Sample Design and Impact Evaluation
Analysis of the 2006 Custom Program

July 20, 2007

Prepared for:

National Grid

55 Bearfoot Road

Northborough, MA 01532

Prepared By:

RLW ANALYTICS

1055 Broadway, Suite G

Sonoma, CA 95476

(707) 939-8823

Table of Contents

Sample Design and Impact Evaluation Analysis of the 2006 Custom Program

Introduction

This report provides estimates of the realization rates and statistical precision for the Custom measures installed in the year-2006 Energy Initiative and Design 2000*plus* programs.

Purpose of this Study

This study has the following purposes:

1. To document the sample designs used to select the projects that were used to calculate the new realization rates for Process and Lighting measures. The samples were drawn from various program years, 2004 and 2005 for Process, and 2006 for Lighting.
2. To provide a statistical analysis of the engineering studies of 2004 and 2005 Custom Process installations carried out for the evaluation of the Process category of Custom measures installed in year 2006 in the Energy Initiative and Design 2000*plus* programs,
3. To provide a statistical analysis of the engineering studies of 2006 Custom Lighting installations carried out for the evaluation of the Lighting category of Custom measures installed in year 2006 in the Energy Initiative and Design 2000*plus* programs,
4. To assess the error ratios, i.e., the measures of variability, to be used in developing the sample designs for future studies, and
5. To draw together the results from the new Process and Lighting studies and the previously reported HVAC and Comprehensive Design Approach (CDA) studies to:
   - Provide unbiased estimates of the collective realization rate of all projects in the program population,
   - Summarize the overall savings, and

- Determine the statistical precision for all Custom measures installed in year 2006 in the Energy Initiative and Design 2000*plus* programs.

Scope

The scope of the analysis includes installations in the three New England states that National Grid serves: Massachusetts, Rhode Island and New Hampshire.

Methodology

For the last ten years or more, National Grid has used the model-assisted stratified ratio estimation methodology described in [1] and [2]. The key parameter of interest is the population realization rate, i.e., the ratio of the evaluated savings for all population projects divided by the tracking estimates of savings for all population projects. Of course, the population realization rate is unknown, but it can be estimated by evaluating the savings in a sample of projects. The sample realization rate is the ratio between the weighted sum of the evaluated savings for the sample projects divided by the weighted sum of the tracking estimates of savings for the same projects. The sample realization rate is equivalent to the usual stratified ratio estimator of the population realization rate. The total tracking savings in the population is multiplied by the sample realization rate to estimate the total evaluated savings in the population.

Sample Design

The sample designs guide the selection of the projects to be studied. This year's report differs from prior year's reports in that only the most recent Process and Lighting sample designs will be presented. The study of PY2005 Custom HVAC projects was not complete at the time this report was finalized. Sample data from PY05 will be combined with sample data from PY06 in a later report on Custom HVAC measures. The samples have been drawn from various program years, 2004 and 2005 for Process, and 2006 for Lighting.

Each of the sample designs was developed using the model-based methodology [1]. A statistical model was used to describe the relationship between the evaluated savings and tracking savings for all projects in the target population. The parameters of this model

were combined with the information in the tracking system to develop an efficient sample design with the expected statistical precision that is desired. The key parameters of the model are the realization rate (defined above), the error ratio, and gamma. The error ratio is a measure of the project-to-project variation in the relationship between the evaluated savings and the tracking estimate of savings. The error ratio was used to choose the sample size and to estimate the expected statistical precision. Gamma describes how the residual standard deviation varies with the tracking estimate and was primarily used to stratify the population.

These parameters have been estimated as part of the analysis of many prior evaluation studies. Reference [3] provides an overview of the results found in earlier Custom studies carried out from 1994 through 1999. In these and other studies, we have found that the realization rate and error ratio vary from measure category to category and from one measure of savings to another. We have also found that the estimated value of gamma tends to vary randomly around 0.8. Therefore we currently use a simplified methodology to estimate the error ratio from sample data that assumes that the true value of gamma is 0.8.

We have also learned that it can be advantageous in recruiting and fieldwork to reduce the sampling fraction for the large projects. In particular, we have learned that reducing the set gamma moderately reduces the expected statistical precision very little but often yields more effective recruiting and field work. Therefore, it has become our standard practice to construct the sample designs with a set gamma of 0.5.

The sample designs used in the present studies reflect the values of tracking savings observed in the program-year population from which the measures were drawn, combined with the realization rates and error ratios found in the prior studies. This information was used to choose the new sample sizes and to estimate the statistical precision to be expected from the new studies.

Analysis

When sample data are used to estimate the characteristics of a particular population, the accuracy of the results depends on the weights applied to each case in the sample. The case weight is defined to be the ratio between the number of projects in each stratum of the population divided by the number of projects in the corresponding stratum in the sample. As long as the sample projects are randomly selected from each stratum, the sample realization rate is a virtually unbiased estimator of the population realization rate.[1]

Since the Process sample projects were drawn from earlier program years, the sample projects have been post-stratified to reflect the 2006 population. The revised case weights have been used to calculate the realization rates, to estimate the statistical precision of the results, and to calculate new estimates of the error ratios.

The Population and Samples

The results presented in the main sections of this report are based on the new definitions of peak periods used in both this years and last years reports for Custom Process. For Custom Lighting the results are presented for this new definition as well as a definition being proposed for the ISO New England Forward Capacity Market (FCM). The results for the old definition of peak for Custom Process and the FCM definition are provided in a separate section after the main results[2]. Table 1 summarizes the Program Year ("PY") 2006 tracking information used in the analysis. The table shows the gross first-year annual and on-peak energy savings in MWh, and the gross summer and winter demand savings in kW. The Process category had more projects, 142, and more savings, while Lighting had 34 projects and less savings.

---

[1] Technically the ratio estimator is biased but in practice the bias is negligible with a properly stratified sample design.

[2] From the sample data files, the following variables were assigned to the other and new peak definitions:

***Lighting**: labeled as 'Current', considered 'New Peak'; labeled as 'FCM', included in 'Other Peak' section*

***Process**: labeled as 'New', considered 'New Peak'; labeled as 'Old', included in 'Other Peak' section*

Table 1: Tracking Statistics

Category	Number of Projects	Gross Annual MWh	Gross On-peak MWh	Gross Summer kW	Gross Winter kW
HVAC	50	7,574	3,016	949	1,058
Lighting	34	3,846	2,215	632	561
Process	142	18,682	7,674	2,242	2,306
CDA	5	2,004	1,110	564	175
Total	231	32,105	14,014	4,387	4,100

Table 2 summarizes the number of sample projects used to develop the 2006 savings estimates. The Custom Lighting study sites were all installed in program year 2006 while the process sites were a combination of program year 2004 and 2005 install years. Detailed methodologies of sample selection for both categories are listed below.

Table 2: Sample Sizes

Category	New Study	Install Year	Sample Size
HVAC	No	PY03	10
Lighting	Yes	PY06	10
Process	Yes	PY05	15
Process	No	PY04	19
CDA	No	PY03	3
Total			64

Sample Designs

This section summarizes the sample designs used to select the Process and Lighting projects analyzed in this report. The Process sample design for PY2004 was documented in [4], while PY2005 for Process and the Lighting sample design are documented in this report. Those reports as well as [1] provide more details about the methodology used to develop the sample designs described in the present report.

Table 3 summarizes the PY2004 Process sample design. The PY2004 Process tracking data were stratified by gross annual MWh savings into five strata as shown in the table. For example, stratum one consisted of all projects with tracking annual savings of 79

MWh or less. There were 50 projects in stratum one in the PY2004 population, with a total tracking annual savings of 1,642 MWh. Four projects were randomly selected from these 50 projects.

Table 3: PY2004 Process Sample Design

Stratum	*Max Annual MWh*	*Projects in PY2004 Population*	*Total Annual MWh*	*Projects in Sample*
1	79	50	1,642	4
2	139	27	2,776	4
3	227	20	3,555	4
4	569	15	5,161	4
5	1,433	9	8,425	4

Table 4 summarizes the PY2005 Process sample design. The PY2005 Process tracking data were stratified by gross annual MWh savings into five strata as shown in the table. For example, stratum one consisted of all projects with tracking annual savings of 45 MWh or less. There were 44 projects in stratum one in the PY2005 population, with a total tracking annual savings of 1,045 MWh. Three projects were randomly selected from these 44 projects.

Table 4: PY2005 Process Sample Design

Stratum	*Max Annual MWh*	*Projects in PY2005 Population*	*Total Annual MWh*	*Projects in Sample*
1	45	44	1,045	3
2	80	27	1,760	3
3	155	20	2,208	3
4	272	14	3,257	3
5	2,732	7	7,399	3

Although the PY2004 sample design called for a sample of 20 projects, the final sample contained 19 projects. Three projects were replaced by alternates and one project dropped out of the evaluation. So taking the PY2004 and PY2005 samples together, 34 Process sample projects were available for analysis.

Table 5 shows the assumptions that we used in the PY05 Process sample design. During the sample design process, it was assumed that the PY05 sample would be combined with the PY04 samples[3]. The table shows the number of projects and total savings from the PY05 tracking data, which differs from the data displayed for Process in the preceding section on PY06. The table also shows the realization rates and error ratios found in the PY04 evaluation of Process which analyzed projects from PY02 and PY03. These are the key parameters needed to plan new studies.

Table 5: PY05 Process Sample Design Assumptions

PY2005 Sample Design	*PROCESS*
Number of Projects	112
Planned Sample	30
Expected MWh	10,670
Expected Relative Precision	17.0%
Expected Error Bound	1,810
Gross Annual MWh	15,669
Realization Rate	0.681
Error Ratio	0.660

Table 6 summarizes the PY2006 Lighting sample design. The PY2006 Lighting tracking data were stratified by gross annual MWh savings into five strata as shown in the table. For example, stratum one consisted of all projects with tracking annual savings of 77 MWh or less. There were 17 projects in stratum one in the PY2006 Lighting population, with a total tracking annual savings of 574 MWh. Two projects were randomly selected from these 17 projects.

Table 6: PY2006 Lighting Sample Design

Stratum	*Max Annual MWh*	*Projects in PY2006 Population*	*Total Annual MWh*	*Projects in Sample*
1	77	17	574	2
2	167	6	730	2
3	193	4	710	2
4	221	4	851	2
5	395	3	981	2

[3] During the planning stages it was assumed that there would be 15 sample sites in each of the two years, resulting in a total of 30 sample sites. The final sample for PY04 was 19 sites and for PY05 it was 15 sites.

Table 7 shows the assumptions that we used in the sample design. The table shows the number of projects and total savings from the PY06 tracking data, as discussed in the preceding section. The table also shows the realization rates and error ratios found in recent evaluations of Lighting.

Table 7: Lighting Sample Design Assumptions

PY2006 Sample Design	*LIGHTING*
Number of Projects	34
Planned Sample	10
Expected MWh	3,238
Expected Relative Precision	11.3%
Expected Error Bound	365
Gross Annual MWh	3,846
Realization Rate	0.842
Error Ratio	0.350

Case Weights

Although the 34 Process sample projects were selected from the PY2004 and PY2005 Process populations, we wished to extrapolate the results to the PY2006 Process population. Therefore new strata were constructed using a technique called balanced stratification.

Using balanced stratification, the 34 projects in the Process sample were sorted in increasing order according to the value of tracking annual savings of each project and then divided equally among the strata.[4] The stratum boundaries were calculated as the midpoints between the tracking annual savings in adjoining strata. Then the stratum boundaries were used to tabulate the number of projects in each stratum in the 2006 population, and, finally, the case weights were calculated as the number of projects in the population divided by the number of projects in the sample in each stratum.

Table 8 shows the case weights that were used to extrapolate the available sample sites to the 2006 population. For example, in stratum one, the stratum boundary was calculated

[4] Seven projects were assigned to the first four strata and six to the fifth stratum.

as the midpoint between the tracking annual savings of the seventh and eighth projects in the sorted list, giving 66 MWh. So stratum one consisted of all projects with tracking annual savings less than or equal to 66 MWh. The 2006 population contained 82 such projects and the sample contained 7 such projects so the case weight was 82 / 7 = 11.71.

Table 8: Process Case Weights

Category	*Stratum*	*Maximum Annual MWh*	*Projects in PY2006 Population*	*Total Annual MWh*	*Sample*	*Case Weight*
Process	1	66	82	2,515	7	11.7
Process	2	107	21	1,802	7	3.0
Process	3	228	17	2,702	7	2.4
Process	4	580	15	4,810	7	2.1
Process	5	1,433	7	6,852	6	1.2

In the case of Lighting, we used the stratum boundaries from original sample design shown in Table 6 since these projects were drawn from the PY2006 population and only one backup sample site was selected. The final case weights for Lighting are shown in the final column in Table 9.

Table 9: Lighting Case Weights

Category	*Stratum*	*Maximum Annual MWh*	*Projects in PY2006 Population*	*Total Annual MWh*	*Sample*	*Case Weight*
Lighting	1	77	17	574	2	8.5
Lighting	2	167	6	730	2	3.0
Lighting	3	193	4	710	2	2.0
Lighting	4	221	4	851	2	2.0
Lighting	5	395	3	981	2	1.5

Process Results

This section summarizes the primary results found from the analysis of the Process sample. Table 10 summarizes the results of the stratified ratio analysis of the Process sample. The table shows the results for each of the four measures of savings. In the case of Annual MWh savings, the realization rate for Process measures was found to be 108.5%. The relative precision was found to be ± 17.5% at the 80% level of confidence. The error ratio was found to be 0.69.

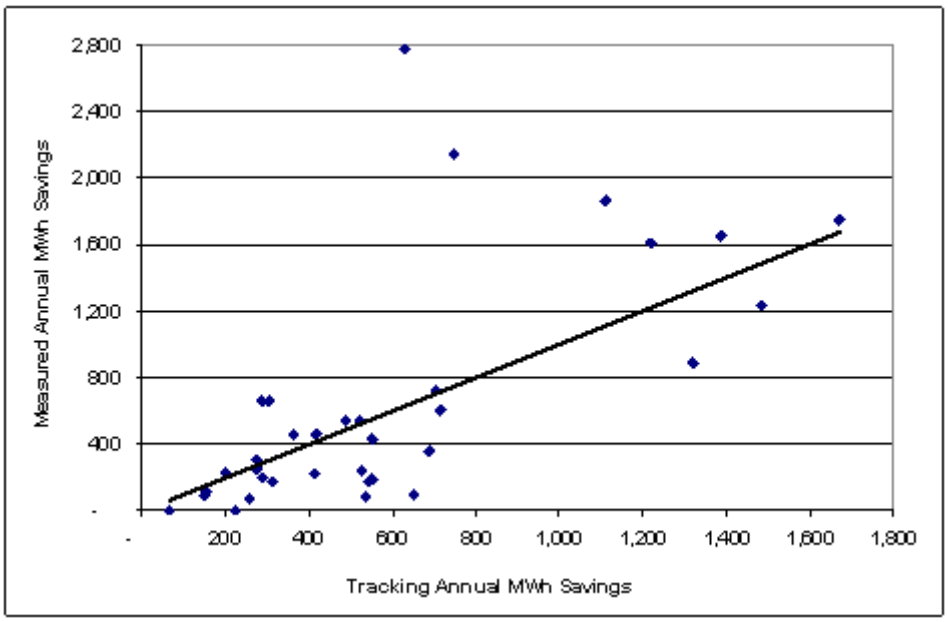
Table 10 also shows the results for the on-peak savings, measured in MWh. The on-peak MWh savings is the percent on-peak times the annual MWh savings. Our analysis gave a realization rate of 141% for the on-peak MWh savings, meaning that the measured on-peak savings was about 141% of the tracking on-peak savings. Considering all projects taken together and using the percent on-peak found in the tracking system, 41% of the savings were on peak. The evaluation results indicate that 53% of all savings were on peak. The ratio between these two results is the realization rate for the percent on-peak savings, 130%.

Table 10: Summary of Process Results

Statistic	*Annual MWh*	*On-Peak MWh*	*Summer kW*	*Winter kW*	*Percent On-Peak*
Total Tracking Savings	18,682	7,674	2,242	2,306	41.1%
Realization Rate	108.5%	140.9%	109.7%	100.7%	129.9%
Relative Precision at 80% Confidence	17.5%	18.0%	18.8%	19.9%	
Relative Precision at 90% Confidence	22.4%	23.1%	24.1%	25.6%	
Total Measured Savings	20,266	10,810	2,459	2,322	53.3%
Error bound for Measured Savings at 80%	3,545	1,946	461	463	
Error bound for Measured Savings at 90%	4,549	2,497	592	594	
Error ratio	0.69	0.72	0.83	0.84	

Figure 1 shows the sample data underlying the realization rate for the annual savings in the Process category. The figure has been obtained by multiplying both the tracking and measured savings of each sample project by the case weight associated with the project and then creating a scatter plot of the results. We have also plotted the line through the origin with slope equal to the realization rate estimated from the sample projects. If each of the sample projects had the same realization rate, then all of the points would lie along this line.

Figure 1: Custom Process Measured vs. Tracking Weighted Annual Savings



Lighting Results

This section summarizes the primary results found from the analysis of the Lighting sample. Table 11 summarizes the results of the stratified ratio analysis of the Lighting sample. The table shows the results for each of the four measures of savings. In the case of Annual MWh savings, the realization rate for Lighting measures was found to be 117.2%. The relative precision was found to be ± 12.2% at the 80% level of confidence. The error ratio was found to be 0.31.

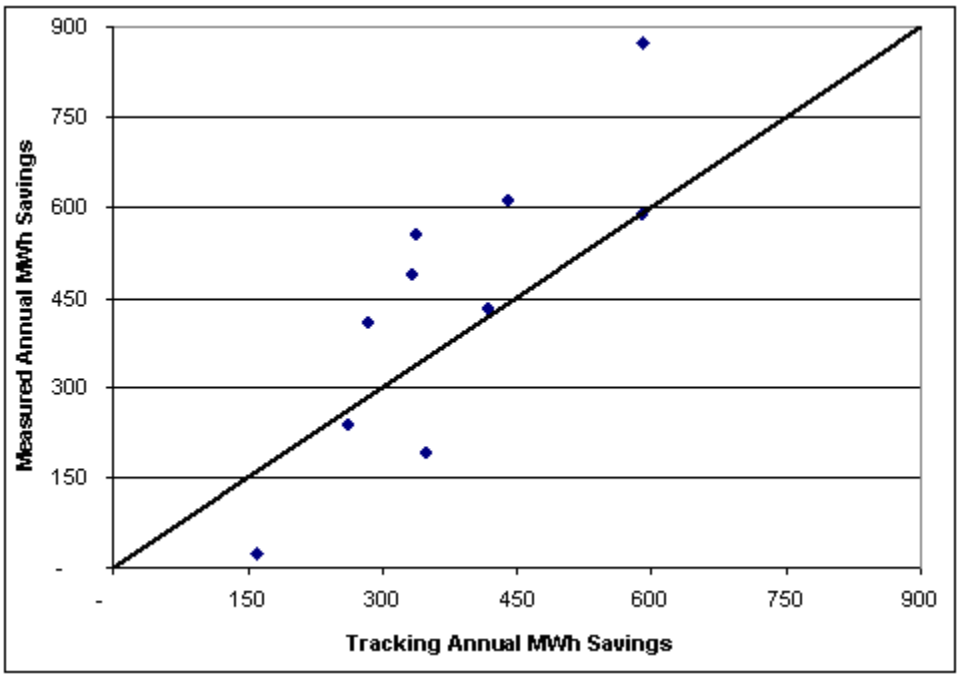
Table 11 also shows the results for the on-peak savings, measured in MWh. The on-peak MWh savings is the percent on-peak times the annual MWh savings. Our analysis gave a realization rate of 127% for the on-peak MWh savings, meaning that the measured on-peak savings was about 127% of the tracking on-peak savings. Considering all projects taken together and using the percent on-peak found in the tracking system, 58% of the savings were on peak. The evaluation results indicate that 62% of all savings were on peak. The ratio between these two results is the realization rate for the percent on-peak savings, 108%.

Table 11: Summary of Lighting Results

Statistic	Annual MWh	On-Peak MWh	Summer kW	Winter kW	Percent On-Peak
Total Tracking Savings	3,846	2,215	632	561	57.6%
Realization Rate	117.2%	126.8%	109.7%	113.6%	108.1%
Relative Precision at 80% Confidence	12.2%	15.3%	20.5%	33.7%	
Relative Precision at 90% Confidence	15.6%	19.6%	26.3%	43.2%	
Total Measured Savings	4,508	2,807	694	637	62.3%
Error bound for Measured Savings at 80%	548	428	142	215	
Error bound for Measured Savings at 90%	703	550	182	275	
Error ratio	0.31	0.41	0.58	0.83	

Figure 2 shows the sample data underlying the realization rate for the annual savings in the Lighting category. The figure has been obtained by multiplying both the tracking and measured savings of each sample project by the case weight associated with the project and then creating a scatter plot of the results. We have also plotted the line through the origin with slope equal to the realization rate estimated from the sample projects. If each of the sample projects had the same realization rate, then all of the points would lie along this line.

Figure 2: Custom Lighting Measured vs. Tracking Weighted Annual Savings



Combined Results

This section combines the new results for the Process and Lighting categories with the results from previous HVAC and CDA studies in order to obtain results for all Custom Program measure categories taken together.

Table 12 summarizes the estimated realization rates obtained from the statistical analysis. The first four rows of the table show the estimated realization rates for the four measure categories. The final row shows the overall realization rate for the four measure categories taken together. Considering Annual MWh savings as an example, we estimated the realization rate to be 117% for Lighting and 108% for Process. Combining the new results from these two categories with the previous results for HVAC and CDA, we estimated an overall realization rate of 107% for the annual savings of all 2006 projects in the four categories. This indicates that the annual savings would be found to be about 7% larger than the gross savings from the tracking system if all 2006 projects were to be evaluated.

Table 12: Realization Rates

Category	*Annual MWh*	*On-Peak MWh*	*Summer kW*	*Winter kW*	*Percent On-Peak*
HVAC	97.7%	83.1%	122.5%	104.0%	85.1%
Lighting	117.2%	126.8%	109.7%	113.6%	108.1%
Process	108.5%	140.9%	109.7%	100.7%	129.9%
CDA	108.2%	91.1%	106.9%	94.0%	84.2%
Total	107.0%	122.3%	112.11%	103.0%	114.3%

The first four columns of Table 12 show the realization rates for each type of savings: Annual MWh, On-peak MWh, Summer kW, and Winter kW. These results are the ratio between the case-weighted sum of the evaluated savings divided by the case-weighted sum of the tracking savings, summed across all projects in the sample. If the realization rate is greater than one, the total evaluated savings estimated in the population is greater than the total tracking savings for the corresponding category. This occurred, for example, with the annual energy savings for Process measures, where the realization rate was about 108%.

The last column of Table 12 shows the realization rates for the percent on-peak energy savings. This is the realization rate for the estimate of the percent on-peak energy savings found in the tracking system for each measure category. The same results for on-peak energy savings can be obtained in either of two ways:

1. Multiply the annual kWh savings found in the tracking system by the percent on-peak found in the tracking system, and multiply the results by the on-peak energy realization rate, or
2. Multiply the percent on-peak found in the tracking system by the percent on-peak realization rate to get an adjusted percent on-peak. Then multiply the annual savings found in the tracking system by the annual energy realization rate, and multiply this adjusted annual energy savings by the adjusted percent on-peak.

Table 13 and Table 14 report the relative precision obtained for each measure of impact for each category and over all measures taken together. The results are calculated at the 80% and 90% levels of confidence. The overall relative precision for annual savings was ±15.2% at the 80% level of confidence, and ±19.5% at the 90% level of confidence. The overall relative precision for the on-peak energy impacts and the summer and winter demand impacts was in the range ±13.4% to ± 23.7% at the 80% level of confidence and ±14.8% to ± 22.2% at the 90% level of confidence.

Table 13: Relative Precision at 80% Level of Confidence

Category	*Annual MWh*	*On-Peak MWh*	*Summer kW*	*Winter kW*
HVAC	51.4%	44.9%	42.0%	78.1%
Lighting	12.2%	15.3%	20.5%	33.7%
Process	17.5%	18.0%	18.8%	19.9%
CDA	10.5%	19.4%	3.6%	22.4%
Total	15.2%	13.4%	14.0%	23.7%

Table 14: Relative Precision at 90% Level of Confidence

Category	Annual MWh	On-Peak MWh	Summer kW	Winter kW
HVAC	65.9%	57.6%	32.7%	60.8%
Lighting	15.6%	19.6%	26.3%	43.2%
Process	22.4%	23.1%	24.1%	25.6%
CDA	13.5%	24.9%	2.8%	17.4%
Total	19.5%	17.1%	14.8%	22.2%

Usually, the relative precision is better for the total impact than for individual categories. This is because the error of estimation is independent from one category to another. Therefore when the results are pooled across categories, underestimates in some categories will tend to be offset by overestimates in other categories. However, in the instance of Annual savings in the present study, the overall relative precision is compromised by the relative precision in the HVAC category and is poorer than the relative precision of the Lighting and CDA category.

Table 15 shows the measured savings for the PY2006 projects. These results were obtained by multiplying the tracking savings by the realization rates. Table 16 and Table 17 show the error bounds associated with the measured savings at the 80% and 90% levels of confidence. For example, in the case of the Process category, the 80% confidence interval for the measured annual MWh savings was 20,266 ± 3,545 MWh.

Table 15: Measured Savings

Category	Annual MWh	On-Peak MWh	Summer kW	Winter kW	Percent On-Peak
HVAC	7,398	2,507	1,163	1,100	33.9%
Lighting	4,508	2,807	694	637	62.3%
Process	20,266	10,810	2,459	2,322	53.3%
CDA	2,168	1,011	603	165	46.6%
Total	34,341	17,135	4,919	4,224	49.9%

Table 16 and Table 17 show the error bounds associated with the total measured savings. These results are equal to the square root of the sum of the squared error bounds of all categories. For example, for the total Annual MWh savings of all categories, the error

bound is 5,226 MWh and the 80% confidence interval for the total Annual MWh savings is 34,341 ± 5,226 MWh. The overall relative precision shown in Table 13 can be obtained from these results. For example, the relative precision for the total Annual MWh savings is 5,226 / 34,341 = 15.2%.

Table 16: Error Bounds at 80% Level of Confidence

Category	*Annual MWh*	*On-Peak MWh*	*Summer kW*	*Winter kW*
HVAC	3,800	1,124	488	859
Lighting	548	428	142	215
Process	3,545	1,946	461	463
CDA	228	196	22	37
Total	5,226	2,288	687	999

Table 17: Error Bounds at 90% Level of Confidence

Category	*Annual MWh*	*On-Peak MWh*	*Summer kW*	*Winter kW*
HVAC	4,876	1,443	380	669
Lighting	703	550	182	275
Process	4,549	2,497	592	594
CDA	293	252	17	29
Total	6,705	2,936	727	937

The information developed in the present study can be used to help plan future studies of the Custom program. Some important insights can be drawn from Table 16. The measure categories with the largest error bounds, e.g., HVAC and Process in the case of Annual MWh savings, contribute the greatest uncertainty to the overall program impact. This suggests that added attention should be given to these categories.

To quantify the expected statistical precision of a new study and to choose new sample sizes, it is necessary to estimate the variability in the population. For stratified ratio estimation the appropriate measure of variability is a population parameter called the error ratio. In the context of impact evaluation, the error ratio is a measure of the variability between the evaluated savings and the tracking estimate of savings adjusted for the realization rate of the category. The error ratio is a statistical measure of the

variability in the entire population, but it is reflected in the sample scatter plot shown in Figure 1 for Process. If the error ratio is close to zero then the points are expected to lie close to the line. It the error ratio is larger, then the points are expected to be more widely scattered around the line.

The error ratio can be regarded as a measure of the quality of the tracking estimates for the population of individual projects. Error ratios less than 0.5 are desirable. An error ratio of 0.5 would indicate that for the majority of projects the evaluated savings are within ± 50% of the savings recorded in the tracking system after adjustment for the realization rate. When the error ratio is greater than one, it indicates that the measured savings are poorly related to the tracking estimates of savings. In such instances, it may be productive to seek improvements in the procedures for determining the tracking savings.

Although the true error ratios are always unknown, the error ratios can be estimated from the sample data. Error ratios were estimated for the Process category based on the PY04 and PY05 sample data, and for the Lighting category based on the PY06 sample data. The HVAC and CDA error ratios are from the PY05 report [4]. Table 18 shows the results.

Table 18: Estimated Error Ratios

Category	*Annual MWh*	*On-Peak MWh*	*Summer kW*	*Winter kW*
HVAC	1.12	0.99	0.82	1.14
Lighting	0.31	0.41	0.58	0.83
Process	0.69	0.72	0.83	0.84
CDA	0.16	0.30	0.12	0.13

The estimates of Process savings are not as accurate as estimates of savings for Custom Lighting and CDA projects. The sample in the HVAC category has a large outlier, causing the high error ratio for HVAC.

For Lighting, the error ratios are generally 0.5 or smaller for energy. This indicates that in the Lighting category, the tracking estimates of energy savings provide fairly accurate estimates of the evaluated energy savings for the majority of Custom projects after adjustment for the realization rates. The Lighting error ratios for demand savings are higher.

Process Comparison with Prior Studies

This section compares the new Process results with the results from the preceding study. Table 19 summarizes the results for the realization rates. The realization rates are a measure of the bias of the tracking estimates. For example, a realization rate less than 100% indicates that the tracking estimates tend to overstate savings across the projects in the category. Ideally, the realization rate should be close to 100%.

The realization rates found in the present Process study are substantially higher than those found in most of the prior studies of this category. These results continue to reverse the low values found in the PY2002-03 study.

Table 19: Custom Process New and Prior Realization Rates

Study	*Year*	*Sample*	*Annual*	*On-Peak*	*Summer*	*Winter*
New	PY2004-05	34	108.5%	140.9%	109.7%	100.7%
Prior	PY2003-04	39	85.4%	80.6%	85.8%	72.1%
Prior	PY2002-03	40	68.1%	60.2%	68.1%	62.4%
Prior	PY2001-02	41	85.0%	85.2%	86.0%	75.9%
Prior	PY2000-01	41	87.8%	85.3%	81.2%	75.0%

Table 20 compares the error ratios found in the current and prior Process studies. In the new study, the error ratios are in line with the PY2000-03 trend – ending what appeared to be an upward trend.

Table 20: Custom Process New and Prior Error Ratios

Study	*Year*	*Sample*	*Annual*	*On-Peak*	*Summer*	*Winter*
New	PR2004-05	34	0.69	0.72	0.83	0.84
Prior	PY2003-04	39	0.70	0.85	1.16	1.26
Prior	PY2002-03	40	0.66	0.72	0.83	1.15
Prior	PY2001-02	41	0.62	0.75	0.63	0.90
Prior	PY2000-01	41	0.54	0.74	0.71	1.27

Lighting Comparison with Prior Studies

This section compares the new Lighting results with the results from the preceding Lighting study. Table 21 summarizes the results for the realization rates. The realization rates are a measure of the bias of the tracking estimates. For example, a realization rate less than 100% indicates that the tracking estimates tend to overstate savings across the projects in the category. Ideally, the realization rate should be close to 100%.

The realization rates found in the present Lighting study are higher than those found in the two prior studies, and are more similar to the results found in the PY2000 study where a Custom Lighting realization rate over 100% was also found.

Table 21: Custom Lighting New and Prior Realization Rates

Study	*Year*	*Sample*	*Annual*	*On-Peak*	*Summer*	*Winter*
New	PY2006	10	117.2%	126.8%	109.7%	113.6%
Prior	PY2004	11	84.2%	77.3%	94.7%	62.7%
Prior	PY2002	10	86.6%	77.7%	107.6%	63.8%
Prior	PY2000	10	105.9%	101.6%	112.8%	109.0%

Table 22 compares the error ratios found in the current and prior Lighting studies. In the Lighting category, the error ratios are remarkably similar between the new and prior studies.

Table 22: Custom Lighting New and Prior Error Ratios

Study	*Year*	*Sample*	*Annual*	*On-Peak*	*Summer*	*Winter*
New	PY2006	10	0.31	0.41	0.58	0.83
Prior	PY2004	11	0.35	0.37	0.32	0.71
Prior	PY2002	10	0.26	0.39	0.21	0.55
Prior	PY2000	10	0.20	0.23	0.36	0.33

Other Peak Definitions

This section presents the results for the Process and Lighting peak summer and winter kW using 'Other Peak' definitions. From the sample data files, the following variables were assigned to the other and new peak definitions:

Lighting:

labeled as 'Current', considered 'New Peak';

labeled as 'FCM', included in 'Other Peak' section

Process:

labeled as 'New', considered 'New Peak';

labeled as 'Old', included in 'Other Peak' section

Table 23 through Table 26 present the realization rates, relative precision, measured savings, and the error bounds for the summer and winter kW estimates.

Table 23: Realization Rates

Category	*Other Summer kW*	*Other Winter kW*
Lighting	111.1%	112.2%
Process	122.3%	98.9%

Table 24: Relative Precision

Category	Other Summer kW	Other Winter kW	Other Summer kW	Other Winter kW
	80% Level of Confidence		90% Level of Confidence	
Lighting	19.9%	34.3%	25.6%	44.0%
Process	21.6%	20.3%	27.8%	26.0%

Table 25: Measured Savings

Category	Other Summer kW	Other Winter kW
Lighting	703	629
Process	2,742	2,279

Table 26: Error Bounds

Category	Other Summer kW	Other Winter kW	Other Summer kW	Other Winter kW
	80% Level of Confidence		90% Level of Confidence	
Lighting	140	216	180	277
Process	593	462	761	593

Planning Future Studies

Given the time required to execute these Custom evaluation studies, the Company was required to plan the next set of studies before the completion of the present report. The 2007 studies were planned in the Spring of 2007 using PY2006 tracking data and before the results for Lighting and Process measure categories were available. The Company has begun new studies of 11 HVAC projects and 15 Process projects and 2 CDA projects. The new, expanded HVAC sample (11 PY2006 sites and the completion of 15 PY2005 sites) may mitigate the poor statistical precision for the Custom HVAC measures in the previous report.

Conclusions and Recommendations

The following conclusions and recommendations are offered:

- Realization rates have been estimated for the Process category by combining a new sample of PY2005 projects with a prior sample of PY2004 projects. These results are believed to provide the best available estimates of the realization rates of this measure category.

- The new realization rates for the Process category have confirmed a reverse in the declining realization rates observed in the PY2002-03 study.
- When all 34 PY2004 and PY2005 sample projects are considered together, the current Process study appears to end what appeared to be an upward trend in the error ratio.
- The Company should continue to strive to improve the accuracy of the tracking estimates of savings, especially in the Process and HVAC categories.

Using the Results in the Savings Calculations

The realization rates developed in this study will be applied to calculate post-evaluation energy and demand savings for the 2006 program year.

References

[1] *The California Evaluation Framework,* prepared for Southern California Edison Company and the California Public Utility Commission, by the TecMarket Works Framework Team, June 2005, Chapters 12-13.

[2] *Model Assisted Survey Sampling,* C. E. Sarndal, B. Swensson, and J. Wretman, Springer, 1992.

[3] *Meta-Analysis of the Custom Evaluation Studies: 1994-1999,* Prepared for National Grid by RLW Analytics, February 12, 2001.

[4] *Sample Design and Impact Evaluation Analysis of the 2005 Custom Program,* Final Report, Prepared for National Grid by RLW Analytics, July 18, 2006.