Evaluation of the Southern California Gas Company 2004-05 Non-Residential Financial Incentives Program

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EXECUTIVE SUMMARY

NRFIP BACKGROUND

The Southern California Gas Company (SCG) Nonresidential Financial Incentives Program (NRFIP) is a local program focusing on small to medium nonresidential (commercial, agricultural, and industrial) gas customers served under core rate schedules. The program incorporates technical support, education, training, outreach, contractor referral, prescriptive rebates and equitable financial incentives through three program elements. The Commercial Food Service Equipment Rebate (Food Service) element provides a list of approved products eligible for rebates. The "Nonresidential Equipment Replacement " (NRER) provides incentives for "kind-for-kind" replacement of old, inefficient commercial or industrial end-use gas-fired technology with higher efficiency alternatives. The "Nonresidential Energy Conservation" (NREC) incentive element provides qualified customers with a financial incentive to implement energy efficient retrofits, industrial process modernizations, or industrial process energy efficiency improvements.

Examples of the measures in the Food Service channel include energy efficient ovens (convection, combination, conveyor, rotisserie, deck and rotating rack), broilers, griddles, fryers, cheese melters, salamanders, steam kettles, braising pans, cabinet steamers and more. The NRER channel includes industrial furnaces, kilns, ovens, dryers, industrial washers, incinerators, thermal oxidizers and others. Qualifying measure examples for the NREC channel include heat recovery applications, process equipment modernization, process steam improvements, high-efficiency burner replacement and other process improvements.

Figure ES-1 shows how participants in 2004-2005 are distributed across the three program elements. As shown below, the majority of the NRFIP participants (80 percent) participated in the Food Service element. Total therm savings, on the other hand, are distributed relatively equally between the three program segments, as can be seen in Figure ES-2. This indicates that projects in the NRER and NREC components tend to be much larger projects with higher savings than projects in the Food Service segment.

Figure ES-1: Share of NRFIP Participants By Segment

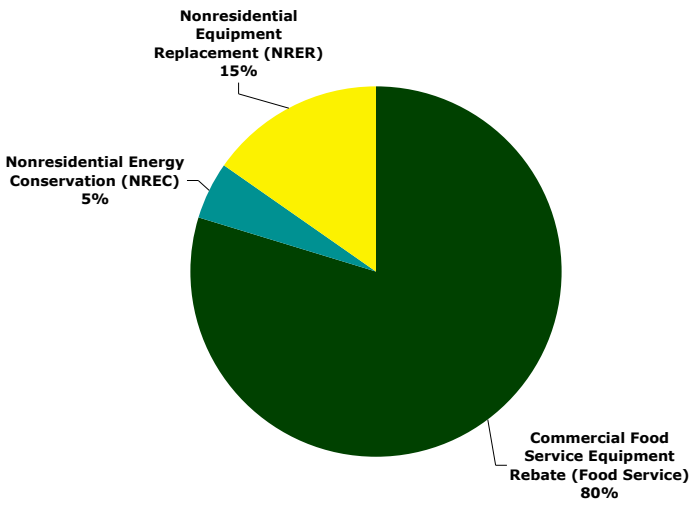
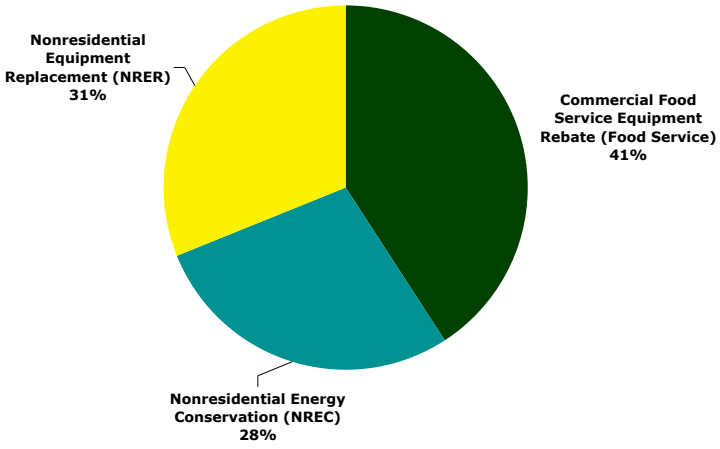


Figure ES-2: Share of NRFIP Therm Savings



EVALUATION OVERVIEW

The 2004-2005 NRFIP evaluation had three primary objectives:

1. **Measure and Verify Energy Savings.** The evaluation verified the *ex ante* gross therm savings claimed by the program by conducting a thorough review of participant records and the program-tracking database. Specific tasks include a billing analysis to determine *ex post* impacts, an engineering review of savings calculations and available background documentation, and a self-report free-ridership analysis. The results of these analysis tasks were used to produce *ex post* net realization rates and report net savings consistent with the CPUC's reporting requirements.

2. **Process Evaluation.** The second objective was to evaluate the program implementation process. This was done through interviews with utility program staff and the implementation contractor in addition to phone surveys of participating and nonparticipating customers. In addition, some of the survey questions are identical to those used in the Express Efficiency evaluation so that responses can be compared. Differences in responses between NRFIP and Express Efficiency participants may help support the underlying program theory for the NRFIP.

3. **Measure Customer Satisfaction and Program Influence.** Through the data collection process, the evaluation identified program strengths so that these can be emphasized in future program years. In addition, the evaluation also identified areas where the program delivery could be improved so that the program can be refined in future years to better meet the needs of the target population. The evaluation also focused on determining the degree to which the program is influencing customer decisions regarding which energy efficient measures they choose to install.

The evaluation was conducted in two stages. The first stage was primarily process oriented and was designed to provide feedback to the program while it is still being implemented. The results of the first evaluation phase were delivered as an interim report in February 2005. The major evaluation tasks for the first phase included completing half of the scheduled participant surveys (150 completes) and on-site audits (50 audits). Preliminary work on savings verification and self-reported free ridership are also included in the first evaluation phase.

The second phase includes an additional round of surveys (150 participants, 246 nonparticipants, 50 on-site audits). The results of the second wave of surveys are combined with the first wave and presented in this report. In addition to the surveys, a detailed engineering review of the savings calculation tools and selected project applications was completed during this phase. A billing analysis was also completed to determine the net realized impacts for the program. These tasks and sample sizes are consistent with those in the original EM&V plan approved by the CPUC for this evaluation.

IMPACT ANALYSIS

To determine net impacts for the NRFIP, a billing regression model was estimated to determine *ex post* net impacts for the 2004-05 NRFIP. For this task, two separate billing regressions were used:

1. **Food Service.** This model utilized monthly usage data from a sample of participants and nonparticipants from the phone surveys, which allowed additional survey information on changes at the facility during the post-installation period to be incorporated into the model.

2. **NRER / NREC.** A combined model for the NRER and NREC components was developed based on participations only and using billing data and measure information contained in the program tracking database. Because this model was estimated using participant data only, additional adjustments were made to the model results based on the self-report analysis to determine net impacts.

Details on the model specifications, data, and estimation results are included in this section. Following the model discussions, the results are applied to the 2004-05 NRFIP participation to determine the *ex post* realized net impacts for the entire program.

Food Service Billing Regression

Using data for both participants and nonparticipants, a Statistically Adjusted Engineering (SAE) billing model is estimated using ordinary least squares regression (OLS). The model includes variables that control for the primary influences on gas usage. These include basic firmographic variables such as pre-installation therm usage, business type, and categorical variables based on therm usage. Weather data expressed as changes in cooling degree days and heating degree days are also incorporated into the model. In addition, phone survey data from both participants and nonparticipants were used to create additional variables that capture any changes at the business that may have affected gas usage in the post-installation period.

The savings variables used in this model are the original gross *ex ante* impact estimates rather than net *ex ante* savings values. Since nonparticipants are included in the model, the coefficient estimate on the savings variable is accounting for free ridership as nonparticipant actions outside the program are used as the baseline. Therefore, the savings coefficient from this model can be used as an *ex post* realization rate that includes any free ridership effect. As discussed below, the coefficient estimate is then adjusted for spillover post- model to derive the *ex post* net realized impacts for this program component.

The basic form for the net billing model for the Food Service component is as follows:

$$Therm_{i,post} = \alpha + \beta' Savings_i + \beta'(SiteChng_i * Therm_{i,pre}) + \beta' Therm_{i,pre} + \beta'(UsageCat_i * Therm_{i,pre}) + \beta' NonRestaurant_i + \beta' Weather_i + \varepsilon_i$$

Where :

$Therm_{i,post}$ = *Gas usage during the program post – period for customer i*

$Savings$ = *Adjusted ex ante savings estimates*

$SiteChng_i * Therm_{i,pre}$ = *Survey responses regarding changes at site interacted with usage*

$Therm_{i,pre}$ = *Gas usage during the pre – program period*

$Therm_{i,pre}UsageCat$ = *Gas usage during the pre – program period interacted with usage category*

$NonRestaurant$ = *Variable indicating non - restaurant business*

$Weather$ = *Change in heating degree days and cooling degree days by climate zone*

ε_i = *Random error term assumed normally distributed*

α, β = *Coefficients to be estimated*

Separate therm usage variables were developed for the model based on annual pre-installation consumption from the billing data. These variables were constructed so that approximately 10 percent of the sample falls within each usage category. The usage category definitions are shown in Table ES-1.

Table ES-1: Usage Category Definitions

Usage Category	Therm Range	
	Min	Max
1	765	5,079
2	5,079	6,779
3	6,779	8,478
4	8,478	10,178
5	10,178	11,877
6	11,877	17,733
7	17,733	23,589
8	23,589	29,444
9	29,444	35,300
10	35,300	232,402

To estimate the billing model, several data screens were used to create a dataset with complete billing data and to rule out potential outlier observations that might have undue influence over the model. Specifically, the data screens were designed to remove those observations that had incomplete billing data or did not have sufficient post-installation billing data to estimate annual impacts. In addition, those observations that had disproportionately large estimated savings relative to overall usage were dropped from the analysis, as the large savings (greater than 50 percent of pre-period usage) are likely reflecting errors in the usage data rather than actual impacts given the types of measures promoted by this program.

Table ES-2 shows the estimation results from the final net billing model specification for the Food Service installations. The model fits the data well overall as evidenced by the high R-squared value and the statistically significant F statistic. A high R-squared is common when lag variables are used in regression models, and the high t-value for the pre-usage therm variables also indicates that the lag usage is the predominant driver for this model.

The pre-installation therm variable interacted with the therm usage categories generally decreases in magnitude with the large usage categories. However, only a few of these interaction terms are statistically significant indicating that most of the pre-installation usage effect may be captured in the single pre-installation usage variable PRE-USAGE.

The variable indicating a non-restaurant business was not statistically significant, which indicates that there is not a significant difference in usage between restaurants and non-restaurants in the billing model. Finally, changes in both heating degree days and cooling degree days did not have a significant effect on post-installation usage, indicating that gas usage was generally invariant to weather for these businesses.

The survey variables indicating changes at the business that may affect overall gas usage were all statistically significant. Each of these variables was interacted with pre-installation gas usage so that the coefficient reflects the effect of the change in terms of percentage of pre-installation usage. Changes in production had an average impact of about a 3.9 percent reduction of gas usage in the post-installation period. Similarly, changes in square footage increased usage by 1.5 percent while changes in the number of employees reduced usage by about 2.2 percent.

The highlighted variable in Table ES-2 is the coefficient on the *ex ante* savings estimates. Several different specifications were attempted that broke out savings by measure type (Ovens, Broiler, Fryers, Other). For the broiler category, the coefficient estimate was consistently positive due to the fact that of the 22 broilers in the sample, 16 had increases in therm usage from the pre-installation to the post-installation period. Since it was not possible to get a reasonable realization rate for this particular measure, broilers were dropped from the sample and the other measures were grouped together to get a single coefficient estimate on savings. The coefficient estimate on the combined savings variable would then be applied to all Food Service measures (including broilers) to calculate net realized impacts.

As shown in the table, the savings coefficient has an estimate of -0.50 and is statistically significant from zero at less than 1 percent level. It is also significantly different from 1.0 at the less than 1 percent level of significance. This indicates that 50 percent of the *ex ante* gross savings is being realized by Food Service participants. However, a 90 percent confidence interval around the savings coefficient results in an error band of +/- 56 percent, which indicates a moderate to high level of uncertainty for the *ex post* net realization rate.

The lower realization rate is likely due to several factors. As discussed previously in the engineering review and in *Appendix A* with the review of the savings calculator spreadsheets, there may be a tendency to overstate savings in the *ex ante* savings calculations, particularly when an increase in production is being claimed. To the extent that the savings do not materialize, the model will adjust the coefficient estimate downward to reflect the difference in savings from initial expectations.

Another factor influencing the savings coefficient is the presence of nonparticipants in the sample. Since some nonparticipants are making changes outside the program, the coefficient incorporates the effect of free ridership. In the model, realized net impacts are 50 percent less than the original *ex ante* gross impacts. If this entire reduction were due to free ridership, this would imply a free ridership rate of 50 percent, which is higher than the self-report free ridership analysis discussed earlier (30-39 percent). As discussed above, however, some of the 50 percent reduction is correcting for errors in the savings calculations so the free ridership rate implied by the billing model will be less than 50 percent.

Table ES-2: Net Billing Regression Model Results (Food Service)

Model Statistics	Value
Observations	244
Variables	17
F Statistic	2,194.1
F Statistic Level of Significance	< 1%
Adjusted R-Squared	0.9935

Parameter Estimates	Coefficient	Standard Error	T Value	Level of Significance
Intercept	-1,922.21	699.07	-2.75	1%
Savings-All Measures	-0.50	0.17	-2.91	0%
Survey Response-Gas Increase	-0.02	0.01	-2.24	3%
Survey Response-Square Footage Increase	0.01	0.02	0.79	43%
Survey Response-Employee Increase	0.07	0.02	2.89	0%
Pre Usage	1.09	0.01	131.18	< 1%
Pre Usage*Pre Usage Category 1	0.45	0.19	2.33	2%
Pre Usage*Pre Usage Category 2	0.25	0.13	1.89	6%
Pre Usage*Pre Usage Category 3	0.20	0.11	1.87	6%
Pre Usage*Pre Usage Category 4	0.11	0.10	1.07	29%
Pre Usage*Pre Usage Category 5	0.14	0.08	1.74	8%
Pre Usage*Pre Usage Category 6	0.04	0.05	0.68	50%
Pre Usage*Pre Usage Category 7	0.04	0.04	1.04	30%
Pre Usage*Pre Usage Category 8	-0.02	0.03	-0.64	52%
Pre Usage*Pre Usage Category 9	-0.03	0.03	-0.76	45%
Business Type (Non-Restaurant)	276.16	480.32	0.57	57%
Weather-Change in cooling degree days (post-pre)	-1.69	2.20	-0.77	44%
Weather-Change in heating degree days (post-pre)	-0.71	0.81	-0.87	38%

NRER / NREC Billing Model

A separate billing model was run for the NRER and NREC components of the program that utilizes the same basic structure as the Food Service regression model. However, with the Food Service model it was relatively easy to match a sample of nonparticipants as the measures were generally restricted to food service industries. With the NRER and NREC, there is a much wider range of industries, equipment types, and industrial processes involved and we were not able to identify an appropriate group of nonparticipants to use as a baseline. As a result, the NRER / NREC model was estimated using a sample of participants only.

Since only participants are used in the billing model, the coefficient estimates on savings reflect *ex post* gross realization rates. Any deviation from 1.0 for the savings coefficient will reflect differences in conditions at the site in the post-installation period relative to the conditions

initially assumed for the *ex ante* savings calculations. Since the nonparticipants are not included in the model, the results of this billing model will need to be adjusted post-model to determine the realized net impacts. As discussed below, we combined the results of the NREC / NRER billing model with the self-reported free ridership results and a spillover adjustment factor to determine the final *ex post* net realization rate for the NREC and NRER program components.

The billing model specification is similar to that used for Food Service, with the exception that no information from the phone survey was incorporated in the model. The sample was also screened using similar criteria discussed with the Food Service model. The billing model specification used for NRER and NREC is as follows:

$$Therm_{i,post} = \alpha + \beta'(UsageCat_i * Therm_{i,pre}) + \beta' Expand_i + \beta' Savings_i + \beta' Weather_i + \beta' Application_i + \varepsilon_i$$

$$Where:$$

$$Therm_{i,post} = Gas\ usage\ during\ the\ program\ post-period\ for\ customer\ i$$

$$Expand_i = Therms\ required\ to\ meet\ expanded\ production\ with\ existing\ equipment$$

$$Savings = Ex\ ante\ savings\ estimates$$

$$Therm_{i,pre} = Gas\ usage\ during\ the\ pre-program\ period$$

$$UsageCat_i * Therm_{i,pre} = Gas\ usage\ during\ the\ pre-program\ period\ interacted\ with\ usage\ category$$

$$Weather = Change\ in\ heating\ degree\ days\ and\ cooling\ degree\ days\ by\ climate\ zone$$

$$Application = Indicator\ variables\ for\ reasons\ for\ equipment\ purchase\ from\ NRFIP\ application$$

$$\varepsilon_i = Random\ error\ term\ assumed\ normally\ distributed$$

$$\alpha, \beta = Coefficients\ to\ be\ estimated$$

In this model, three usage variables ($UsageCat_i$) are created that reflect small customers (less than 20,000 therm usage annually), medium customers (20,000 to 80,000 therms annually) and large customers (more than 80,000 therms annually). In addition, the NRER and NREC participants each fill out an application sheet where they are asked to indicate the reasons for the equipment installation. Possible reasons are increased production and labor, failed or impending failure of equipment, and to reduce operating costs and gas costs. Since these reasons may influence the type of equipment chosen, they have been incorporated into the billing model through a series of indicator variables based on the application data.

Each project application also indicates whether or not the equipment installation was part of an expansion in production. The information on production expansion as well as information on existing equipment was used to calculate how much therm usage would have increased had the expanded production been met with the existing equipment. By including this information in the model, the resulting coefficient on savings should reflect the realized savings over what would have been achieved relative to the existing equipment.

The results of the NRER / NREC billing model are shown in Table ES-3. The relatively high R-squared value and the statistically significant F statistic indicate that the model generally fits the data well and has significant explanatory power.

The pre-installation therm variable interacted with the therm usage categories was statistically significant and positive for medium and large customers, indicating that there is a benefit to breaking out the effect of pre-installation usage by customer size in the model. Changes in cooling degrees had a positive and significant effect while changes in heating degree days were statistically insignificant.

The variables developed from the project applications regarding the reasons for the equipment installation (the last 6 coefficients shown in Table 50) had the expected signs but were generally not statistically significant at the 10 percent level. However, the variable indicating that the existing equipment failed is negative and significant at the 11 percent level and the increase in labor was positive and significant at the 15 percent level.

The variable for expanded production had a coefficient estimate of 0.41, which indicates that on average only 41 percent of the estimated increase in usage due to expanded production (assuming existing equipment) is being realized in the post-installation period. This variable is significant at the 17 percent level, however, which is slightly less than the 10 percent significance criteria commonly used for these models.

The highlighted variable in Tables ES-3 is the coefficient on the *ex ante* savings estimates. As shown in the table, the savings coefficient has an estimate of -0.75 and is significantly different from zero at the 1 percent level of significance. This indicates that 75 percent of the *ex ante* gross savings is being realized by NRER and NREC participants. The coefficient estimate is not significantly different from 1.0, however. Using the standard error of 0.26 for the savings coefficient yields a 90 percent confidence interval of +/- 57 percent.

As discussed in this report, there appears to be a tendency to overestimate *ex ante* savings for NRER and NREC projects, especially in those cases when a production expansion is assumed. The realization rate from the billing model provides additional support for this finding, as only 75 percent of the *ex ante* savings are being achieved. Given the issues with the savings variables and the confidence interval for the realization rate, there is a high level of uncertainty with the *ex post* gross impact estimates for the NRER and NREC components.

Table ES-3: NRER / NREC Billing Model Regression Results

Model Statistics	Value
Observations	124
Variables	14
F Statistic	69.977
F Statistic Level of Significance	< 1%
Adjusted R-Squared	0.879

Parameter Estimates	Coefficient	Standard Error	T Statistic	Level of Significance
Intercept	46828.00	14699.14	3.19	< 1%
Small Customer *Pre-Usage (< 20,000 annual therms)	-0.76	0.73	-1.05	30%
Medium Customer *Pre-Usage (20-80,000 annual therms)	0.56	0.20	2.76	1%
Large Customer*Pre-Usage (> 80,000 annual therms)	0.81	0.04	18.87	< 1%
Expanded Production	0.41	0.29	1.40	17%
Savings	-0.75	0.26	-2.82	1%
Change in cooling degree days (post-pre)	171.74	49.73	3.45	< 1%
Change in heating degree days (post-pre)	9.86	19.92	0.50	62%
Increased Gas Costs	-14183.00	10949.35	-1.30	20%
Impending Equipment Failure	-3039.00	7882.10	-0.39	70%
Operating Cost Reduction	-11848.00	15678.56	-0.76	45%
Equipment Failed	-29281.00	18245.48	-1.61	11%
Increased Labor	20249.00	13896.25	1.46	15%
Increased Production	7831.99	7318.06	1.07	29%

Ex Post Net Impacts

Table ES-4 below summarizes the impact adjustments recommended by program component that take into account the results of the billing analysis, spillover, and self-reported free ridership. The final *ex post* net realization rate is the product of all the adjustment factors shown in the table. In those cases where no adjustment is needed (such as with the on-site verifications), an adjustment factor of 1 is used.

For the Food Service component, the *ex post* net realization rate consists of the coefficient estimate from the billing regression, which accounts for free ridership and a general realization rate based on actual post-installation usage. In addition, a 10 percent spillover adjustment is made to create a final adjustment factor of 0.55, which is used as the *ex post* net realization rate for the Food Service component.

For the NRER and NREC components, the billing regression only uses participant data so the resulting savings coefficient needs to be adjusted for both free ridership and spillover. From the self-report analysis we derived a net-to-gross ratio of 0.80 that accounts for both free ridership and spillover. When this is combined with the savings coefficient, the final *ex post* net realization rate is 0.60 for both the NRER and NREC components.

For reasons discussed above, there is a high degree of uncertainty with these *ex post* net realization rates for each of the NRFIP components. Some uncertainty is introduced through the billing models that utilize samples with diverse projects and business types and savings estimates that are potentially overstated. In addition, the self-report free ridership is based on a method that by necessity assigns weights somewhat arbitrarily. The free ridership result was consistent with the result using a different self-report method as well as the results of the billing analysis (for

Food Service) which helps reduce the uncertainty. Finally, the spillover assumption of 10 percent was based on our experience with other energy program evaluation but was not supported with any primary research in its application to this evaluation.

Table ES-4: *Ex Post* Net Realization Rates for Therm Impacts

Program Component	Spillover (1 + Spillover)	Self-Report Net-to-Gross Ratio	Verification	Billing Analysis Realization Rate	*Ex Post* Net Realization Rate
Food Service	1.1	--	1	0.50	0.55
NRER	--	0.8	1	0.75	0.60
NREC	--	0.8	1	0.75	0.60

Using the *ex post* net realization rates, the *ex post* net savings numbers are shown below in Table ES-5 by program component. Note that Table ES-4 shows the adjustment between the *ex ante* gross and *ex post* net savings. Table ES-5 shows a comparison between the *ex ante* and *ex post* net savings numbers.

The reductions in net savings shown in Table ES-5 are due in part to free ridership, as evidenced by both the billing regression model results and the self-report free ridership analysis. In addition, our engineering review indicates that the initial savings estimates may be overestimated. There is little or no background documentation on how the savings values are calculated, however, so the evaluation was unable to review the underlying calculation assumptions beyond the review of a small sample of applications and the calculation spreadsheets for selected measures.

Note that the Food Service component realized a larger reduction going from *ex ante* net impacts to *ex post* net impacts than the other components. This is due to the fact that SCG applies an 80 percent net-to-gross ratio to the NRER and NREC components, and a 100 percent net-to-gross ratio is applied to calculate the net therm impacts for the Food Service component. The SCG net therm savings for the NRER and NREC components have therefore already been reduced by 20 percent from the gross savings value while the Food Service component has not realized any reduction from gross savings to SCG net savings.

Table ES-5: Comparison of *Ex Ante* and *Ex Post* Net Therm Impacts

Program Component	Number of Participants	*Ex Ante* Gross Therm Savings	SCG *Ex Ante* Net Therm Savings	Evaluation *Ex Post* Net Therm Savings	Difference Between Evaluation and SCG Net Savings (%)
Food Service	1,135	2,203,054	2,203,054	1,343,863	-39%
NREC	69	1,570,078	1,256,063	942,047	-25%
NRER	219	1,697,750	1,358,200	1,018,650	-25%
Total	1,423	5,470,883	4,817,317	3,304,560	-31%

CONCLUSIONS AND RECOMMENDATIONS

Based on the evaluation results presented in this report, we draw the following conclusions for the 2004-5 NRFIP evaluation.

- **Participation satisfaction with the NRFIP is very high.** In the survey, 88 percent of participants said they were very satisfied with the program and none of the participants said they were dissatisfied with their overall program experience. In addition, most participants also expressed high levels of satisfaction with the equipment installed through the program (79 percent responded with "Very Satisfied".)

- **All measures included in the on-site audit sample were verified.** Through the 100 on-site audits we were able to verify virtually every measure that was included in the tracking system for these customers.

- **Participant satisfaction, program influence, and awareness levels similar to Express Efficiency.** Participants from both programs had very high satisfaction levels, were strongly influenced by the program to purchase energy efficient equipment in the future, and relatively low awareness levels of other energy efficiency programs. These similarities are not surprising given that these programs are implemented in the same manner.

- **The program is effectively addressing the hard-to-reach aspects of its target customers.** Current participation shows high levels of customers that speak languages other than English, and this rate is higher than what was observed for SCG customers in the 2003 Express Efficiency evaluation. Similarly, the NRFIP has been successful in recruiting renters, which traditionally has been a difficult group to reach with energy efficiency programs. The NRFIP has also been successful in reaching customers in more remote geographic locations. Participant survey results also indicate that these customers are generally unaware of other energy efficiency programs.

- **SCG program sponsorship is important.** From the participant survey, 73 percent of respondents said that having SCG sponsor the program was very important and that just over half (57 percent) first became aware of the NRFIP through a SCG representative. In addition, 93 percent of the participants indicated that their program participation caused them to be more likely to install other energy efficient measures in the future.

- **Free ridership is high.** Our self-report analysis suggests that free ridership may be in the neighborhood of 30 percent for this program, a result that is consistent with net billing analysis completed for the Food Service component. While this finding is similar with the rate observed for some other non-residential programs (such as Standard Performance Contracting) it is much higher than the rate that has been assumed historically for this program.

Based on the evaluation results presented in this report, we offer the following recommendations for improving the NRFIP.

- **Background documentation on all savings calculations is urgently needed.** There was not adequate background documentation to support any of the savings calculations for any of the measures included in the NRFIP. Developing work papers to document the savings assumptions should be made a high priority for this program. (Conversations with utility staff regarding the 2006-08 NRFIP indicate that significant progress has already been made on this issue.)

- **Projects with large therm savings should receive more engineering scrutiny.** Large projects should not rely only on field staff calculations or recommendations by vendors to determine savings. Engineers should be reviewing and adjusted savings calculations as needed for these projects. (See *Section 4* and *Appendix A* for engineering-related recommendations for specific measures.)

- **Include bill information on project application for use in calculating savings.** For a sample of projects reviewed in the engineering review, it appears that the savings estimates may be overstated. Including a customer bill showing monthly therm usage for the prior year to verify actual therm usage should help produce more accurate savings estimates during the application process.

- **Assumptions regarding production increases in the savings calculations should be limited to special circumstances.** Part of the overestimation of savings may be due to assuming increases in production that ultimately do not materialize. As discussed in this report, an increase in capacity does not necessarily result in an increase in production. If production increases are allowed in the savings calculations, they should be limited to special circumstances that are well documented.

- **For engine rebuilds, the 15-year measure life assumption should be re-evaluated.** Two of the three customers we visited during on-sites that had engine rebuilds stated that they rebuild their engines within 5 years or less. Even with modest use, it is unlikely that this measure will last 15 years as currently assumed.

1. INTRODUCTION

NRFIP BACKGROUND

The Southern California Gas Company (SCG) Nonresidential Financial Incentives Program (NRFIP) is a local program focusing on small to medium nonresidential (commercial, agricultural, and industrial) gas customers served under core rate schedules. The program incorporates technical support, education, training, outreach, contractor referral, prescriptive rebates and equitable financial incentives through three program elements. The Commercial Food Service Equipment Rebate (Food Service) element provides a list of approved products eligible for rebates. The "Nonresidential Equipment Replacement " (NRER) provides incentives for "kind-for-kind" replacement of old, inefficient commercial or industrial end-use gas-fired technology with higher efficiency alternatives. The "Nonresidential Energy Conservation" (NREC) incentive element provides qualified customers with a financial incentive to implement energy efficient retrofits, industrial process modernizations, or industrial process energy efficiency improvements.

Examples of the measures in the Food Service channel include energy efficient ovens (convection, combination, conveyor, rotisserie, deck and rotating rack), broilers, griddles, fryers, cheese melters, salamanders, steam kettles, braising pans, cabinet steamers and more. The NRER channel includes industrial furnaces, kilns, ovens, dryers, industrial washers, incinerators, thermal oxidizers and others. Qualifying measure examples for the NREC channel include heat recovery applications, process equipment modernization, process steam improvements, high-efficiency burner replacement and other process improvements.

Figure 1 shows how participants in 2004-2005 are distributed across the three program elements. As shown below, the majority of the NRFIP participants (80 percent) participated in the Food Service element. Total therm savings, on the other hand, are distributed relatively equally between the three program segments, as can be seen in Figure 2. This indicates that projects in the NRER and NREC components tend to be much larger projects with higher savings than projects in the Food Service segment.

Figure 1: Share of NRFIP Participants By Segment

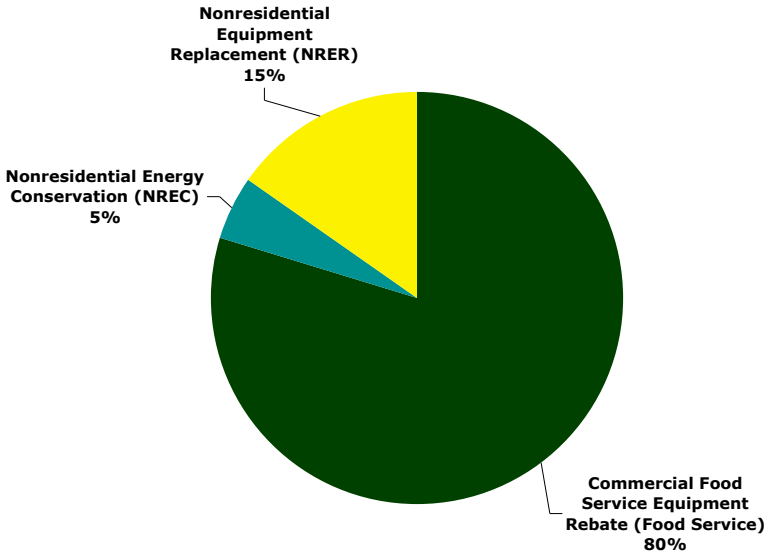


Figure 2: Share of NRFIP Therm Savings

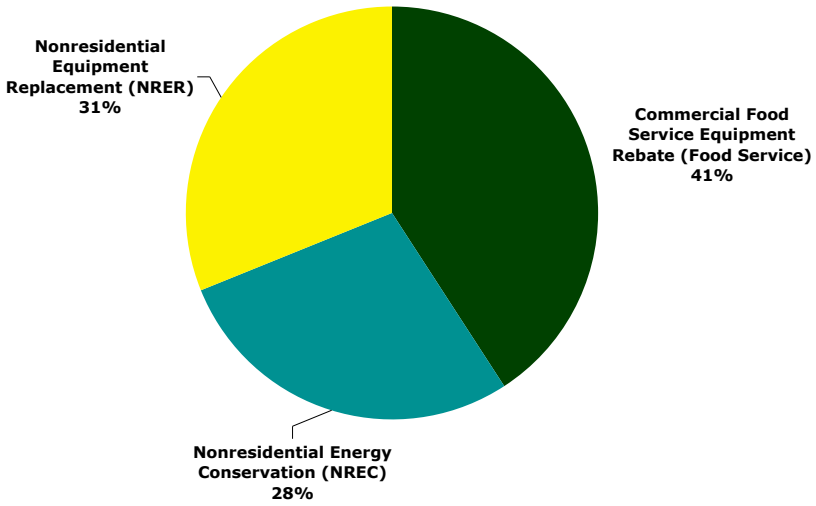
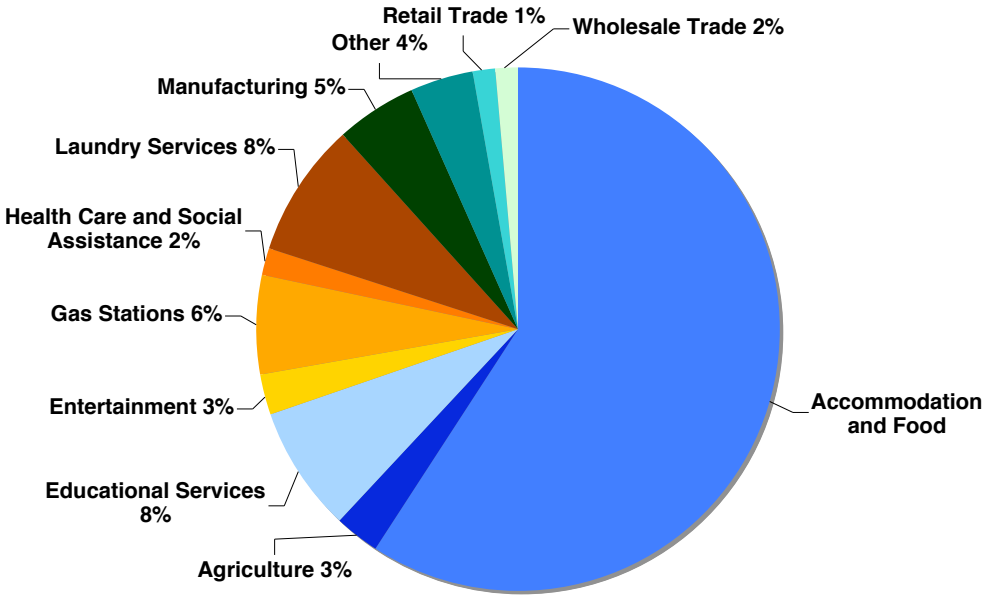


Figure 3 shows the distribution participants across industry sectors. Not surprisingly, the Food Service Sector has the most participants as the Food Service element also has the highest participation. Laundry Services and Education each account for 8 percent of the total participants, with the rest being dispersed through a variety of other industries.

Figure 3: NRFIP Participation by Industry



EVALUATION OVERVIEW

The 2004-2005 NRFIP evaluation had three primary objectives:

4. **Measure and Verify Energy Savings.** The evaluation verified the *ex ante* gross therm savings claimed by the program by conducting a thorough review of participant records and the program-tracking database. Specific tasks include a billing analysis to determine *ex post* impacts, an engineering review of savings calculations and available background documentation, and a self-report free-ridership analysis. The results of these analysis tasks were used to produce *ex post* net realization rates and report net savings consistent with the CPUC's reporting requirements.

5. **Process Evaluation.** The second objective was to evaluate the program implementation process. This was done through interviews with utility program staff and the implementation contractor in addition to phone surveys of participating and nonparticipating customers. In addition, some of the survey questions are identical to

those used in the Express Efficiency evaluation so that responses can be compared. Differences in responses between NRFIP and Express Efficiency participants may help support the underlying program theory for the NRFIP.

6. **Measure Customer Satisfaction and Program Influence.** Through the data collection process, the evaluation identified program strengths so that these can be emphasized in future program years. In addition, the evaluation also identified areas where the program delivery could be improved so that the program can be refined in future years to better meet the needs of the target population. The evaluation also focused on determining the degree to which the program is influencing customer decisions regarding which energy efficient measures they choose to install.

The evaluation was conducted in two stages. The first stage was primarily process oriented and was designed to provide feedback to the program while it is still being implemented. The results of the first evaluation phase were delivered as an interim report in February 2005. The major evaluation tasks for the first phase included completing half of the scheduled participant surveys (150 completes) and on-site audits (50 audits). Preliminary work on savings verification and self-reported free ridership are also included in the first evaluation phase.

The second phase includes an additional round of surveys (150 participants, 246 nonparticipants, 50 on-site audits). The results of the second wave of surveys are combined with the first wave and presented in this report. In addition to the surveys, a detailed engineering review of the savings calculation tools and selected project applications was completed during this phase. A billing analysis was also completed to determine the net realized impacts for the program. These tasks and sample sizes are consistent with those in the original EM&V plan approved by the CPUC for this evaluation.

The remainder of this report is organized as follows. The *Phone Survey* section contains the results of both the participant and nonparticipant phone surveys. Following these results, the *Savings Verification* section presents the initial work done to verify savings and includes the results of the on-site verification audits. This is followed by an *Engineering Review* chapter that details the review of the savings calculations. The free ridership analysis using the results of the participant phone survey is presented next in the *Self-Report Free Ridership* section. Following this, the results of the billing analysis are combined with other evaluation findings to derive the net impacts for the program, and these results are presented in the *Net Impacts* section. The final *Conclusions* section provides some general conclusions and recommendations derived from all phases of this evaluation. Detail on the evaluation review of the savings calculator spreadsheets used by the program to estimate savings is included as *Appendix A*. Copies of the participant and nonparticipant phone survey instruments are included in *Appendix B*.

2. PHONE SURVEYS

SURVEY METHODOLOGY

To develop the participant survey instrument, NRFIP background documents were reviewed and program staff were interviewed to obtain information on program theory and important implementation issues that should be addressed by the evaluation. During this process, the following key elements underlying the program theory were identified:

- Many small and medium businesses rent their buildings, which may prove to be a challenge for participation as the renters may not be making the decisions relating to energy use and equipment installations, or may not remain at the same site long enough to see any benefit of energy efficiency investments.
- Cost for installing energy efficiency technologies can be prohibitive for these customers and therefore a financial incentive is important for participation.
- Relatively remote locations for some of the target customers is a potential market barrier that needs to be addressed by this program.
- Non-English speakers comprise a significant part of the target population and language issues may pose a significant barrier to participation.
- Customers are sometimes suspicious of the types of assistance offered by the NRFIP and therefore utility sponsorship is important for gaining customer trust.
- For these reasons, many of the targeted customers are unaware of other energy efficiency program offerings, and many of these customers fall into the 'hard-to-reach' category.

From these program theory elements, the evaluation analysis was structured to collect information on the following key issues:

- The importance of utility sponsorship of the NRFIP
- The role of the rebate in the equipment purchase decision
- Customer plans to install measures in absence of the program
- The share of customers that speak languages other than English
- The number of participants located in more remote areas of SCG's service territory
- Awareness of other energy efficiency programs

In addition to the program theory issues, a participant survey was used to collect process-related information, such as satisfaction with their new equipment and the program participation processes. The survey was also used to conduct a phone verification of the measures installed and to recruit participants for the on-site audits.

Quantum Consulting fielded the first wave of the participant survey in January 2005 and the second wave in December 2005. A total of 301 surveys were completed across both waves and the surveys lasted about 16 minutes.

Table 1 shows the final sample for the participant survey, which was randomly drawn from the participant population. The final participant survey sample had very good representation from each program element, ranging from 19 percent of the Food Service participant population to 31 percent for NREC. For the Food Service and combined NRER / NREC program components, the sample is large enough to achieve a relative precision level greater than "90/10", meaning that we can be at least 90 percent confident that the sample values are within 10 percent of the population values even under conservative assumptions regarding the population.

Table 1: Participant Survey Sample

Program Component	Population	Survey Sample	Percent of Population
Food Service	1,135	218	19%
NRER	219	67	31%
NREC	69	16	23%
Total	1,423	301	21%

In addition to the participant survey, a nonparticipant survey was also fielded as part of this evaluation. The nonparticipant survey was fielded by Quantum Consulting in September 2005 and lasted about 13 minutes. The purpose of this survey was to collect information on awareness, attitudes, and perceptions of energy efficiency among the population targeted by the program. For the nonparticipant survey, the sample consisted of commercial gas customers and was randomly drawn from the population of customers with the same NAICS codes as the participants. Additional surveys were done in the Food Service industry in order to use the survey results in the billing analysis for this program element. A total of 246 nonparticipant surveys were completed.

With all survey questions, there is the potential for false response bias if the questions are not answered accurately. We have attempted to minimize this by using survey questions that have been tested in other evaluations as well as by pre-testing both the participant and nonparticipant surveys. Nevertheless, the potential for bias exists for those questions where respondents may not accurately recall their program participation experience. An additional source of bias occurs when respondents intentionally give false information in order to provide responses that appear more socially desirable (such as claiming that they will install energy efficiency equipment in the future).

Other than using survey questions that have been tested in other evaluations, we did not attempt to correct for any of these potential biases in the survey results. For some questions relating to free-ridership, we have asked a series of related questions that are designed to identify those respondents providing consistent responses, which should help reduce any response bias.

The remainder of this section presents selected results from both the participant and nonparticipant surveys.

PARTICIPANT SURVEY RESULTS

The following tables show results from both waves of the participant survey. Additional survey results on free-ridership, installation verification, and the importance of utility sponsorship are provided in the *Savings Verification* and the *Self-Report Free Ridership* sections of this report. Key survey findings are compared with participant survey results from the 2003 Express Efficiency program, where identical survey questions were used. Differences in responses between NRFIP and Express Efficiency participants relating to the program theory elements provides support to the current program design and helps justify offering a program distinct from Express Efficiency that targets these customers.

Firmographic Information

The following tables provide firmographic information for the 2004 NRFIP participants. Table 2 shows the building size for the participants included in the survey sample. Overall, about one-third of businesses occupy a fairly small businesses space of 2,500 square feet or less with another third in the 2,500 and 10,000 square foot range. The Food Service and NRER elements typically had smaller participants (less than 5,000 square feet) while the NREC component had customers of all sizes including very large customers (more than 100,000 square feet). The NRER element also had several agriculture customers with outdoor applications.

Table 2: Building Size

F5. Can you estimate the total square footage of your facility at this address?	Total (%)	Food Service (%)	NREC (%)	NRER (%)
Less than 2,500 square feet	31	30	6	40
2,500 but less than 5,000 square feet	22	24	6	16
5,000 but less than 10,000 square feet	12	14	13	6
10,000 but less than 20,000 square feet	6	6	13	3
20,000 but less than 50,000 square feet	5	4	19	7
50,000 but less than 100,000 square feet	4	4	0	3
Ag/nonfacility - outdoors	4	0	6	13
Over 100,000 square feet	7	6	31	4
Don't know	10	11	6	6
Sample Size	301	218	16	67

Note: Survey responses weighted to the participant population.

Table 3 shows the number of employees for each business interviewed. Not surprisingly, the employee numbers tend to mirror the facility square footage, with the Food Service and NRER participants tending to have fewer employees (fewer than 50) while most of the participants in the NREC element have more than 50 employees.

Table 3: Number of Employees

F6. How many employees does your firm have at this address?	Total (%)	Food Service (%)	NREC (%)	NRER (%)
1 to 5	25	17	0	55
6 to 10	13	14	0	13
11 to 20	12	12	6	13
21 to 50	24	31	19	4
51 to 100	11	10	44	7
Over 100	13	13	31	6
Don't know	2	3	0	0
Sample Size	301	218	16	67

Note: Survey responses weighted to the participant population.

Table 4 shows the business type for the participants in our survey sample, with most of the participation coming from restaurants. The NREC channel tends to have more industrial customers (50 percent of NREC participants) while the NRER channel has more participants from the agricultural sector (18 percent of the NRER participants) and from laundries (31 percent of NRER participants).

Table 4: Business Type

F15. What is the main activity at your business?	Total (%)	Food Service (%)	NREC (%)	NRER (%)
Restaurant	53	73	0	1
Other	11	5	19	30
Laundry	7	0	0	31
Hotel or motel	5	4	6	6
Industrial Process/Manufacturing/Assembly	5	0	50	7
Agriculture	5	0	13	18
School	4	5	6	1
Food/Food service	3	3	0	3
Health care/hospital	2	3	0	0
Community Service/Church/ Temple/Municipality	1	2	0	0
Retail (non-food)	1	1	0	0
College/university	1	1	0	0
Grocery store	1	1	0	0
Warehouse	1	0	6	1
Personal Service	1	1	0	0
Don't know	0	0	0	0
Sample Size	301	218	16	67

Note: Survey responses weighted to the participant population.

Table 5 shows how often a language other than English is spoken at participating businesses. Other languages are spoken in 74 percent of the program's businesses, with Spanish the most common language among these businesses. This helps confirm the program theory that many of the target customers speak languages other than English. The non-English speaking rate is also

higher than what is observed for Express Efficiency, where 44 percent of the SCG participants spoke languages other than English.[1] The higher participation levels for non-English speaking customers suggest that the NRFIP is doing a better job than Express Efficiency in addressing this barrier and helps to validate the current program delivery method.

Table 5: Language

L5, 10. Is a language other than English spoken at your business? Other than English, what language is spoken to conduct business at your facility?	Total (%)	Food Service (%)	NREC (%)	NRER (%)
Spanish	86	83	100	93
Chinese	4	6	0	0
Korean	2	1	0	4
Vietnamese	1	0	0	4
Japanese	0	1	0	0
No other languages	24	27	13	19
Don't know if there are other languages	1	1	6	0
Sample Size	301	218	16	67

Note: Survey responses weighted to the participant population.

Table 6 shows building ownership status for program participants. There is a pretty even split between businesses that rent (54 percent) and those that own (45 percent) their facility. The NREC channel has a higher ownership rate (69 percent). This is a significantly higher level of renters than what was observed in the 2003 Express Efficiency program where SCG participants were comprised of 34 percent renters. This suggests that the current program is more effective in addressing market barriers relating to renters.

Table 6: Building Ownership

R5. Does your business own or lease the facility?	Total (%)	Food Service (%)	NREC (%)	NRER (%)
Lease/Rent	54	56	31	52
Own	45	42	69	48
Don't know	1	1	0	0
Sample Size	301	218	16	67

Note: Survey responses weighted to the participant population.

Table 7 shows the role that participants play in making gas equipment or energy efficient product purchase decisions. Businesses in all channels showed strong involvement in the purchase of these types of equipment. Overall, 68 percent were "Very active" and another 24 percent were "Somewhat active" in these decisions. Even in the Food Service sector, which has 56 percent of

[1] 2003 Statewide Express Efficiency Program Measurement and Evaluation Study, Appendix 2. All other comparisons to the SCG Express Efficiency evaluation results come from this same study.

participants renting, the role in energy decisions is high with 92 percent of participants at least somewhat active and 65 percent very active in energy-related decisions. Not surprisingly, the level of involvement is greater in the NREC and NRER elements, where ownership rates are also much higher.

Table 7: Role in Energy Decisions

R1. How active a role does your business take in decisions to purchase gas equipment or energy-efficient products for this facility?	Total (%)	Food Service (%)	NREC (%)	NRER (%)
Very active	68	65	75	78
Somewhat active	24	27	19	18
Slightly active	6	8	0	3
Not at all active	1	1	0	0
Don't know	1	0	6	1
Sample Size	301	218	16	67

Note: Survey responses weighted to the participant population.

Participation Process

Table 8 shows the source of awareness among NRFIP participants. Participants typically became aware through an SCG Service Technician or an Account Rep (57 percent overall). For the NREC channel this was higher (94 percent) and with NRER it was significantly lower (28 percent). The NRER respondents more often became aware of the program through vendors and manufacturers (43 percent). Overall, these results are only slightly higher than those found for SCG Express Efficiency in 2003, where 46 percent of participants first became aware of the program through an SCG Service Technician or Account Rep.

Table 8: Source of Awareness

A25. How did you first become aware of the program?	Total (%)	Food Service (%)	NREC (%)	NRER (%)
SCG Service Technician/Account Rep	57	63	94	28
Vendor/Manufacturer/Distributor	16	9	0	43
Other	5	6	6	4
Letter/Mailing	5	5	0	4
Other businesses / word of mouth	5	5	0	6
Past Participant	4	5	0	1
Bill insert	3	3	0	4
Don't know	2	2	0	3
Newspaper/Television	1	0	0	4
Corporate office	1	1	0	0
Internet	0	0	0	0
Sample Size	301	218	16	67

Note: Survey responses weighted to the participant population.

Table 9 provides information on awareness levels of other energy efficiency programs. For each program element, at least half of the participants were unaware of other available efficiency

programs with an additional 7 percent responding that they did not know. This finding is consistent with the large portion of 'hard-to-reach' customers that have historically participated in the program, as these customers tend to have low awareness of efficiency program offerings. However, this finding is not significantly different than awareness levels observed for participants in the 2003 SCG Express Efficiency program, where 82 percent either were either unaware or responded "don't know" to the same question.

Table 9: Awareness of Other Efficiency Programs

A30. Besides the program you participated in, are you aware of other programs or resources provided by the Gas Company that are designed to promote energy efficiency for businesses like yours?	Total (%)	Food Service (%)	NREC (%)	NRER (%)
Not aware of any other programs	65	68	50	57
Express Efficiency	1	2	0	0
Business Energy Audits	1	1	0	3
Commercial Food Service Equip. Rebate	3	4	6	1
Non-residential equipment replacement	4	4	6	4
Non-residential energy conservation	1	1	6	0
Rebate (unspecified)	9	6	25	19
Seminars through energy resource center	7	7	13	4
Other	5	5	6	1
Refused	0	0	0	0
Don't know	7	6	6	12
Sample Size	301	218	16	67

Note: Survey responses weighted to the participant population.

Table 10 shows the reasons for participating in the program. The rebate was mentioned by about two-thirds of respondents overall. Saving money on gas bills was mentioned by 50 and 48 percent of the NREC and NRER participants, respectively, but by just 25 percent of the Food Service channel participants. Other responses included "replacing old or broken equipment" (18 percent overall) and to "improve their process efficiency" (16 percent overall).

Table 10: Reasons for Participation

A45. Why did your company participate in the program?	Total (%)	Food Service (%)	NREC (%)	NRER (%)
To receive a rebate	66	67	56	64
Saving money on gas bills	30	25	50	48
Replacing old or broken equipment	18	15	31	31
Improving process efficiency	16	13	38	25
Acquiring the latest technology	9	9	13	9
Other	4	4	13	6
The program was sponsored by SCG	4	5	0	3
Energy crisis	4	3	19	4
Recommended by utility account rep	1	1	0	4
Helping protect the environment	1	2	0	0
Increase capacity	1	1	14	0
Save energy	1	1	0	3
Don't know	1	0	0	3
Previous experience with SCG program	1	1	0	0
Recommended by contractor	0	0	0	1
Sample Size	301	218	16	67

Note: Survey responses weighted to the participant population.

Satisfaction

The following tables show satisfaction with the various aspects of the NRFIP. Table 11 shows participant satisfaction with individual elements of the program. Satisfaction was very high for the program overall as evidenced by 88 percent of respondents indicating they were "Very satisfied" and another 11 percent being "Somewhat satisfied" with their program experience. Participation process, rebate processing time, equipment installation process, and the satisfaction with the contractor received similar satisfaction levels, with the vast majority of respondents reporting being very satisfied with these elements. Satisfaction levels with bill savings were lower with one-quarter of participants "somewhat satisfied" with the bill savings and a small number (5 percent) were "not at all satisfied". These satisfaction responses are very similar to the responses from the 2003 SCG Express Efficiency evaluation, where participants were asked most of the same battery of satisfaction questions.[2]

For those participants that expressed some dissatisfaction with a program process, almost all participants attributed it to a delay in getting their rebate. With respect to bill savings, the respondents who were not satisfied indicated that their overall bill payments had increased due to higher gas prices. Given the high satisfaction levels for the program experience overall, it seems that businesses who were not completely satisfied with some aspect of the program still have a positive impression of their program experience.

[2] The question addressing satisfaction with the equipment installation process (SAT34) was not asked of participants in the 2003 Express Efficiency program.

Table 11: Program Satisfaction

Question	Very satisfied (%)	Somewhat satisfied (%)	Not at all satisfied (%)	Don't know (%)	Sample Size
SAT1. How satisfied were you with your overall program experience?	88	11	1	0	301
SAT30. How satisfied were you with your bill savings?	47	27	5	21	301
SAT31. How satisfied were you with the participation process?	75	24	1	1	301
SAT32. How satisfied were you with the rebate processing time?	69	22	5	5	301
SAT33. How satisfied were you with the installation contractor?	74	22	2	3	190
SAT34. How satisfied were you with the equipment installation process?	79	17	1	2	301

Note: Survey responses weighted to the participant population.

Table 12 provides additional information on satisfaction with the equipment installed. Across all channels, satisfaction levels were extremely high, with 86 percent overall very satisfied with the measure they implemented. (SCG Express Efficiency participants also had 85 percent of participants saying they were "Very satisfied" with their installed measure.)

Table 12: Satisfaction with Equipment

A20_SAT. How satisfied have you been with the performance of the measure?	Total (%)	Food Service (%)	NREC (%)	NRER (%)
Very satisfied	86	84	93	91
Somewhat satisfied	11	12	7	9
Not at all satisfied	1	1	0	0
Don't know	2	2	0	0
Sample Size	329	251	14	64

Note: Survey responses weighted to the participant population.

It appears that the NRFIP is having a very positive effect on intentions to install energy saving measures in the future. As shown in Table 13, 93 percent of respondents said that they were now more likely to install energy efficiency measures in the future due to their experience participating in the program. This suggests that there may be positive participant spillover impacts resulting from the program. This finding is consistent with that found for the 2003 SCG Express Efficiency evaluation, where 92 percent of participants said they were more likely to install energy efficiency measures in the future as a result of their participation in the Express Efficiency program.

The responses shown in Table 13 are subject to false response bias and the results presented here should be interpreted with caution. Questions relating to future purchase intentions may be

biased in favor of the program as some respondents may be providing answers that they believe are more socially desirable rather than reporting their true future intentions. As a result, the results shown here may overestimate the positive influence the NRFIP is having on these customers.

Table 13: Influence of NRFIP on Future Measure Installations

PE11. Are you more or less likely to install energy-efficient products as a result of your experience with the program?	Total (%)	Food Service (%)	NREC (%)	NRER (%)
More likely	93	93	94	93
Less likely	1	1	6	0
Neither more or less	4	3	0	6
Don't know	2	3	0	1
Sample Size	301	218	16	67

Note: Survey responses weighted to the participant population.

Table 14 shows the results of multiple survey questions designed to obtain information on market barriers. Respondents were given a statement relating to a potential barrier to purchasing energy efficient equipment and respondents were asked to rate how much they agreed or disagreed using a 10-point scale. The 10-point scale was converted into several response categories ranging from "Agree Completely" to "Disagree".

The most consistent agreement was the concern that actual savings would be less than what was estimated. Almost two-thirds of the respondents agreed either "completely" or "somewhat" with this concern. The other frequent obstacle was that a lack of financing is a barrier to making energy efficient investments, agreed to by 57 percent of businesses. Half of the participants we interviewed also agreed that they did not have enough information to make an informed decision about energy efficiency investments. This further supports the program assumption that the customers have not been effectively reached by other energy efficiency program offerings.

Most participants (61 percent) did not agree that finding a qualified contractor was a significant issue. Participants also did not think that the utility rebate was a hassle, with 79 percent of respondents disagreeing with this statement.

Table 14: Perceptions of Market Barriers

Question	Agree completely (%)	Agree somewhat (%)	Disagree (%)	Don't know (%)	Mean (1-10)	Sample Size
PE35a. When considering a new energy efficiency investment, I am concerned that the actual bill savings will be less than what was estimated.	28	34	35	3	5.1	301
PE35b. I don't have the information I need to make an informed decision about energy efficient investments.	22	28	50	1	4.3	301
PE35c. There is too much time and hassle involved in selecting a qualified energy efficiency contractor.	15	20	61	4	3.5	301
PE35d. Lack of financing is a barrier to our organization making energy efficiency investments that we want to make.	27	30	42	1	4.7	301
PE35e. Getting a utility rebate is too much hassle.	8	13	79	0	2.4	301
PE35f. It's not worth investing because it's not my building.	10	11	78	1	2.5	301

Note: Respondents provided rating on 1 to 10 scale. The categories represented here were created after the survey. Ratings of 8-10 were coded as "Agree Completely," ratings of 4-7 as "Agree Somewhat," and ratings of 1-3 as "Disagree." Responses weighted to the participant population.

NONPARTICIPANT SURVEY RESULTS

In addition to the participant survey, a nonparticipant survey was fielded to collect information from 246 SCG gas customers who did not participate in the NRFIP program. The purpose of this survey was to understand attitudes and perceptions that nonparticipants have towards energy efficient technologies and to determine their awareness of energy efficiency program opportunities. The nonparticipant survey sample was increased to include additional respondents from the restaurant and food service industries. These additional nonparticipant survey respondents for these industries were included in the billing analysis sample used for the Food Service billing analysis discussed later in this report.

Key findings from the nonparticipant survey are presented below.

Table 15 shows how many nonparticipants have replaced gas appliances in the last two years. Of the appliances specified, installations of water heaters were the most common with 20 percent of respondents stating that they have installed a gas water heater in the last two years. Boilers and cooking equipment – two equipment types targeting by the NRFIP – had a relatively small amount of replacement activity among the nonparticipants we surveyed.

Table 15: Installation of Gas Appliances

E65. In the last two years, did you install any gas appliances at your facitlity?	Yes (%)	No (%)	Sample Size
Water Heater	20%	80%	246
Stove or Cooking Equipment	16%	84%	246
Boiler	7%	93%	246
Other	4%	96%	246
Furnace	1%	99%	246
Gas Booster For Dishwasher	0%	100%	246
Heat Recovery Equipment For Boiler or Other	0%	100%	246

Respondents that made an equipment purchase were also asked if the new equipment was high efficiency, and these responses are shown in Table 16. For the equipment mentioned by respondents as being replaced, water heaters and boilers were most likely to be high efficiency with 55 percent and 47 percent of the installed units high efficiency, respectively. Furnaces were the least likely to be high efficiency, with only 3 percent of the units categorized as high efficiency. In terms of quantity, stove or cooking equipment appliances had the most units installed (78) with 33 percent of those categorized as high efficiency.

These results suggest that there are at least some high efficiency equipment purchases being made outside the program, possibly through participation in other programs such as Express Efficiency. Respondents were not provided with a strict definition of high efficiency during the survey, so perceptions of what constitutes high efficiency may be different than what is actually being covered in the NRFIP.

Table 16: Efficiency of Installed Gas Appliances

E75. Was the Gas Appliance you installed standard or high efficiency?	High Efficiency (%)	Standard Efficiency (%)	Don't Know (%)	Number of Units
Water Heater	55%	34%	11%	71
Boiler	47%	50%	3%	32
Stove or Cooking Equipment	33%	51%	15%	78
Other	31%	46%	23%	26
Furnace	3%	90%	7%	30

Table 17 shows nonparticipant awareness of both the NRFIP and the Statewide Express Efficiency program. The survey results show that a significant number of nonparticipants are aware of both programs, with a slightly higher awareness rate for the NRFIP.

Table 17: Awareness of NRFIP and Express Efficiency Programs

A1/A5. Are you aware of SCG's NRFIP / Express Efficiency program?	NRFIP	Express Efficiency
Yes	44%	41%
No	55%	59%
Don't Know	1%	0%
Sample Size	246	246

Those respondents that were aware of the Statewide Express Efficiency program were asked if they had ever participated. As shown in Table 18, 14 percent of the nonparticipants that were aware of the Express Efficiency program had participated and received a rebate within the last two years. The 14 percent translates to about 6 percent of the total nonparticipant sample (those aware and unaware of the Express Efficiency program). This suggests that the Express Efficiency program is not recruiting large numbers of participants from this particular population and that the NRFIP may be able to meet this need. An additional 8 percent indicated that they had some sort of interaction with Express Efficiency, either by participating in another location or participating but not receiving a rebate.

Table 18: Participation of SCG's Express Efficiency Program

A15. In the last two years did your firm participate in the SCG's Express Efficiency program?	Total (%)
No, did not participate in Express Efficiency program	71%
Yes, participated in Express Efficiency	14%
Don't Know	5%
Yes, participated in Express Efficiency, but at other location	3%
No, did not recieve rebate but did participate in program	3%
Yes, participated but I don't recall that as the name	2%
Other	2%
Sample Size	100

Table 19 shows that the majority of nonparticipant respondents believe they were knowledgeable about energy efficiency products. Among the nonparticipants surveyed, 29 percent indicated that they were extremely knowledgeable and an additional 42 percent were somewhat knowledgeable about their energy efficient equipment options.

Table 19: Knowledge of Energy Efficiency Products

PE15. Using a scale of 1 to 10, rate how likely you will be to actively consider energy-efficient equipment when installing or replacing gas equipment	Total
Very likely (8-10)	78%
Somewhat likely (4-7)	16%
Not very likely (1-3)	4%
Don't know	1%
Mean	8.5
Sample Size	246

Table 20 shows the results of a question that asked nonparticipants to rate how likely they would be to consider energy efficiency when replacing gas equipment. The majority of the respondents gave themselves a rating of 8-10, indicating that they are very likely to consider energy efficiency when replacing gas appliances.

Table 20: Consideration of Energy Efficient Equipment

PE30. Using a scale of 1 to 10, rate how knowledgeable you feel you are about what energy efficiency products are available and how they will perform	**Total**
Extremely knowledgeable (8-10)	29%
Somewhat knowledgeable (4-7)	42%
Not very knowledgeable (1-3)	28%
Mean	5.3
Sample Size	246

Table 21 shows the responses to a series of questions designed to address the potential market and program barriers faced by commercial gas customers. Of all of the barrier statements presented, confidence in the actual bill savings was the most important, with 71 percent of respondents either completely or somewhat agreeing that this is a concern. Most respondents (69 percent) also either completely or somewhat agreed with the statement that they did not have enough information to make informed decisions regarding energy efficient investments. Nonparticipants also had concerns regarding contractors, with 54 percent either completely or somewhat agreeing that there was too much time and hassle involved with finding a qualified contractor to do the installation.

In contrast, significant numbers of nonparticipants disagreed with statements relating to the perceived hassle factor with utility rebates and investment decisions regarding the building.

When asked about utility rebates, 56 percent of nonparticipants disagreed with the statement that there was too much hassle involved. Similarly, the length of time that respondents believe they will occupy the building and issues of building ownership are no perceived as major barriers, with 65 percent and 70 percent disagreeing with these statements, respectively.

It is also worth noting that both participants and nonparticipants generally place the same order of importance of barriers to adoption of energy efficiency technologies, although the nonparticipants tended to agree a little more than participants with the barrier statements. With both groups, confidence in the actual bill savings, lack of information and lack of financing had the highest average response.

Table 21: Market Barriers

Market Barrier Questions	Agree Completely (%)	Agee Somewhat (%)	Disagree (%)	Don't Know / Refused (%)	Mean	Sample size
PE35A. When considering a new energy efficiency investment, I am concerned that the actual bill savings will be less than what was estimated	35	36	26	2	5.7	246
PE35B. I don't have the information I need to make an informed decision about energy efficient investments	35	34	30	0	5.6	246
PE35C. There is too much time and hassle involved in selecting a qualified energy efficiency contractor	25	29	42	4	4.4	246
PE35D. Lack of financing is a barrier to our organization making energy efficiency investments that we want to make	35	30	34	2	5.4	246
PE35E. Getting a utility rebate is too much hassle	22	19	56	4	3.8	246
PE35F. I need the owner's consent to make improvements	39	11	48	2	5.1	246
PE35G. I'm not at this location for long	19	15	65	1	3.3	246
PE35H. It's not worth investing because it's not my building	15	14	70	0	3.0	246

Note: Respondents provided rating on 1 to 10 scale, categories created after the survey. Ratings of 8-10 coded as "Agree Completely", 4-7 coded as "Agree Somewhat", and 1-3 as "Disagree".

3. SAVINGS VERIFICATION

This chapter presents the results of the telephone and on-site verification analysis. In addition, the level of free ridership associated with the program is presented, based on telephone survey data.

TELEPHONE SURVEY MEASURE INSTALLATION VERIFICATION

A survey was conducted to verify that the participants installed the measures specified in the program tracking database. The survey asked a sample of 305 participants if they recalled participating in SCG's Nonresidential Financial Incentive program. Nearly every participant recalled participating in the program, as shown below in Table 22.

Table 22: Participation in the NRFIP

A5. Earlier this year did your business participate in a Gas Company energy efficiency program at this location?	Food Service	NREC	NRER	N
Yes, participated in program as described	217	15	66	298
Yes, participated in program, but at other location	1	0	0	1
Yes, participated in program, but don't recall that as the name	0	1	1	2
No, did not participate in program	2	0	0	2
Refused	0	0	0	0
Don't know	1	0	0	2
Total	221	16	67	305

Participants were also asked if they had installed the equipment rebated under the program. Some of the participants that rebated measures under the Food Service Rebate program component, installed more than one type of equipment. These customers were asked about each type of equipment. Of the 358 measures (unique participant-measure types) asked about in the survey, only 16 measures were not verified by the respondents, as seen in Table 23. Another 11 respondents were unsure if their measures had been installed.

Table 23: Measure Installation (Survey Respondents)

A20. Was the Given Measure Installed Through The Gas Company's Program?	Food Service	NREC	NRER	Total
Yes	252	15	64	331
No	12	1	3	16
Don't know	11	0	0	11
Total	275	16	67	358

Table 24 below provides the quantity of equipment that was installed that corresponds to the customers' responses provided in Table 23 above. Participants were able to identify more than 93 percent of the measures.

Table 24: Measure Installation (Number of Measures)

A20. Was the Given Measure Installed Through The Gas Company's Program?	Food Service	NREC	NRER	Total
Yes	334	23	431	788
No	18	1	26	45
Don't know	13	0	0	13
Total	365	24	457	846

It is important to note that of the 16 customers that did not verify the rebated equipment over the phone, five were visited on-site, and the rebated equipment was found to be in place and operable.

ON-SITE MEASURE INSTALLATION VERIFICATION

On-site audits were also completed for a sample of 100 sites, covering 23 different categories of equipment installed across the 3 program elements. Every piece of rebated equipment was found to be in place and operating at all 100 sites. Table 25 shows the distribution of measures that were verified among the 100 sites, by measure and program element.

As part of the on-site visit, the auditor also validated the manufacture and model numbers, when it was feasible to locate this information on the piece of equipment.

Table 25: Summary of Equipment Verified During On-Site Visits

Measure	Program Element	Number of Sites Verified
Cabinet Steamer	Food Service	1
Convection Oven	Food Service	14
Conveyor Oven	Food Service	2
Deck Oven	Food Service	4
Fryer - High Effic. Unit	Food Service	6
Griddle	Food Service	19
Over-fired [char] broiler	Food Service	2
Rotating Rack Oven	Food Service	4
Rotisserie Oven	Food Service	1
Salamander	Food Service	6
Steam Kettle	Food Service	3
Under-fired broiler	Food Service	9
Sub-total		60*
Clothes Dryer	NRER	18
Conveyor/Batch Oven Repair/Replacement	NRER	6
Furnace Repair/Replacement	NRER	2
Gas Engine Repair/Replacement	NRER	4
Greenhouse Heater	NRER	1
Sub-total		31
Boiler Modification/Part Replacement	NREC	4
Burner Replacement Batch Oven	NREC	1
Chiller Repair/Replacement	NREC	1
Evaporator Repair/Replacement	NREC	1
Furnace Repair/Replacement	NREC	1
Heat Recovery System	NREC	1
Sub-total		9
TOTAL SITES VERIFIED		100

* Some sites had more than one measure verified.

4. ENGINEERING REVIEW OF PROJECT APPLICATIONS

The original EM&V plan for this evaluation called for a review of the white papers and other documentation for the savings values used for all the measures covered in the program. Through conversations with NRFIP staff, it became apparent that adequate documentation for the savings calculations did not exist for any of the measures in the program. Consequently, a review of the background savings calculations could not be completed.

In lieu of reviewing the documentation, the engineering analysis focused on three related tasks:

1. **Review of custom applications**. We randomly selected 4 custom project applications for review from the sample of participants where on-site verifications had been completed. These custom project applications were combined with pre-installation and post-installation billing data and information obtained during the on-site audits. The purpose of these reviews was to check the initial savings calculations and underlying assumptions and to compare the expected savings with actual changes in monthly consumption.

2. **Assessment of projects involving production increases.** Many of the projects done through the NRFIP involve claims of production increases. These production increases will have a significant impact on the savings achieved and are sensitive to the underlying assumptions regarding baseline behavior used to calculate savings. To investigate if the production increases are being handled appropriately in the savings calculations, we reviewed the applications of 27 projects from our on-site audit sample where the application claimed a production increase.

3. **Review of savings calculation spreadsheets.** We were provided with copies of the savings calculation spreadsheets for several measures including engine rebuilds, pump rebuilds, coin-operated laundry, flue gas economizer, melting efficiency, atmospheric burners, and piping insulation. These spreadsheet tools are used by the Account Representatives to estimate savings for these installations. We reviewed each spreadsheet calculator to assess the appropriateness of the assumptions used to calculate savings.

The results of these tasks are presented in this section, with additional detail on the savings calculation spreadsheets included in *Appendix A*.

CUSTOM PROJECT APPLICATION REVIEW

In this section, we provide comments on the approach to documenting the "customized" applications, our evaluation of the measure impact, and suggestions to improve documentation for these projects. The savings calculators for selected measures were also reviewed as part of this evaluation, and these results are included as *Appendix A* of this report.

For the custom project application review, we visited 50 sites from PY2004 applications and 50 sites from PY2005 applications. Sites visited represented NRER, NREC and Food Service Program participants. We randomly selected 1 customized application from the NREC program

and 1 application from the NRER program from each program year for evaluation for a total of 4 detailed application reviews.

PY 2004 NREC Application #1

This application involves the re-tubing of a fire tube boiler that serves a hotel. According to information in the project file, the customer proceeded with the project prior to the project being entered into the 2004 NREC Program. A note from the account representative states that the customer was ready to proceed with the project, but the 2004 Program had not commenced accepting applicants. The application was filed soon after the program commenced in March 2004. The invoice for the work from the contractor to the customer is dated January 26, 2004.

The *ex ante* savings calculation for this project is based on the efficiency of the boiler increasing from 65 percent to 80 percent after the retrofit, with a 10 percent increase in production. The calculation is based on the boiler operating continuously with 4,900 Mbtuh input, and a 40 percent load factor. Using these parameters the calculated *ex ante* savings is 40,531 therms annually.

Unlike many other similar projects, a flue gas analysis was not performed for this project before and after the retrofit to verify the boiler efficiency. There is no load balance or disaggregation included with the application, and no utility bill data to verify the base case energy usage. Documentation in the application states that there are two boilers and it is unclear if the energy usage accounts for both boilers plus other gas fired equipment at the facility such as space heating, swimming pool, cooking, laundry (washer and dryer) and domestic hot water heating. The justification for a 10 percent increase in production is not provided.

The $1,598 incentive for the project appears to be 30 percent of the $5,325 material cost for the project.

Ex Post Savings Analysis

We obtained utility bill information for 2003 and 2004. According to the project documentation the retrofit was completed in January 2004. Considering that the February 2004 utility bill may have included some days in January before and after the retrofit, we elected to compare the utility bills from March to December 2003 before the retrofit, to the utility bills from March to December 2004 after the retrofit to evaluate the savings associated with this measure. Utility bill data for 2003 and 2004 is shown in Table 26 below.

Table 26: Monthly Utility Bill Data (Application #1)

	Therm Usage	
Month	2003	2004
January	43,226	47,700
February	40,274	43,861
March	37,911	37,970
April	37,546	33,453
May	36,177	30,188
June	33,548	30,584
July	29,689	32,392
August	30,374	33,152
September	31,366	30,522
October	34,773	37,589
November	42,624	36,824
December	47,830	44,086
Total	445,338	438,321
Total March-December	361,838	346,760

In 2003 before the retrofit, March to December gas usage was 361,838 therms. In March to December 2004 gas usage was 346,760 therms. The difference between the March to December usage in 2003 and the March to December usage in 2004 is 15,078 therms. Multiplying this by 12/10 yields an annualized estimate of 18,094 therms. The realization rate for this project is 44.6 percent. Table 27 summarizes the *ex post* impact analysis, and Table 28 summarizes the *ex ante* and *ex post* impacts and the associated realization rate for the project.

Table 27: Summary of *Ex Post* Analysis (Application #1)

Period	Therms
March-December 2003	361,838
March-December 2004	346,760
10 Month Difference	15,078
Annualized to 12 months	18,094

Table 28: *Ex Ante* and *Ex Post* Impacts (Application #1)

Ex Ante Impact (therms)	40,531
Ex Post Impact (therms)	18,094
Realization Rate	44.6%

The *ex post* savings are less than the *ex ante* savings because the utility bill analysis indicates that the ex ante savings have not been realized. It is worth noting that the *ex post* impact is approximately 4 percent of the total annual usage and may in fact be associated with factors other than the boiler retrofit. A more accurate analysis of the annual savings could be performed by a regression analysis that includes hotel occupancy, weather data and an accounting for any other changes in gas usage at the facility. This information is not available and this type of analysis is beyond the scope of the evaluation.

We conclude that at this point the pre-retrofit boiler efficiency cannot be determined, a load balance was not provided and the gas usage attributed to the boiler may be overstated. It is very likely that this project was necessary to keep the boiler operating and that energy efficiency played a secondary role in the decision to implement this project.

The true impact of the retrofit associated with this project is difficult to quantify without pre and post boiler efficiency measurements and a load balance for all gas consuming equipment at the facility. Information on hotel occupancy and weather data could be useful in performing a more precise analysis.

PY 2004 NRER Application #2

This application involves replacing two tortilla ovens with one conveyor tortilla oven. The application documents state that the customer performed the same retrofit on June 30, 2003 and that no other changes were made to gas consuming equipment. The customer stated that annual production in 2003 was 14 million dozen tortillas, and was not expected to change in 2004.

Since the 2004 project was expected to be identical to the 2003 project, the *ex ante* savings for the 2004 project were estimated by utility bill analysis of the last 6 months of 2002 versus the last 6 months of 2003.

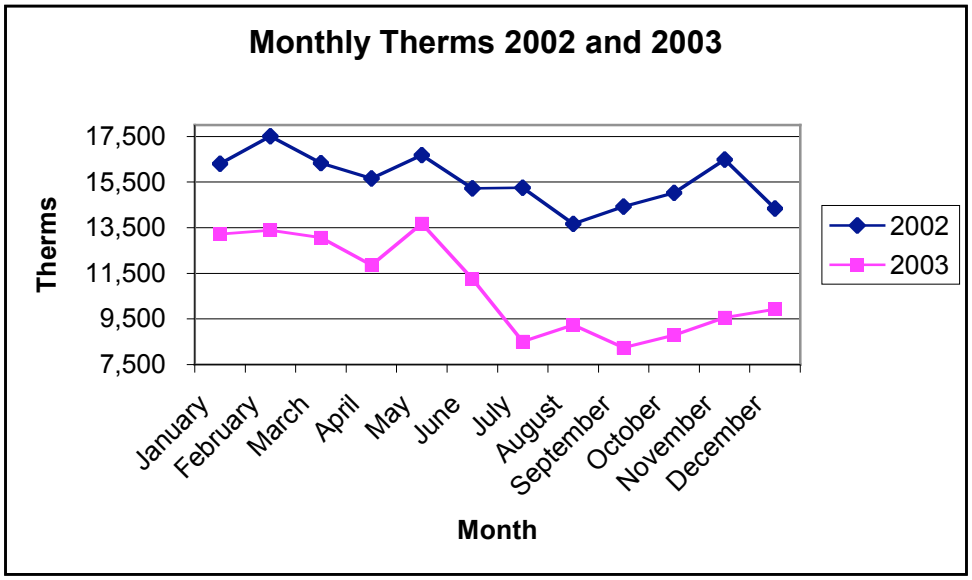
Analysis of the July to December 2003 utility bills indicated a 34,937 therm decrease in gas usage when compared to July to December 2002 period (89,196 therms versus 54,259 therms). The 6 month decrease was doubled to annualize the result to 69,874 therms and this is the *ex ante* savings associated with the project. A $20,385 incentive (30 percent of the project cost) was paid for this application.

Table 29 shows a summary of the bills that are included in the application. A review of the utility bills shows that the gas usage decreased significantly when the first 6 months of 2002 are compared to the first 6 months of 2003 (97,711 therms in the first six months of 2002 versus 76,462 therms in the first six months of 2003) even before the first tortilla oven retrofit on June 30, 2003. Figure 4 shows the decrease in energy consumption that occurred in 2003 before the retrofit. There is no discussion of this in the application documents, but it appears that some significant change in gas consumption occurred in this time period before the first tortilla oven retrofit. Additionally, the application does not include a discussion of how the new tortilla oven will reduce energy consumption.

Table 29: Monthly Utility Bills (Application #2)

	Therm Usage	
Month	2002	2003
January	16,309	13,216
February	17,514	13,386
March	16,329	13,059
April	15,652	11,856
May	16,678	13,682
June	15,229	11,263
July	15,258	8,508
August	13,669	9,234
September	14,422	8,243
October	15,033	8,795
November	16,479	9,557
December	14,335	9,922
Total	186,907	130,721
First 6 Months	97,711	76,462
Second 6 Months	89,196	54,259

Figure 4: Monthly Therm Usage (Application #2)



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Ex Post Method 1

Utilizing the same utility bill data, we performed an alternate analysis from the *ex ante* method used in the application since it appears that a significant change in gas usage occurred between 2002 and 2003 before the first tortilla oven retrofit was installed. We compared the first and last 6 months of 2002 to the first and last 6 months of 2003. In 2002, before the retrofit, gas usage

was 97,711 therms in the first 6 months of the year and 89,196 therms in the second 6 months of the year, a difference of 8,515 therms in a 6-month period.

In 2003, in the first 6 months before the June 30 retrofit gas usage was 76,462 therms and 54,259 therms in the second 6 months of the year after the retrofit, a difference of 22,203 therms in a 6 month period.

To estimate the impact of the measure, we subtracted the 22,203 therm difference observed between the first and last 6 months of 2003 from the 8,515 therm difference observed between the first and last 6 months of 2002, and doubled it to annualize the result. Using this method, we obtain an estimated savings of 27,376 therms annually, less than 40 percent of the *ex ante* estimate in the application.

Ex Post Method 2

We obtained additional utility bill information that includes the period after the second tortilla oven retrofit. An invoice for the second tortilla oven included in the application is dated September 8, 2004. An incentive check was issued by SCG on September 30, 2004.

Using post retrofit utility bill data, we performed a second utility bill analysis comparing the gas usage in the first 8 months of 2004 before the second tortilla oven retrofit, to the first 8 months in 2005 after the tortilla oven retrofit. Utility bill data is summarized in Table 30 below.

Table 30: Monthly Utility Bill Data (Application #2)

	Therm Usage	
Month	2004	2005
January	9,922	8,594
February	8,953	4,898
March	9,778	6,031
April	9,643	6,929
May	8,633	7,394
June	10,874	7,903
July	8,325	7,326
August	8,346	6,905
September	7,997	6,313
October	8,211	6,818
November	7,097	-
December	7,252	-
Total First 8 Months	74,474	55,980

In 2004, in the first eight months before the September retrofit, gas usage was 74,474 therms and in 2005 after the second tortilla oven retrofit gas usage was 55,980 therms, a difference of 18,494 therms in an 8 month period. Multiplying by 12/8 to annualize the result, we obtain an estimated savings of 27,741 therms annually for the project. This is remarkably similar to the 27,376 therms obtained in the *ex post* method 1 above, and indicates that the *ex ante* savings for this project are probably greatly overestimated. Table 31 summarizes the *ex ante* and *ex post* savings

analyses. The *ex post* savings are less than the *ex ante* savings because the utility bill analysis indicates that the *ex ante* savings have not been realized.

Table 31: Summary of Savings Analysis (Application #2)

Analysis	Annual Therms	Realization Rate
Ex ante	69,874	NA
Ex post method 1	27,376	39.2%
Ex post method 2	27,741	39.7%

A more accurate analysis of the annual savings could be performed by a regression analysis that includes tortilla production data and an accounting for any other changes in gas usage at the facility. This data is not available and this type of analysis is beyond the scope of the evaluation.

PY 2005 NREC Application #3

This application involves the installation of variable speed drives on air handler fan motors and enhanced temperature and humidity controls for a refrigerated warehouse. The control of existing VFDs serving the chilled water system was also modified. The facility is served by direct fired gas absorption chillers. SCG offered an incentive since the project was expected to reduce the chilled water load and space re-heating. The customer also participated in a Southern California Edison incentive program for the electric savings associated with the project. A letter from the vendor to the customer states that a similar retrofit was performed for another facility, which according to the vendor is a "cookie cutter" of this facility. The vendor stated that the gas savings were expected to be 20 percent for the chiller.

It appears that the account representative prepared the savings calculations for the project. There is a load balance in the application estimating the pre-retrofit energy consumption of the two absorption chillers and two space heaters to be 183,498 therms annually. The calculation shows a 20 percent reduction of this amount (36,700 therms) as the ex ante savings, presumably based on the vendor's estimate. A $25,000 incentive was paid to the customer on December 6, 2004.

The basis of the energy savings is vaguely described by the vendor and primarily rests on the results of a retrofit at another one of the customer's facilities that the vendor states is nearly identical to this one. Engineering calculations and detailed descriptions of the existing and proposed systems are not included in the application documents.

Ex Post Savings Analysis

We obtained utility bill information for 2003, 2004 and 2005. According to the project documentation, the retrofit was completed in September 2004. We compared the utility bills from September 2003 to August 2004 before the retrofit, to the utility bills from September 2004 to August 2005 after the retrofit to evaluate the savings associated with this measure. Utility bill data for these periods is shown in Table 32 below.

Table 32: Monthly Utility Bill Data (Application #3)

Month & Year	Therms	Month & Year	Therms
September '03	25,486	September '04	20,101
October '03	25,890	October '04	9,769
November '03	16,686	November '04	5,561
December '03	19,177	December '04	4,070
January '04	17,054	January '05	3,926
February '04	17,853	February '05	4,916
March '04	32,539	March '05	4,137
April '04	35,934	April '05	5,190
May '04	36,691	May '05	8,539
June '04	37,099	June '05	9,690
July '04	36,642	July '05	14,330
August '04	33,803	August '05	13,862
Total	334,854		104,091

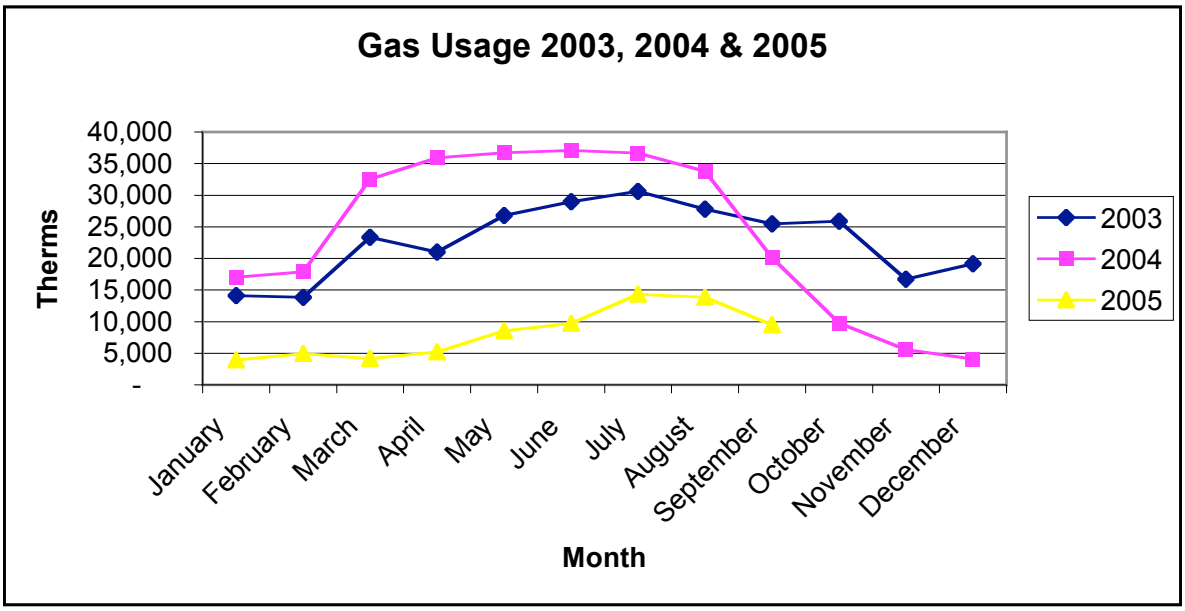
From September 2003 to August 2004 before the retrofit, gas usage was 334,854 therms. From September 2004 to August 2005, gas usage was 104,091 therms. The difference between the two periods is 230,763 therms. The results of the *ex post* analysis are shown in Table 33 below.

Table 33: Summary of *Ex Post* Savings Analysis (Application #3)

Period	Therms
September '03-August '04	334,854
September '04-August '05	104,091
12 Month Difference	230,763

The 12 month difference shown in the *ex post* analysis (230,763 therms) is greater than the total energy consumption (183,498 therms) estimated for the chillers and two air handlers before the retrofit in the load balance included in the application. The load balance in the application lists the customer's total annual usage as 273,610 therms, which appears to be the usage for 2003. The monthly gas usage for 2003, 2004 and 2005 (through September) are shown in Figure 5 below.

Figure 5: Monthly Gas Usage (Application #3)



Examination of Figure 5 reveals that before the retrofit, the monthly gas consumption increased significantly when March-August 2004 is compared to March-August 2003. There is a dramatic decrease in consumption beginning in September 2004 when the project documented in the application was completed. Based on these observations, we conclude that the facility has a variable usage of natural gas and that the project documented in the application appears to have had a significant impact on gas usage, likely in excess of the 36,700 therms claimed in the *ex ante* calculations.

Unfortunately there is a lack of technical data supporting the application and a more detailed analysis is beyond the scope of the evaluation. The utility bills show a dramatic decrease in gas consumption following the completion of the project. Since we are unable to resolve the discrepancies in the analysis we accept the *ex ante* savings estimate. The realization rate for this project is 100 percent.

A more accurate calculation of the annual savings could be performed by a psychrometric analysis that includes the entering and leaving conditions for each fan system (dry bulb and wet bulb temperatures, enthalpy, supply, return, outside air flow, etc.) before and after the retrofit, with consideration of the performance characteristics of the absorption chillers and the heating system. It would also be useful to perform an accounting for any other changes in gas usage at the facility, which are apparent when examining the utility bills described above.

The true impact of the retrofit associated with this project is difficult to quantify without an engineering analysis and a load balance for all gas consuming equipment at the facility.

PY 2005 NREC Application #4

This application documents the installation of a new crouton oven that replaced an existing crouton oven. According to data in the application, the old oven could produce 2,500 lb/hr of croutons and had a installed input burner capacity of 5,000 Mbtuh. The new oven can produce 6,500 lb/hr of croutons and has a installed input burner capacity of 12,900 Mbtuh.

Correspondence included in the application between the account representative and the customer reveals that the account representative estimated the annual production of the small oven being replaced to be 10 million pounds of croutons annually, and that the new oven is expected to produce 26 million pounds annually. The account representative requested that the customer provide actual production data for the small oven for 2004, and verify the expected production for the new oven. The customer did not provide this data and replied by email that the numbers used by the account representative are correct.

The account representative prepared the savings calculations for the project. There is a load balance in the application estimating the pre-retrofit energy consumption of a spray washer, a large crouton oven and the small crouton oven that is being replaced. The load balance estimates that the small oven consumed 166,400 therms annually, and the efficiency of the oven is determined to be 0.01664 therms/lb. by dividing the annual therms consumed by the 10 million pounds of croutons produced by this oven. The efficiency of the new oven was calculated based on performance data shown in an equipment submittal included in the application. The manufacturer's data shows that the typical energy consumption at full design capacity is 9,385 Mbtuh. Dividing the energy consumption by the 6,500 lb./hr yields an efficiency of 0.01444 therms/lb. The *ex ante* savings calculation limited the increase in crouton production for this oven to be equal to what the old oven could produce if it operated continuously. This was determined to be 21.9 million pounds annually and was calculated by multiplying 2,500 lb./hr by 8,760 hours.

The *ex ante* savings were calculated as follows:

$$\begin{aligned} Ex\ ante\ Savings &= 21{,}900{,}000\ lb/yr \times (0.01664\ therms/lb - 0.01444\ therms/lb) \\ &= 48{,}235\ therms/yr \end{aligned}$$

A $25,000 incentive was paid for this project. The energy savings are based on the operating efficiency of the new crouton oven determined from the manufacturer's literature compared to the efficiency of the old crouton oven. The old crouton oven efficiency was calculated using estimates of energy consumption and production. The savings calculation also assumes that the production of croutons from the new oven will more than double to 21.9 million pounds annually.

Ex Post Savings Analysis

During the site visit, we confirmed that the production rate has increased significantly. The facility representative stated that the new oven operates approximately 100 hours per week producing 6,500 lb/hr of croutons. This equates to more than 30 million pounds annually. The representative stated that the oven was custom built based on the customer's design.

Examination of the calculations reveals that the efficiency of the old oven was based on annual gas consumption estimated from a load balance and estimated annual production. The efficiency of the new oven was calculated at the manufacturer's expected input capacity at normal operating conditions shown in an equipment submittal included in the application.

The calculated efficiency of the old oven is very sensitive to the estimates of production and energy consumption. Neither estimate is very well substantiated. The only similar benchmark included in the application for both ovens is the maximum hourly production capacity and the maximum input gas capacity. According to data in the application, the old oven could produce 2,500 lb/hr of croutons and had a installed capacity of 5,000 Mbtuh input (0.0200 therms/lb.). The new oven can produce 6,500 lb/ hr of croutons and has a installed capacity of 12,900 Mbtuh input (0.0198 therms/lb.). The manufacturer's literature indicates that the new oven will consume 9,385 Mbtuh when producing 6,500 lb./hr of croutons under normal operating conditions. Dividing 9,385 Mbtuh by 12,900 Mbtuh yields a load factor of 73.8 percent.

There is no explanation about how the new oven saves energy and no reason to assume that the load factor of the new oven is any different than the old oven. Given that the efficiency of both ovens at full gas input capacity and full crouton production is virtually identical (0.0200 therms/lb versus 0.0198 therms/lb.), the savings claim for this project may be overstated.

The documentation included in the application presents a weak case for the *ex ante* savings. Based on information obtained during our site visit, we feel comfortable with the estimates of increased production but there is little evidence that supports the notion that the new oven is more efficient than the old oven.

Unfortunately there is a lack of technical data supporting the application and a more detailed analysis is beyond the scope of the evaluation. Since we are unable to resolve the issue of oven efficiency we are unable to determine the *ex post* savings and the realization rate.

Recommendations from the Application Review

Based on our review of the project applications, we make the following recommendations.

- Projects with large savings claims should receive much more engineering scrutiny. Do not rely on account representatives to perform engineering analysis for complex projects.
- Include a copy of the utility bill data in the application so that the annual energy use can be easily verified.
- Consider measuring the pre and post retrofit system conditions or using the customer's building automation system to trend data that can be used for a savings analysis.
- Add a load balance section to the savings calculator to provide an accounting of all equipment served by the gas meter. Make sure that the load balance information is correctly transferred into the savings calculation.

- Require more detailed descriptions of how measures reduce energy consumption and engineering calculations to support *ex ante* savings claims. Do not rely on statements from vendors.

- There does not seem to be a good case for increasing annual production by 10 percent for this project. Do not allow increases in annual production except in unique well documented cases. (Make the existing estimate of annual production equal to the proposed estimate of annual production.)

- Measure the pre and post retrofit boiler efficiency. Since the customer may have proceeded without the knowledge of SCG this may not have been possible for this project.

- Obtain verifiable production data from customers when this data is used for savings calculations. Estimates in email correspondence are insufficient.

- Provide credible and verifiable data for equipment efficiency when it is used as the basis of *ex ante* calculations. If possible take field measurements

EVALUATION OF PRODUCTION INCREASE CLAIMS

In this section we present our evaluation of production increase claims and their impact on program savings. We used data gathered from our PY2004 site visits and PY2004 applications for the analysis. The evaluation includes 27 applications. The analysis is primarily subjective, based on data contained in the applications and customer interviews.

Our review of the NRER, NREC and Food Service programs revealed that many projects include claims of increased production associated with the installation or retrofit that is documented in the application. In most cases, the energy consumption of the base case equipment is compared to the energy consumption of the retrofit/new equipment at the increased production rate. Therefore claims of increased production have a direct proportional impact on the *ex ante* savings.

During our site visits we asked the customer if they thought the production of the new/retrofit equipment had increased, decreased or stayed the same. If they felt that production had increased or decreased we asked them to estimate the percent change.

Thirteen of the 27 applications reviewed showed an increase in production associated with the project. For those 13, the un-weighted average increase was 80 percent, with a maximum of 400 percent, a minimum of 3 percent and a median of 40 percent.

During the site visits, 6 customers (sites 2125, 2178, 2627, 2446, 2150, and 2897) claimed greater increases than shown in the applications, including two (Sites 2627 and 2446) that had no increase shown in their applications. These customer's estimates ranged from 7 percent to 40 percent more production than shown in the application. Five customers (Sites 2306, 2523, 2800, 2496 and 2053) stated no increase although their applications showed an increase ranging from 30 percent to 400 percent. Three customers (Sites 2042, 2497 and 2188), stated that the increase

was less than shown in the application and one (Site 2499) stated the increase was equal to that shown in the application. The remainder did not claim an increase in their applications or during the site visits.

For these 15 applications where there was a claim of production increase in the application or by the customer during the site interview, the average difference between what is shown in the application and what the customer stated is 49 percent. It appears that the *ex ante* savings for these projects is significantly overstated. Table 34 shows a summary of the 27 sites included in the analysis.

Table 34: Summary of Analysis of Production Increases

siteid	2042	2368	2280	2099	2125	2178	2188	2306	2519
Increase claim in calcs. (y=1, n=0)	1	0	0	0	1	1	1	1	0
Increase % claimed in calculations	10%	-	-	-	3%	33%	85%	30%	-
Increase % claimed in site interview	3%	-	-	-	10%	40%	25%	0	-
Calculations-Interview % Increase	7%	-	-	-	-7%	-7%	60%	30%	-

siteid	2523	2800	2499	2497	2367	2363	2663	2496	2627
Increase claim in calcs. (y=1, n=0)	1	1	1	1	0	0	0	1	0
Increase % claimed in calculations	165%	76%	40%	111%	-	-	-	400%	-
Increase % claimed in site interview	-	-	40%	50%	-	-	-	-	15%
Calculations-Interview % Increase	165%	76%	0%	61%	-	-	-	400%	-15%

siteid	2181	2446	2046	2443	2522	2555	2150	2897	2053
Increase claim in calcs. (y=1, n=0)	0	0	0	0	0	0	1	1	1
Increase % claimed in calculations	-	-	-	-	-	-	15%	15%	50%
Increase % claimed in site interview	-	40%	-	-	-	-	25%	50%	-
Calculations-Interview % Increase	-	-40%	-	-	-	-	-10%	-35%	50%

In many cases, it is difficult to understand the rationale for increasing the production. Generally, the load balances did not indicate equipment operating at anywhere near full capacity. A new piece of equipment may have greater production capacity, but that does not mean that the capacity will be utilized. The application with a 400 percent increase in production (site 2496) is for a new sausage smoker. The new smoker has four times the capacity of the old smoker, but the customer had not increased production at the time of the interview. Another example is clothes dryers. Many Laundromats have more than a dozen clothes dryers, and few were observed to have more than 50 percent of the dryers operating during the site survey. Unless the Laundromat has increased its level of business, increases in production are unlikely.

Engineering Analysis Conclusions

Our subjective analysis based on a small sample indicates that claims of increased production are probably overstated for the NRER, NREC and Food Service programs. The production increase claims directly impact the *ex ante* savings estimates for all programs and the financial incentives for the NRER and NREC programs.

It is our recommendation that SCG should not allow increases in annual production or productivity except in unique well documented cases. Limit the potential to claim production

increases to manufacturing facilities where production levels are verifiable. For other projects, make the existing estimate of annual production equal to the proposed estimate of annual production.

SAVINGS CALCULATOR TOOL REVIEW

The final element of the engineering analysis was a review of the savings calculator spreadsheet tools used by NRFIP staff to calculate expected savings for individual projects. The tools we reviewed cover the following measures:

- Engine rebuild
- Pump rebuild
- Coin-operated laundry
- Flue gas economizer
- Melting efficiency
- Atmospheric burner conversion
- Piping insulation

Detailed reviews of each spreadsheet calculator are included in *Appendix A*. Each review consisted of reviewing all of the input assumptions used for the existing and new equipment in the savings calculations. This includes factors such as operating hours, equipment efficiency levels, the basic savings calculations, and how expansions in production are handled.

General conclusions and recommendations from *Appendix A* include the following:

- **Include utility bill data with each project application for all measures.** This will allow for easy verification of annual energy use.
- **Do not allow increases in production except in well-documented instances.** As discussed above, an increase in capacity does not necessarily translate to an increase in production.
- **Detailed work papers are needed.** Since documentation does not currently exist, detailed work papers for each measure should be developed that include the specific input assumptions used in the savings calculations. These papers should also detail the savings calculation formulas that are used in each spreadsheet calculator.
- **Provide detailed and credible references and documentation to support the existing and proposed equipment efficiencies used in the calculator.**
- **For engine rebuilds, the 15-year measure life assumption should be re-evaluated.** Two of the three customers we visited during on-sites that had engine rebuilds stated that

they rebuild their engines within 5 years or less. Even with modest use, it is unlikely that this measure will last 15 years as currently assumed.

- **For flue gas economizers, performance will likely vary based on the boiler loading.** It would be useful to test the economizer performance over a range of operating points and use the results to help determine savings.

- **For the melting efficiency measure, add annual savings to the calculator and link the load balance data from section one to the other sections of the calculator.**

- **For atmospheric burner conversions, add a load balance section to the calculator to provide an accounting of all equipment served by the gas meter.** The load balance information then needs to be integrated into the savings calculations.

5. SELF-REPORT FREE RIDERSHIP ANALYSIS

An assessment was performed to determine the influence the program has had on the participant's decision to install the measures covered by the NRFIP. In the participant survey, questions were asked relating to the timing of the purchase decision and the influence that the program and the rebate had on the final choice of equipment. Responses to these questions were analyzed using two different methods to estimate a self-reported free ridership rate.

As discussed previously, the responses to some survey questions (particularly those discussed in this section) may be biased if respondents do not correctly recall the timing of their decisions or if they are providing responses they perceive to be more socially desirable instead of accurately reporting their experiences. While we asked multiple questions in order to identify consistent responses and hopefully minimize this bias, the potential for bias still exists. We did not attempt to adjust the responses post-survey to account for any bias. Consequently, the free ridership results should be interpreted with these potential biases in mind.

One of the first steps in the free ridership analysis was to assess the importance of SCG sponsorship on the decision to participate in the NRFIP. As shown in Table 35, 73 percent of the participants felt that the fact that SCG sponsored the program was very important in their decision to participate. This rating did not vary significantly across program components.

Table 35: Importance of SCG Sponsorship of the Program

REB1. In deciding to participate in the program, how important was it to you that the Gas Company sponsored the program?	Total (%)	Food Service (%)	NREC (%)	NRER (%)
Very Important	73	72	75	76
Somewhat Important	19	21	19	15
Not at all Important	7	6	6	9
Don't know	1	1	0	0
Sample Size	301	218	16	67

Note: Survey responses weighted to the participant population.

Furthermore, 57 percent of participants felt that the rebate was very influential when deciding on the equipment they purchased, and other 30 percent felt it was somewhat influential, as shown in Table 36.

Table 36: Importance of Rebate on Purchase Decision

REB2. How important was the rebate on influencing the type of equipment you purchased?	Total (%)	Food Service (%)	NREC (%)	NRER (%)
Very Important	57	54	56	69
Somewhat Important	30	30	44	25
Not at all Important	13	16	0	6
Don't know	0	0	0	0
Sample Size	301	218	16	67

Note: Survey responses weighted to the participant population.

In addition to the rebate, customers reported being very influenced by the Gas Company representative that they spoke to regarding their equipment purchase. Of the 159 participants that were surveyed in the second phase survey[3], 60 percent of the participants reported discussing their equipment installation with a Gas Company representative, as shown in Table 37. All seven NREC participants discussed their equipment installation with a Gas Company representative.

Table 37: Discussion with SCG Representative

GR1. Did you discuss your equipment installation with a Gas Company representative?	Total (%)	Food Service (%)	NREC (%)	NRER (%)
Yes	60	58	100	59
No	36	37	0	41
Don't know	3	4	0	0
Sample Size	159	118	7	34

Note: Survey responses weighted to the participant population.

Among the surveyed participants that discussed their equipment installation with a Gas Company Representative, 42 percent reported that the representative was very influential in their equipment purchase decision, and another 32 percent were somewhat influenced, as shown in Table 38 below.

[3] A number of new questions were added to the second phase participant survey, including this question. These additional questions were designed to further refine the free ridership analysis and to identify potential influences of the NRFIP program efforts. Since these questions were only asked during the second round of surveys, the sample sizes are smaller relative to other questions that were asked in both survey phases.

Table 38: Influence of SCG Representative

GR3. How influential was the Gas Company representative in helping you decide which specific equipment to install?	Total (%)	Food Service (%)	NREC (%)	NRER (%)
Very influential	42	48	29	25
Somewhat influential	32	29	57	35
Not very influential	8	6	0	20
Not at all influential	17	16	14	20
Don't know	1	1	0	0
Sample Size	96	69	7	20

Note: Survey responses weighted to the participant population.

The results shown in Table 39 indicate that the Gas Company Representatives are also influencing the efficiency of the equipment purchased. As shown below, 25 percent of the surveyed participants that discussed their equipment installation with a Gas Company Representative report that they would have purchased less efficient equipment if they had not discussed their equipment installation with the representative.

Table 39: Participant Self-Reported Actions in the Absence of Discussions with SCG Representative

GR4. If you did not discuss your equipment installation with the Gas Company representative would you have purchased the same equipment, or something less efficient?	Total (%)	Food Service (%)	NREC (%)	NRER (%)
The same equipment efficiency	66	64	71	70
Something less efficient	25	26	14	25
Refused	1	1	0	0
Don't know	8	9	14	5
Sample Size	96	69	7	20

Note: Survey responses weighted to the participant population.

Participants were also asked what action they would have taken in the absence of the program and these responses are shown in Table 40. Seventy-four percent of the participants claim they would have installed the same energy efficient equipment. Virtually none of the participants (only 2 percent), claim they would not have purchased any equipment, indicating that all of the participants were in the market for new equipment (repair or replacement). Furthermore, only 21 percent claimed they would have purchased less expensive (implying standard efficiency) equipment.

Table 40: Participant Self-Reported Actions in the Absence of the Program

REB50. Regarding the equipment, which of the following three statements best describes the actions you would have taken had you not participated in the program?	Total (%)	Food Service (%)	NREC (%)	NRER (%)
Bought no equipment	2	2	7	3
Bought the same energy efficient equipment	74	75	57	66
Bought less efficient or less expensive equipment	21	21	29	27
Don't know	2	2	7	5
Sample Size	329	251	14	64

Note: Survey responses weighted to the participant population. Sample size is based on unique participants and measure type.

Table 41 shows those participants that claim they would have purchased the same energy efficient equipment in the absence of the program were also asked if they would have purchased that equipment at the same time, within a year, or more than a year, if the program had not existed. Eighty-six percent of those participants claim they would have purchased the equipment at the same time, and very few (7 percent) would have waited more than a year, indicating that all of these participants were currently in the market for new equipment (repair or replacement).

Table 41: Participant Self-Reported Timing of Installation Among Participants That Would Have Purchased Same Equipment in Absence of the Program

REB55. When would you have bought the equipment if the program had not provided it?	Total (%)	Food Service (%)	NREC (%)	NRER (%)
At the same time	86	86	100	64
Within a year	7	6	0	24
More than a year later	7	7	0	10
Don't know	1	1	0	2
Sample Size	223	173	8	42

Note: Survey responses weighted to the participant population. Sample size is based on unique participant and measure type.

To assess free ridership with the program, we considered three ways in which the program may have influenced customers to install energy efficient equipment. First, the program's rebate may have influenced customers to purchase more energy efficient equipment. Second, the discussions that the customers had with their Gas Company representative may have influenced customers to purchase more energy efficient equipment. Finally, the rebate may have also influenced the customer to purchase their equipment earlier than they otherwise would have.

Two different series of questions were asked to assess the program's influence with respect to these program elements. The first series of questions were presented above in Table 36 (question REB2, regarding the influence of the rebate), Table 38 (question GR3, regarding the influence of the Gas Company representative), and Table 40 and Table 41 (questions REB50 and REB55, regarding what the customers' stated actions would have been in the absence of the program). Table 42 below shows the integrated results of the series of questions.

To estimate free ridership we assumed the following:

- Any customer that reported they would have purchased less efficient equipment or no equipment at all in the absence of the program was a net participant (0 percent free rider).
- Any customer that reported they would have purchased the same equipment, but at a later date was initially set to be a partial (50 percent) free rider.
- Any customer that reported they would have purchased the same equipment, but at the same time was initially set to be a full (100 percent) free rider.
- If the customer reported being very influenced by the rebate, the free ridership rate was reduced by 50 percent.
- Similarly, if the customer reported being very influenced by their Gas Company representative, the free ridership rate was reduced by 50 percent.

For example, a customer that would have purchased the same equipment, but at a later date, and was very influenced by both the rebate and the Gas Company Representative, would have a 12.5 percent free ridership rate (0.5*0.5*0.5). Based on this approach, as shown in Table 42, the program level free ridership rate is 39 percent.

Table 42: Free Ridership Assessment Based on Self-Report Responses Regarding Actions in Absence of Program, Influence of Rebate, and Influence of SCG Representative

Purchase in Absence of Program	*Influence of Rebate*	*Influence of SCG Rep*	*N*	*Free Ridership Rate*
No Equipment	Very	Very	1	0%
No Equipment	Very	Not At All	4	0%
No Equipment	Not At All	Not At All	1	0%
Less Efficiency Equipment	Very	Very	14	0%
Less Efficiency Equipment	Very	Somewhat	5	0%
Less Efficiency Equipment	Very	Not At All	7	0%
Less Efficiency Equipment	Somewhat	Very	1	0%
Less Efficiency Equipment	Somewhat	Somewhat	3	0%
Less Efficiency Equipment	Somewhat	Not At All	4	0%
Same Equipment, But Later	Very	Very	5	13%
Same Equipment, But Later	Very	Somewhat	4	25%
Same Equipment, But Later	Very	Not At All	6	25%
Same Equipment, But Later	Somewhat	Very	1	25%
Same Equipment, But Later	Somewhat	Somewhat	2	50%
Same Equipment, But Later	Somewhat	Not At All	3	50%
Same Equipment, But Later	Not At All	Very	1	25%
Same Equipment, But Later	Not At All	Not At All	1	50%
Same Equipment	Very	Very	6	25%
Same Equipment	Very	Somewhat	12	50%
Same Equipment	Very	Not At All	13	50%
Same Equipment	Somewhat	Very	3	50%
Same Equipment	Somewhat	Somewhat	3	100%
Same Equipment	Somewhat	Not At All	20	100%
Same Equipment	Not At All	Very	3	50%
Same Equipment	Not At All	Somewhat	1	100%
Same Equipment	Not At All	Not At All	11	100%
Total Sample			**129**	**39%**

A second free ridership assessment was based on a second series of three questions, where participants were asked to rate on a one to ten scale how much they agreed with three different statements, where a one means they disagree and a ten means they agree. The three questions asked were geared towards assessing the three components of influence discussed above. These questions, and the percent of the participants that strongly agreed, somewhat agreed and strongly disagreed to the statements, are provided in Table 43.

Table 43: Self-Reported Influence of the Rebate and SCG Representative

NEW1-NEW5. Rate the following statements using a 1-to-10 scale, where 1 means you DISAGREE with the statement, and 10 means you AGREE COMPLETELY with the statement		Total (%)	Food Service (%)	NREC (%)	NRER (%)
Thanks to the program rebate, I was able to install a more energy efficient piece of equipment than I would have otherwise.	Strongly Agree (8-10)	51%	51%	43%	53%
	Somewhat Agree (4-7)	18%	17%	43%	18%
	Strongly Disagree (1-3)	31%	32%	14%	29%
Without the Gas Company representative's assistance, I would have bought a less efficient piece of equipment.	Strongly Agree (8-10)	25%	26%	29%	22%
	Somewhat Agree (4-7)	18%	19%	14%	16%
	Strongly Disagree (1-3)	57%	55%	57%	62%
I would have delayed purchasing the particular energy-efficient equipment if the Gas Company had not offered a financial incentive for the equipment.	Strongly Agree (8-10)	30%	25%	57%	41%
	Somewhat Agree (4-7)	11%	9%	0%	21%
	Strongly Disagree (1-3)	59%	66%	43%	38%
Sample Size		159	118	7	34

Note: Survey responses weighted to the participant population.

Based on Table 43, the program rebate would appear to have the most influencing effect on the participants decision to purchase energy efficient equipment, with about 51 percent being strongly influenced (consistent with Table 36, where 57 percent reported being strongly influenced by the rebate). Twenty-five percent were strongly influenced by the Gas Company representative (also consistent with Table 37 and Table 38, which report 60 percent spoke to a representative, and 42 percent were very influenced). Finally, 30 percent were strongly influenced to purchase their equipment earlier because of the incentive (somewhat consistent with Table 41, which reports that 14 percent would have delayed their installation in the absence of the program).

Below in Table 44, the three questions are cross tabulated. Overall, 59 percent of the participants claim to be strongly influenced by one or more of the three elements. Twenty-four percent of the participants appear to be uninfluenced by all three aspects of the programs. The remaining 17 percent were somewhat influenced by one or more aspects. In terms of free ridership, if we assumed the 24 percent uninfluenced participants were full free riders (100 percent free riders), the 17 percent somewhat influenced participants were partial free riders (50 percent free riders), and the 50 percent very influenced participants were net participants (0 percent free riders), the net result would be a 29 percent free ridership rate, compared with the 39 percent rate developed in Table 44.

Table 44: Self-Reported Influence of the Rebate and SCG Representative

Thanks to the program rebate, I was able to install a more energy efficient piece of equipment than I would have otherwise.	Without the Gas Company representative's assistance, I would have bought a less efficient piece of equipment.	I would have delayed purchasing the particular energy-efficient equipment if the Gas Company had not offered a financial incentive for the equipment.	N	%
Strongly Agree (8-10)	Strongly Agree (8-10)	Strongly Agree (8-10)	21	13.8
		Somewhat Agree (4-7)	3	2.0
		Strongly Disagree (1-3)	7	4.6
	Somewhat Agree (4-7)	Strongly Agree (8-10)	6	4.0
		Somewhat Agree (4-7)	4	2.6
		Strongly Disagree (1-3)	7	4.6
	Strongly Disagree (1-3)	Strongly Agree (8-10)	9	5.9
		Somewhat Agree (4-7)	1	0.7
		Strongly Disagree (1-3)	19	12.5
Somewhat Agree (4-7)	Strongly Agree (8-10)	Strongly Agree (8-10)	3	2.0
		Somewhat Agree (4-7)	1	0.7
		Strongly Disagree (1-3)	2	1.3
	Somewhat Agree (4-7)	Strongly Agree (8-10)	1	0.7
		Somewhat Agree (4-7)	2	1.3
		Strongly Disagree (1-3)	3	2.0
	Strongly Disagree (1-3)	Strongly Agree (8-10)	3	2.0
		Somewhat Agree (4-7)	3	2.0
		Strongly Disagree (1-3)	11	7.2
Strongly Disagree (1-3)	Strongly Agree (8-10)	Strongly Agree (8-10)	0	0.0
		Somewhat Agree (4-7)	0	0.0
		Strongly Disagree (1-3)	1	0.7
	Somewhat Agree (4-7)	Strongly Agree (8-10)	0	0.0
		Somewhat Agree (4-7)	2	1.3
		Strongly Disagree (1-3)	3	2.0
	Strongly Disagree (1-3)	Strongly Agree (8-10)	2	1.3
		Somewhat Agree (4-7)	2	1.3
		Strongly Disagree (1-3)	36	23.7
TOTAL			152	

Note: Survey responses weighted to the participant population. Total responses (N) based on unique participant and measure type.

As a final approach to estimating free ridership, each of the three ratings presented in Table 43 were used to develop a probability that the participant was influenced by the program (or a net participant, and not a free rider). For a given question, if the customer gave a 10 rating, the probability was set to one. If the customer gave a 1 rating, the probability was set to zero. For all other ratings (X), the probability was set to (X-1)/9, so that a 5 (for example) would be equal to 0.44.

The first question examined was the influence of the rebate on the customer. The probability of that influence was estimated as discussed above (call this probability P1).

Next, if the customer was not fully influenced by the rebate (i.e., the rating was not a 10, or P1 was not one), then the customer may have also been influenced by the Gas Company Representative. Therefore, whatever probability was not influenced by the rebate (1-P1) was assessed to see if the Gas Company Representative influenced the customer (with the probability calculated as above, and called P2). The product of (1-P1) times P2 represents the amount of additional influence the Gas Company Representative provides above what was already credited by the rebate. Therefore P1 + (1-P1)*P2 is the cumulative amount of influence provided by the two elements (this can also be represented by P1 + P2 – P1*P2, which may be more intuitively considered as the sum of the two probability minus "double counting", or the joint probability that both elements influenced the customer).

A similar thought process holds for adding in the third element of influence. The probability that the customer is not influenced by either of the first two elements is (1-P1)*(1-P2). So, the probability that can be added from the third element would be (1-P1)*(1-P2)*P3. However, because the third element only affects the timing of when the customer would have otherwise adopted the same equipment, we only give this element 50 percent of the benefit towards being a net participant.

Therefore, to develop an overall probability of being influenced by the program, the following equation was used:

$$P(Influenced) = P1 + (1 - P1) * P2 + 0.5 * (1 - P1)(1 - P2) * P3$$

This can be intuitively described as the probability of being influenced by the rebate to install more efficient equipment; plus the probability of not being influenced by the rebate, but being influenced instead by the Gas Company representative to install more efficient equipment; plus 50 percent of the probability of not being influenced by either the rebate or the Gas Company representative to install more efficient equipment, but rather being influenced by the rebate to install energy efficient equipment earlier than they otherwise would have.

This probability was calculated for each participant that was surveyed in the second wave of participant interviews. Overall, we found the weighted average probability (weighted by energy savings) to be 70 percent. Therefore, we estimated free ridership to be 30 percent for the program overall.

SUMMARY OF SELF-REPORT FREE RIDERSHIP APPROACHES

To validate that the last assessment of free ridership was reasonable, we compared each individual's probability of being a free rider (i.e., one minus the probability of being influenced) to their response to the survey questions used in the first approach (presented in Table 43). Table 45 presents the cross-tabulation of these survey questions used in the first approach, along with the free ridership rate estimated from this first approach, and compares it to the average probability of free ridership estimated in the third approach.

Table 45: Comparison of Self-Reported Free Ridership Estimation Approaches

Purchase in Absence of Program	Influence of Rebate	Influence of SCG Rep	N	Approach 1 Free Ridership Rate	Approach 3 Probability of Free Rider
No Equipment	Very	Very	1	0%	1%
No Equipment	Very	Not At All	4	0%	14%
No Equipment	Not At All	Not At All	1	0%	20%
Less Efficiency Equipment	Very	Very	14	0%	3%
Less Efficiency Equipment	Very	Somewhat	5	0%	6%
Less Efficiency Equipment	Very	Not At All	7	0%	6%
Less Efficiency Equipment	Somewhat	Very	1	0%	7%
Less Efficiency Equipment	Somewhat	Somewhat	3	0%	32%
Less Efficiency Equipment	Somewhat	Not At All	4	0%	20%
Same Equipment, But Later	Very	Very	5	13%	30%
Same Equipment, But Later	Very	Somewhat	4	25%	28%
Same Equipment, But Later	Very	Not At All	6	25%	23%
Same Equipment, But Later	Somewhat	Very	1	25%	0%
Same Equipment, But Later	Somewhat	Somewhat	2	50%	31%
Same Equipment, But Later	Somewhat	Not At All	3	50%	50%
Same Equipment, But Later	Not At All	Very	1	25%	0%
Same Equipment, But Later	Not At All	Not At All	1	50%	100%
Same Equipment	Very	Very	6	25%	12%
Same Equipment	Very	Somewhat	12	50%	15%
Same Equipment	Very	Not At All	13	50%	58%
Same Equipment	Somewhat	Very	3	50%	31%
Same Equipment	Somewhat	Somewhat	3	100%	100%
Same Equipment	Somewhat	Not At All	20	100%	37%
Same Equipment	Not At All	Very	3	50%	36%
Same Equipment	Not At All	Somewhat	1	100%	100%
Same Equipment	Not At All	Not At All	11	100%	57%
Total Sample			**129**	**39%**	**30%**

Note: Survey responses weighted to the participant population. Total sample is based on unique participant and measure type.

Table 45 shows that the probability model is well validated by the first estimation approach. Customers that report purchasing no equipment or less efficient equipment have lower probabilities of free ridership than those claiming to purchase the same equipment. Similarly, those reporting to purchase the same equipment, but later, also have lower probabilities than those claiming they would have purchased the same equipment at the same time. Also, the probabilities for participants that report being very influenced by either the rebate or Gas Company representative, are lower than those that are somewhat influenced. Similarly, participants that report being somewhat influenced have lower probabilities than those that are not at all influenced. There are of course some anomalies, as one might expect with qualitative self-report data. But overall, the qualitative data support the free ridership probability model.

Across the three program elements, free ridership does not vary significantly. The program element-specific estimates of free ridership are 27 percent for the Food Service Rebate program, 36 percent for the NRER program, and 26 percent for the NREC program.

Because we feel the probability approach (the third approach discussed) is the most objective, we recommend using the resulting 30 percent free ridership rate. This result does not contradict the 39 percent rate from the first approach, which is more subjective. For example, with the first approach the 50 percent reductions in free ridership assigned to being very influenced by the rebate or the Gas Company representative are very subjective and have been arbitrarily set in this evaluation. Note that the overall free ridership value is very sensitive to the reduction values used. If a 75 percent reduction were used, free ridership would be 30 percent. If a 25 percent reduction were used, free ridership would be 49 percent.

In order to develop an overall net-to-gross ratio for the program, spillover effects must also be considered. It is likely that the program may have some spillover effects, both on participants and nonparticipants. Using this 30 percent free ridership estimate from the probability approach, and assuming a 10 percent effect for spillover, the resulting net-to-gross ratio would equal 0.80 (or 1.00 - 0.30 + 0.10).

6. IMPACT ANALYSIS

To determine net impacts for the NRFIP, a billing regression model was estimated to determine *ex post* net impacts for the 2004-05 NRFIP. For this task, two separate billing regressions were used:

3. **Food Service.** This model utilized monthly usage data from a sample of participants and nonparticipants from the phone surveys, which allowed additional survey information on changes at the facility during the post-installation period to be incorporated into the model.

4. **NRER / NREC.** A combined model for the NRER and NREC components was developed based on participations only and using billing data and measure information contained in the program tracking database. Because this model was estimated using participant data only, additional adjustments were made to the model results based on the self-report analysis to determine net impacts.

Details on the model specifications, data, and estimation results are included in this section. Following the model discussions, the results are applied to the 2004-05 NRFIP participation to determine the *ex post* realized net impacts for the entire program.

FOOD SERVICE BILLING REGRESSION

Using data for both participants and nonparticipants, a Statistically Adjusted Engineering (SAE) billing model is estimated using ordinary least squares regression (OLS). The model includes variables that control for the primary influences on gas usage. These include basic firmographic variables such as pre-installation therm usage, business type, and categorical variables based on therm usage. Weather data expressed as changes in cooling degree days and heating degree days are also incorporated into the model. In addition, phone survey data from both participants and nonparticipants were used to create additional variables that capture any changes at the business that may have affected gas usage in the post-installation period.

The savings variables used in this model are the original gross *ex ante* impact estimates rather than net *ex ante* savings values. Since nonparticipants are included in the model, the coefficient estimate on the savings variable is accounting for free ridership as nonparticipant actions outside the program are used as the baseline. Therefore, the savings coefficient from this model can be used as an *ex post* realization rate that includes any free ridership effect. As discussed below, the coefficient estimate is then adjusted for spillover post- model to derive the *ex post* net realized impacts for this program component.

The basic form for the net billing model for the Food Service component is as follows:

$$Therm_{i,post} = \alpha + \beta' Savings_i + \beta'(SiteChng_i * Therm_{i,pre}) + \beta' Therm_{i,pre}$$
$$+\beta'(UsageCat_i * Therm_{i,pre}) + \beta' NonRestaurant_i + \beta' Weather_i + \varepsilon_i$$

Where :

$Therm_{i,post}$ = *Gas usage during the program post – period for customer i*

$Savings$ = *Adjusted ex ante savings estimates*

$SiteChng_i * Therm_{i,pre}$ = *Survey responses regarding changes at site interacted with usage*

$Therm_{i,pre}$ = *Gas usage during the pre – program period*

$Therm_{i,pre}UsageCat$ = *Gas usage during the pre – program period interacted with usage category*

$NonRestaurant$ = *Variable indicating non - restaurant business*

$Weather$ = *Change in heating degree days and cooling degree days by climate zone*

ε_i = *Random error term assumed normally distributed*

α, β = *Coefficients to be estimated*

Separate therm usage variables were developed for the model based on annual pre-installation consumption from the billing data. These variables were constructed so that approximately 10 percent of the sample falls within each usage category. The usage category definitions are shown in Table 46.

Table 46: Usage Category Definitions

Usage Category	Therm Range	
	Min	Max
1	765	5,079
2	5,079	6,779
3	6,779	8,478
4	8,478	10,178
5	10,178	11,877
6	11,877	17,733
7	17,733	23,589
8	23,589	29,444
9	29,444	35,300
10	35,300	232,402

To estimate the billing model, several data screens were used to create a dataset with complete billing data and to rule out potential outlier observations that might have undue influence over the model. Specifically, the data screens were designed to remove those observations that had incomplete billing data or did not have sufficient post-installation billing data to estimate annual impacts. In addition, those observations that had disproportionately large estimated savings relative to overall usage were dropped from the analysis, as the large savings (greater than 50 percent of pre-period usage) are likely reflecting errors in the usage data rather than actual impacts given the types of measures promoted by this program.

The number of observations dropped from each of these screens for participants and nonparticipants is shown in Table 47. Note that for many of these observations, multiple screening criteria apply. For reporting purposes, Table 47 shows the total number of observations for each type of screen. The number of unique observations that are dropped due to any of the screeners is shown at the bottom of the table.

Table 47: Observations Dropped Due to Screening Criteria (Food Service)

Screening Criteria	Part	NonPart
Survey Sample	217	242
Late Installation	25	
Missing Usage Data (Pre-Period)	51	23
Missing Usage Data (Post-Period)	18	5
Post usage twice as much as pre-period usage	12	13
Post usage half as much as pre-period usage	4	5
Savings greater than pre period usage	25	
Savings greater than half of pre period usage but less than equal to pre-period usage	35	
Large variance in pre period usage	44	50
Large variance in post period usage	63	57
No Industry code	2	
Missing cooling degree day data	11	10
Missing heating degree day data	11	10
Annual usage greater than part sample maximum	2	
Unique Screened Observations	137	78
Analysis Observations	80	164

Table 48 shows the estimation results from the final net billing model specification for the Food Service installations. The model fits the data well overall as evidenced by the high R-squared value and the statistically significant F statistic. A high R-squared is common when lag variables are used in regression models, and the high t-value for the pre-usage therm variables also indicates that the lag usage is the predominant driver for this model.

The pre-installation therm variable interacted with the therm usage categories generally decreases in magnitude with the large usage categories. However, only a few of these interaction terms are statistically significant indicating that most of the pre-installation usage effect may be captured in the single pre-installation usage variable PRE-USAGE.

The variable indicating a non-restaurant business was not statistically significant, which indicates that there is not a significant difference in usage between restaurants and non-restaurants in the billing model. Finally, changes in both heating degree days and cooling degree days did not have a significant effect on post-installation usage, indicating that gas usage was generally invariant to weather for these businesses.

The survey variables indicating changes at the business that may affect overall gas usage were all statistically significant. Each of these variables was interacted with pre-installation gas usage so that the coefficient reflects the effect of the change in terms of percentage of pre-installation usage. Changes in production had an average impact of about a 3.9 percent reduction of gas usage in the post-installation period. Similarly, changes in square footage increased usage by 1.5 percent while changes in the number of employees reduced usage by about 2.2 percent.

The highlighted variable in Table 48 is the coefficient on the *ex ante* savings estimates. Several different specifications were attempted that broke out savings by measure type (Ovens, Broiler, Fryers, Other). For the broiler category, the coefficient estimate was consistently positive due to the fact that of the 22 broilers in the sample, 16 had increases in therm usage from the pre-installation to the post-installation period. Since it was not possible to get a reasonable realization rate for this particular measure, broilers were dropped from the sample and the other measures were grouped together to get a single coefficient estimate on savings. The coefficient estimate on the combined savings variable would then be applied to all Food Service measures (including broilers) to calculate net realized impacts.

As shown in the table, the savings coefficient has an estimate of -0.50 and is statistically significant from zero at less than 1 percent level. It is also significantly different from 1.0 at the less than 1 percent level of significance. This indicates that 50 percent of the *ex ante* gross savings is being realized by Food Service participants. However, a 90 percent confidence interval around the savings coefficient results in an error band of +/- 56 percent, which indicates a moderate to high level of uncertainty for the *ex post* net realization rate.

The lower realization rate is likely due to several factors. As discussed previously in the engineering review and in *Appendix A* with the review of the savings calculator spreadsheets, there may be a tendency to overstate savings in the *ex ante* savings calculations, particularly when an increase in production is being claimed. To the extent that the savings do not materialize, the model will adjust the coefficient estimate downward to reflect the difference in savings from initial expectations.

Another factor influencing the savings coefficient is the presence of nonparticipants in the sample. Since some nonparticipants are making changes outside the program, the coefficient incorporates the effect of free ridership. In the model, realized net impacts are 50 percent less than the original *ex ante* gross impacts. If this entire reduction were due to free ridership, this would imply a free ridership rate of 50 percent, which is higher than the self-report free ridership analysis discussed earlier (30-39 percent). As discussed above, however, some of the 50 percent reduction is correcting for errors in the savings calculations so the free ridership rate implied by the billing model will be less than 50 percent.

Table 48: Net Billing Regression Model Results (Food Service)

Model Statistics	Value
Observations	244
Variables	17
F Statistic	2,194.1
F Statistic Level of Significance	< 1%
Adjusted R-Squared	0.9935

Parameter Estimates	Coefficient	Standard Error	T Value	Level of Significance
Intercept	-1,922.21	699.07	-2.75	1%
Savings-All Measures	-0.50	0.17	-2.91	0%
Survey Response-Gas Increase	-0.02	0.01	-2.24	3%
Survey Response-Square Footage Increase	0.01	0.02	0.79	43%
Survey Response-Employee Increase	0.07	0.02	2.89	0%
Pre Usage	1.09	0.01	131.18	< 1%
Pre Usage*Pre Usage Category 1	0.45	0.19	2.33	2%
Pre Usage*Pre Usage Category 2	0.25	0.13	1.89	6%
Pre Usage*Pre Usage Category 3	0.20	0.11	1.87	6%
Pre Usage*Pre Usage Category 4	0.11	0.10	1.07	29%
Pre Usage*Pre Usage Category 5	0.14	0.08	1.74	8%
Pre Usage*Pre Usage Category 6	0.04	0.05	0.68	50%
Pre Usage*Pre Usage Category 7	0.04	0.04	1.04	30%
Pre Usage*Pre Usage Category 8	-0.02	0.03	-0.64	52%
Pre Usage*Pre Usage Category 9	-0.03	0.03	-0.76	45%
Business Type (Non-Restaurant)	276.16	480.32	0.57	57%
Weather-Change in cooling degree days (post-pre)	-1.69	2.20	-0.77	44%
Weather-Change in heating degree days (post-pre)	-0.71	0.81	-0.87	38%

NRER / NREC Billing Model

A separate billing model was run for the NRER and NREC components of the program that utilizes the same basic structure as the Food Service regression model. However, with the Food Service model it was relatively easy to match a sample of nonparticipants as the measures were generally restricted to food service industries. With the NRER and NREC, there is a much wider range of industries, equipment types, and industrial processes involved and we were not able to identify an appropriate group of nonparticipants to use as a baseline. As a result, the NRER / NREC model was estimated using a sample of participants only.

Since only participants are used in the billing model, the coefficient estimates on savings reflect *ex post* gross realization rates. Any deviation from 1.0 for the savings coefficient will reflect differences in conditions at the site in the post-installation period relative to the conditions initially assumed for the *ex ante* savings calculations. Since the nonparticipants are not included in the model, the results of this billing model will need to be adjusted post-model to determine the realized net impacts. As discussed below, we combined the results of the NREC / NRER billing model with the self-reported free ridership results and a spillover adjustment factor to determine the final *ex post* net realization rate for the NREC and NRER program components.

The billing model specification is similar to that used for Food Service, with the exception that no information from the phone survey was incorporated in the model. The billing model specification used for NRER and NREC is as follows:

$$Therm_{i,post} = \alpha + \beta'(UsageCat_i * Therm_{i,pre}) + \beta' Expand_i + \beta' Savings_i + \beta' Weather_i + \beta' Application_i + \varepsilon_i$$

Where :

$Therm_{i,post}$ = *Gas usage during the program post – period for customer i*

$Expand_i$ = *Therms required to meet expanded production with existing equipment*

$Savings$ = *Ex ante savings estimates*

$Therm_{i,pre}$ = *Gas usage during the pre – program period*

$UsageCat_i * Therm_{i,pre}$ = *Gas usage during the pre – program period interacted with usage category*

$Weather$ = *Change in heating degree days and cooling degree days by climate zone*

$Application$ = *Indicator variables for reasons for equipment purchase from NRFIP application*

ε_i = *Random error term assumed normally distributed*

α, β = *Coefficients to be estimated*

In this model, three usage variables ($UsageCat_i$) are created that reflect small customers (less than 20,000 therm usage annually), medium customers (20,000 to 80,000 therms annually) and large customers (more than 80,000 therms annually). In addition, the NRER and NREC participants each fill out an application sheet where they are asked to indicate the reasons for the equipment installation. Possible reasons are increased production and labor, failed or impending failure of equipment, and to reduce operating costs and gas costs. Since these reasons may influence the type of equipment chosen, they have been incorporated into the billing model through a series of indicator variables based on the application data.

Each project application also indicates whether or not the equipment installation was part of an expansion in production. The information on production expansion as well as information on existing equipment was used to calculate how much therm usage would have increased had the expanded production been met with the existing equipment. By including this information in the model, the resulting coefficient on savings should reflect the realized savings over what would have been achieved relative to the existing equipment.

Various screening criteria were used to develop a usable sample of NRER and NREC installations for the billing model. Table 49 shows the screening criteria used. Since we were limited to fewer participants, fewer screening criteria were used relative to the Food Service sample in order to maintain a sample large enough to estimate the billing model with some degree of statistical confidence. The number of observations dropped due to the screening criteria are shown in Table 49.

Two very large customers were dropped from the regression sample, as these observations had a disproportionately large influence on the overall regression results. When these customers are included in the sample, the savings coefficient changes from -0.76 to -0.26 and reduces the statistical significance of the savings variable to 18 percent. In order to achieve a realization rate that is more representative of the entire sample, these outliers were dropped from the regression model.

Table 49: NRER / NREC Billing Model Screening Criteria

Screening Criteria	# Observations
Initial Sample	**260**
Post-installation usage greater than 500,000 therms	2
Incomplete pre-installation billing data	73
Incomplete post-instasllation billing data	20
Post-installation usage twice pre-installation usage	18
Savings greater than half of pre-installation usage	20
Late Installation	59
Other missing regression data	7
Total Screened Observations	**136**
Final Regression Analysis Sample	**124**

Note: Multiple screening criteria may apply to the same observation

The results of the NRER / NREC billing model are shown in Table 50. The relatively high R-squared value and the statistically significant F statistic indicate that the model generally fits the data well and has significant explanatory power.

The pre-installation therm variable interacted with the therm usage categories was statistically significant and positive for medium and large customers, indicating that there is a benefit to breaking out the effect of pre-installation usage by customer size in the model. Changes in cooling degrees had a positive and significant effect while changes in heating degree days were statistically insignificant.

The variables developed from the project applications regarding the reasons for the equipment installation (the last 6 coefficients shown in Table 50) had the expected signs but were generally not statistically significant at the 10 percent level. However, the variable indicating that the existing equipment failed is negative and significant at the 11 percent level and the increase in labor was positive and significant at the 15 percent level.

The variable for expanded production had a coefficient estimate of 0.41, which indicates that on average only 41 percent of the estimated increase in usage due to expanded production (assuming existing equipment) is being realized in the post-installation period. This variable is significant at the 17 percent level, however, which is slightly less than the 10 percent significance criteria commonly used for these models.

The highlighted variable in Table 50 is the coefficient on the *ex ante* savings estimates. As shown in the table, the savings coefficient has an estimate of -0.75 and is significantly different from zero at the 1 percent level of significance. This indicates that 75 percent of the *ex ante* gross savings is being realized by NRER and NREC participants. The coefficient estimate is not significantly different from 1.0, however. Using the standard error of 0.26 for the savings coefficient yields a 90 percent confidence interval of +/- 57 percent.

As discussed previously and in *Appendix A*, there appears to be a tendency to overestimate *ex ante* savings for NRER and NREC projects, especially in those cases when a production expansion is assumed. The realization rate from the billing model provides additional support for this finding, as only 75 percent of the *ex ante* savings are being achieved. Given the issues with the savings variables and the confidence interval for the realization rate, there is a high level of uncertainty with the *ex post* gross impact estimates for the NRER and NREC components.

Table 50: NRER / NREC Billing Model Regression Results

Model Statistics	Value
Observations	124
Variables	14
F Statistic	69.977
F Statistic Level of Significance	< 1%
Adjusted R-Squared	0.879

Parameter Estimates	Coefficient	Standard Error	T Statistic	Level of Significance
Intercept	46828.00	14699.14	3.19	< 1%
Small Customer *Pre-Usage (< 20,000 annual therms)	-0.76	0.73	-1.05	30%
Medium Customer *Pre-Usage (20-80,000 annual therms)	0.56	0.20	2.76	1%
Large Customer*Pre-Usage (> 80,000 annual therms)	0.81	0.04	18.87	< 1%
Expanded Production	0.41	0.29	1.40	17%
Savings	-0.75	0.26	-2.82	1%
Change in cooling degree days (post-pre)	171.74	49.73	3.45	< 1%
Change in heating degree days (post-pre)	9.86	19.92	0.50	62%
Increased Gas Costs	-14183.00	10949.35	-1.30	20%
Impending Equipment Failure	-3039.00	7882.10	-0.39	70%
Operating Cost Reduction	-11848.00	15678.56	-0.76	45%
Equipment Failed	-29281.00	18245.48	-1.61	11%
Increased Labor	20249.00	13896.25	1.46	15%
Increased Production	7831.99	7318.06	1.07	29%

EX POST NET IMPACTS

Table 51 below summarizes the impact adjustments recommended by program components that take into account the results of the billing analysis, spillover, and self-reported free ridership. The final *ex post* net realization rate is the product of all the adjustment factors shown in the table. In those cases where no adjustment is needed (such as with the on-site verifications), an adjustment factor of 1 is used.

For the Food Service component, the *ex post* net realization rate consists of the coefficient estimate from the billing regression, which accounts for free ridership and a general realization rate based on actual post-installation usage. In addition, a 10 percent spillover adjustment is made to create a final adjustment factor of 0.55, which is used as the *ex post* net realization rate for the Food Service component.

For the NRER and NREC components, the billing regression only uses participant data so the resulting savings coefficient needs to be adjusted for both free ridership and spillover. From the self-report analysis we derived a net-to-gross ratio of 0.80 that accounts for both free ridership and spillover. When this is combined with the savings coefficient, the final *ex post* net realization rate is 0.60 for both the NRER and NREC components.

For reasons discussed above, there is a high degree of uncertainty with these *ex post* net realization rates for each of the NRFIP components. Some uncertainty is introduced through the billing models that utilize samples with diverse projects and business types and savings estimates that are potentially overstated. In addition, the self-report free ridership is based on a method that by necessity assigns weights somewhat arbitrarily. The free ridership result was consistent with the result using a different self-report method as well as the results of the billing analysis (for Food Service) which helps reduce the uncertainty. Finally, the spillover assumption of 10 percent was based on our experience with other energy program evaluation but was not supported with any primary research in its application to this evaluation.

Table 51: *Ex Post* Net Realization Rates for Therm Impacts

Program Component	Spillover (1 + Spillover)	Self-Report Net-to-Gross Ratio	Verification	Billing Analysis Realization Rate	*Ex Post* Net Realization Rate
Food Service	1.1	--	1	0.50	0.55
NRER	--	0.8	1	0.75	0.60
NREC	--	0.8	1	0.75	0.60

Using the *ex post* net realization rates, the *ex post* net savings numbers are shown below in Table 52 by program component. Note that Table 51 shows the adjustment between the *ex ante* gross and *ex post* net savings. Table 52 shows a comparison between the *ex ante* and *ex post* net savings numbers.

As discussed above, the reductions in net savings shown in Table 52 are due in part to free ridership, as evidenced by both the billing regression model results and the self-report free ridership analysis. In addition, our engineering review indicates that the initial savings estimates may be overestimated. There is little or no background documentation on how the savings values are calculated, however, so the evaluation was unable to review the underlying calculation assumptions beyond the review of a small sample of applications and the calculation spreadsheets for selected measures.

Note that the Food Service component realized a larger reduction going from *ex ante* net impacts to *ex post* net impacts than the other components. This is due to the fact that SCG applies an 80 percent net-to-gross ratio to the NRER and NREC components, and a 100 percent net-to-gross ratio is applied to calculate the net therm impacts for the Food Service component. The SCG net therm savings for the NRER and NREC components have therefore already been reduced by 20 percent from the gross savings value while the Food Service component has not realized any reduction from gross savings to SCG net savings.

Table 52: Comparison of *Ex Ante* and *Ex Post* Net Therm Impacts

Program Component	Number of Participants	*Ex Ante* Gross Therm Savings	SCG *Ex Ante* Net Therm Savings	Evaluation *Ex Post* Net Therm Savings	Difference Between Evaluation and SCG Net Savings (%)
Food Service	1,135	2,203,054	2,203,054	1,343,863	-39%
NREC	69	1,570,078	1,256,063	942,047	-25%
NRER	219	1,697,750	1,358,200	1,018,650	-25%
Total	1,423	5,470,883	4,817,317	3,304,560	-31%

Finally, Table 53 presents the savings table required by the CPUC that shows the savings over time taking into account the expected useful life for each measure. Annual savings for measures installed as part of the 2004-05 NRFIP decreases over time once the equipment life is exceeded.

Table 53: CPUC Impact Table Showing Cumulative Therm Savings Over Time

Program ID*:	1260-04							
Program Name:	Southern California Gas Company Non-Residential Financial Incentives Program							
	Year	**Calendar Year**	**Gross Program-Projected MWh Savings**	**Net Evaluation Confirmed Program MWh Savings**	**Gross Program-Projected Peak MW Savings**	**Evaluation Projected Peak MW Savings****	**Gross Program-Projected Therm Savings**	**Net Evaluation Confirmed Program Therm Savings**
	1	2004	---	---	---	---	2,428,620.57	1,463,629.57
	2	2005	---	---	---	---	5,470,882.91	3,304,560.29
	3	2006	---	---	---	---	5,470,882.91	3,304,560.29
	4	2007	---	---	---	---	5,470,882.91	3,304,560.29
	5	2008	---	---	---	---	5,470,882.91	3,304,560.29
	6	2009	---	---	---	---	5,470,882.91	3,304,560.29
	7	2010	---	---	---	---	5,470,882.91	3,304,560.29
	8	2011	---	---	---	---	5,470,882.91	3,304,560.29
	9	2012	---	---	---	---	5,470,882.91	3,304,560.29
	10	2013	---	---	---	---	5,442,652.02	3,287,339.45
	11	2014	---	---	---	---	5,406,053.58	3,265,014.40
	12	2015	---	---	---	---	5,406,053.58	3,265,014.40
	13	2016	---	---	---	---	4,788,561.74	2,888,344.38
	14	2017	---	---	---	---	3,267,828.43	1,960,697.06
	15	2018	---	---	---	---	3,267,828.43	1,960,697.06
	16	2019	---	---	---	---	3,204,340.43	1,922,604.26
	17	2020	---	---	---	---	3,182,408.43	1,909,445.06
	18	2021	---	---	---	---	3,182,408.43	1,909,445.06
	19	2022	---	---	---	---	3,182,408.43	1,909,445.06
	20	2023	---	---	---	---	3,182,408.43	1,909,445.06
	TOTAL	**2004-2023**	---	---	---	---	89,708,635.80	54,087,603.14

7. CONCLUSIONS AND RECOMMENDATIONS

Based on the evaluation results presented in this report, we draw the following conclusions for the 2004-5 NRFIP evaluation.

- **Participation satisfaction with the NRFIP is very high.** In the survey, 88 percent of participants said they were very satisfied with the program and none of the participants said they were dissatisfied with their overall program experience. In addition, most participants also expressed high levels of satisfaction with the equipment installed through the program (79 percent responded with "Very Satisfied".)

- **All measures included in the on-site audit sample were verified.** Through the 100 on-site audits we were able to verify virtually every measure that was included in the tracking system for these customers.

- **Participant satisfaction, program influence, and awareness levels similar to Express Efficiency.** As discussed earlier, participants from both programs had very high satisfaction levels, were strongly influenced by the program to purchase energy efficient equipment in the future, and relatively low awareness levels of other energy efficiency programs. These similarities are not surprising given that these programs are implemented in the same manner.

- **The program is effectively addressing the hard-to-reach aspects of its target customers.** Current participation shows high levels of customers that speak languages other than English, and this rate is higher than what was observed for SCG customers in the 2003 Express Efficiency evaluation. Similarly, the NRFIP has been successful in recruiting renters, which traditionally has been a difficult group to reach with energy efficiency programs. The NRFIP has also been successful in reaching customers in more remote geographic locations. Participant survey results also indicate that these customers are generally unaware of other energy efficiency programs.

- **SCG program sponsorship is important.** From the participant survey, 73 percent of respondents said that having SCG sponsor the program was very important and that just over half (57 percent) first became aware of the NRFIP through a SCG representative. In addition, 93 percent of the participants indicated that their program participation caused them to be more likely to install other energy efficient measures in the future.

- **Free ridership is high.** Our self-report analysis suggests that free ridership may be in the neighborhood of 30 percent for this program, a result that is consistent with net billing analysis completed for the Food Service component. While this finding is similar with the rate observed for some other non-residential programs (such as Standard Performance Contracting) it is much higher than the rate that has been assumed historically for this program.

Based on the evaluation results presented in this report, we offer the following recommendations for improving the NRFIP.

- **Background documentation on all savings calculations is urgently needed.** There was not adequate background documentation to support any of the savings calculations for any of the measures included in the NRFIP. Developing work papers to document the savings assumptions should be made a high priority for this program. (Conversations with utility staff regarding the 2006-08 NRFIP indicate that significant progress has already been made on this issue.)

- **Projects with large therm savings should receive more engineering scrutiny.** Large projects should not rely only on field staff calculations or recommendations by vendors to determine savings. Engineers should be reviewing and adjusting savings calculations as needed for these projects. (See *Section 4* and *Appendix A* for engineering recommendations for specific measures.)

- **Include bill information on project application for use in calculating savings.** For a sample of projects reviewed in the engineering review, it appears that the savings estimates may be overstated. Including a customer bill showing monthly therm usage for the prior year to verify actual therm usage should help produce more accurate savings estimates during the application process.

- **Assumptions regarding production increases in the savings calculations should be limited to special circumstances.** Part of the overestimation of savings may be due to assuming increases in production that ultimately do not materialize. As discussed in this report, an increase in capacity does not necessarily result in an increase in production. If production increases are allowed in the savings calculations, they should be limited to special circumstances that are well documented.

- **For engine rebuilds, the 15-year measure life assumption should be re-evaluated.** Two of the three customers we visited during on-sites that had engine rebuilds stated that they rebuild their engines within 5 years. Even with modest use, it is unlikely that this measure will last 15 years as currently assumed.

APPENDIX A: REVIEW OF SAVINGS CALCULATORS

As part of this evaluation, we requested work paper documentation that supports the NRER, NREC and Food Service incentive programs. We received 7 spreadsheet calculators for specific customized measures in the NRER and NREC programs. Our review of the 7 calculators is summarized below.

ENGINE REBUILD CALCULATOR

A calculator for the engine rebuild is shown as Figure A-1 below. In the first section of the calculator, annual gas consumption from utility bills is input. There is also verification of any increase or decrease in production. The fuel rate for the existing equipment is set at 10,180 btu/HP based on an engine efficiency of 25 percent. The fuel rate for the equipment after rebuild or replacement is set at 9,089 btu/HP based on an engine efficiency of 28 percent. This section indicates that the measure will increase the efficiency of the engine from 25 percent to 28 percent, and that the savings associated with this measure is a constant 1,091 btu/HP-hr.

The second section of the calculator is a description of the existing equipment. The primary purpose of this section is to provide a load balance, which accounts for the annual gas usage by end use. The spreadsheet inputs include number of units, nominal HP of each unit, annual hours and an estimated design load factor. The annual therm usage at design load factor is calculated for each end use and then adjusted so that the total matches the annual usage obtained from the utility bills.

The third section of the calculator details the annual performance characteristics of the existing equipment to be repaired or replaced (gas engines). In this section there is an opportunity to input different operating parameters than in the second section. It is unclear why the equipment operating parameters should be different than those input and calculated in the previous section.

In the fourth section of the calculator, the operating characteristics of the equipment after repair or replacement are input. The spreadsheet inputs include number of units, nominal HP of each unit, annual hours and an estimated design load factor. The annual therm usage at design load factor is calculated for each end use and then adjusted. In this section there is an opportunity to input different operating parameters than in the second or third sections, to account for planned changes in operation of the equipment. The annual equivalent full load hours EFLH are calculated with a maximum allowable value of 4,000.

After all this input, the annual savings are calculated solely based on the number of units multiplied by the nominal HP and EFLH and the assumed fuel rate savings of 1,091 btu/HP-hr. Field verification of the increase in efficiency for engines would be difficult since precise testing equipment and laboratory conditions are required to accurately measure engine performance parameters.

We received a document listing the measure life for different measures in the program. The document shows a 15-year life for the engine and pump rebuild or replacement. For PY2004, we visited three customers who participated with this measure. Two of three stated that they rebuild

their engines regularly (within 5 years or less) and they operate an average of 4,350 hours annually.

The algorithm methodologies used in the calculator that compare an existing engine operating at one efficiency to a rebuilt/new engine operating at a different efficiency are correct.

Recommendations:

1. Include a copy of the utility bill data in the application so that the annual energy use can be easily verified.

2. Do not allow increases in annual production except in unique well-documented cases. Consider that if the engine is driving a pump, the annual EFLH may actually decrease after rebuild/replacement since presumably only a fixed amount of water needs to be pumped and a more efficient engine may accomplish this in less time.

3. Provide detailed credible references and documentation to support the existing and proposed engine efficiencies used in the calculator.

4. Remove the third section of the calculator or explain why it is different than the second section and what its purpose is.

5. Create a detailed work paper documenting all aspects of the calculator clearly listing facts and assumptions and outlining calculation methodologies.

6. SCG should reevaluate the measure life used for engine rebuilds or replacements. It is unlikely that any engine that has even modest usage will operate 15 years before a rebuild is necessary.

Figure A-1: Engine Rebuild / Replacement Calculator

Single and Multiple Gas Engine Pump Therm Savings Calculation Spread Sheet

Please read Instructions tab. Input in yellow cells only!

Has Production increased or decreased?	No	(Yes or No)
Annual Usage (from MAS)	100,000	
Usage (Increased/ Decreased Production)	0	
Annual Usage	100,000	

	Efficiency	BTU/HP	Fuel Rate
Existing Equipment	25%	2,545	10,180
Incent Equipment	28%	2,545	9,089
Savings/HP*Hr			1,091

Engine Rebuild/Replacement - Existing Equipment

Number of Units	Hp	Hours /Day	Days /Week	Weeks /Year	Design Load Factor (<= 1)	Usage at Design	Adjusted Load Factor	Estimated Annual
2	150	24	7	50	0.85	218,056	0.14	36,691
2	200	24	7	50	0.85	290,741	0.14	48,921
1	200	24	7	50	0.50	85,512	0.08	14,388
							Total	100,000
							Scaling Factor	16.8%

Existing Equipment Being Replaced/Repair

Number of Units	Hp	Hours /Day	Days /Week	Weeks /Year	Design Load Factor (<= 1)	Usage at Design	Adjusted Load Factor	Estimated Annual
2	150	5	7	50	0.85	45,428	0.14	7,644
2	200	5	7	50	0.85	60,571	0.14	10,192
						0	0.00	0

Incent Equipment After Replacement/Repair

Number of Units	HP	Hours /Day	Days /Week	Weeks /Year	Design Load Factor (<=1)	Usage at Design	Adjusted Load Factor	Estimated Annual	EFLH
2	150	24	7	50	0.40	91,620	0.07	15,416	565
2	200	24	7	50	0.35	106,890	0.06	17,986	495
						0	0.00	0	0

Engine Therms Saved **4,008** (Approximately $3006.17 rebate)

PUMP REBUILD CALCULATOR

A calculator for the pump rebuild is shown as Figure A-2 below. This calculator is linked to the engine calculator since a gas engine presumably drives the pump and it is implied that engine is rebuilt or replaced along with the pump. The user inputs for this calculator include number of units, nominal HP of each unit and annual hours of operation. This calculator indicates that the measure will increase the efficiency of the pump from 68 percent to 75 percent. The decrease in pump motor HP is calculated based on the assumed increase in efficiency. The EFLH are calculated based on the scaling factor determined in the engine rebuild calculator multiplied by the annual hours and load factor for the pump.

The annual savings are estimated by multiplying the EFLH by the HP reduction and engine fuel rate assuming a 28 percent efficient engine. The algorithms used in the calculator that compare an existing pump operating at one efficiency to a rebuilt/new pump operating at a different efficiency are correct. It would be useful to evaluate this measure using pump curves obtained from pump manufacturers to verify the operating points of the pumps and determine the accuracy of the assumptions used in the calculator.

General comment: The Engine/Pump calculator appears to be overly complex with some inconsistencies in its methodology. For instance, since the pump is presumably linked to the motor, the equivalent full load hours (EFLH) should be equal for both. Also, once the disaggregated annual gas usage is calculated, it should be used to determine other parameters such as EFLH, and there should be consistent operating parameters (such as annual hours and load factors) used for the various calculations.

Field verification of the increase in efficiency for pumps and engines would be difficult since precise testing equipment and laboratory conditions are required to accurately measure pump and engine performance parameters.

Recommendations:

1. Include a copy of the utility bill data in the application so that the annual energy use can be easily verified.

2. Do not allow increases in annual production except in unique well-documented cases. Consider that with increased pump efficiency, the annual EFLH may actually decrease after rebuild/replacement since presumably only a fixed amount of water needs to be pumped and a more efficient pump may accomplish this in less time.

3. Provide detailed credible references and documentation to support the existing and proposed pump efficiency used in the calculator.

4. Create a detailed work paper documenting all aspects of the calculator clearly listing facts and assumptions and outlining calculation methodologies.

Figure A-2: Pump Rebuild / Replacement Calculator

Pump Rebuild/Replacement

Number of Units	Baseline Hp	Baseline Efficiency	Water Hp	New Efficiency	New Engine Hp	Hp Reductio	Hours/day	Days /week	Weeks /Year	Design Load	Adjusted Load	EFLH
2	200	0.68	136	0.75	181	19	5	7	50	0.40	0.0673	118
		0.68	0	0.75	0	0					0.0000	0
		0.68	0	0.75	0	0					0.0000	0

Pump Therms Saved **400** (Approximately $299.76 rebate)

MAS Input - Engine	First Engine	Second Engine	Third Engine		
Old Equipment Annual Therm Usage	7,644	10,192	0		
New Equipment Annual Therm Usage	15,416	17,986	0		
Old Equipment Annual Production	1.00	1.00	1.00		
New Equipment Annual Production	2.26	1.98	0.00		
Annual Therm Savings	1,850	2,158	0	4,008	=Total Engine Project (Must equal cell C32)

MAS Input - Pump	First Pump	Second Pump	Third Pump		
Old Equipment Annual Therm Usage	4,282	0	0		
New Equipment Annual Therm Usage	3,883	0	0		
Old Equipment Annual Production	1.00	1.00	1.00		
New Equipment Annual Production	1.00	1.00	1.00		
Annual Therm Savings	400	0	0	400	=Total Pump Project (Must equal cells C42)

COIN-OP LAUNDRY CALCULATOR

A calculator for the coin-op laundry is shown as Figure A-3 below. The first section of the calculator is the facility and audit information. The primary purpose of this section is to provide a load balance that accounts for the annual gas usage by end use. Typical end uses are clothes dryers and water heating boilers. The spreadsheet inputs include number of units, input Mbtuh of each unit, annual hours and an estimated design load factor. The annual therm usage at design load factor is calculated for each end use and then adjusted so that the total matches the annual usage obtained from the utility bills.

The second section of the calculator details the annual performance characteristics of the existing equipment to be replaced (clothes dryers). In this section the annual therms usage from section 1 of the calculator, the estimated dryer efficiency expressed as btu input to remove one pound of water and the percent of water in each pound of wet laundry are used to calculate the annual pounds of laundry (annual production) dried in the existing dryers. The efficiency of the existing dryers is also estimated by dividing the "ideal" efficiency of 1,080 btu/lb by the estimated existing dryer efficiency.

In the third section of the calculator the new equipment performance is provided and annual gas consumption is calculated. Inputs include the number of units, loads per day, load size, percent water per pound of laundry and dryer efficiency expressed as btu input to remove one pound of water. The efficiency of the new dryers is also estimated by dividing the "ideal" efficiency of 1,080 btu/lb by the estimated existing dryer efficiency. One flaw in this calculator is that the annual production (lbs of laundry) is recalculated in this section and not necessarily the same as calculated in section 2. There is really no justification in most cases in increasing the annual production since the estimated load factors and loads per day are quite low.

Finally, the annual therm savings are calculated by using the value for new annual production calculated in the third section of the calculator and the efficiencies of the existing and proposed clothes dryers.

The algorithms used in the calculator that compare an existing clothes dryer operating at one efficiency to a new clothes dryer operating at a different efficiency are correct.

Recommendations:

1. Include a copy of the utility bill data in the application so that the annual energy use can be easily verified.

2. Do not allow increases in annual production except in unique well-documented cases since most clothes dryers are operating at low load factors. (Make the existing estimate of annual production equal to the proposed estimate of annual production.)

3. Provide detailed documentation to support the existing and proposed clothes dryer efficiency used in each application.

4. Create a detailed work paper documenting all aspects of the calculator clearly listing facts and assumptions and outlining calculation methodologies.

Figure A-3: Coin-Operated Clothes Dryer Calculator

Facility Audit Information

Annual Usage (from MAS): 14,471

All Existing Equipment Description	Number of Units	Size (MBtu)	Hours /Day	Days /Week	Week /Year	Design Load Factor	Usage at Design (Th)	Adjusted Load Factor	Estimated Annual Therm Use
Dryers	28	105	16	7	52	0.25	42,806	6.2%	10,635
Water Heater	3	178.5	24	7	52	0.33	15,438	8.2%	3,836
Equipment 2							0	0.0%	0
Equipment 3							0	0.0%	0
Equipment 4							0	0.0%	0
Equipment 5							0	0.0%	0
Equipment 6							0	0.0%	0
Equipment 7							0	0.0%	0
								Sum	14,471
								Scaling Factor	24.8%

Existing Equipment being Replaced

Type	No of Units	Ave. Loads/ Day	Load Size	Loads/ Year	Annual Production (lbs)	Water in Load (%H_2O)	Water Removed (lbs)	BTU/lb
Dryers	28	2.8	30	28,590	857,695	50%	428,847	2,480

Size/Unit (MBTU)	Hours/ Day	Days/ Week	Weeks/ Year	Annual Therms	Cycle Time (min.)	Est. Effic*
105	16	7	52	10,635	30	43.5%

New Equipment being Added

Type	No of Units	Loads/ Day	Load Size	Loads/ Year	Annual Production (lbs)	Water in Load (%H_2O)	Water Removed (lbs)	BTU/lb
Dryer	25	2.0	60	17,745	1,064,700	50%	532,350	1827

Size (MBTU)	Hours/ Day	Days/ Week	Weeks/ Year	Load Factor	Annual Therms	Maximum Loads/Day	Est. Effic*
160	16	7	52	4.2%	9,726	27	59.1%

* Efficiency is based on 1080 BTU/lb ideal efficiency

The Therms Saved for this project is 3,476

The Existing Dryers operates 5824 hours / 5,824 EFLH
The New Dryer operates 5824 hours / 243 EFLH

FLUE GAS ECONOMIZER CALCULATOR

A calculator for the flue gas economizer is shown as Figure A-4 below. The calculator inputs include the annual therm consumption and burner size. Boiler efficiency, percent excess air and the flue gas inlet and outlet temperatures are also input and presumably obtained from field testing of the boiler after the flue gas economizer is installed.

The calculator uses a mass and energy balance to determine the savings associated with the measure. The maximum heat recovery rate is calculated through a series of equations that includes measurements of excess air and flue gas inlet and outlet temperatures. The annual therms saved is estimated by multiplying the maximum heat recovery rate by the EFLH and dividing by the system efficiency.

The mass and energy balance algorithms used in the calculator that estimate the impact of a flue gas economizer installation based on field-measured pre and post retrofit data are correct.

Recommendations:

1. Include a copy of the utility bill data in the application so that the annual energy use can be easily verified.

2. The performance of the economizer is likely to vary based on the boiler loading. It would be useful to test the economizer performance over a range of operating points and use the results for the analysis.

3. Create a detailed work paper documenting all aspects of the calculator clearly listing facts and assumptions and outlining calculation methodologies.

Figure A-4: Flue Gas Economizer Calculator

Economizer Therm Savings

Enter variable information in the yellow cells only

Annual Usage	136188	Therms/year
Burner Size	4850	MBTU
EFLH	2808	
Boiler Efficiency	79	%
Boiler Surface Loss	7	%
Load Factor	100	%
HHV of Natural Gas	23879	BTU/lb
Mass Flow Rate (Natural Gas)	203	lb/hr
AFR (Stoichiometric)	17.16	lb(air)/lb(fuel)
Excess Air	20	%
AFR(actual)	20.592	
Mass Flow Rate (Flue Gas)	4385	lb/hr
Flue Gas Inlet Temperature	400	°F
Flue Gas Exit Temperature	300	°F
C_P(Flue)	0.245	BTU/lb-°F
Cp(Water)	1.04	BTU/lb-°F
Max Heat Recovery Rate	107	MBTU/hr
Therms Saved	**4190**	**Therms/Year**

MELTING EFFICIENCY CALCULATOR

A portion of the calculator for melting efficiency is shown in Figure A-5. (The first section of the calculator is not included.) The first section of the calculator is the facility audit information. The primary purpose of this section is to provide a load balance that accounts for the annual gas usage by end use. The spreadsheet inputs include number of units, input Mbtuh of each unit, annual hours and an estimated design load factor. The annual therm usage at design load factor is calculated for each end use and then adjusted so that the total matches the annual usage obtained from the utility bills.

The second section of the calculator details the annual performance characteristics of the existing melting equipment. In this section the annual therm usage from section 1 of the calculator, the estimated melting efficiency, re-melt rate and heat content for the metal are used to calculate the annual pounds of metal melted. The calculator user chooses either zinc or aluminum metal for the project and the spreadsheet selects the associated heat content for the metal. The efficiency of the melting process is estimated by dividing the estimated melt rate by the heat content for the metal.

In the third section of the calculator the new equipment performance is provided and annual gas consumption and production are calculated. Inputs include the connected load (Mbtuh), number of units, annual operating hours, production increase and melt rate. The efficiency of the melting process is estimated by dividing the estimated melt rate by the heat content for the metal.

The savings for the measure are not calculated. Presumably they would be based by comparing the annual therm consumption of the old equipment at the new production rate versus the new equipment at the new production rate.

This calculator is the most complete and detailed of the 7 reviewed. It contains detailed instructions for the user, is easy to follow with color-coded cells and has cited references for constants used in the equations. There are some inconsistencies, however; the data from the load balance in section 1 is not linked in the version we received to the "Connected load" and "annual therm usage" sections of the second section of the calculator. This could cause calculation errors.

Recommendations:

1. Include a copy of the utility bill data in the application so that the annual energy use can be easily verified.

2. Create a detailed work paper documenting all aspects of the calculator clearly listing facts and assumptions and outlining calculation methodologies.

3. Add the annual savings calculation to the calculator.

4. Link the load balance data from section one to the other sections of the calculator.

5. Require that the customer submit performance data for the new equipment and make sure this information is contained in the project file.

6. Obtain production data from the customer to support project documentation.

Figure A-5: Melting Efficiency Calculator

NOT FOR EXTERNAL DISTRIBUTION

Customer Name Here

Zinc

	Connected Load Mbtu	Units	Hours/Day	Days/Week	Weeks/Year	Therm Conversion	LF [2]	Annual Therm Use	Efficiency	Remelt Rate %	Heat Content for Zinc (BTU/#) [3]	Melt Rate (BTU/#)	Base Lbs/Yr	Total Lbs/Year with Remelt [1]
OLD	5,000	1	16	5	52	0.01	24%	50,000	14%	10%	142	1000	5,000,000	5,500,000

										Production Increase			Total Lbs/Year with Remelt and Production Increase
NEW	5,000	1	16	5	52	0.01	25%	51,425	17%	10%	142	850	6,050,000

Data from Load Balance Sheet [2]
Data collected from customer letter
Data collected from vendor letter
Data collected from audit of facility and MAS

Comments:

Enter comments supporting this equation here.

[1] *This number should include the remelt rate obtained by customer in lbs/yr.*

[2] *Hours of operation and load factor to be obtained through use of Load Balance sheet attached.*

[3] *The Heat Content figures were taked from the North American Combustion Handbook, 3rd Edition, Volume II, Table A.12US 'Thermal Properties of Metals', p260.*

DISCLAIMER: "The above figures are estimates only, based on numerous contingencies and assumptions, and are not warranted, either express or implied, to be accurate, complete, or useful. Actual costs will vary with usage, load, tariff rate changes, and other factors that are subject to change. In no event will Southern California Gas Company be liable for damages of any kind arising out of the use of or reliance upon the information contained in this document, even if it has been advised of the possibility of such damages."

Instructions:

Load Balance Sheet:

1 Complete the Load Balance sheet

Efficiency Formula sheet:

2 Enter Customer Name

3 Select Aluminum or Zinc from the drop down menu

4 Enter data collected from audit of facility and MAS in the yellow fields

5 Enter data collected from vendor letter in the green fields

6 Enter data collected from customer letter in the orange fields

7 Complete the comments section

8 Print both sheets for inclusion in DSM Packet or customer folder

9 Therm savings derived from production increases are equated in MAS when the project is enetered

ATMOSPHERIC BURNER CONVERSION TO POWER BURNER CALCULATOR

A calculator for the atmospheric burner conversion to power burner is shown in Figure A-6. The calculator inputs include burner size, furnace process efficiency, percent excess air for the atmospheric burner and power burner, annual hours, load factor and the furnace internal and ambient temperatures.

The calculator uses a mass and energy balance to determine the savings associated with the measure. The annual savings are calculated based on the difference between the air fuel ratios, the mass flow rate of methane, the difference between the ambient and furnace internal temperatures, annual operating hours and load factor.

The mass and energy balance algorithms used in the calculator that estimate the impact of converting an atmospheric burner to a power burner with combustion controls based on field measured pre and post retrofit data are correct.

Recommendations:

1. Include a copy of the utility bill data in the application so that the annual energy use can be easily verified.

2. Add a load balance section to the calculator to provide an accounting of all equipment served by the gas meter. Make sure that the load balance information is correctly transferred into the savings calculation.

3. Create a detailed work paper documenting all aspects of the calculator clearly listing facts and assumptions and outlining calculation methodologies.

Figure A-6: Atmospheric to Power Burner Calculator

Atmospheric Burner to Power Burner Replacement

Burner Size (MBTU)	Density of Methane @STP (lbs/ft^3)	M_f (Lbs/Hr)	Cp_{air} (BTU / lbs-degF)	Furnace Process Efficiency
1000	0.045	45	0.26	**90%**

Atmospheric Burner

Excess Air	AFR_A	$T_{furnace}$ (°F)	T_{amb} (°F)	Hours	Load Factor
250%	60.39	**1100**	85	**6500**	**0.5**

Power Burner

Excess Air	AFR_P
20%	20.71

Therms Saved	**17,019**

PIPING INSULATION CALCULATOR

A portion of the calculator for piping insulation is shown in Figure A-7 below. (Only the second part of the calculator is shown). The calculator inputs for the base case include the pipe length, diameter, surface temperature and ambient temperature plus the annual hours of operation, load factor and boiler efficiency for the system. Heat transfer equations are used to estimate the annual heat loss from the bare pipe.

In the second part of the calculator, the insulation thickness and cladding emissivity are input and material properties for insulation and pipe cladding are utilized in the heat transfer equations to estimate the heat loss after the retrofit. Annual savings is estimated by subtracting the heat loss from the first and second parts of the calculator.

This calculator provides an excellent approach to estimating the savings associated with this measure. Adding additional supporting details to a work paper will enhance the credibility of the projects associated with this measure.

The heat transfer algorithms used in the calculator that estimate the impact of piping insulation need to have better documentation for the coefficients and heat transfer equations and used in the calculator.

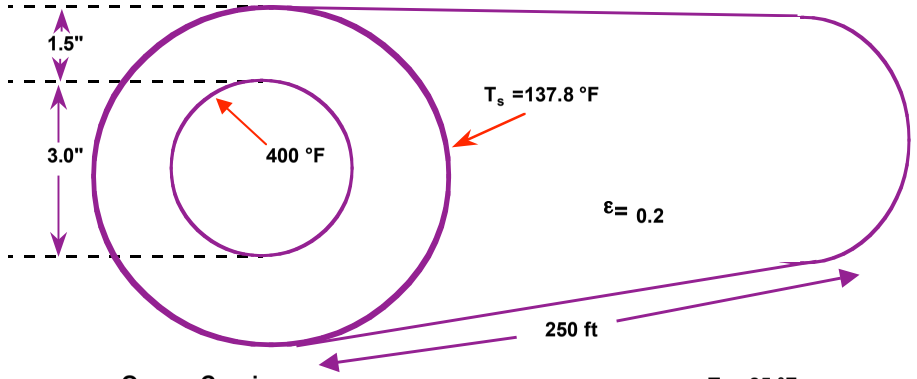
Recommendation:

1. Create a detailed work paper documenting all aspects of the calculator clearly listing facts and assumptions and outlining calculation methodologies, the source of the heat transfer equations, coefficients and material properties used and the applicability and limitations of the calculator.

Figure A-7: Piping Insulation Calculator (Second Part)

Insulation Thickness (inches)	**1.5**
Pipe Temperature (°F)	400.0
Room Temperature, T_∞ (°F)	85.0
Estimated Surface Temp, T_s (°F)	137.8
Mean Temperature, T_m (°F)	268.9
Insulation, k (BTU•in/hr•ft^2•°F)	0.35
T_s-T^∞ (°F)	52.8
R_{al} (hr•ft^2•°F/BTU)	0.85
R_{ins} (hr•ft^2•°F/BTU)	4.25
Aluminum Thickness (inches)	0.016
Insulation Surface Area (ft^2)	295
Qconv (BTU/hr ft2)	62
Qconv (BTU/hr)	18,187
Qrad (BTU/hr)	3,981
Qtotal (BTU/hr)	22,169
Qtotal (Therms/hr)	0.22
EFLH (Hours)	1872
Boiler Efficiency	80%
Qloss Bare Pipe (Therms/yr)	5,758
Qloss w/Insulation (Therms/yr)	519

Annual Therm Savings 5,240 Therms



Owens Corning

k Values, BTU•in/hr•ft^2•°F

Mean Temperature	TIW Type I	TIW Type II
0	0.22	0.20
50	0.24	0.21
75	0.26	0.22
100	0.28	0.24
200	0.39	0.30
300	0.54	0.38
400	0.75	0.44
500	1.03	0.62
600	1.41	0.79

Rs Values, hr•ft^2•°F/BTU

T_s-T^∞, (°F)	Aluminum	Stainless Steel
10	0.90	0.81
25	0.88	0.79
50	0.86	0.76
75	0.84	0.75
100	0.80	0.72
emissivity	0.2	0.4

APPENDIX B: SURVEY INSTRUMENTS

PARTICIPANT SURVEY

Q1. Hello, this is <INTERVIEWER NAME> calling from Quantum Consulting on behalf of the Southern California Gas Company . This is not a sales call. May I please speak with [PROGRAM CONTACT]?

Our records show that your company purchased some new gas-fired equipment this year and received a rebate through the Gas Company's <PROG> program. We are calling to do a follow-up study about your firm's participation in this program. This information will help The Gas Company determine the energy savings achieved through the program and improve its services to business customers like you. This survey will take about 10 minutes and all answers will remain confidential.

I was told you're the person most knowledgeable about this equipment installation.

Is this correct?

May we speak with the person most knowledgeable about the new equipment you purchased, who may have been involved in participating in the Gas Company program?

[IF NO PROGRAM CONTACT]

Hello, this is <INTERVIEWER NAME> calling from Quantum Consulting on behalf of Southern California Gas Company. I need to speak with the person most knowledgeable about recent equipment changes for your firm at this location.

[IF NEEDED] Our records show that your company replaced some older gas-fired equipment this year with new, high efficiency equipment through the Southern California Gas Company <PROG> program. . We are calling to do a follow-up study about your firm's participation in this program. May we speak with the person most knowledgeable about this equipment purchase? This survey will take about 10 minutes.

Screener

[Add variable PROG showing which program they participated in, either: Commercial Food Service Equipment Rebate, Non-residential Equipment Replacement, or Non-residential Energy Conservation.]

A5. Just to check, earlier this year did your business participate in the Gas Company's <PROG> program at this location? [IF NEEDED] This is a Gas Company program where your business received a rebate to replace older gas-fired equipment with new, more energy efficient equipment.

1	Yes, participated as described	A20
2	Yes, participated in program, but at other location	A20
3	Yes, participated in program, but don't recall that as the name	A15
4	NO, did NOT participate in program	A10

77	Other (specify)	A10
88	Refused	A10
99	Don't know	A10

A10. Is it possible that someone else at your [SERV_ADDR] actually dealt with the equipment installation?

1	Someone else dealt with it	A5
2	Installed EE measures (but do not recall rebate or program)	T&T
3	Participated in program/have not installed new equipment yet	T&T
77	Other (SPECIFY) _____	T&T
88	Refused	T&T
99	Don't know	T&T

A15. OK, for the rest of the survey I'll be referring to your participation in the program called the <PROG> program

A20. I'd like to confirm some information in the Gas Company's database. Our records show that you had the following equipment installed through the program. Is this correct?

NOTE: Verify measure and measure quantity. Note below any discrepancies in either measure description or measure quantity.

Quantity	Measure	
&M1	&MEAS1	
&M2	&MEAS2	
&M3	&MEAS3	
&M4	&MEAS4	
&M5	&MEAS5	
&M6	&MEAS6	
&M7	&MEAS7	
&M8	&MEAS8	
&M9	&MEAS9	
&M10	&MEAS10	

[ENTER IN NOTES IF THERE ARE DIFFERENCES]

Measure	
&DIFMEAS1	
&DIFMEAS2	
&DIFMEAS3	
&DIFMEAS4	
&DIFMEAS5	
&DIFMEAS6	
&DIFMEAS7	
&DIFMEAS8	
&DIFMEAS9	
&DIFMEAS10	

Ask for each Measure, repeat up to 3 measures:

SAT1. How satisfied have you been with the performance of the <&MEASn>. Would you say you are:

1	Very Satisfied	RET20
2	Somewhat Satisfied	RET20
3	Not at All Satisfied	RET20
88	Refused	RET20
99	Don't Know	RET20

If SAT1 = 2 or 3 then ask "Why did you say that?" Record answer verbatim.

RET20. Is the <&MEASn> still in place or has it been removed?

1	Yes, still in place	A25
2	No, removed	RET30
88	Refused	A25
99	Don't Know	A25

RET30. Why did you remove the new equipment?

1	Equipment failed	A25
2	Did not perform adequately	A25
3	Savings lower than expected	A25

4	Remodeling disabled the installation	A25
5	Type of business changed	A25
6	Moved	A25
7	Equipment upgrade	A25
8	Other – RECORD VERBATIM	A25
99	Don't Know/Unable to determine	A25

Ask for each Measure, repeat up to 3 measures:

RET40. Did the installation of [&MEASn] involve simply repairing existing equipment, or was the old equipment completely removed and replaced with the new [&MEASn]?

Program Awareness and Participation

Let's talk about your decision to participate in the program.

A25. How did you first become aware of the <PROG> program?

1	From Gas Company Service Technician or Account Rep	A30
2	Bill insert	A30
3	Letter / mailing	A30
4	Vendor / Manufacturer / Distributor	A30
5	Other businesses / word of mouth	A30
6	Other – SPECIFY	A30
99	Don't Know/Unable to determine	A30

A30. Besides the <PROG> program, are you aware of OTHER programs or resources provided by the Gas Company that are designed to promote energy efficiency for businesses like yours: [IF YES] What types of programs can you recall? [RECORD ALL MENTIONS]

1	Express Efficiency	A45
2	Business energy audits	A45
3	Commercial Food Service Equipment Rebate (aka PARR)	A45
4	Non-residential Equipment Replacement	A45
5	Non-residential Energy Conservation	A45
6	Rebate (unspecified)	A45
7	No, not aware of any programs	A45
77	Other programs (SPECIFY) _____	A45
88	Refused	A45

99	Don't know	A45

A45. Why did your company participate in the <PROG> program? [DO NOT READ CATEGORIES; ACCEPT MULTIPLE S]

1	Acquiring the latest technology	A46
2	Saving money on gas bills	A46
3	To receive a rebate	A46
4	Replacing old or broken equipment	A46
5	Because the program was sponsored by the Gas Company	A46
6	Energy crisis	A46
7	Helping protect the environment	A46
8	Previous experience with other Gas Company programs	A46
9	Recommended by utility account reps or service technicians	A46
10	Recommended by contractors	A46
11	Participation in previous years	A46
12	Part of a broader facility remodeling/renovation	A46
13	Recommended by neighboring business or friend	A46
14	A competing business participated	A46
77	Other (SPECIFY) _____	A46
88	Refused	A46
99	Don't know	A46

A46. Did you use a contractor to install the equipment you purchased through the <PROG> program?

1	Yes	PE11
2	No	PE11
99	DK	PE11

PROGRAM EFFECTS

Now we would like to ask you some questions about your program experience.

PE11. Are you more or less likely to install energy-efficient products as a result of your experience with the program?

1	More likely	PE12

2	Less likely	PE15
3	Same	PE15
99	DK	PE15

IF PE11 = 1

PE12. What energy efficiency equipment are you more likely to install?

PE15. Since the new equipment was installed, have you noticed any changes in the amount of gas you consume?

1	Yes	PE25
2	No	PE29
99	DK	PE29

PE25. In percentage terms, how much has your consumption been reduced since you installed the new equipment?

1	Percentage	PE27
99	DK	PE27

PE27. Is the savings more, less, or about the same as what you expected?

1	Savings more than expected	PE29
2	Savings less than expected	PE29
3	Savings the same as expected	PE29
99	DK	PE29

PE29. After you had installed the new equipment and completed the program application, how long did it take for you to receive your rebate check? Was it [READ LIST]:

1	Less than 1 month	PE30
2	1 to 2 months	PE30
3	2 to 3 months	PE30
4	More than 3 months	PE30
5	Still haven't received rebate	PE30
99	DK	PE30

PE30. Using a scale from 1 to 10, where 1 means you aren't knowledgeable at all, and 10 means you are fully knowledgeable, how knowledgeable are you about energy efficiency products and how they'll perform?

#		PE33

PE33. How about your knowledge BEFORE participating in the program, using the same scale

#		PE35

PE35. Now I'd like to read a brief series of statements and I'd like you to tell me how well each statement describes your beliefs about energy efficient investments -- or if they even express your beliefs at all. We'll again use a 1-to-10 scale, where 1 means you DISAGREE with the statement, and 10 means you AGREE COMPLETELY with the statement. The first/next one is … [RANDOMIZE, READ AND OBTAIN A RATING FOR EACH. WHEN SEQUENCE COMPLETE, GO TO REB1.]

[T1-P923]

1	When considering a new energy efficiency investment, I am concerned that the actual bill savings will be less than what was estimated.	REB1
2	I don't have the information I need to make an informed decision about energy efficient investments.	REB1
3	There is too much time and hassle involved in selecting a qualified energy efficiency contractor.	REB1
4	Lack of financing is a barrier to our organization making energy efficiency investments that we want to make.	REB1
5	Getting a utility rebate is too much hassle.	REB1
6	I need the owner's consent to make improvements.	REB1
7	I'm not at this location for long	REB1
8	It's not worth investing because it's not my building	REB1
99	DK/Refused	REB1

INFLUENCE

Let's talk about your participation in the <PROG> program and what influenced you to install high efficiency equipment.

REB1. In deciding to participate in the <PROG> program, how important was it to you the Gas Company sponsored the program? Would you say it was . . .

1	Very Important	REB2
2	Somewhat Important	REB2
3	Not at all Important	REB2
99	DK	REB2

REB2. How important was the rebate on influencing the type of equipment you purchased?

1	Very Important	REB3
2	Somewhat Important	REB3
3	Not at all Important	REB3
99	DK	REB3

If A46 = 1 ask:

REB3. How important was the input from the contractor you worked with in deciding which specific equipment to install? Was it

1	Very Important	REB23
2	Somewhat Important	REB23
3	Not at all Important	REB23
99	DK	REB23

GR1. Did you discuss your equipment installation with a Gas Company representative?

GR2. Did the Gas Company representative discuss the program rebate options with you?

GR3. How influential was the Gas Company representative in helping you decide which specific equipment to install?

GR4. If you did not discuss your equipment installation with the Gas Company representative would you have purchased the same equipment, or something less efficient?

REPEAT FOR UP TO 3 MEASURES:

Now we'd like to ask some questions specifically about the {MEAS_DESC} that you installed.

REB23. Before you began shopping, were you aware of the different levels of energy efficiency for your item?

1 Yes REB25

2	No	REB25
88	Refused	REB25
99	Don't know	REB25

REB25. Were you aware of the rebate **before or after** you began shopping for [MEAS1]?

1	Before	REB30
2	After	REB30
3	Same time	REB30
88	Refused	REB30
99	Don't know	REB30

REB30. Were you **aware of the rebate before or after you** decided on purchasing equipment that qualified for the rebate?

1	Before	REB35
2	After	REB35
3	Same time	REB35
88	Refused	REB35
99	Don't know	REB35

REB35. When you started shopping for [MEAS1, had you already decided you wanted energy efficient equipment?

1	Yes	REB50
2	No	REB50
77	Other [SPECIFY]:_____	REB50
88	Refused	REB50
99	Don't know	REB50

REB37. When you became aware of the program rebate, did you decide to change the specific type of equipment that you installed?

REB50. Regarding the [MEASn], which of the following three statements best describes the actions you would have taken had you not participated in the <PROG> program**:**

1	We would have bought NO equipment	SAT1

2	We would have bought the SAME **energy efficient** equipment	REB55
3	We would have bought less efficient or less expensive equipment	SAT1
88	Refused	SAT1
99	Don't know	SAT1

IF REB50 = 2

REB55. When would you have bought [MEAS1] if the program had not provided it:

1	At the same time	REB 65
2	Within a year	REB 65
3	More than a year	REB 60
88	Refused	REB 65
99	Don't know	REB 65

IF REB55 = 3

REB60. How many years would you have waited before buying [MEAS1] if they had not been provided through the program??

1	Number of Years	SAT1
88	Refused	SAT1
99	Don't know	SAT1

END REPEAT FOR 3 MEASURES

ASK ALL ONCE:

Now I'd like to read a brief series of statements and I'd like you to tell me how well each statement describes what may have influenced your equipment purchase decision.

We'll again use a 1-to-10 scale, where 1 means you DISAGREE with the statement, and 10 means you AGREE COMPLETELY with the statement. The first/next one is … [RANDOMIZE, READ AND OBTAIN A RATING FOR EACH. WHEN SEQUENCE COMPLETE, GO TO SAT1.]

1	Thanks to the program rebate, I was able to install a more energy efficient piece of equipment than I would have otherwise.	SAT1
2	I was already planning on buying the exact piece of equipment I installed before I even knew about the rebate.	SAT1
3	Without the Gas Company representative's assistance, I would have bought a less efficient piece of equipment.	SAT1

4	The contractor that installed my equipment was much more influential in my equipment selection decision than the Gas Company or the rebate.	SAT1
5	I would have delayed purchasing the particular energy-efficient equipment if the Gas Company had not offered a financial incentive for the equipment.	SAT1
99	DK/Refused	SAT1

SATISFACTION

We'd like to get a sense of your satisfaction with the program. Please rate your satisfaction with these factors as VERY, SOMEWHAT or NOT AT ALL satisfied.

SAT1	Overall satisfaction with the <PROG> program experience	
SAT30	Satisfaction with the **bill savings**	
SAT31	Satisfaction with the participation process	
SAT32	Satisfaction with rebate processing time	
SAT33	Satisfaction with the installation contractor	If A46=1
SAT34	Satisfaction with the equipment installation process	

For any responses that indicate NOT AT ALL satisfied, ask:

SAT44. Why do you say that?

SAT45. Other than what you already mentioned, were you at all dissatisfied with any other aspects of the program?

#		SAT50

SAT50. If yes: why? [RECORD VERBATIM.]

Renter Battery

R1. How active a role does your business take in decisions to purchase gas equipment at this facility? [READ LIST.]

[Q7-P923]

[2002 : PART, NP]

1	Very active	R5
2	Somewhat active	R5
3	Slightly active	R5
4	Not active at all	R5
99	DK/NA/refused	R5

R5. Does your business own or lease the facility?

[Q3-P923]

[2002 : PART, NP]

1	Own	F1
2	Lease/rent	R10
99	DK/NA/refused	R10

R10. How long is the term of your lease?

[R15-P923]

[2002 : PART, NP]

1	1 year	R15
2	2 years	R15
3	3 years	R15
4	4 years	R15
5	5 years	R15
6	6 years	R15
7	7 years	R15
8	8 years	R15
9	9 years	R15
10	10 years	R15
11	Greater than 10 years	R15
12	Month to month	R15
13	Other (Specify)	R15
99	DK/Refused	R15

R15. How familiar are you with the terms of your lease regarding energy costs and energy efficiency improvements to the facility you occupy? Would you say you are:

[R20-P923]

[2002 : PART, NP]

1	Not at all familiar	F1
2	Somewhat familiar	F1
3	Very familiar	F1
99	DK/Refused	F1

Firmographics

F1. In the last two years, have there been any changes at your facility that increased or decreased your gas consumption by 10% or more?

1	Yes	F2
2	No	F2
88	Refused	F2
99	Don't know	F2

F2. Has the square footage changed?

1	Yes	F3
2	No	F3
88	Refused	F3
99	Don't know	F3

F3. Has the number of employees changed?

1	Yes	F4
2	No	F4
88	Refused	F4
99	Don't know	F4

F4. Have you added or removed any equipment that involved fuel switching within the last 2 years, such as changing from electricity to gas?

1	Yes	F4a
2	No	F4a
88	Refused	F4a
99	Don't know	F4a

F4a. Have you expanded production at your facility?

1	Yes	F4b
2	No	F5
88	Refused	F5
99	Don't know	F5

F4b. How much has your production expanded?

1	Percent Expanded:_____	F5
88	Refused	F5
99	Don't know	F5

F5. Can you estimate the total square footage of your facility at this [SERV_ADDR] to be …?

[Q84-P923]

[2002 : PART, NP]

1	Less than 2,500 square feet	F6
2	2,500 but less than 5,000 square feet	F6
3	5,000 but less than 10,000 square feet	F6
4	10,000 but less than 20,000 square feet	F6
5	20,000 but less than 50,000 square feet	F6
6	50,000 but less than 100,000 square feet	F6
7	Ag/Non-facility – Outdoors	F6
99	Don't know	F6

F6. Which of the following categories describes the number of employees your firm has at this[SERV_ADDR]?

[Q83-P923]

[2002 : PART]

1	1 to 5	F12
2	6 to 10	F12
3	11 to 20	F12
4	21 to 50	F12
5	51 to 100	F12
6	Or, over 100	F12
9	[DO NOT READ:] DK/NA/refused	F12

F12. How long has your business been at this location?

F15. What is the main activity at your business?

[Q0-P923]

[2002 : PART]

1	Office	L5
2	Retail (non-food)	L5
3	College/university	L5
4	School	L5
5	Grocery store	L5
6	Convenience store	L5
7	Restaurant	L5
8	Health care/hospital	L5
9	Hotel or motel	L5
10	Warehouse	L5
11	Personal Service	L5
12	Community Service/Church/Temple/Municipality	L5
13	Industrial Process/Manufacturing/Assembly	L5
14	Condo Assoc/Apartment Mgmt	L5
15	Agriculture	L5
77	Other (SPECIFY)	L5
99	DK/Refused	L5

L5. Is a language other than English spoken at your business?

[2002 : PART, NP]

1	Yes	L10
2	No	F10
88	Refused	F10
99	Don't know	F10

L10. Other than English, what language is primarily spoken at your business? [ACCEPT MULTIPLES]

[2002 : PART, NP]

1	Spanish	F10
2	Chinese	F10
3	Korean	F10
4	Vietnamese	F10
5	Japanese	F10
6	Indian	F10
77	Other (SPECIFY)	F10
88	Refused	F10
99	Don't know	F10

F10. How many locations does your firm have in California?

[Q91-P923]

[2002 : PART, NP]

1	1	
2	2 to 4	
3	5 to 10	
4	11 to 25	
5	Over 25	
9	[DO NOT READ:] DK/NA/refused	

As you may know, the <PROG> program is an important component of the Southern California Gas Company's ongoing efforts to save energy and reduce emissions, and your participation is much appreciated. In order to improve this program's performance, the Gas Company wants to make an accurate measurement of the energy savings associated with this program by collecting and analyzing information from selected customers.

Based on your answers to the previous questions, you are a perfect candidate for this project. If you agree to participate, Quantum Consulting, on behalf of the Gas Company will visit your business and quickly verify the installations of the equipment you installed through the <PROG> are operating. The visit will take less than an hour.

Q11. Are you interested in participating in this project?
If no, TNT

Q12. What is the main business activity at this facility?

SCHEDULING APPOINTMENT

Great, our technician Jerry Middleton will be the person contacting you to schedule an appointment to visit your business.

I5. Are you the person we should contact to set up the appointment?

1	Yes	I15
2	No	I10
88	Refused	I10
99	DK	I10

I10. What is the name and phone number of the person we should contact to set up the appointment?

I15. Our technician will also need to meet a representative of your company at this facility. Do you have the name and the phone number of the manager or facilities staff he should meet at <ADDRESS>?

I20. Can you give any directions that would help Jerry find your business?

Thank you very much for helping the Gas Company to improve its energy saving efforts. If you have any additional questions regarding this effort that I am unable to answer today, please call Jerry Middleton of Quantum Consulting at 1.800.531.0188 or Mary Wold at (858) 636-6838.

NONPARTICIPANT SURVEY

Q1. Hello, this is <INTERVIEWER NAME> calling from Quantum Consulting on behalf of Southern California Gas Company. May I please speak with [&PROGRAM_CONTACT]?

May I please speak with the person at this location who is most knowledgeable about decisions affecting your energy using gas equipment such as heating and cooking systems?

1	No, this person no longer works here	Q2
2	No, this person is not available right now	appoint
4	Yes	E65
77	No, Other reason (specify)	T&T
88	Refused	T&T
99	Don't know	T&T

[IF NEEDED:] This is a fact-finding survey only – we are NOT interested in selling anything, and responses will not be connected with your firm in any way. SoCal Gas wants to better understand how businesses think about and manage their energy consumption.

[WHEN CORRECT RESPONDENT IS ON-LINE (REPEAT AS NEEDED WHEN CURRENT INDIVIDUAL IS BEST CONTACT):]

Q2. Hello, this is <INTERVIEWER NAME> calling from Quantum Consulting on behalf of SoCal Gas. I understand you are the person at this location who is most knowledgeable about decisions affecting the energy using gas equipment, such as heating and cooking, at this location.

Today we're conducting a very important study on the needs and perceptions of firms like yours, how businesses like yours think about and manage their energy consumption. This survey should take no more than about 10 minutes, and it's an important opportunity to make sure your views are represented.

Our records show that the address for this business is [ADDRESS.] Is this correct?

IF NOT CORRECT: Could you please tell me the correct address for this business?

[IF NEEDED:] Can I confirm that you're responsible for making energy-related decisions for your firm at [ADDRESS]??

[IF NEEDED:] This is a fact-finding survey only – we are NOT interested in selling anything, and responses will not be connected with your firm in any way. SoCal Gas wants to better understand how businesses think about and manage their energy consumption.

1	Current individual is best contact	E1
2	Transferred to best contact	Repeat Q2 w/best contact
3	Given best contact's name and number	Record for future contact
99	Don't know/refused	Thank & terminate

[IF NEEDED] SoCal Gas wants to better understand how businesses like yours think about and manage their energy consumption. Your input is very important to the utilities and to them.

77	There is no one here with information on that address/wrong address	T&T
1	Address correct/Continue	E65

Gas Equipment Replacement

One way that businesses can reduce their energy use is to install more energy efficient equipment. We would now like to ask you about what kinds of gas equipment purchases you are considering, or have made in the last two years.

E65. In the last two years, did you install any gas appliances at your facility, such as a boiler, water heater, furnace, stove, gas booster for dishwasher?

[GS020-P923]

[2002 : NP]

1	Yes	E70
2	No Change	E90
88	Refused	E90
99	Don't Know	E90

IF E65 = 1

E70. What types of gas appliances were installed?

[GS099-P923]

[2002 : NP]

[SELECT ALL THAT APPLY]

1	Boiler		E71
2	Water heater		E71
3	Furnace		E71
4	Stove or Cooking equipment		E71
5	Gas booster for dishwasher		E71
6	Heat recovery equipment for boiler or other		E71
77	Other (specify)		E71
99	Don't know/refused		E71

IF E70 > 1

E71. How many [Gas_Appliance_type] did you install?

PROBE for customer's best Guess.

&num	Number		E75
88	Refused		E75
99	Don't Know		E75

IF E70 > 1

E75. Was the [Gas_Appliance_type] number [gas_appliance_number] that you installed standard or high efficiency? (Ask for each of boilers and each of water heaters, etc.).

[GS080-P923]

[2002 : NP]

1	Standard efficiency		SAT1_1
2	High efficiency		SAT1_1
88	Refused		SAT1_1
99	Don't know		SAT1_1

SAT1_1. How satisfied have you been with the performance of the [gas_appliance_type] number [gas_appliance_number]? Would you say you are:

1	Very Satisfied	E78
2	Somewhat Satisfied	SAT1_3a
3	Not at All Satisfied	SAT1_3a
88	Refused	E78
99	Don't Know	E78

If SAT [gas_appliance_type]_[gas_appliance_number] = 2 or 3

SAT1_3a : Why did you say that? [Record Verbatim]

E78. By roughly how much do you think the gas equipment purchases you've made have reduced your overall gas usage?

[CON25-P923]

[2002 : PART, NP]

1	0 to 5 percent	E90
2	6 to 10 percent	E90
3	11 to 15 percent	E90
4	16 to 20 percent	E90
5	21 to 30 percent	E90
6	More than 30 percent	E90
88F	Refused	E90
99	Don't know	E90

E90. In the last two years, were there any opportunities to improve energy efficiency by installing energy saving gas equipment at your facility that were identified but not undertaken?

[Q54-P923]

[2002 : NP]

1	Yes	E105
2	No	A1
88	Refused	A1

99	Don't know	A1

E105. What had you thought to do?

1	Boiler		A1
2	Water heater		A1
3	Furnace		A1
4	Stove or Cooking equipment		A1
5	Gas booster for dishwasher		A1
6	Heat recovery Equipment for boiler or other		A1
77	Other (specify)		A1
99	Don't know/refused		A1

Program Awareness and Participation

A1. Are you aware of the Gas Company's [prog] Program?

1	Yes	A5
2	No	A2
88	Refused	A2
99	Don't know	A2

A2. [prog_desc] Before this survey, had you ever heard of the Gas Company's [prog] program?

[Prog desc]: The Non-Residential Financial Incentive Program has 3 parts. The Food Service part provides streamlined rebates to those customers who install one or more energy efficiency products from a prescribed list. The primary focus is prescriptive measures for foodservice type equipment. The Equipment Replacement part offers incentives for replacement of boiler heat recovery equipment or installation of new kilns, ovens or industrial dryers. The Custom Conservation part offers incentives for new equipment, refurbishing of selected applications, or modification of your gas related process that increase efficiency and are not covered by other programs.

1	Yes	A5
2	No	A5

88	Refused	A5
99	Don't know	A5

A5. Are you aware of the Gas Company's Express Efficiency rebate program?

1	Yes	A15
2	No	A10
88	Refused	A10
99	Don't know	A10

A10. Express Efficiency is a program offered by the Gas Company where businesses like yours receive a rebate for installing one or more energy-efficient products. Before this survey, had you ever heard of the Gas Company's Express Efficiency Program?

1	Yes	A15
2	No	PE15
88	Refused	PE15
99	Don't know	PE15

A15. In the last two years did your firm participate in the Gas Company's Express Efficiency rebate program at this location?

[Q3-1999 Part Survey, A-5]

[2002 : Part, NP]

1	Yes, participated in Express Efficiency as described	PE15
2	Yes, participated in Express Efficiency, but at other location	PE15
3	Yes, participated in [UTILITY] program, but don't recall that as the name	PE15
4	NO, did NOT participate in Express Efficiency program	PE15
5	NO, did NOT receive rebate (but did participate in program)	PE15
77	Other (specify)	PE15
88	Refused	PE15

99	Don't know	PE15

Program Effects

Next, I'd like to ask you about your knowledge and attitudes toward energy efficiency and various sources of energy efficiency information.

PE15. Using a scale from 1 to 10 where 10 indicates extremely likely please rate how likely will you be to actively consider energy-efficient gas equipment when installing or replacing gas equipment for your business in the future?

[Q49-1999 Part survey]

[2002 : PART, NP]

#	1-10 scale	PE12

IF PE15 >7

PE12. What energy efficiency gas equipment are you more likely to install?

1	Boiler		PE30
2	Water heater		PE30
3	Furnace		PE30
4	Stove or Cooking equipment		PE30
5	Gas booster for dishwasher		PE30
6	Heat recovery equipment for boiler or other		PE30
77	Other (specify)		PE30
99	Don't know/refused		PE30

PE30. Using a scale from 1 to 10, where 1 means you aren't knowledgeable at all, and 10 means you are fully knowledgeable, please rate how knowledgeable you feel that you are about what energy efficiency products are available, and how they'll perform?

[DM108-P861]

[2002 : PART, NP]

#		PE35

PE35. Now I'd like to read a brief series of statements and I'd like you to tell me how well each statement describes your beliefs about energy efficient investments -- or if they even express your beliefs at all. We'll again use a 1-to-10 scale, where 1 means you DISAGREE with the statement, and 10 means you agree completely with the statement. The first/next one is … [RANDOMIZE, READ AND OBTAIN A RATING FOR EACH. WHEN SEQUENCE COMPLETE, GO TO REB1.]

[T1-P923]

1	When considering a new energy efficiency investment, I am concerned that the actual bill savings will be less than what was estimated.	PE40
2	I don't have the information I need to make an informed decision about energy efficient investments.	PE40
3	There is too much time and hassle involved in selecting a qualified energy efficiency contractor.	PE40
4	Lack of financing is a barrier to our organization making energy efficiency investments that we want to make.	PE40
5	Getting a utility rebate is too much hassle.	PE40
6	I need the owner's consent to make improvements.	PE40
7	I'm not at this location for long	PE40
8	It's not worth investing because it's not my building	PE40
99	DK/Refused	PE40

PE40. Information on energy efficiency can come from a number of different sources. How would you prefer to receive energy-related information? Please rate the following sources on a 1 to 10 scale, where 1 means NOT DESIRABLE and 10 means HIGHLY DESIRABLE.

[2002 : PART, NP]

#	Internet	R1
#	Directly from contractor	R1
#	At a community event or trade organization meeting	R1

#	As part of an audit recommendation	R1
#	Printed materials from [UTILITY]	R1

Renter Battery

R1. How active a role does your business take in making gas equipment and usage decisions? [READ LIST.]

[Q7-P923]

[2002 : PART, NP]

1	Very active – involved in all phases and have veto power.	R5
2	Somewhat active – we approve decisions and provide some input and review.	R5
3	Slightly active – we have a voice but it's not the dominant voice.	R5
4	Not active at all – we're part of a larger firm.	R5
5	Or, not active at all – our firm doesn't get involved in these issues.	R5
99	DK/NA/refused	R5

R5. Does your business own or lease the facility?

[Q3-P923]

[2002 : PART, NP]

1	Own	A1
2	Lease/rent	R10
99	DK/NA/refused	R10

IF R5 = 2

R10. How long is the term of your lease?

[R15-P923]

[2002 : PART, NP]

1	1 year	R15

2	2 years	R15
3	3 years	R15
4	4 years	R15
5	5 years	R15
6	6 years	R15
7	7 years	R15
8	8 years	R15
9	9 years	R15
10	10 years	R15
11	Greater than 10 years	R15
12	Month to month	R15
13	Other (Specify)	R15
99	DK/Refused	R15

IF R5 = 2

R15. How familiar are you with the terms of your lease regarding gas energy costs and energy efficiency improvements to the facility you occupy? Would you say you are:

[R20-P923]

[2002 : PART, NP]

1	Not at all familiar	A1
2	Somewhat familiar	A1
3	Very familiar	A1
99	DK/Refused	A1

Firmographics

F1. Can you estimate the total indoor square footage of your facility at this location to be …?

[Q84-P923]

[2002 : PART, NP]

1	Less than 2,500 square feet	F5
2	2,500 but less than 5,000 square feet	F5
3	5,000 but less than 10,000 square feet	F5
4	10,000 but less than 20,000 square feet	F5
5	20,000 but less than 50,000 square feet	F5
6	50,000 but less than 100,000 square feet	F5
7	Ag/Non-facility – Outdoors	F5
99	Don't know	F5

F5. Which of the following categories describes the number of employees your firm has at this location?

[Q83-P923]

[2002 : PART, NP]

1	1 to 5	F10
2	6 to 10	F10
3	11 to 20	F10
4	21 to 50	F10
5	51 to 100	F10
6	Or, over 100	F10
9	[DO NOT READ:] DK/NA/refused	F10

F10. How many locations does your firm have?

[Q91-P923]

[2002 : PART, NP]

1	1	F12
2	2 to 4	F12
3	5 to 10	F12
4	11 to 25	F12
5	Over 25	F12

9	[DO NOT READ:] DK/NA/refused	F12

F12. How long has your business been at this location?

#	Years	F15

F15. What is the main activity at your business?

[Q0-P923]

[2002 : PART, NP]

1	Office	F20
2	Retail (non-food)	F20
3	College/university	F20
4	School	F20
5	Grocery store	F20
6	Convenience store	F20
7	Restaurant	F20
8	Health care/hospital	F20
9	Hotel or motel	F20
10	Warehouse	F20
11	Personal Service	F20
12	Community Service/Church/Temple/Municipality	F20
13	Industrial Process/Manufacturing/Assembly	F20
14	Condo Assoc/Apartment Mgmt	F20
77	Other (SPECIFY)	F20
99	DK/Refused	F20

F20. In the last two years, have there been any changes at your facility that increased or decreased your gas consumption by 10% or more?

1	Yes,	F25

2	No	F25
88	Refused	F25
99	Don't know	F25

F25. Has the square footage changed?

1	Yes	F30
2	No	F30
88	Refused	F30
99	Don't know	F30

F30. Has the number of employees changed?

1	Yes	F35
2	No	F35
88	Refused	F35
99	Don't know	F35

F35. Have you added or removed any equipment that involved fuel switching within the last 2 years, such as changing from electricity to gas?

1	Yes	L5
2	No	L5
88	Refused	L5
99	Don't know	L5

L5. Is a language other than English spoken at your business?

[2002 : PART, NP]

1	Yes	L10
2	No	END
88	Refused	END
99	Don't know	END

L10. Other than English, what language is primarily spoken at your business? [ACCEPT MULTIPLES]

[2002 : PART, NP]

1	Spanish	END
2	Chinese	END
3	Korean	END
4	Vietnamese	END
5	Japanese	END
6	Indian	END
77	Other (SPECIFY)	END
88	Refused	END
99	Don't know	END