estimating Net-To-Gross Ratios Using the Self-Report Approaches* (Guidelines).

- The method used a 0 to 10 scoring system for key questions used to estimate the NTGR rather than using fixed categories that were assigned weights. It asked respondents to jointly consider and rate the importance of the many likely events or factors that may have influenced their energy efficiency decision making, rather than focusing narrowly on only their rating of the program's importance. This question structure more accurately reflected the complex nature of the real-world decision making and helped to ensure that all non-program influences were taken into account in assessing the unique contribution of the program as reflected in the NTGR.

- There are three levels of free-ridership analysis. The most detailed level of analysis, the Standard – Very Large Project NTGR, was applied to the largest and most complex projects (representing 10 to 20% of the total) with the greatest expected levels of gross savings.[19] The Standard NTGR, involving a somewhat less detailed level of analysis, was applied to projects with moderately high levels of gross savings. The least detailed analysis, the Basic NTGR, was applied to all remaining projects. Evaluators exercised their own discretion as to what the appropriate thresholds should be for each of these three levels.

3.7.1 Data Sources

There are five sources of free-ridership information in this study. Each level of analysis relies on information from one or more of these sources.

Table 3-10 below shows the data sources that were used in each of the three levels of free-ridership analysis. Although more than one level of analysis may share the same source, the amount of information that was utilized in the analysis varied. For example, all three levels of analysis obtained core question data from the Decision Maker survey. The Large Nonresidential NTG Survey Instrument can be found in Appendix C-2.

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[19] Note that we do not refer to an Enhanced level of analysis, since this is defined by the Protocols to involve the application of two separate analysis approaches, such as billing analysis or discrete choice modeling.

Table 3-10: Information Sources for Three Levels of NTGR Analysis

	Program File	Decision Maker Survey Core Question	Vendor Surveys	Decision Maker Survey Supplemental Questions	Utility & Program Staff Interviews	Other Research Findings
Basic NTGR	√	√	√[1]		√[2]	
Standard NTGR	√	√	√[1]	√	√	
Standard NTGR - Very Large Projects	√	√	√[3]	√	√	√

Footnotes below reference question numbers provided in Appendix C-2.

[1] Only performed for sites that indicate a vendor influence score (N3d) greater than maximum of the other program element scores (N3b, N3c, N3g, N3h, N3l).

[2] Only performed for sites that have a utility account representative

[3] Only performed if significant vendor influence reported or if secondary research indicates the installed measure may be becoming standard practice.

3.7.2 NTGR Questions and Scoring Algorithm

The NTGR was calculated as an average of three scores. Each of these scores represented the highest response or the average of several responses given to one or more questions about the decision to install a program measure.

1. A **Timing and Selection** score that reflected the influence of the **most important** of various program and program-related elements in the customer’s decision to select the specific program measure at this time. Program influence through vendor recommendations was also incorporated in this score.

2. A **Program Influence** score that captured the perceived importance of the program (whether rebate, recommendation, training, or other program intervention) relative to non-program factors in the decision to implement the specific measure that was eventually adopted or installed. This score was determined by asking respondents to assign importance values to both the program and most important non-program influences so that the two total 10. The program influence score was adjusted (i.e., divided by 2) if respondents said they had already made their decision to install the specific program qualifying measure before they learned about the program.

3. A **No-Program** score that captures the likelihood of various actions the customer might have taken at this time and in the future if the program had not been available (the counterfactual). This score also accounted for deferred free ridership by incorporating the likelihood that the customer would have installed program-qualifying measures at a later date if the program had not been available.

When there were multiple questions that fed into the scoring algorithm, as was the case for both the **Timing and Selection** and **No-Program** scores, the maximum score was always used. The rationale for using the maximum value was to capture the most important program element in the participant's decision making. Thus, each score was always based on the strongest influence indicated by the respondent. However, high scores that were inconsistent with other previous responses triggered consistency checks and led to follow-up questions to clarify and resolve the discrepancy.

When there were missing data or 'don't knows' to critical elements of each score, one of two options was used. The missing element was sometimes backfilled with a value that represented the average of the lowest and highest extreme values. Alternatively, if it was one of several other elements that were considered in the algorithm, the missing element may simply have been excluded from consideration.

The self-reported core NTGR in most cases was simply the average of the Program Influence, Timing and Selection, and No-Program Scores, divided by 10. The one exception to this was when the respondent indicated a 10 in 10 probability of installing the same equipment at the same time in the absence of the program, in which case the NTGR was based on the average of the Program Influence and No-Program scores only.

3.7.3 Data Analysis and Integration

The calculation of the Core NTGR was generally mechanical and was based on the answers to the closed-ended questions. However, the reliance of the Standard NTGR – Very Large on more information from so many different sources required more of a case study level of effort. The SRA Guidelines point out that a case study is one method of assessing both quantitative and qualitative data in estimating a NTGR. A case study is an organized presentation of all these data available about a particular customer site with respect to all relevant aspects of the decision to install the efficient equipment. In such cases where multiple interviews were conducted eliciting both quantitative and qualitative data and a variety of program documentation had been collected, all of this information was integrated into an internally consistent and coherent story that supported a specific NTGR.

Sometimes, *all* the quantitative and qualitative data clearly pointed in the same direction while, in others, the *preponderance* of the data pointed in the same direction. Other cases were more ambiguous. In all cases, in order to maximize reliability, it was essential that more than one person be involved in analyzing the data. Each person analyzed the data separately and then compared and discussed the results. Important insights can emerge from the different ways in which two analysts look at the same set of data. Ultimately, differences were resolved and a case made for a particular NTGR. Careful training of analysts in the systematic use of rules was carried out to insure inter-rater reliability.[20]

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[20] Inter-rater reliability is the extent to which two or more individuals (coders or raters) agree. Inter-rater reliability addresses the consistency of the implementation of a rating system.

Once the individual analysts completed their review, they discussed their respective findings and presented their respective rationales for any recommended changes to the equation-derived NTGR. The outcome of this discussion was the final NTGR for a specific project.

4

Results

This section presents the quantitative results of the PG&E Fab impact evaluation. It begins with an analysis of program-specific participation patterns by quarter and then continues with a detailed reporting of gross and net realization rates for each sampling domain. Sampling domains are defined in Sections 2 and 3 of this report and include pump-off controllers (POCs), all other electric measures (non-POCs), and gas measures.

4.1 Quarterly Participation Patterns

During the first two years of the funding cycle, two programs accounted for virtually all of the participation and claimed savings, the PG&E Fabrication, Process and Heavy Industrial Manufacturing program (PGE2004) and the Energy Efficiency Services for Oil Production program (PGE2058) operated by Global Energy Partners. In 2008, several additional third party programs contributed to the mix of participation, including

- *PGE2042,* the Heavy Industry Energy Efficiency Program operated by Lockheed Martin
- *PGE2046,* QuEST's California Wastewater Process Optimization Program
- *PGE2064,* Nexant's Refinery Energy Efficiency Program
- *PGE2081*, Air Power USA's Assessment, Implementation and Monitoring Program
- *PGE2084,* Ecos Consulting's Energy Efficiency of Compressed Systems
- *PGE2087,* Enovity's Commercial and Industrial Boiler Efficiency Program

Figure 4-1 below summarizes these participation patterns, in terms of claimed ex-ante gross kWh savings for the PG&E Fab contract group[21], and selected programs within that group that accounted for the largest shares of participation.

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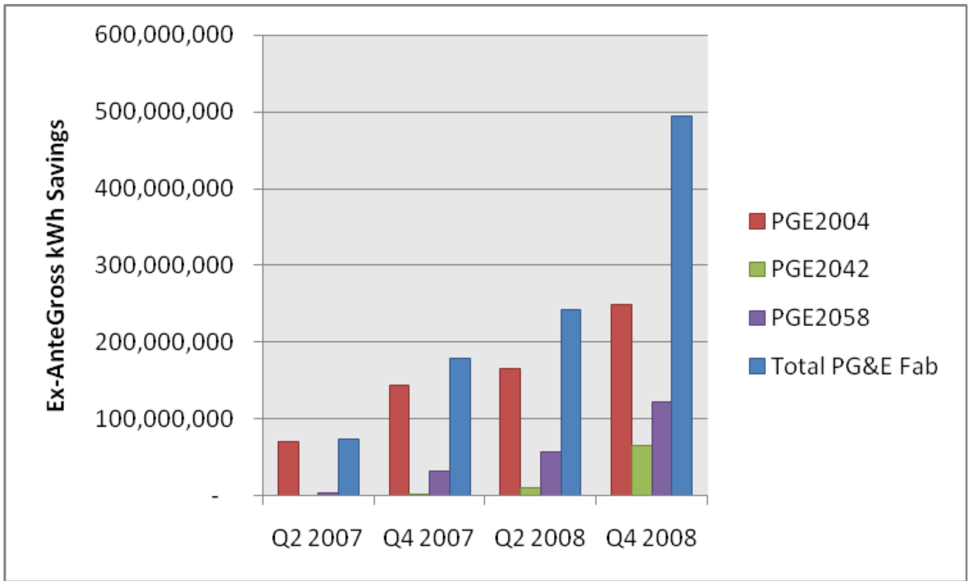
[21] Please note that the reported total ex-ante gross kWh savings for this group of programs includes 11,497,218 gross kWh of savings from 58 projects classified as New Construction - Commercial that were transferred to the New Construction contract group for evaluation. They were not addressed in this evaluation.

Figure 4-1: Participation for Selected Programs (Q2 2007 through Q4 2008)



The data clearly demonstrate the ‘hockey stick’ pattern of participation in these types of Industrial programs, whereby long-lead-time projects lead to relatively low savings claims during the early part of the plan period, and dramatically higher savings claims at the end of the plan period. For example, total reported and claimed electric energy savings doubled between Q2 2007 and Q2 2008, and then doubled again to reach 494 GWh in Q4 2008.

4.2 Site-Specific Gross Impacts

In this sub-section we present our gross impact results on an unweighted basis by project. Anonymous site-specific results are included in summary tables. The impact evaluation results are based on a combined sample, for all three sampling domains, of 130 matched gross and net projects – 41 POC projects, 61 Non-POC electric projects, and 28 gas projects. In addition, the net-to-gross sample is larger than the gross sample since it also includes a number of ‘net-only’ sites.

As described in Section 3, a complete M&V plan and an impact evaluation report were developed for each site. The resulting detailed site-specific project descriptions, ex-ante methods, ex-post methods, and ex-post results are provided in the site reports which comprise Appendix F.

Ex-ante energy savings from the installation report, ex-post savings from this impact evaluation, and associated realization rates are shown in Table 4-1 for each project in the evaluation sample. .

Table 4-1: Summary of Ex-Ante and Ex-Post Savings for All Sampled Projects

		Fuel	Ex Ante Savings			Ex Post Savings			Realization Rate		
Site ID	IOU ID	Sampled	kWh	kW	Therms	kWh	kW	Therms	kWh	kW	Therms
B001	2K6-L0204E	Electric	3,902,824	394	0	2,209,538	219	0	0.566	0.556	-
B002	2K6-L0196E	Electric	3,819,518	370	0	2,162,376	206	0	0.566	0.556	-
B003	2K6-L0210E	Electric	3,327,156	333	0	1,883,631	185	0	0.566	0.556	-
B004	2K6-L0205E	Electric	2,369,046	248	0	1,341,208	138	0	0.566	0.556	-
B005	2K6-S0214E	Electric	2,211,749	201	0	1,110,298	101	0	0.502	0.504	-
B006	2K6-L0522E	Electric	2,131,152	202	0	1,369,488	156	0	0.643	0.773	-
B007	2K6-S0215E	Electric	2,101,575	203	0	1,054,991	102	0	0.502	0.504	-
B008	2K6-L0202E	Electric	2,003,552	212	0	1,134,287	118	0	0.566	0.556	-
B009	2K6-S0212E	Electric	1,921,175	182	0	964,430	92	0	0.502	0.504	-
B010	2K6-L0203E	Electric	1,741,438	173	0	985,895	96	0	0.566	0.556	-
B011	2K6-L0216E	Electric	1,618,033	154	0	749,709	72	0	0.463	0.465	-
B012	2K6-L0010E	Electric	504,570	27	0	504,570	27	0	1.000	1.000	-
B013	2K6-L0443E	Electric	923,551	0	0	1,332,681	-14	0	1.443	-	-
B014	2K6-L0308E	Electric	620,707	85	0	489,596	56	0	0.789	0.657	-
B015	2K6-L0235E	Electric	557,213	116	0	591,497	118	0	1.062	1.015	-
B016	2K6-S0211E	Electric	1,340,656	134	0	559,053	56	0	0.417	0.418	-
B017	2K6-L0290E	Electric	630,747	73	0	126,187	19	0	0.200	0.257	-
B018	NC0045069	Electric	928,106	106	0	525,436	59	0	0.566	0.556	-
B019	NC0044109	Electric	152,008	17	0	90,199	10	0	0.593	0.606	-
B020	2K6-L0306E	Electric	233,773	30	0	119,483	17	0	0.511	0.579	-
B021	2K6-L0152E	Electric	251,328	68	0	298,344	96	0	1.187	1.412	-
B022	NC0052813	Electric	248,021	30	0	117,015	13	0	0.472	0.448	-
B023a	2K6-S0213E	Electric	1,502,391	145	0	754,200	73	0	0.502	0.504	-
B024a	2K6-L0762E	Electric	7,456,038	857	0	5,869,628	774	0	0.787	0.903	-
B025	NC0054415	Electric	17,580	2	0	0	0	0	0.000	0.000	-
B026a	NC0050053	Electric	6,612,695	754	0	1,308,333	149	0	0.198	0.198	-
B027	NC0049256	Electric	17,580	2	0	0	0	0	0.000	0.000	-
B028	NC0051917	Electric	65,925	8	0	45,534	5	0	0.691	0.693	-
B029	NC0050920	Electric	65,925	8	0	42,452	5	0	0.644	0.667	-
B030	NC0060217	Electric	52,740	6	0	48,784	6	0	0.925	0.933	-
B036a	2K6-L0349E	Electric	3,741,621	384	0	3,499,715	389	0	0.935	1.013	-
B044	TCA0001250	Electric	917,813	89	0	444,588	43	0	0.484	0.484	-
B046	TCA0001250	Electric	3,696,381	358	0	1,790,525	173	0	0.484	0.484	-
B047	TCA0001250	Electric	3,238,915	321	0	1,568,929	155	0	0.484	0.484	-
B048a	TAA0001639	Electric	5,032,246	904	0	4,782,240	842	0	0.950	0.932	-
B048b	TAA0001789	Electric	42,731	0	0	50,849	0	0	1.190	-	-
B048c	TAA0001789	Electric	802,090	147	0	770,394	144	0	0.960	0.981	-
B049	TAA0001789	Electric	415,741	0	0	0	0	0	0.000	-	-
B050	TAA0001789	Electric	1,505,214	32	0	0	0	0	0.000	0.000	-
B052	TAA0001758	Electric	728,232	83	0	698,289	86	0	0.959	1.030	-
B053	TAA0001758	Electric	1,040,375	119	0	872,603	131	0	0.839	1.101	-
B055	TBA0001717	Electric	3,015,908	355	0	0	0	0	0.000	0.000	-
B056	TBA0001717	Electric	185,549	22	0	-353,683	-42	0	-1.906	-1.906	-
B057	TAA0001771	Electric	1,237,788	141	0	-227,194	-23	0	-0.184	-0.162	-
B058	TAA0001771	Electric	424,620	63	0	390,235	44	0	0.919	0.688	-
B062	2K08007843	Electric	406,443	0	0	198,510	0	0	0.488	-	-
B063	NC0021889	Electric	3,451,202	394	0	-5,563,434	-1,107	9,128,462	-1.612	-2.810	-
B064	NC0065636	Electric	2,722,524	349	0	2,722,524	349	0	1.000	1.000	-
B065	2K6-L0208E	Electric	2,299,921	240	0	1,302,073	134	0	0.566	0.556	-
B066	NC0046290	Electric	2,193,879	219	0	1,265,432	145	0	0.577	0.664	-
B067	NC0051153	Electric	2,036,807	262	0	1,589,275	211	0	0.780	0.806	-
B068	2K6-L0195E	Electric	2,010,736	198	0	1,138,355	110	0	0.566	0.556	-
B069	2K07000602	Electric	1,707,423	263	0	513,026	116	0	0.300	0.440	-
B070a	TAA0001341	Electric	975,873	112	0	938,945	109	0	0.962	0.974	-
B071	NC0058114	Electric	674,256	77	0	595,333	68	0	0.883	0.883	-
B072	2K07000363	Electric	626,641	86	0	25,301	2	0	0.040	0.021	-
B073	NC0052113	Electric	618,418	73	0	54,869	6	0	0.089	0.086	-
B074	NC0057254	Electric	527,397	60	0	298,580	34	0	0.566	0.556	-
B075	NC0061813	Electric	523,973	60	0	399,920	46	0	0.763	0.758	-
B076	2K6-L0690E	Electric	444,093	210	0	23,800	5	0	0.054	0.023	-
B077	2K6-L0461E	Electric	334,668	50	0	14,815	2	0	0.044	0.049	-
B078	2K07000364	Electric	289,219	40	0	92,578	12	0	0.320	0.314	-
B079	2K6-L0465E	Electric	282,799	33	0	309,443	36	0	1.094	1.075	-
B080	NC0059813	Electric	208,479	35	0	-4,225	-1	0	-0.020	-0.037	-
B081	2K6-L0572E	Electric	188,580	75	0	74,921	9	0	0.397	0.116	-
B082	2K6-L0828E	Electric	77,070	9	0	91,380	14	0	1.186	1.585	-

Table 4-1: Summary of Ex-Ante and Ex-Post Savings for All Sampled Projects (Continued)

		Fuel	Ex Ante Savings			Ex Post Savings			Realization Rate		
Site ID	IOU ID	Sampled	kWh	kW	Therms	kWh	kW	Therms	kWh	kW	Therms
B083	NC0061421	Electric	65,925	8	0	0	0	0	0.000	0.000	-
B084	NC0060256	Electric	17,580	2	0	4,277	1	0	0.243	0.250	-
B085	NC0060273	Electric	17,580	2	0	0	0	0	0.000	0.000	-
B086	NC0058597	Electric	17,580	2	0	5,993	1	0	0.341	0.350	-
B087	NC0042109	Electric	14,362	2	0	2,415	0	0	0.168	0.000	-
B088	2K6-L0268E	Electric	2,877,912	354	0	2,709,637	328	0	0.942	0.926	-
B089	NC0053434	Electric	2,699,832	308	0	3,974,712	454	0	1.472	1.472	-
B090	2K6-L0391E	Electric	1,212,803	532	0	0	0	0	0.000	0.000	-
B091a	TBA0001525	Electric	1,807,356	163	0	1,799,671	163	0	0.996	1.000	-
B092	NC0046973	Electric	628,455	45	0	129,391	15	0	0.206	0.329	-
B095	TAA0001789	Electric	14,966,829	3,452	0	-30,324	0	0	-0.002	0.000	-
B096	TAA0001758	Electric	4,782,886	436	0	0	0	0	0.000	0.000	-
B097	2K07000022	Electric	10,096,226	1,002	0	4,814,890	480	0	0.477	0.479	-
B098	2K6-S0456E	Electric	2,471,624	237	0	1,178,717	114	0	0.477	0.479	-
B099	2K6-S0457E	Electric	3,110,328	325	0	1,483,315	156	0	0.477	0.479	-
B100	CDI0000066	Electric	2,979,032	347	0	817,053	113	0	0.274	0.325	-
B101	2K08006373	Electric	4,136,817	0	0	130,370	0	0	0.032	-	-
B102a	TAA0001098	Electric	5,377,755	614	0	918,925	104	0	0.171	0.169	-
B103	2K6-L0269E	Electric	2,751,685	406	0	1,049,331	120	0	0.381	0.295	-
B104	NC0057214	Electric	2,483,163	283	0	1,405,814	157	0	0.566	0.556	-
B105	NC0053293	Electric	3,025,212	447	0	3,025,212	0	0	1.000	0.000	-
B106	TCA0001784	Electric	2,474,928	83	0	748,613	85	0	0.302	1.030	-
B107	TBA0000481	Electric	943,435	101	0	786,883	83	0	0.834	0.821	-
B108	TCA0001175	Electric	626,641	57	0	171,868	19	0	0.274	0.327	-
B109	TCA0001784	Electric	646,483	64	0	100,157	12	0	0.155	0.186	-
B110	TAA0001093	Electric	908,564	105	0	1,391,805	130	0	1.532	1.241	-
B111	TCA0000258	Electric	1,344,741	157	0	2,019,566	231	0	1.502	1.472	-
B111a	TCA0000893	Electric	596,509	63	0	180,053	21	0	0.302	0.336	-
B112	TCA0001175	Electric	873,171	85	0	239,483	28	0	0.274	0.325	-
B113	TAA0001259	Electric	1,088,430	124	0	921,990	105	0	0.847	0.847	-
B114	TBA0000304	Electric	952,115	111	0	1,124,410	131	0	1.181	1.181	-
B115	TCA0001784	Electric	719,604	65	0	197,364	21	0	0.274	0.325	-
B116a	TBA0000815	Electric	965,563	112	0	307,306	35	0	0.318	0.312	-
B117	TCA0001331	Electric	780,133	59	0	213,965	19	0	0.274	0.325	-
B118	TAA0001767	Electric	1,358,695	155	0	519,502	99	0	0.382	0.635	-
B119	TCA0000744	Electric	487,263	50	0	147,077	17	0	0.302	0.337	-
B120	TAA0001772	Electric	765,274	93	0	155,607	22	0	0.203	0.234	-
B121	TBA0001420	Electric	732,865	96	0	511,220	68	0	0.698	0.709	-
B031	NC0056653	Gas	0	0	1,264,741	0	0	1,269,988	-	-	1.004
B033	2K6-L0633G	Gas	0	0	754,518	0	0	585,092	-	-	0.775
B034	2K6-L0830G	Gas	0	0	624,204	0	0	972,726	-	-	1.558
B035	NC0043970	Gas	0	0	530,950	0	0	2,065,336	-	-	3.890
B037	2K6-L0641G	Gas	0	0	477,292	0	0	497,747	-	-	1.043
B038	NC0054093	Gas	0	0	260,000	0	0	0	-	-	0.000
B039	2K6-L0308G	Gas	0	0	132,699	0	0	137,605	-	-	1.037
B040	2K6-L0757G	Gas	0	0	198,494	0	0	182,565	-	-	0.920
B041a	2K07000155	Gas	0	0	4,919,708	0	0	0	-	-	0.000
B042	2K6-L0010G	Gas	0	0	56,939	0	0	56,935	-	-	1.000
B042a	2K6-L0443G	Gas	0	0	33,489	0	0	24,036	-	-	0.718
B043	2K6-L0754G	Gas	0	0	4,063,495	0	0	250,452	-	-	0.062
B061	TAA0001766	Gas	0	0	65,922	0	0	73,318	-	-	1.112
B093	2K6-L0261G	Gas	0	0	2,179,147	0	0	897,223	-	-	0.412
B094	NC0062033	Gas	0	0	1,037,385	0	0	1,292,229	-	-	1.246
B122	2K08005445	Gas	0	0	3,725,770	0	0	3,008,858	-	-	0.808
B123	2K07000224	Gas	0	0	3,497,000	0	0	1,093,590	-	-	0.313
B124	TAA0001789	Gas	0	0	1,654,351	0	0	1,384,296	-	-	0.837
B125	NC0068194	Gas	0	0	959,743	0	0	959,743	-	-	1.000
B126	TAA0001341	Gas	0	0	2,754,489	0	0	2,072,672	-	-	0.752
B127a	2K6-L0032G	Gas	0	0	506,780	0	0	0	-	-	0.000
B128a	TAA0001341	Gas	0	0	623,988	0	0	758,454	-	-	1.215
B129	NC0071593	Gas	2,078,448	129	861,120	610,713	-53	473,616	-	-	0.550
B130	2K6-L0588G	Gas	0	0	641,903	0	0	219,615	-	-	0.342
B131	TAA0001758	Gas	0	0	581,275	0	0	1,454,652	-	-	2.503
B132	TAA0001352	Gas	0	0	165,879	-48,946	-24	239,557	-	-	1.444
B133	TAA0000423	Gas	0	0	156,586	0	0	184,405	-	-	1.178
B134	TAA0001352	Gas	0	0	59,895	0	0	69,424	-	-	1.159
B135	2K07002369	Gas	,	0	438,606	,	0	496,881	-	-	1.133

4.3 Site-Specific Net-to-Gross Results

Table 4-2 provides a summary of the net-to-gross results for all sampled projects. As discussed in the methodology section, the estimated NTGR is an average of three scores: a timing and selection score that reflects the influence of the most important of the program elements in the customer's decision to select the program measure; a program influence score that captures the perceived influence of the program relative to non-program factors in the decision to implement the measure; and a no-program score that captures the likelihood of various actions the customer might have taken in the absence of the program.

As the table shows, NTGRs range from a low of 0.00 to a high of 1.00. In the NTG table below "adj" refers to cases in which an adjustment was made to the default NTG algorithm as described in Section 3 and the detailed site reports in Appendix D.

Table 4-2: Summary of Site-Specific Net-to-Gross Results

Rigor	Timing and Selection Score	Program Influence Score	No-Program Score	NTGR	Adj.	Itron ID	APP ID	MEASURE	PROGRAM
Std - VL	10	5.9	8.5	0.62	Yes	B001, B002, B003, B004, B005, B007, B008, B009, B010, B011, B016, B018, B023a, B068, B074, B097, B098, B099, B104	Various	Pump off Controllers	PGE2004
Standard	10	8	5.5	0.68		B015	2K6-L0235	EE lighting, occupancy sensors	PGE2004
Std - VL	8	3	10	0.70		B017	2K6-L0290E	Injection molding machine	PGE2004
Standard	10	5	3	0.60		B019	NC0044109	Pump off Controllers	PGE2004
Standard	10	9	5.4	0.68		B020	2K6-L0306E	Air Compressor sequencer/controls	PGE2004
Standard	4	10	4	0.60		B022	NC0052813	Injection molding machine	PGE2004
Std - VL	7	6	8	0.70		B024a	2K6-L0762E	Injection molding machine	PGE2004
Std - VL	0	0	0	0.00		B025, B027, B028, B029, B030, B083, B084, B085, B086,B044, B045, B046, B047	Various	Pump off Controllers	PGE2058
Std - VL	8	6	6.6	0.69		B026a	NC0050053	Cawello Pipeline	PGE2004
Std - VL	8	4	4	0.40	Yes	B031, B035 and B094	Various	relocating the SCR	PGE2004
Std - VL	0	0	0	0.00		B032	2K6-L0726G	flue gas heat recovery preheat coil	PGE2004
Std - VL	8	7	10	0.83		B033		Replacement of the condensate receiver tank and Waste heat recovery from pulp dryer condensate.	
Std - VL	4	5	9.4	0.61		B036a	2K6-L0349E	Lighting retrofit	PGE2004
Std - VL	6	0.8	0	0.04	Yes	B041a	2K07000155	4 mile pipeline, heat recovery	PGE2004
Std - VL	10	6	8.3	0.81		B048, B048a, B048b,B048c	TAA0001789, TAA0001639	Facility wide lighting retrofit.	PGE2042
Std - VL	10	6	10	0.87		B050, B042, B049, B101	Various	DDC Controls	PGE2004
Standard	10	5	0	0.25		B052	TAA0001758	PROCESS CHANGE/ADD EQUIPMENT	PGE2046
Standard	9	3	9.1	0.70		B053	TAA0001758	PROCESS CHANGE/ADD EQUIPMENT	PGE2046
Std - VL	10	6	10	0.87		B056	TBA0001717	VFD on Fire water Jockey Pump. pump & vfd	PGE2064
Basic	8	5	5.4	0.61		B061	TAA0000820	Process boiler economizer	PGE2087
Basic	7	6	7.7	0.69		B062	2K08007843	DDC Controls	PGE2004
Std - VL	3	3	3	0.30	Yes	B063	NC0021889	New Reverse Osmosis Plant	PGE2004

Table 4-2: Summary of Site-Specific Net-to-Gross Results (continued)

Rigor	Timing and Selection Score	Program Influence Score	No-Program Score	NTGR	Adj.	Itron ID	APP ID	MEASURE	PROGRAM
Standard	10	5	0	0.25		B064	NC0065636	Energy Efficient Motors, VFDs	PGE2004
Std - VL	10	2	0	0.10	Yes	B066	NC0046290	Install new VFD on Air Compressor	PGE2004
Standard	5	6	10	0.70		B067	NC0051153	VFDs, Premium Efficient Motors	PGE2004
Std - VL	7	4	6	0.57		B069	2K07000602	Low pressure air recovery system & monitoring controls	PGE2004
Standard	8	10	10	0.93		B070a	TAA0001341	MH FIXTURES - INDOOR	PGE2042
Std - VL	9	8	10	0.90		B071	NC0058114	VSDs on reinjection pump and skim water pump. Phase 4	PGE2004
Std - VL	9	5	10	0.80		B072	2K07000363	Injection molding machine	PGE2004
Std - VL	9	8	10	0.90		B073	NC0052113	Install 15 VFDs on collection system pumps	PGE2004
Standard	4	10	4	0.60		B075	NC0061813	Injection molding machine	PGE2004
Basic	10	8	10	0.93		B076	2K6-L0690E	No more detail in Site Planning Tool	PGE2004
Std - VL	10	6	7.7	0.79		B077, B080	2K6-L0461E, NC0059813	Injection molding machines	PGE2004
Std - VL	8	3	10	0.70		B078	2K07000364	Injection molding machine	PGE2004
Basic	9	5	7	0.70		B081	2K6-L0572E	Install VFD on Baghouse Fan	PGE2004
Std - VL	10	7	10	0.90		B082	2K6-L0828E	Lighting retrofit	PGE2004
Basic	8	3	3	0.47		B087	NC0042109	Install Three (3) New Premium Efficiency Motors for Log Washing	PGE2004
Std - VL	10	7	9.7	0.89		B088	2K6-L0268E	Retrofit nitrogen recycle compressor	PGE2004
Std - VL	3	2	2	0.23		B089	NC0053434	29r substation	PGE2004
Standard	8	4	5.7	0.59		B090	2K6-L0391E	ADJUSTABLE SPEED DRIVE	PGE2004
Std - VL	9	6	10	0.83		B091a	TBA0001525	Premium efficiency motors and VFDs.	PGE2064
Std - VL	2	1	0	0.05		B093	2K6-L0261G	Install regenerative thermal oxidizer	PGE2004
Std - VL	3	3	3	0.15	Yes	B095	TAA0001789	Modernization of the powder mill feed system	PGE2042
Std - VL	3	2.8	2.5	0.28		B100, B108, B112, B115	Various	Pump off Controllers	PGE2004, PGE2058
Std - VL	10	7	10	0.90		B102a	TAA0001098	Compressed air retrofit	PGE2081
Std - VL	8	8	10	0.87		B103	2K6-L0269E	150 hp VFDs Phase 2	PGE2004
Std - VL	10	3	0	0.15	Yes	B105	NC0053293	VFDs - also EE motors, lighting, & HVAC	PGE2004
Std - VL	4	5	3	0.40		B106	TCA0001784	Artificial gas lift to electric submersible pump	PGE2058
Std - VL	10	7	10	0.90		B107	TBA0000481	EE motors and VFDs	PGE2064
Std - VL	7	5	7.5	0.65		B109	TCA0001784	Pump off Controllers	PGE2058

Table 4-2: Summary of Site-Specific Net-to-Gross Results (continued)

Rigor	Timing and Selection Score	Program Influence Score	No-Program Score	NTGR	Adj.	Itron ID	APP ID	MEASURE	PROGRAM
Std – VL	10	6	10	0.87		B110	TAA0001093	MH Indoor fixtures	PGE2042
Std - VL	5	2	2	0.30		B111	TCA0000258	VSDs and Premium Efficiency motors on water injection pumps	PGE2058
Std - VL	10	9	9	0.93		B111a, B119	TCA0000893, TCA0000744	Pump off Controllers	PGE2058
Std - VL	4	5	3	0.40		B114	TBA0000304	Artificial gas lift to electric submersible pump with a drive	PGE2058
Standard	10	7	9.1	0.87		B118	TAA0001767	AIR COMPRESSER SYSTEM CHANGE/MODIFY	ECOS Air
Std - VL	7	2	2	0.20	Yes	B122	2K08005445	Install heat recovery	PGE2004
Std - VL	5	3	1	0.20	Yes	B123	2K07000224	New pipeline for directly supplying hot feed from DHT to CCU	PGE2004
Std - VL	10	2.5	10	0.25	Yes	B124	TAA0001789	Install regenerative thermal oxidizer	PGE2042
Std - VL	10	3	0	0.15	Yes	B125	NC0068194	Heat recovery devices and regenerative catalytic oxidixer	PGE2004
Std - VL	10	2	3	0.50		B126,B127,B128	TAA0001341	Condensing Economizer	PGE2042
Std - VL	7	1.5	0	0.08	Yes	B128a	TAA0001341	Biofilter	PGE2042
Std - VL	10	2	0	0.10	Yes	B129	NC0071593	Biofilter	PGE2004
Standard	8	5	10	0.77		B132	TAA0001352	Heat recovery project	PGE2087
Std - VL	10	7	10	0.90		B133	TAA0000423	Process Boiler Economizer	PGE2087
Basic	9	4	4	0.57		B134	TAA0001352	Condensate and Blowdown heat recovery	PGE2087

4.4 Overall First-Year Gross Impact Realization Rate

In this sub-section, we present the overall weighted realization rates; that is, for all electric measures combined (i.e., POCs and non-POCs) and, separately, for all gas measures. First, we graphically summarize ex-post versus ex-ante savings estimates for the entire sample.

Figure 4-2, Figure 4-3 and Figure 4-4 present the ex-ante (PG&E tracking system) and ex-post evaluated savings for the entire sample, for kWh, summer demand kW, and therms, respectively. The charts also include a unity line, which divides the results into those in which the site-specific realization rates were above one (sites above the line) and below one (sites below the line). Any sites for which the kW impact analysis was inconclusive are excluded from the calculation of the program realization rate (they are not defaulted to realization rates of 1.0).

Figure 4-2: First-Year Ex-Post and Ex-Ante Savings (kWh) for PY2006-2008 Gross Sample (n =104)

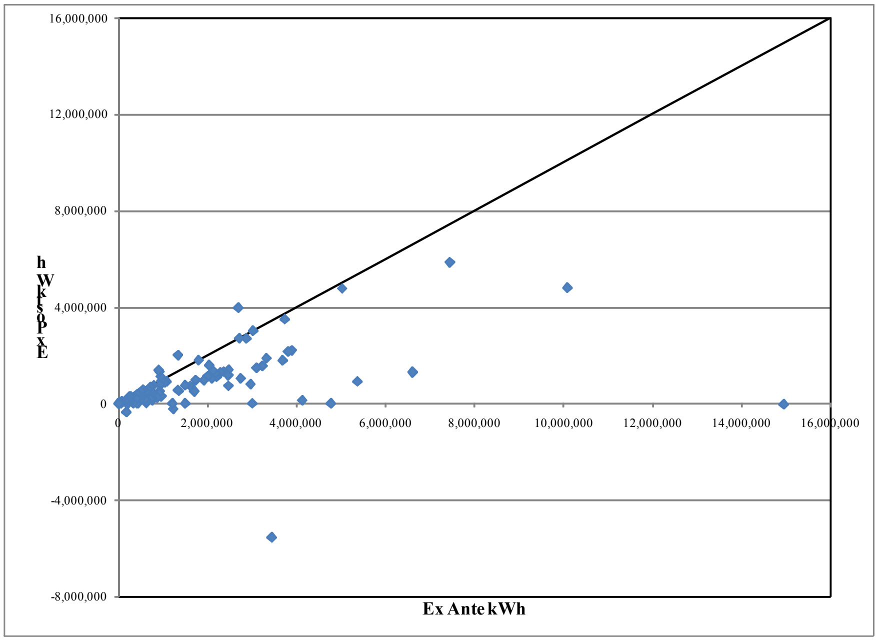


Figure 4-3: First-Year Ex-Post and Ex-Ante Savings (kW) for PY2006-2008 Gross Sample (n = 99)

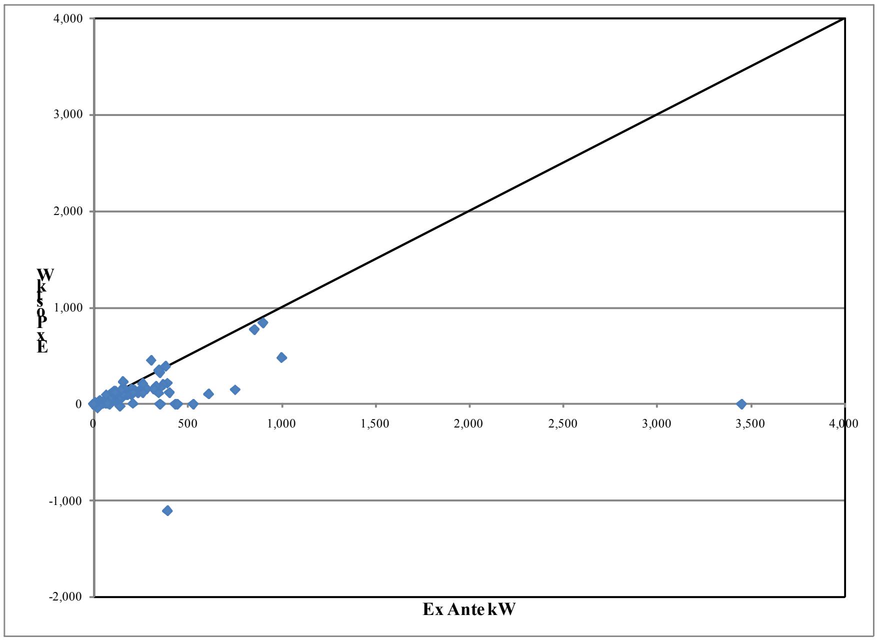


Figure 4-4: First-Year Ex-Post and Ex-Ante Savings (Therms) for PY2006-2008 Gross Sample (n = 29)

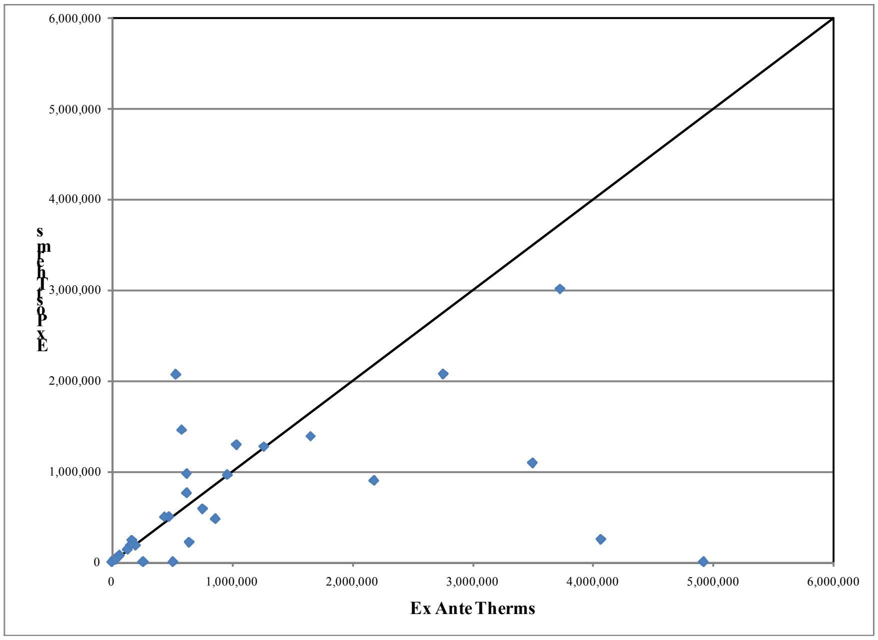


Figure 4-5 and Figure 4-6 present the ex-ante (tracking system) and ex-post (engineering estimate) savings for the Pump-Off Controller (POC) sample, for kWh and summer demand kW respectively.

Figure 4-5: First-Year Ex-Post and Ex-Ante Savings (kWh) for PY2006-2008 Gross Pump-Off Controller Sample (n = 41)

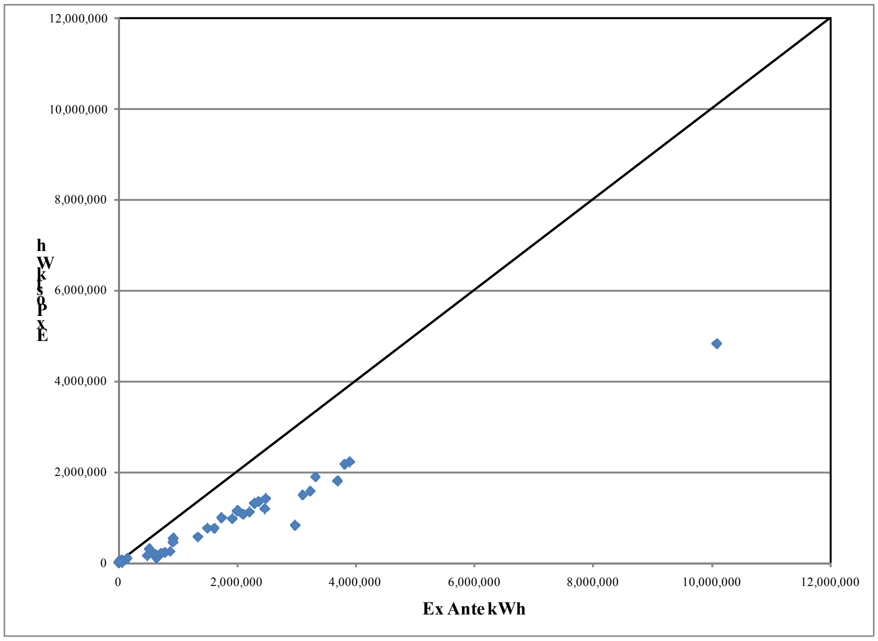


Figure 4-6: First-Year Ex-Post and Ex-Ante Savings (kW) for PY2006-2008 Gross Pump-Off Controller Sample (n = 41)

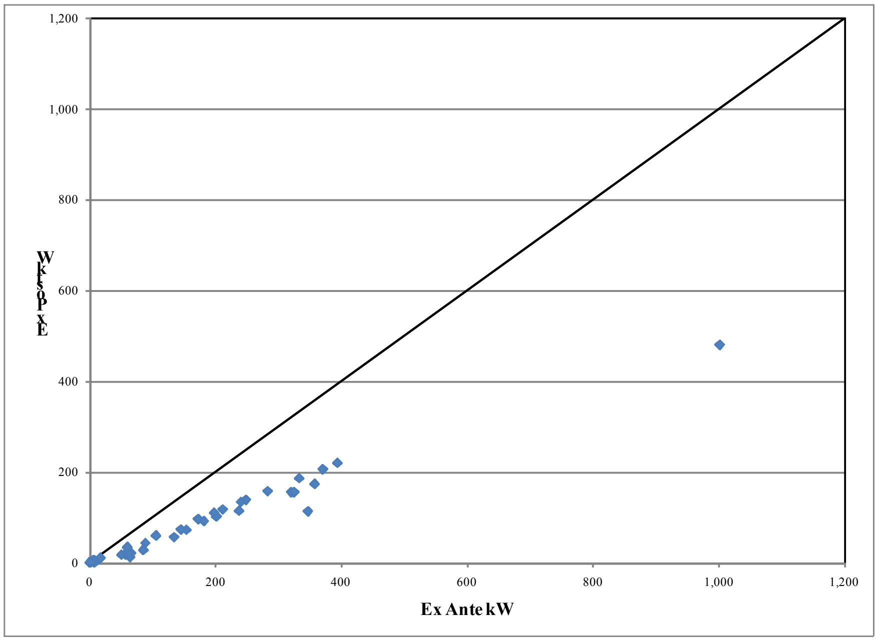


Figure 4-7 and Figure 4-8 present the ex-ante (tracking system) and ex-post (engineering estimate) savings for the non-POC Electric sample, for kWh and summer demand kW respectively.

Figure 4-7: First-Year Ex-Post and Ex-Ante Savings (kWh) for PY2006-2008 Gross Electric Non-POC Sample (n = 63)

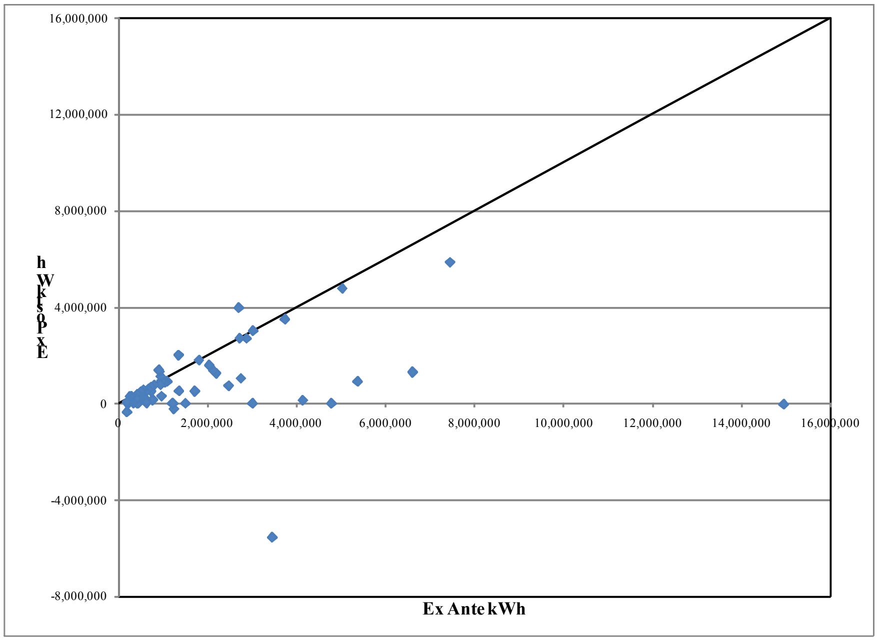
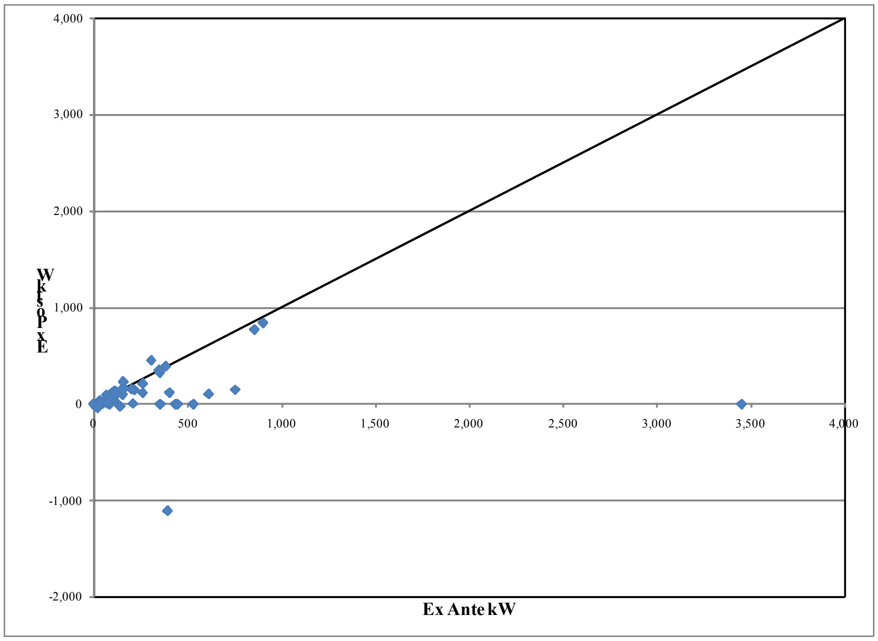


Figure 4-8: First-Year Ex-Post and Ex-Ante Savings (kW) for PY2006-2008 Gross Electric Non-POC Sample (n = 58)



Information for the Gas sample is presented in Figure 4-4 above.

4.5 Weighted First-Year Overall Program Gross Realization Rates

To produce the overall realization rate for each sampling domain (POCs, non-POC electric, and gas), the individual realization rates for each of the field sample points were weighted by the size of the energy savings impacts associated with each sample project, and by the proportion of the total program impacts represented by each stratum. The total population impacts for PY2006-2008 are presented below for each of these domains.

Table 4-3 through Table 4-5 present statistics by sampling stratum for the population and gross impact sample completes used to develop the final weighted results for each sampling domain.

Table 4-3: Tracking System and M&V Gross Sample kWh and kW Savings for PY2006-2008 Pump-Off Controllers by Gross Impact Weighting Stratum

	Number of Records		Gross Ex Ante kWh		Gross Ex Ante kW	
Sampling Strata	Population	Sample	Population	Sample	Population	Sample
1	12	11	45,915,363	41,494,213	4,661	4,218
2	13	8	25,186,925	15,908,178	2,494	1,561
3	64	12	57,264,412	9,946,166	5,705	978
4	38	10	10,967,428	490,423	1,060	56
5	529		24,316,255		2,741	
All	656	41	163,650,384	67,838,981	16,661	6,813

Table 4-4: Tracking System and M&V Gross Sample kWh and kW Savings for PY2006-2008 Electric Non-POC Projects by Gross Impact Weighting Stratum

	Number of Records		Gross Ex Ante kWh		Gross Ex Ante kW	
Sampling Strata	Population	Sample	Population	Sample	Population	Sample
1	22	16	96,532,343	75,126,091	12,674	10,096
2	15	5	30,039,943	9,876,617	3,532	1,109
3	137	26	111,845,708	22,870,588	13,955	2,862
4	222	13	59,567,119	3,913,313	8,392	656
5	360	3	20,939,166	134,163	4,119	11
All	756	63	318,924,279	111,920,771	42,672	14,734

Table 4-5: Tracking System and M&V Sample kWh and kW Savings for PY2006-2008 Gas Projects by Gross Impact Weighting Stratum

	Number of Records		Gross Ex Ante Therms	
Sampling Strata	Population	Sample	Population	Sample
1	8	8	24,058,701	24,058,701
2	1	6	1,059,000	4,878,873
3	6		4,878,873	
4	5	5	2,720,285	2,720,285
5	132	10	7,427,520	1,568,509
All	152	29	40,144,380	33,226,369

Across all sampled projects, the gross realization rates by stratum, as well as the overall weighted realization rate and the associated confidence interval are shown in Table 4-6. The overall weighted gross realization rate across all sampled projects is 0.49 for kWh, 0.46 for kW and 0.68 for Therms. The 90 percent confidence interval for the 0.48 overall kWh gross realization rate is 0.426 to 0.557.

Table 4-6: PY2006-2008 First-Year Gross Impact Realization Rates Across All Sampled Projects

	RR		
Sampling Strata	kWh	kW	Therms
1	0.39	0.32	0.41
2	0.58	0.60	0.92
3	0.58	0.55	
4	0.34	0.30	1.76
5	0.62	0.62	0.93
Weighted RR	0.49	0.46	0.68
90 Percent CI	0.426 to 0.557	0.372 to 0.541	0.621 to 0.733
Relative Precision	0.133	0.186	0.083
N measures in sample	104	99	29
N measures in population	1,412	1,325	152
ER	0.86	0.86	0.30

Table 4-7 shows for the Pump-Off Controller sampling domain, the gross realization rates by stratum, as well as the overall weighted realization rate and the associated confidence interval.

Table 4-7: PY2006-2008 First-Year Gross Impact Realization Rates for Pump-Off Controller Projects

	RR	
Sampling Strata	kWh	kW
1	0.50	0.50
2	0.53	0.53
3	0.39	0.41
4	0.48	0.49
5		
Weighted RR	0.46	0.47
90 Percent CI	0.418 to 0.502	0.428 to 0.514
Relative Precision	0.091	0.092
N measures in sample	41	41
N measures in population	656	655
ER	0.37	0.37

Gross realization rates for the Electric Non-POC domain, are shown in Table 4-8 by stratum, as are the overall weighted realization rate and the associated confidence interval.

Table 4-8: PY2006-2008 First-Year Gross Impact Realization Rates for Electric Non-POC Projects

	RR	
Sampling Strata	kWh	kW
1	0.33	0.25
2	0.66	0.71
3	0.66	0.60
4	0.33	0.29
5	1.08	1.26
Weighted RR	0.53	0.51
90 Percent CI	0.437 to 0.615	0.375 to 0.637
Relative Precision	0.170	0.258
N measures in sample	63	58
N measures in population	756	670
ER	0.85	1.25

Across the gas sample projects, the gross realization rates by stratum, as well as the overall weighted realization rate and the associated confidence interval are shown in Table 4-9.

Table 4-9: PY2006-2008 First-Year Gross Impact Realization Rates for Gas Projects

	RR
Sampling Strata	Therms
1	0.41
2	0.92
3	
4	1.76
5	0.93
Weighted RR	0.68
90 Percent CI	0.621 to 0.733
Relative Precision	0.083
N measures in sample	29
N measures in population	152
ER	0.30

The gross realization rates for the PG&E Fab program are lower than the ex-ante evaluation gross realization rates estimated for the statewide SPC program for 2002-2003 (0.89) and 2004-2005 (0.79).[22] In addition, the program administrator did not apply a gross realization

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[22] Note that the statewide SPC program and evaluation included commercial as well as industrial customers.

factor to the claimed savings estimates. This further widens the gap between claimed and evaluated gross savings. The likely causes of the lower gross realization rates and recommendations for how to address and improve upon it are presented in Section 5 – Findings and Recommendations.

4.6 Net-to-Gross Results

The methodology used to develop the individual, site-specific net-to-gross estimates is summarized in Section 3. Here, we present the weighted results both for each sampling domain and for selected programs where the findings are sufficiently robust. To produce an estimate of the net-to-gross (NTG) ratio, the individual net-to-gross ratios for each of the applications in the sample were weighted by the size of the impacts associated with the application and the proportion of the total sampling domain impacts represented by each sampling stratum.

Table 4-10 through Table 4-12 present statistics for the population and net-to-gross sample completes used to develop the final weighted results for each sampling domain. Note that the net-to-gross sample is larger than the gross sample; in addition to gross sampled sites, it also includes a number of ‘net-only’ sites. For all 3 sampling domains, a large number of surveys were completed, representing very high percentages of the total population and providing for robust results across all sample strata.

Table 4-10: PY2006-2008 Net-to-Gross Evaluation Sample – Tracking System Savings by Gross Impact Weighting Stratum: Pump-Off Controller Projects

	Number of Records		Gross Ex Ante kWh		Gross Ex Ante kW	
Sampling Strata	Population	Sample	Population	Sample	Population	Sample
1	12	11	45,915,363	41,494,213	4,661	4,218
2	13	13	25,186,925	25,186,925	2,494	2,494
3	64	56	57,264,412	49,041,760	5,705	4,829
4	38	29	10,967,428	8,181,841	1,060	813
5	529	141	24,316,255	6,181,797	2,741	692
All	656	250	163,650,384	130,086,537	16,661	13,046

Table 4-11: PY2006-2008 Net-to-Gross Evaluation Sample – Tracking System Savings by Gross Impact Weighting Stratum: Electric Non-POC Projects

	Number of Records		Gross Ex Ante kWh		Gross Ex Ante kW	
Sampling Strata	Population	Sample	Population	Sample	Population	Sample
1	22	14	96,532,343	67,327,297	12,674	9,306
2	15	6	30,039,943	12,167,456	3,532	1,307
3	137	65	111,845,708	52,723,000	13,955	6,660
4	222	99	59,567,119	25,532,241	8,392	3,578
5	360	35	20,939,166	2,139,439	4,119	288
All	756	219	318,924,279	159,889,431	42,672	21,138

Table 4-12: PY2006-2008 Net-to-Gross Evaluation Sample – Tracking System Savings by Gross Impact Weighting Stratum: Gas Projects

Sampling Strata	Number of Records		Gross Ex Ante Therms	
	Population	Sample	Population	Sample
1	8	8	24,058,701	24,058,701
2	1	7	1,059,000	5,937,873
3	6		4,878,873	
4	5	3	2,720,285	1,632,230
5	132	23	7,427,520	1,393,671
All	152	41	40,144,380	33,022,476

Applying the same ratio estimation weighting approach referenced in the realization rate discussion in the Methods section, the resulting weighted net-to-gross ratio estimate for kWh savings is 0.53. (Corresponding values for kW and gas savings are 0.52 and 0.31, respectively.) The kWh and kW values are virtually identical to the estimate of corresponding net-to-gross ratios for the statewide Standard Performance Contracting (SPC) program in the PY2004-2005 evaluation. In addition, they are very similar to the NTG estimates made in prior SPC evaluations conducted for each program year since the program's inception in 1998. Table 4-13 through Table 4-15 summarizes the net-to-gross values by stratum, along with the 90 percent confidence interval, overall and for each sampling domain.

Table 4-13: PY2006-2008 Net-to-Gross Ratio: All Projects[23]

Sampling Strata	NTGR*		
	kWh	kW	Therms
1	0.51	0.46	0.20
2	0.56	0.57	0.26
3	0.59	0.61	
4	0.56	0.59	0.34
5	0.22	0.23	0.66
Weighted NTGR	0.53	0.52	0.31
90 Percent CI	0.505 to 0.547	0.491 to 0.543	0.277 to 0.334
Relative Precision	0.04	0.05	0.09
N measures in sample	469	449	41
N measures in population	1,412	1,325	152
ER	0.65	0.65	0.42

* 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.

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[23] The reader should not draw any conclusions about the results by sampling strata and project size, since the results reflect numerous small-size application submittals by one very large customer.

Table 4-14: PY2006-2008 Net-to-Gross Ratio: Pump-Off Controller Projects[24]

	NTGR*	
Sampling Strata	kWh	kW
1	0.49	0.49
2	0.58	0.58
3	0.50	0.51
4	0.54	0.54
5	0.05	0.05
Weighted NTGR	0.45	0.44
90 Percent Confidence Interval	0.432 to 0.458	0.428 to 0.454
Relative Precision	0.030	0.030
N measures in sample	250	250
N measures in population	656	655
Error Ratio	0.36	0.36

* 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.

Table 4-15: PY2006-2008 Net-to-Gross Ratio: Electric Non-POC Projects

	NTGR*	
Sampling Strata	kWh	kW
1	0.53	0.45
2	0.52	0.57
3	0.68	0.69
4	0.57	0.60
5	0.69	0.68
Weighted NTGR	0.60	0.59
90 Percent CI	0.561 to 0.639	0.544 to 0.633
Relative Precision	0.065	0.075
N measures in sample	219	199
N measures in population	756	670
ER	0.70	0.77

* 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.

Gas NTG Results. Note that the gas sampling domain results are also reported in Table 4-13. The evaluated NTG value of 0.31 for gas projects is much lower than the values seen in previous SPC evaluations, which ranged from 0.45 to 0.60.[25] Values for the large and

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[24] The reader should not draw any conclusions about the results by sampling strata and project size, since the results reflect numerous small-size application submittals by one very large customer.

[25] Note that this was the first time in recent years that the NTGR was developed separately for gas for large nonresidential SPC-type programs. The observation is based on a comparison of the gas NTGR of 0.31 in this evaluation versus an NTFR for the 2004-05 SPC program of 0.54 (exclusive of adjusters).

medium-sized projects in Tier 1 through 4 are lowest (ranging from 0.20 to 0.34), while that for the smallest Tier 5 projects is much higher (0.66). The likely specific causes of this and recommendations for how to address and improve upon it are presented in Section 5 – Findings and Recommendations.

POC NTG Results. The NTG values for Pump-Off Controllers of 0.45 (kWh) and 0.44 (kW) fall below the contract group average and are indicative of moderate to high free ridership. POCs on new oil well applications are particularly prone to high levels of free ridership, since the cost of a POC is a small fraction of the cost of drilling a new well. The POC NTG research was completed in March 2009, and the results were summarized in an Early Feedback memo to the CPUC staff and the utilities. The utilities subsequently decided to suspend rebates on POCs for new well applications starting in 2009.

Electric Non-POC NTG Results. Values for Electric Non-POCs (0.60 for kWh and 0.59 for kW) are above the average for all measures, and above the longer-term value for the SPC program. This sampling domain covers a broad range of custom energy efficiency measures, and results vary widely as a function of the project size, measure type, rationale for the project and economic condition of the company, among other factors.

4.7 Spillover Results

In accordance with CPUC policy rules, spillover is not considered in the calculation of the NTG values for PY2006-2008 programs. However, evaluators were directed to research and report on spillover as part of the NTG research. Research was to be performed on only those projects (1) for which significant program influence was reported, and (2) which had sizable impacts.

Itron routinely administered the standard battery of spillover questions as a part of the NTG interview process. However, there were no cases of spillover reported that met both of the above conditions. Therefore, there are no spillover results to report.

4.8 Net First-Year Realization Rates

Table 4-16 through Table 4-19 below present a comparison, for all projects and for each sampling domain, of the evaluation verified net savings with the final program claimed net savings, as obtained from the final PY2006-2008 reports posted on EEGA. These net realization rates are obtained by combining the net-to-gross ratios and gross impact realization rates to produce estimates of net realization rates. Each of these tables includes a calculation of the evaluation-based net savings as a percentage of the claimed net savings.

Table 4-16: Comparison of First-Year Evaluation-Based Net Savings with the Final Program-Claimed Net Savings: All Projects*

	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.

Table 4-17: Comparison of First-Year Evaluation-Based Net Savings with the Final Program-Claimed Net Savings: Pump-Off Controller Projects

	Electric Savings	
	kWh/year	Avg. peak kW
Tracking		
a. Claimed Gross Savings	163,650,384	16,661
b. Claimed NTG Ratio	0.80	0.80
c. Claimed Net Savings (c = a x b)	130,358,878	13,346
Evaluation		
d. Evaluation Gross Realization Rate	0.46	0.47
e. Evaluated Gross Results (e = a x d)	75,349,452	7,842
f. Evaluation NTG Ratio**	0.45	0.44
g. Evaluated Net Results (g = e x f)	33,542,611	3,458
h. Evaluation Net Realization Rate (h = d x f)	0.20	0.21
i. Evaluated Net Savings as a Fraction of Claimed Net Savings (i = g / c)	**0.26**	**0.26**

* 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.

Table 4-18: Comparison of First-Year Evaluation-Based Net Savings with the Final Program-Claimed Net Savings: Electric Non-POC Projects

	Electric Savings	
	kWh/year	Avg. peak kW
Tracking		
a. Claimed Gross Savings	318,924,279	42,672
b. Claimed NTG Ratio	0.78	0.78
c. Claimed Net Savings (c = a x b)	249,298,171	33,331
Evaluation		
d. Evaluation Gross Realization Rate	0.53	0.51
e. Evaluated Gross Results (e = a x d)	167,824,526	21,583
f. Evaluation NTG Ratio**	0.60	0.59
g. Evaluated Net Results (g = e x f)	100,680,800	12,703
h. Evaluation Net Realization Rate (h = d x f)	0.32	0.30
i. Evaluated Net Savings as a Fraction of Claimed Net Savings (i = g / c)	**0.40**	**0.38**

* 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.

Table 4-19: Comparison of First-Year Evaluation-Based Net Savings with the Final Program-Claimed Net Savings: Gas Projects

	Gas Savings
	Therms/Year
Tracking	
a. Claimed Gross Savings	40,144,380
b. Claimed NTG Ratio	0.76
c. Claimed Net Savings (c = a x b)	30,325,098
Evaluation	
d. Evaluation Gross Realization Rate	0.68
e. Evaluated Gross Results (e = a x d)	27,169,773
f. Evaluation NTG Ratio**	0.31
g. Evaluated Net Results (g = e x f)	8,302,483
h. Evaluation Net Realization Rate (h = d x f)	0.21
i. Evaluated Net Savings as a Fraction of Claimed Net Savings (i = g / c)	**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.

As indicated in the tables above, PG&E included ex-ante estimates of net-to-gross ratios in their claims, but did not include any ex-ante realization rate ratios to adjust the gross impacts in their tracking system for industrial projects. There are fairly significant differences between claimed and evaluated NTGRs. The primary source of these differences are claimed

NTGRs which are substantially below evaluated values, which average 0.53 (kWh) across all evaluated electric projects and 0.31 across all evaluated gas projects.

PG&E's ex-ante NTGRs used for this program cycle were based on DEER values which were in effect at the start of the 2006-2008 program cycle. These values of 0.7 for SPC-like measures and 0.94 for new construction measures included estimates of spillover and potential self-report bias that were included in an SPC net-to-gross analysis that was conducted in 2001 and reflected CPUC policy at that time. That policy has since changed and the NTGR is to be reflective of free ridership only, with no adjustments for spillover or self-report bias. Had PG&E instead used the NTGR resulting from the evaluation of the 2004-05 Standard Performance Contracting Program (or earlier SPC evaluations), exclusive of spillover, the ex-ante value would have been much closer to the ex-post NTGR resulting from this evaluation.

Finally, evaluated net savings as a percentage of program claimed net savings range from 26% to 40%, depending on the sampling domain. These values indicate that verified net program savings are on the order of one-fourth to just under one-half of claimed savings, far below program savings estimates. The specific reasons for these low realization rates are discussed in more detail in Section 5 – Findings and Recommendations.

4.9 Project Lifetime Impact Reporting

All of the realization rates presented in the above tables represent first-year results only. The ex-ante and ex-post evaluation kWh, kW and/or therm projections for the 133 on-site sample points were also used to derive a unit energy consumption (UEC) shape over the lifetime of each evaluated project, which takes into account the evaluation team's estimate of savings over the effective useful life (EUL) of the measures. These evaluation-based EULs include some differences in ex-ante and evaluator matching of CPUC-approved EULs to projects and some effects of the recession[26] (see discussion in Section 5 – Findings and Recommendations). The UEC shapes are normalized to the gross, first-year ex ante savings, and were derived as follows:

- Each sample point was attributed a whole year's worth of savings for the year in which an incentive was paid for measure installation, regardless of the actual installation date of the measure. Measures for which the incentive paid date was missing or dated after December 31, 2008 were considered installed in year 2008.

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[26] For sites that were found to have permanently closed (due to the recession or normal market conditions), savings were only included in the site-specific, multi-year savings tables (in Appendix D – Site Reports) for the years with actual savings (that is, the years prior to closure, typically only one to three years given the earliest year of installation is 2006). The multi-year program savings tables in this section are a roll-up (using the case weights for the sample) of the site-specific, multi-year tables presented in Appendix D – Site Reports. Consequently, if one were to calculate a weighted average EUL for the program by dividing lifetime savings by first-year savings, the resulting de facto weighted-average EUL for the *program* will be lower than what would be calculated from a weighted average of the EUL values themselves.

- The annualized evaluation projections for each sample point were “aligned” so that the first year’s savings for each sample point was always labeled “year 1”.
- For each of the 133 sample points, the gross ex-ante unit energy consumption (UEC) shape was derived by dividing the 20-year annualized ex-ante savings projection by the tracking database ex-ante savings.
- Similarly, for each sample point, a gross evaluation-based ex-post UEC shape was derived by dividing the 20-year annualized ex-post evaluation projection by the tracking database gross ex-ante savings.
- The tracking database ex-ante savings for each sample point and the program-wide tracking database savings per stratum were used as weights to derive overall gross ex-ante and gross ex-post UEC shapes.
- The net ex-post UEC shape was obtained by multiplying the gross ex-post UEC shape by the net-to-gross ratio.

The gross ex-ante, gross ex-post and net ex-post UEC shapes for each of the three sampling domains are presented in Table 4-20 to Table 4-22. The net ex-post shape incorporates both the engineering realization rates and the net-to-gross ratios.

Table 4-20: Lifetime Unit Energy Consumption Shapes (normalized to first-year, gross ex ante savings): All Projects

Year	Calendar Year	Gross ExAnte Claimed kWh UEC	Gross ExPost Verified kWh UEC	Net ExPost Verified kWh UEC	Gross ExAnte Claimed kW UEC	Gross ExPost Verified kW UEC	Net ExPost Verified kW UEC	Gross ExAnte Claimed Therm UEC	Gross ExPost Verified Therm UEC	Net ExPost Verified Therm UEC
1	2006	1.000	0.491	0.258	1.000	0.457	0.236	1.000	0.677	0.207
2	2007	1.000	0.493	0.259	1.000	0.457	0.237	1.000	0.677	0.207
3	2008	1.000	0.474	0.249	1.000	0.447	0.231	1.000	0.641	0.196
4	2009	1.000	0.429	0.226	1.000	0.407	0.211	1.000	0.604	0.185
5	2010	1.000	0.424	0.223	1.000	0.400	0.207	1.000	0.604	0.185
6	2011	1.000	0.424	0.223	1.000	0.400	0.207	1.000	0.596	0.182
7	2012	1.000	0.424	0.223	1.000	0.400	0.207	1.000	0.596	0.182
8	2013	1.000	0.424	0.223	1.000	0.400	0.207	1.000	0.596	0.182
9	2014	1.000	0.386	0.203	1.000	0.376	0.194	1.000	0.596	0.182
10	2015	1.000	0.369	0.194	1.000	0.357	0.185	1.000	0.596	0.182
11	2016	0.935	0.353	0.186	0.939	0.345	0.178	1.000	0.589	0.180
12	2017	0.935	0.349	0.184	0.939	0.341	0.176	1.000	0.589	0.180
13	2018	0.935	0.349	0.184	0.939	0.341	0.176	1.000	0.589	0.180
14	2019	0.935	0.349	0.184	0.939	0.341	0.176	1.000	0.589	0.180
15	2020	0.935	0.349	0.184	0.930	0.334	0.173	1.000	0.589	0.180
16	2021	0.365	0.033	0.017	0.406	0.037	0.019	0.978	0.379	0.116
17	2022	0.266	0.005	0.002	0.300	0.000	0.000	0.978	0.379	0.116
18	2023	0.266	0.005	0.002	0.300	0.000	0.000	0.978	0.379	0.116
19	2024	0.266	0.005	0.002	0.300	0.000	0.000	0.978	0.379	0.116
20	2025	0.266	0.005	0.002	0.300	0.000	0.000	0.978	0.379	0.116

Table 4-21: Lifetime Unit Energy Consumption Shapes (normalized to first-year, gross ex ante savings): Pump-Off Controllers

Year	Calendar Year	Gross ExAnte Claimed kWh UEC	Gross ExPost Verified kWh UEC	Net ExPost Verified kWh UEC	Gross ExAnte Claimed kW UEC	Gross ExPost Verified kW UEC	Net ExPost Verified kW UEC
1	2006	1.000	0.460	0.205	1.000	0.471	0.208
2	2007	1.000	0.457	0.203	1.000	0.466	0.205
3	2008	1.000	0.457	0.203	1.000	0.466	0.205
4	2009	1.000	0.457	0.203	1.000	0.466	0.205
5	2010	1.000	0.457	0.203	1.000	0.466	0.205
6	2011	1.000	0.457	0.203	1.000	0.466	0.205
7	2012	1.000	0.457	0.203	1.000	0.466	0.205
8	2013	1.000	0.457	0.203	1.000	0.466	0.205
9	2014	1.000	0.457	0.203	1.000	0.466	0.205
10	2015	1.000	0.457	0.203	1.000	0.466	0.205
11	2016	1.000	0.457	0.203	1.000	0.466	0.205
12	2017	1.000	0.457	0.203	1.000	0.466	0.205
13	2018	1.000	0.457	0.203	1.000	0.466	0.205
14	2019	1.000	0.457	0.203	1.000	0.466	0.205
15	2020	1.000	0.457	0.203	1.000	0.466	0.205
16	2021	0.284	0.000	0.000	0.305	0.000	0.000
17	2022	0.284	0.000	0.000	0.305	0.000	0.000
18	2023	0.284	0.000	0.000	0.305	0.000	0.000
19	2024	0.284	0.000	0.000	0.305	0.000	0.000
20	2025	0.284	0.000	0.000	0.305	0.000	0.000

Table 4-22: Lifetime Unit Energy Consumption Shapes (normalized to first-year, gross ex ante savings): Electric Non-POC Projects

Year	Calendar Year	Gross ExAnte Claimed kWh UEC	Gross ExPost Verified kWh UEC	Net ExPost Verified kWh UEC	Gross ExAnte Claimed kW UEC	Gross ExPost Verified kW UEC	Net ExPost Verified kW UEC
1	2006	1.000	0.526	0.316	1.000	0.506	0.298
2	2007	1.000	0.530	0.318	1.000	0.508	0.299
3	2008	1.000	0.497	0.298	1.000	0.491	0.289
4	2009	1.000	0.427	0.256	1.000	0.433	0.255
5	2010	1.000	0.420	0.252	1.000	0.423	0.249
6	2011	1.000	0.420	0.252	1.000	0.423	0.249
7	2012	1.000	0.420	0.252	1.000	0.423	0.249
8	2013	1.000	0.420	0.252	1.000	0.423	0.249
9	2014	1.000	0.355	0.213	1.000	0.391	0.230
10	2015	1.000	0.330	0.198	1.000	0.366	0.215
11	2016	0.907	0.309	0.186	0.918	0.350	0.206
12	2017	0.907	0.300	0.180	0.918	0.342	0.201
13	2018	0.907	0.300	0.180	0.918	0.342	0.201
14	2019	0.907	0.300	0.180	0.918	0.342	0.201
15	2020	0.907	0.300	0.180	0.907	0.333	0.196
16	2021	0.443	0.066	0.039	0.476	0.126	0.074
17	2022	0.273	0.007	0.004	0.283	0.000	0.000
18	2023	0.273	0.007	0.004	0.283	0.000	0.000
19	2024	0.273	0.007	0.004	0.283	0.000	0.000
20	2025	0.273	0.007	0.004	0.283	0.000	0.000

5

Discussion of Findings and Recommendations

In this section, we discuss key findings from the PG&E Fab evaluation and provide associated recommendations. We begin with an overall summary and then discuss findings and recommendations related to specific areas such as baseline specification, program influence, ex ante documentation, tracking systems, pump-off controllers, gas projects, and the evaluation itself.

5.1 Summary of 2006-2008 PG&E Industrial Findings[27]

As shown in Section 4 of this report, the overall net realization rate for all projects implemented by all of the industrial programs covered in the scope of this CPUC evaluation contract group is 0.33, with a gross realization rate of 0.49 and net-to-gross ratio of 0.53. For Gas projects, the gross realization rate is somewhat higher, (0.68), but the net-to-gross ratio is much lower (0.31), resulting in an overall net realization rate of 0.27. These quantitative results indicate that the programs are significantly overestimating their savings claims. In addition, the results for the 2006-2008 program cycle show little to no improvement as compared to the historic results for industrial sector programs and may in fact be worse.

These results would be of concern in their own right but are made more significant by several policy considerations. Previous evaluations have identified many of the same issues as identified in this evaluation yet these key problem areas do not seem to have been adequately addressed. This raises a concern as to whether previous evaluation results have been seriously considered or simply cannot be successfully addressed. The question remains as to how to increase the effectiveness of industrial efficiency programs given the history of the programs and the challenges that the sector presents. We note that, despite these challenges and results, the industrial sector remains an important area for achieving cost effective and significant energy efficiency reductions above those that would otherwise occur due to natural market forces. In addition, programs may remain cost effective even with mediocre realization rates due to the size of the savings opportunities as compared with other sectors. There are a number of specific findings that help to explain why the ex-post savings estimates are significantly below the ex-ante. These findings are discussed in the remainder of this chapter.

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[27] All of the projects cited as examples in this section have detailed site-reports which are contained in Appendix D to this report.

5.2 Problems with Baselines and Gross Savings

5.2.1 Significant Problems with Baselines Used for Claimed Savings

Incorrect use of pre-existing equipment as baseline for estimated savings and inadequate use of remaining useful life (RUL) estimates; inadequate use of replace-on-burnout and natural turnover baselines; inadequate use of industry standard practice baseline as referenced in program procedures manuals

The most common problem in the industrial programs is the use of pre-existing (often referred to as "in situ") equipment as the baseline for estimating program incentives and savings. In many cases, savings were calculated relative to an in situ baseline and then assumed to occur over the entire period of the effective useful life (EUL) of the new equipment. This assumption would only be justifiable in situations where the program induced an early replacement of equipment that would otherwise have had a very high probability of continuing in operation for a period equal to the EUL of the new equipment. Such cases are likely to be extremely rare in practice, yet they are the convention in the program claims. Instead, we find that many of the projects are, in fact, replace-on-burnout or natural turnover events. That is, the pre-existing equipment was either at the end of its physical life or at the end of its effective life because the customer decided to replace the equipment for reasons other than achieving energy savings (e.g., to improve product quality, respond to regulatory requirements, increase production, etc.). There are also a few cases where we estimate that the existing equipment was replaced early but that it's remaining useful life (RUL) was less then the EUL of the new equipment. In these cases, the appropriate approach is to use the in situ equipment as the baseline for the period of the RUL and then to use new equipment as the baseline for the remaining life of the measure (this issue is discussed further in Section 3 of this report). Again, the programs rarely estimate savings in this way but assume savings relative to the in situ equipment over the entire EUL.

In a number of cases in our sample, projects were allowed in the program even when they were clearly a natural turnover event driven by non-energy related production issues that had no readily apparent alternative upon which to make a reasonable baseline claim. Instead, such cases often used a baseline that referenced the in situ equipment, even when the equipment was obviously at the end of its effective useful life or was changed for business reasons other than efficiency improvement. Historically, such projects with no clear alternative to that implemented by the customer have been adjusted in evaluators' free ridership assessments and applied to the net-to-gross ratio. However, these program claims are inconsistent with most of the industrial programs' procedure manual references to "industry standard practice" as the baseline from which savings and incentives are to be estimated. Consequently, in this evaluation we used current industry standard practice to estimate gross savings for applications in which there was strong evidence for use of a replace on burnout or natural turnover baseline (increased and improved use of industry standard practice baselines are discussed further in Section 3). In some cases, the resulting gross savings were zero due to the lack of any alternative to the project implemented by the customer (and the lack of any associated program effect).

Example Sites - B095, B038

Recommendation: Significantly Overhaul Baseline Specifications Used for Estimating Claimed Savings and Customer Incentives

As discussed above, there are a myriad of problems associated with the baseline specification practices observed for the PG&E Fab contract group through this evaluation. Corrective actions that are recommended to address and eliminate these problems include the following:

a) End the practice of using in situ baselines over the EUL of the measure as the default baseline for estimating savings and paying incentives.
b) Identify projects explicitly in program files as replace-on-burnout, natural turnover,[28] or early replacement.
c) For the replace-on-burnout and natural turnover cases, which are likely to be the majority if identified properly, baselines should be based on the efficiency of alternative new equipment, not the existing in situ equipment (see related discussion on defining standard practice below).
d) In the case of early replacement, if a claim is going to made for program-induced early replacement of functioning equipment, and if permitted under CPUC policy, claims should include evidence and documentation of the remaining useful life (RUL) of the equipment replaced, the estimated time at which the equipment would have been replaced in the future, and the effect of the program in accelerating early replacement. In situ baselines should only be claimed in such situations for the period equal to the RUL of the existing equipment; new equipment should then form the basis for the baseline for the remaining portion of the claimed savings.

Recommendation: Clarify and Enforce the Definition of "Industry Standard Practice" Used to Set Baselines for Savings Estimates and Incentives

A number of savings claims were inconsistent with procedure manual references to "industry standard practice" as the baseline from which savings and incentives are to be estimated. Unfortunately, there is little precision and documentation associated with this term, despite its wide use throughout the industry in custom efficiency programs. As a result, different engineers, analysts, program managers, evaluators, and evaluation managers often come to different conclusions on what specific equipment and efficiency levels reflect standard practice. The lack of precision problem is exacerbated in the industrial sector due to the lack of mass market data that can be used to quantify efficiency levels and associated market shares.

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[28] For the purposes of establishing a baseline for gross savings, natural turnover is replacement of equipment or major renovation that occurs for reasons other than equipment burnout (e.g., environmental compliance, technological obsolescence, management of production risk due to failure of aging equipment, modernization of the facility, expansion of capacity for current or future needs, etc.) but not for the *primary* purpose of achieving energy efficiency savings.

It is strongly recommended that, for the next EE program cycle (2010-2012), the CPUC and IOUs should ensure that program and policy references to "industry standard practice" are more precisely defined with respect to program participation requirements, incentive level payments, gross versus net savings attribution, and energy efficiency goal attainment. For example, the CPUC and IOUs could define "industry standard practice" more explicitly with respect to whether it is intended to reflect the mean or typical efficiency, the minimum efficiency available, the efficiency level that a certain percentage of the market exceeds (e.g., 75%) or some other explicit criteria. We recommend that "standard practice" be defined somewhere in between the market minimum and the mean efficiency of the market. Setting the baseline efficiency higher will generally result in an improvement in program-induced savings and higher net and gross realization rates in future evaluations; however, setting the baseline definition too high could present a challenge if there is limited availability of the very highest efficiency options.

5.2.2 Some Projects with Inadequate Basis for Claimed Savings

Another related area concerns the basis for the savings claims being made. In some cases, there was inadequate engineering or physical basis for claiming savings or little or no reference to empirical information to substantiate the estimate of savings. Measurements were inconclusive for some of these measures and, given the lack of empirical data on the basis for savings estimates, it is difficult both to accept the ex ante claim and to develop an ex post estimate of savings.

Example Sites - B043, B127a, B130

Recommendation: Put Measures with an Inadequate Empirical Basis for Savings Estimates in the Emerging Technologies Program

We found that several projects included in our sample had measures that were very new and lacked empirical data or a compelling engineering theory upon which to base and defend savings estimates. We found, as noted above, these cases also present evaluation challenges given the lack of scientific literature and sometimes small samples available. The CPUC and IOUs should develop more explicit criteria for determining whether new measures are included under resource programs or in the Emerging Technologies program. Measures with highly uncertain savings in need of detailed research to establish validity, expected savings, and repeatable algorithms and measurement protocols should be included in the Emerging Technologies program.

5.2.3 Some Projects with Inadequate Enforcement of Program and Policy Rules

There were a few sampled sites where we concluded that the project for which savings were claimed and incentives paid did not qualify for the program because of violations of the program rules or the CPUC's energy efficiency policy rules. As discussed in Section 3 – Methods, we worked closely with the Energy Division to assess potential violations of program and policy rules. Energy Division evaluation managers made the final determination of such violations. For those cases, ex post savings were set to zero.

Examples of these cases included payments for repairs and routine maintenance that did not meet the program and policy requirements for the industrial programs. In one case, incentives were paid for replacement of industrial oven bricks in an application in which such replacement was a necessary and routine part of oven maintenance.

Example Sites – B055, B056, B135, B041a

Recommendation: Improve Enforcement of Program Eligibility and Policy Rule Requirements

Program eligibility and CPUC energy efficiency policy rules should be consistently enforced. Improved enforcement will improve gross realization rates. Where deviations or clarifications of program or policy rules are deemed necessary, program administrators should formally request changes or exceptions from Energy Division, or ALJ rulings as appropriate, and provide documentation and rationales during the implementation process. Energy Division should consider reviewing program and policy rule enforcement for samples of projects periodically throughout the program implementation cycle.

5.2.4 General Issues with Ex-Ante Savings Calculations and Project Reviews

As in prior SPC evaluations, we found a number of cases where the assumptions for the program calculations were unverified and undocumented. Increased documentation of input assumptions for savings estimation is needed, particularly, for larger and more complex sites. To the program's credit, there are energy savings calculations for many controls, refrigeration, and compressed air projects that are based on actual data. However, for many other similarly complex projects, the calculations use an assumed load or estimated average annual load point. In some cases, the applicant assumed that the system would operate an estimated number of hours at a certain load before the modification, and then based their calculations on a reduced number of hours and/or load. Program savings estimates for such projects are too often based on unverified assumptions that can vary widely from site to site. Often, rules of thumb and averages are used in these calculations and there appears, from the results of this evaluation, to be a general tendency to make overly optimistic savings-related assumptions. There is sometimes no measured data to back up the load estimates, nor any documentation of how the load varies throughout the year.

In general, the comprehensiveness of application reviews by program administrators and their proxies varied widely. Some of the applications had very thorough reviews, including documented inquiries to the project sponsor requesting supporting information. However, it appeared that many of the applications received only a cursory review and post installation inspection was very limited and inconclusive.

Recommendation: Increase the Conservatism of Savings Estimates

By definition, ex ante estimates of custom measure savings in the industrial sector are likely to have significant uncertainty given the nature and complexity of the projects. Under these conditions, it is important to adopt an expected-value to conservative orientation to savings estimation and to avoid systematically optimistic assumptions. The ex post gross realization rates indicate that savings-related assumptions have been too optimistic on average. We recommend that the programs make more conservative assumptions for calculated (custom) projects in the industrial sector in the next program cycle until ex post realization rates increase. Increased measurement could be used to address any customer concerns about savings estimates being too conservative; that is, claims of higher savings would have to be substantiated with pre- and post-installation measurement (possibly with Energy Division review for projects with the largest savings claims and incentive levels).

Recommendation: Use a Gross Realization Rate Adjustment in Savings Claims in Program Tracking Systems

Use of a realization rate adjustment in future program cycle ex ante estimates of custom measure claims should be strongly considered until future evaluation results indicate higher gross realization rates. The size of the adjustment to use for the next cycle is closely related to the extent to which the other recommendations made regarding improving specific aspects of gross savings estimation are addressed.

5.2.5 Some Projects with Inadequate Declaration of Fuel Switching, Multi-Fuel Impacts, Distributed Generation

We found that several of our sampled sites involved multiple fuels, fuel switching, or distributed generation but that the savings claim and ex ante analyses did not include these impacts. All program-induced changes in fuel use should be included in savings claims and associated analyses. Some projects claimed savings in one fuel (usually electricity) but neglected changes caused by the project in other fuels (often increases in other fuel use). Other projects were essentially fuel switching projects but did not include a three-prong test analysis and documentation as required by CPUC policy.

Example Sites – B064, B041a, B043

Recommendation: Aggregate and Approve Fuel Switching and Distributed Generation-Related Projects in One or More Explicit Programs or Clearly Identified Program Elements

Fuel switching projects are often very complex in the industrial sector and require careful and complete analysis in order to determine whether they are appropriate for ratepayer-funded energy efficiency incentives and services. These projects should be clearly identified as fuel switching in utility tracking systems and include the three-prong test in accordance with CPUC policy. We recommend that the CPUC consider requiring fuel switching projects to only be permitted through an explicit fuel switching program, or an easily tracked program element, that can be appropriately approved in advance and then reviewed, monitored, and evaluated. If the CPUC approves use of fuel switching, it should investigate whether refinements are needed to the three-prong test to address the state's greenhouse gas reduction policies.

5.2.6 Some Projects with Inadequate Consideration of Total System Energy Analysis

Some of the sampled sites involved industrial processes and systems with complex energy interrelationships that were germane to savings claims but not considered in the ex ante analyses. Energy usage was in some cases only analyzed for a portion of the system that was directly affected by the measure or project even though there were energy interactions with other systems that were also materially affected by the project. Over-isolation of project analysis can lead to problems with baseline specification, savings estimation, and program influence.

Example Site – B063, B071

Recommendation: Include More Complete Energy Analysis for Systems Related to Energy Savings Claims

More complete energy analysis for projects that have an energy efficiency element will help to improve savings estimates and identify potential problems or issues that need to be addressed to improve realized savings.

5.2.7 Non-Operational Measures

Some of the installed measures had already been disabled at the time the evaluation was conducted. There were a number of reasons for this. In two cases, the company was concerned about the possibility of losing temperature and humidity on some critical buildings, and returned their HVAC system to manual control until it could identify an alternative strategy.

Example Sites - B049 and B050, B116a (only two of five pumps operating)

5.2.8 Some Projects with Significant Effects of Recession

Energy savings were also affected by the economic recession that began, according to the National Bureau of Economic Research, in December 2007. For several of our sampled projects, the facility had closed down, resulting in zero savings (since measures have to be operational according to program and policy rules). In other cases, production levels had been reduced, sometimes resulting in corresponding reductions in savings estimates. The project team did not forecast whether closed plants would reopen or whether open plants would close after the evaluation period. Due to the sensitivity of economic cycles and mid-term structural changes in industry composition, we recommend later in this section (under evaluation findings and recommendations) that further research be conducted to assess the persistence of industrial program savings over time (from program cycles preceding 2006-2008 as well). This research would be useful to CPUC, CEC, and IOU efforts to improve understanding of consumption changes in the CEC and IOUs' load forecasts and energy savings from energy efficiency programs.

Example Sites – B013, B006, B024a

5.3 Free Ridership – Moderate (Electric) to Low (Gas) Program Influence

As indicated from the results in Section 4, we estimated moderate to low percentage of claimed savings that were program-induced. In the current evaluation, the evidence indicates that program implementers often arrived late in the decision making process and offered incentives for projects that had obviously already been decided upon. This is a form of cream-skimming that may be associated with program staff being focused on gross rather than net savings, resulting in weak or non-existent net-to-gross related screening of projects. Similarly, as discussed under baselines above, we found that program claims were made on a number of projects that customers initiated for non-energy savings reasons and for which no alternative was ever considered. We also found program incentives were offered for measures and technologies that are industry standard practice (thus significantly increasing the odds of free ridership in any given application). Program attribution was also limited when program incentives were offered for projects that were being implemented by end users in response to mandates from other regulatory agencies, for example, citations from air resources boards.

While we are sensitive to the fact that it is not easy to provide the level of expertise needed at the right time to move industrial customers to higher levels of efficiency given their complex production- and site-specific processes, we also observe that very few readily identifiable steps have been taken by the programs with the specific goal of reducing free ridership.

As shown in the table below, the level of free ridership for the 2006-2008 PG&E Fab programs is comparable to those estimated in previous SPC evaluations for electric measures but lower for gas.

Table 5-1: Statewide Standard Performance Contracting (SPC) Program Evaluation Net to Gross Ratios, 1998-2005

(1 – Free Ridership)	1998	1999	2000	2001	2002	2003	2004-2005
Weighted	0.53*	0.51	0.41	0.65	0.45	0.59	0.57
Unweighted	0.49	0.48	0.46	0.55	0.45	0.60	0.54

* Weighted by incentives rather than by kWh savings.

Previous evaluations of the SPC and even earlier industrial programs[29] all raised concern regarding the relatively high levels of free ridership and provided recommendations for reducing these levels. These findings occurred in both low and high goals environments.

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[29] A review of net-to-gross ratios for California programs as far back as the 1980s estimated an average value of 0.5 for industrial rebate programs. See Rufo, Michael W., and Nancy L. Bester, "An Investigation of Commercial and Industrial Utility Demand-Side Management Program Impacts," Energy Program Evaluation: Conservation and Resource Management, Proceedings from the 1989 International Energy Program Evaluation Conference, Chicago, IL, August, 1989

However, over decadal periods it appears that insufficient effort has been expended on trying to develop and implement approaches to improve the industrial free ridership situation. We believe this issue needs significant CPUC and utility management attention given the long-term pervasiveness of this issue and inherent challenges (and opportunities) in the industrial sector.

Example Sites – *Arrival late* –B032, B121, *Projects with non energy motivations* –B095, B041a, B128a, B038, B122, *Standard practice* - B124, B093, B037

The recommendations below are suggestions for consideration with the end goal being lower levels of free ridership on a percentage basis, while still maintaining high levels of total net savings. We recognize that the utility has ultimate responsibility for program implementation, and the CPUC has responsibility for energy efficiency policy, and each must weigh a variety of different factors, some of which are competing, in developing program requirements, implementation strategies, and policies. The recommendations are not meant to be prescriptive and the utility and CPUC may develop and prefer other approaches to achieve the same overarching goals. We recognize that there are advantages and disadvantages to each of these recommendations as well, many of which are discussed in the CPUC and IOU-sponsored National Energy Efficiency Best Practices volume on custom incentive programs for large nonresidential customers.[30]

Recommendation: Carefully Review Qualifying Measures for Each Program and Eliminate Eligibility for Those that Are Standard Practice

Measures that are already extremely likely to be installed by the vast majority of the market should in most cases not qualify for incentives. Although identification of such measures can be difficult in practice in the industrial sector, 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. A balance must be struck, in determining which measures to retain and which to eliminate, between reducing free ridership and avoiding significant lost opportunities.

Recommendation: Increase the Capability of the Program Influence Advanced Industrial Efficiency Improvements

As we have noted elsewhere in this evaluation, influencing industrial customers to implement energy efficiency projects that go beyond their normal practices and plans is extremely difficult in practice. This sector is probably the most complex and challenging sector in the energy efficiency portfolio due to the engineering and site specific complexities. It is a very difficult task to identify and field the level of highly specialized labor resources and program offerings needed to achieve the magnitude of aggressive efficiency goals in this sector. To move these customers further along the efficiency spectrum takes time and advanced levels of technical expertise, often requiring expertise in specific industry production practices and

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[30] Itron, 2005. National Energy Efficiency Best Practices Study. *Volume NR5 – Nonresidential Large Comprehensive Incentive Programs.* www.eebestpractices.com

options. In addition, even with the right level of expertise on hand, increasing program influence requires providing advanced energy efficiency options directly to end users at the earliest stages of their equipment or facility modification decision making. There is already significant industrial expertise available at the utility and third-party contractors and PG&E should be commended for having developed a large and strong industrial efficiency team for 2006-2008. This expertise should be built upon and further increased. Development of the depth of technical expertise required to increase the net effects of the programs is a long term endeavor that requires both utility and regulatory support. Industrial experts need to know that there will be consistent support over time for efficiency programs if they choose to invest significant portions of their careers in program implementation. End users need to be confident that the suggestions of program staff will work to achieve the targeted savings while also meeting their various production and business requirements.

Recommendation: Enhance the Program's Capability to Become Involved with Projects at the Earliest Possible Stage

Program involvement after the decision to install energy efficient equipment had been made was seen in several projects and is obviously problematic. Program involvement at an early stage to identify large equipment and facility changes helps ensure efficiency opportunities are appropriately considered and maximize the chances of program influence. Utilization of sales or related tracking systems helps prevent projects from becoming lost opportunities.

Recommendation: Provide Continuity in Account Representative Assignments, Particularly for the Largest Customers

Another 'touch point' of program influence is the utility account representative. The utility likely has an internal incentive to maintain continuity in account representative-customer relationships; however, we found many instances where the utility account reps had been reassigned one or more times during the project lifecycle. The likelihood of utility program influence could be weakened in such cases, because the assigned representative may lack the long-term relationship and continuity needed to provide a significant influence on the installed project. Utilities should continue to seek to provide continuity in these account rep assignments, particularly for their largest customers.

Recommendation: Consider Using Early Project NTG and Baseline Screening Prior to the Incentive Being Approved for the Largest Projects and those with Significant Policy Issues such as Fuel Switching, Self Generation, and Greenhouse Gas Impacts

For the largest projects and those with significant policy issues, we recommend that the CPUC consider implementing an Early Project NTG and Baseline Screening step. This step would involve having the CPUC evaluation team review the baseline claim and conduct NTG interviews during the participant's project implementation and program participation decision. The purpose of this screening would be to obtain critical information regarding program influence that might lead to the project being re-defined to increase efficiency levels and program influence or dropped if no influence is evident. This early review could be helpful to the proper specification of the project baseline and the minimization of free-ridership for large, complex, and policy sensitive projects. This approach would also have the advantage of capturing critical information on program influence early in the decision making process, while the information is still fresh in the mind of the decisionmaker(s).

Other recommendations to reduce free ridership. The following are overarching free-ridership-related recommendations:

Consider Limiting or Excluding Incentive Payments to Known Free Riders

One obvious and simple approach to reducing free ridership is for program administrators to simply exclude projects from the program that they (or possibly the Energy Division) believe have a high probability of being free riders. Administrators in several other jurisdictions have used this approach. In these cases, the administrator has the flexibility to determine total incentive amounts on a case-by-case basis, including zero incentives. We believe consideration should be given to implementation of a process by which projects considered to be very high likelihood free riders are excluded from participation (or, conversely, must go to higher efficiency levels than initially planned in order to participate).[31] Alternatively, or in conjunction with this type of approach, rules could be developed that exclude incentive payments for projects that are driven exclusively by non-energy factors that produce energy savings as a by-product, such as some naturally-occurring improvements in certain industrial processes.

Recommendation: Consider Incorporating a Payback Floor

The use of a payback floor (minimum payback level based on energy savings alone) can help to reduce free ridership by eliminating projects that have extremely quick paybacks and thus little need for ratepayer-funded incentives. With a payback floor, the program may also avoid incenting projects that are primarily being done for reasons other than energy savings (modernization, production efficiency, environmental compliance, etc.).

Set Incentive Levels to Maximize Net not Gross Program Impacts

Free riders dilute the market impact of program dollars. Payback floors and increasing incentives with increasing payback levels are one approach. Another is to tie incentive levels to individual measures or types of measures that are known to have extremely high or low naturally occurring adoption levels.

Consider Tying Staff Performance to Independently Verified Net Results

Tying performance reviews of program staff to verified savings as reported through an independent M&V or impact evaluation process is likely to increase project quality and the accuracy of initial savings estimates. Marketing staff, in particular, should have any financial incentives tied to savings that are independently verified.

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[31] If necessary, such a process could involve an advisory group that includes staff from the Energy Division (to address any customer concerns). This would offer IOUs appropriate protection from claims that such exclusions were unfounded or unfair.

5.4 Areas of Success

Despite finding the problems described above and elsewhere in this section on a significant portion of the projects sampled for this evaluation, it is important to also recognize that there was a portion of the sampled projects for which we found significant gross and net impacts. We found net realization rates (product of gross realization rate and net-to-gross ratio) of 70% or above for 14% of the projects sampled. Obviously, if this fraction was higher, the overall program realization rate would be commensurably higher as well. Thus, although increasing the fraction of high realization projects is critically important for the future industrial programs, it is also important to draw attention to those projects that were successful and to look to those projects as models for how the overall program impact can be improved in the future.

5.4.1 Gross

As noted above only a small percentage of projects had high net realization rates (product of gross realization rate and net-to-gross ratio); however, a significant share of non-POC projects (40%) had reasonably high gross realization rates (over 0.8). These projects tended to have more realistic assumptions and analyses than those with lower gross realization rates. Some of the engineering, use of monitoring, and application documentation was also very good. Increasing the proportion of projects with the characteristics shared by these higher realization rate sites would lead to an increase in the overall realization rate in the future.

In the previous 2004-05 SPC evaluation, we found extensive use of an itemized approach to estimate the energy savings and incentive. This resulted in inaccuracies in savings estimation for measures where this approach was not appropriate. In this current evaluation effort, we found much less reliance on the itemized approach, to the credit of the programs.

5.4.2 Net

Many of the projects developed by certain third party programs have demonstrated high-levels of program influence (although a few have lower levels as well). In addition to providing a rebate, these programs provide extensive 'handholding' throughout the project lifecycle. The programs get in early – often at the 'idea generation' stage – and work closely with the customer through all project phases. Some good examples of this are the Energy Efficiency Services for Oil Production program (PGE2058), the California Wastewater Process Optimization Program (PGE2046) and the Commercial and Industrial Boiler Efficiency Program (PGE2087).

5.4.3 Market-Driven Efficiency is Strong in this Sector

In some cases, high free ridership can be viewed as a positive indicator of strong market driven efficiency. Some companies' internal CO_2 reduction policies may be increasing this (e.g., B123). A challenge for the programs is to influence these customers to go even further in their efficiency plans than they would otherwise due to their own internal policies and financial criteria. In one sense, this means setting baselines higher – which can be accomplished by using industry standard practice rather than in situ practice – as the basis for program participation and incentives. It can also mean developing customer specific baselines based on the plans the customer had at the initial point of program interaction.

5.5 Other Application-Related Findings

5.5.1 Unclear from Project Applications Whether Post-Installation Cost Tracking and Incremental Cost Analysis and True-up is being Conducted

Cost data in project files and the utility databases for industrial efficiency projects are generally ex ante values that are based on a generic estimate of costs across projects (e.g., $0.22 per kWh savings claimed). We found significantly different actual project costs through our ex post analyses for our impact sample. Existing information on industrial incremental costs is extremely limited. The CPUC has indicated that the program administrators are to collect and true up actual incremental costs for custom projects.[32] Actual industrial custom costs (and incremental costs which require additional analysis of the costs of alternative projects) were not usually included in the project applications that we sampled, however, we do not know if the program administrators are collecting and analyzing industrial custom measure cost data in a separate activity.

Recommendation: More information is needed on industrial project costs, non-energy costs and benefits, net present value analysis, and associated participant cost-effectiveness analysis

There has been very little analysis conducted of the actual incremental costs of industrial energy efficiency projects. Rules of thumb, such as assuming that incentives represent half of incremental costs, appear to have been used instead as proxies. In addition, there is inadequate financial analysis conducted on program projects to determine what portion of the customer's financial investment threshold is associated with the energy savings of particular projects versus non-energy factors such as increases in production and reductions in labor, materials, and regulatory compliance costs. Further research is needed on industrial incremental measure costs in general and increased financial analysis should be included in industrial project applications, especially for the projects with the largest incentives. Increased review of project financials inclusive of non-energy factors can also help to reduce free ridership.

5.5.2 Differences between Ex Ante and Evaluation EULs

For a number of the sampled sites, the evaluation team differed with the choice of EUL in the ex ante claim. This occurred for a significant portion of the sample. The primary measures for which the evaluation team utilized a different EUL were POCs (15 years instead of the ex ante 20 because POCs are a control measure) and certain gas boiler measures. As noted

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[32] Administrative Law Judge's Ruling on EM&V Protocol Issues, Rulemaking 01-08-028, September 2, 2005. APPENDIX 3: Joint Staff's Proposed Process for Estimating and Verifying Parameters Needed to Calculate Net Resource Benefits.

above under the recession-related finding, effective EULs were also reduced due to some facilities being shut down.

__Recommendation: Add POCs and Other Common Industrial Measures to DEER EUL Tables__

Many industrial measures do not currently match well with CPUC-approved EUL values in DEER. Additional research is needed on more common industrial measure EULs.

5.6 Tracking System and Electronic Claims-Related Findings

This section addresses specific issues and evaluation-related problems found with PG&E's tracking system, which were uncovered in the course of performing the evaluation. Specific problems include missing information about measure descriptions, high level and inconsistent measure descriptions, missing measure units, inconsistency with quarterly data extracts and a lack of site addresses where the measures were installed. This section will also include tracking system-related items where PG&E should be commended.

Tracking System Extracts missing a description of the measure installed. This issue can be divided into two parts:

- Measure descriptions in the tracking system are high-level and inconsistently applied across the programs. For example, pump-off controllers are coded as "PROCESS OTHER" in the Standard Performance Contract (SPC) Program, "PROCESS ENERGY EFFICIENCY MOTOR" in the Nonresidential Retrofit Program, "PROCESS (CUSTOMIZED)" in the Nonresidential New Construction Program, and "ROD BEAM PUMP-OFF CONTROLLER" in the Global Energy Partners third party program.
- The tracking extract for PGE2004 includes a project description field, but in many cases the field contains the customer name rather than a project description. In some cases the field was populated with a very general description (e.g. "POC for new oil well – 75 hp").

Tracking system extracts missing a description of measure "units" and the number of units installed. For a lighting project, it would be expected that the tracking systems would include the type and number of lamps installed. However, for one of the programs[33] reviewed in this evaluation, the "HIGH EFFICIENCY LIGHTING" measures recorded in the tracking system had neither the type nor units installed.

The two issues listed above can be handled in the site-specific engineering portion of the evaluation where the application and associated paperwork usually provide this detail, however, this issue is quite problematic for the net-to-gross analysis. PG&E's tracking system does not contain specific information that can be used in a customer survey. These

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[33] 58 projects from this program (the Nonresidential New Construction Program) were initially assigned to the PG&E Fab contract group, but were later reassigned to the New Construction contract group.

specifics are needed to help a customer recall facts around the installation of a specific measure (e.g., details regarding the measure description, measure units and measure counts).

Projects split into multiple applications. Balkanizing projects into different applications and programs makes evaluation and oversight extremely difficult and inefficient. Projects should address entire systems and be kept together as comprehensive projects when the measures are truly connected or identical.

Consistency with the Tracking System Extracts. PG&E's Q1 2008 tracking extract had two records for PGE2004 marked as 'paid', however, these records did not appear in subsequent extracts. PG&E explained that these projects failed to incorporate the complete list of measures installed and the original tracking system entry was cancelled and the project was re-assigned a new application number with changes in the install date and check paid date for these projects. These changes have an effect on the sample frame for this evaluation. Should this happen in the future, we recommend that PG&E simply add line items to existing applications to make up the difference in savings.

Tracking System Extract lacks address where a measure is installed. Currently, to obtain site addresses, the tracking extract must be merged with customer information in another data source; however, this method does not always produce site information. We recommend that PG&E import all of the site information into the tracking system at the time of program participation.

PG&E Support for Tracking System Follow-up and Data Requests. The tracking system issues listed above resulted in frequent follow-up requests to PG&E for additional information in order to proceed with engineering or net-to-gross analysis. PG&E staff was always willing to work with us to deliver the data or information in a timely manner. In some cases data and/or application files were delivered in phases as the information was gathered. The turn-around time was reasonable but did slow in the last few months due to the large number of data requests coming at the same time.

5.7 High Impact Measure Findings

5.7.1 Pump-Off Controllers (POC) Related Findings

Gross Impact Related POC Findings

This evaluation has concluded that the use of POCs on previously uncontrolled oil wells can be an effective strategy that saves both energy (kWh) and demand (kW); however, at levels significantly below those estimated in the program claims (the gross realization rate for POCs is 0.46).

Benefits of POCs. In addition to energy savings, a very important benefit of POCs is their ability to allow for continuous monitoring and optimization of well pumps. Often, the POCs utilize radio telemetry and are networked to a central computer – allowing real time monitoring and control of wells from a remote location. These capabilities were among the first advantages promoted by POC vendors – and continue to be important today.

Another major benefit of POCs is their early warning of well conditions – before the well goes into a “pump-off” condition. The POC’s effectiveness at reducing wear and tear on the well helps to prevent breakdowns and lost pumping time. The POC itself does not seem to affect overall well production either positively or negatively.

POCs also improve pump efficiency, since they enable more pumping under fully loaded conditions. This results in higher motor loading and higher kW demand at the pump. This is usually offset by lower hours of use – though not always. Less than 5% of the cases show higher use.

Pump-Off Effectiveness. Some wells, especially newer ones, do not pump off. It is difficult to estimate an exact percentage of wells in this situation, but 10% of wells would be a conservative estimate. Some implementers (especially Global Energy Partners) conducted pre-and post-monitoring and when they found a well was not pumping off, therefore there was no savings. The POC was either not eligible for a program rebate, or was moved to a new location (and subsequently became eligible for a rebate). In the case of one facility, no savings were given, but the company still received a rebate.

Pre-Existing Technologies. Older POCs are in place on some wells and many save less energy than the newer POCs. POCs also have replaced time clocks on a small portion of wells, many of which had already been decommissioned. In general, time clocks are notoriously unreliable and may be detrimental to the well, due to their rigid on/off regimes irrespective of the downhole conditions. Sometimes these cause rod failures and increase the need for maintenance.

Net Impact Related POC Findings

Qualitative NTG-Related POC Findings

A number of general themes have emerged from the POC NTG interviews, which have implications for the degree of free ridership, and extent of market transformation for this measure. These are summarized below.

Awareness of the significant non-energy benefits of POCs has increased considerably since 2006. In addition to reducing energy usage and wear and tear on wells, POCs with telemetry allow users to remotely diagnose and operate oil wells from the comfort of their office. Many companies reported not being aware of these benefits during the first year of the program cycle (2006), but gradually becoming aware of them as they gained experience with the POCs.

POC installation as standard practice. For existing wells in California, POCs are not commonly installed outside of rebate programs. Only one of the 16 companies interviewed acknowledged installing POCs as a standard practice for both its existing and new wells.

This company accounts for 11% of POC installations through Q4 2008. Two of the 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.

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 the four major oil companies interviewed indicated they would install POCs on new wells in California even without rebates.

Effect of oil price volatility on POC installations. Volatile oil prices have affected the POC market in various ways. Higher oil prices present up until late 2008 had a positive effect on the POC market by making more capital available to fund POC investments. This led to strategies to install substantial numbers of POCs during the entire 2006-08 period. Conversely, it is possible that current lower oil prices might reduce capital availability for POC investments and lower the number of POC projects now and in the near future. POC installations are continuing into early 2009 as previously planned and funded projects are implemented, but many companies are re-evaluating their capital investment plans and slowing down or halting POC installations on new wells. Capital is less available than previously. In such an environment, and depending on the economics of each case (e.g., payback and internal rates of return with and without the rebate), the rebate may become a more important consideration in the decision to install POCs, for companies that have not adopted POC installations as a standard practice. Further economic and related analysis is needed to increase the certainty of this assessment.

Company size. Larger oil companies (the majors) are farther along in their adoptions of POCs than smaller, independent companies. Larger oil companies, particularly those with operations in multiple states, are more likely to have installed POCs on a significant percentage of wells, both existing and new.

Effect of rebate programs. The role of the rebate program in helping projects meet payback or other financial criteria varies, but generally reduces energy-only payback periods by roughly 50 percent, from around two years on average to around one year on average. While no oil producers were willing to provide information on specific payback criteria, several said that the rebates made POCs an attractive alternative to drilling or developing new wells. California's rebate programs are widely reported to have influenced participants' installations of POCs, particularly for existing wells, in various ways. For example, the Global program was widely praised for providing a turnkey approach with respect to preparing rebate applications, assisting with rebate payment processing steps, etc. Program staff and account representatives were also rated highly for their efforts in making the customer aware of POCs and their eligibility for POC rebates. Program rebates were also rated as important in POC installs by the majority of participants. Among the comments made were: (1) Program rebates make POCs as attractive an investment as expanded oil production/drilling – even when oil prices are high, and (2) program rebates help participants to install POCs on a much larger scale and under a more accelerated schedule than in the absence of rebates.

Quantitative NTG-Related POC Findings

On average, our NTG findings suggest the 2006-2008 rebate programs had a moderate level of influence over participants' decision to install POCs, as indicated by a weighted average NTG ratio of 0.45 for kWh and 0.44 for kW for the POC measure category across all companies interviewed. However, it is important to note that program influence levels (i.e., NTG ratios) vary widely by company as a function of several factors:

- Corporate size and structure (i.e., whether the firm is a "major" integrated firm vs. a smaller independent company)
- Awareness of POC energy and non-energy benefits
- Presence or absence of a corporate environmental or energy efficiency policy
- Availability of capital to fund POC installations
- For major oil companies, NTG ratios vary widely but are generally quite low.
  - Values range from 0.00 to 0.75. Values for two of the three companies interviewed are below 0.50. NTG values are substantially higher for existing wells (0.65) than for new wells (0.20), reflecting the influence of two firms with many POC installations whose responses indicated a high degree of free ridership for new wells. Three of the four companies indicated that POC installation is standard practice for all new well projects. One company that had installed hundreds of POCs before participating in the program said they were standard practice for both existing and new wells. Most companies acknowledge that POCs are beneficial for reasons that go well beyond energy savings.
- For smaller independent companies, NTG values likewise vary significantly by company, ranging from 0.40 to 0.93. Values are 0.50 or above for all but two companies.
  - The weighted average NTG value for independents is 0.74, which suggests that program influence is significant for these types of companies. None of the companies interviewed indicated that POCs were standard practice for either existing or new wells.
- The overall NTG ratio of 0.45 for kWh and 0.44 for kW has implications for rebate levels and other program design parameters. These findings were shared with the CPUC staff and the utilities in an early feedback memo in early 2009. The utilities subsequently elected to suspend POC rebates on new oil wells.

5.7.2 Gas Projects Net-to-Gross Findings

On average, our NTG findings suggest the 2006-2008 rebate programs had a low level of influence over participants' decisions to install energy efficient custom gas projects, as indicated by a weighted average NTG ratio of 0.31 for therms across all sample points. However, it is important to note that program influence levels (i.e., NTG ratios) vary widely by stratum, i.e., size of project. In general, the very largest projects had among the highest levels of free ridership, as evidenced by the low NTG values for Tier 1 projects (0.20) and Tier 2 and 3 projects (0.26). In contrast, the smallest Tier 5 projects had the lowest free ridership, as indicated by the NTG value of 0.66. There were a number of reasons why the largest projects, in particular, were prone to high free ridership:

Many of the projects were largely done for reasons other than improving energy efficiency. Most of the largest gas projects were primarily motivated by factors other than the desire to reduce energy use. Virtually all of these projects were implemented for one of the following reasons: to address and solve an existing operational problem, to comply with air quality regulations, as part of an overall plant expansion or refurbishment, to improve plant productivity, or to reduce labor or material costs. Because the installation of new equipment, regardless of the reasons for it, led to a reduction in energy use as the old equipment was swapped out, these types of custom projects were deemed eligible for rebates by the program implementers and administrator. However, the NTG interviews revealed the real reasons for the project were often not related to the program, and that the overall level of program influence was too often extremely low (in some cases, zero).

The program often became involved long after the customer's decisionmaking stage. Many large custom gas projects were conceived years before the program became involved. In many cases, the program became involved **after** the go/no-go decision on the project was made. Therefore, there was little or no program influence on the decision to do these projects.

The ideas for the projects often came from within each company. This issue is related to the previous point of late program involvement. Because the program arrived at a late stage, the project concepts had already been developed (usually by the company's internal staff or the design/consulting engineers hired by the company to support each project).

The business case for each project was already strong, without consideration of the program rebate. Many of the companies interviewed cited high natural gas prices as a prime motivation for the project. Many revealed that the project payback or ROI already met their cut-off point or hurdle rate without the rebate.

5.8 Evaluation-Related Findings and Recommendations

This subsection presents our recommendations and related findings with respect to future industrial sector program evaluations.

Recommendation: Involve impact evaluators in large projects and a sample of projects on a real-time basis throughout the program cycle

The timing of evaluation processes should be accelerated. Under the current approach, where evaluation activities commence after or well into the program cycle, many projects are evaluated two to three years after they are implemented. Often, the primary decision maker has left. In a few cases in this evaluation, companies had gone bankrupt or transferred operations to another location. Moving the evaluation process forward in time to occur just after the project is installed would effectively address this problem. This can be accomplished through earlier contracting and implementation of the evaluation, combined with improved utility tracking and early reporting of installations (as well as projects in the pipeline), more frequent sampling and evaluation of projects throughout the program plan period.

Recommendation: Evaluation participation requirements should be strengthened

In the course of conducting the evaluation, we experienced 'pushback' from many participants who either refused to participate in evaluation surveys and on-sites or declined to provide required data and documentation. This made it difficult to conduct the evaluation efficiently and can lead to systematic bias. Evaluation participation requirements need to be clearly explained to participants; both at the time they are paid incentives, and later, when evaluation activities commence. Evaluation participation should be clearly and obviously written into program participation and incentive payment agreements.

Recommendation: Conduct a full complement of impact, process, and market evaluations

Large customer programs and markets are very dynamic and require regular assessment in order that they may be continuously improved by program managers and policymakers. Most of the effort for the 2006-2008 industrial evaluation focused on impact evaluation, in accordance with Energy Division's evaluation priorities. Future evaluations should consider more integration of process evaluation and market assessment to capture research economies and reduce customer and vendor interview burdens.

Recommendation: Stagger the timing of process and ex post impact tasks so that process evaluations can be conducted and results communicated on a relatively real-time basis

If process and impact evaluations are more integrated in future evaluations, care must be taken to schedule activities and deliverables appropriately. Because of the sometimes long project installation lag after program commitment in these programs, it is important to schedule process evaluation tasks to be conducted during or just after each program year so that results can be utilized to improve program processes for the subsequent program year (rather than producing results only late in the three-year program cycle for use in the next program cycle).

Recommendation: Conduct baseline research to establish standard industry practices for key measures in key industries

Significant research is needed to establish meaningful and defensible data, especially market share, for establishing industry standard practices for measures that are not completely site specific. Improved information on industry standard practices can then inform decisions about which measures to provide incentives for, which could in turn lead to reductions in free ridership.

Recommendation: Conduct persistence study of industrial sector savings

Few studies of the persistence of program savings in the industrial sector have been conducted, particularly within the last decade. As noted previously in this section, there were a number of participants who closed facilities or shut down processes associated with program measures due to economic factors. In addition, in some program years and cycles industrial production levels will be higher or lower depending on economic conditions. Some facilities that do close may stay closed while others may reopen and reutilize efficiency measures. Research is needed to measure the persistence of savings over time under a range of economic conditions. Sufficient time needs to pass in order to maximize the information provided from such persistence studies. We recommend waiting until the recession is completely over and the economy is in full recovery. To accelerate the time at which meaningful results would be obtained, studies can be conducted using earlier program cohorts, for example, going back to the 2002-2003 or 2004-2005 program cycles (or earlier), rather than simple waiting for the 2006-2008 cohort to age.

Recommendation: Conduct analysis of customer incentives by customer and industry type, further research on use of incentive caps

Customer incentive caps have been utilized in various forms for many years. During times of low budgets and low goals, caps were set low to spread incentives to a broad pool of participants. More recently, as goals and budgets have significantly increased, caps have increased greatly as well. We are not aware of any systematic study of the effect of the incentives caps. Similarly, research is needed to explore how much total incentive dollars have been distributed across or concentrated within certain customers to determine whether these patterns are aligned and supportive of efficiency policy goals.