Evaluation of the PG&E Ceiling Insulation Rebate Program: An Application of the California Evaluation Protocols

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This paper presents a discussion of a recent process and impact evaluation of PG&E's Residential Ceiling Insulation Rebate Program, which provided rebates to nearly 22,000 residential customers who installed ceiling insulation in their homes during 1991 and 1992. The impact evaluation consisted of a multiple regression of billing data using results from 2,700 participant/nonparticipant surveys to determine kWh and therm impacts, and an engineering simulation analysis using on-site data from 150 participant to estimate kW impacts. The process evaluation used customer surveys, interviews with program staff and contractors, and focus groups with participants to determine the level of customer satisfaction and overall effectiveness of the program implementation and marketing strategies.

A major component of this project was to test the newly adopted Joint Protocols for Measurement and Evaluation developed for the California Public Utility Commission and assess their practicality for a full-scale application. These protocols identify specific sample sizes, minimum months of bills for the billing analysis, development and use of a comparison group, and format for reporting results. This paper discusses the implications of these protocols and their application to an evaluation of a energy efficiency program.

Introduction

Background

PG&E has offered rebates for ceiling insulation to its residential customers through the Ceiling Insulation Rebate Program since 1990. From 1990-92, rebates of $100 were offered for all ceiling insulation jobs performed by contractors who are members of EGIA[1]. In each year, rebates have been raised to $200 during the first three months of the year. Approximately 11,000 customers participated in this program in 1991 and in 1992.

EGIA uses established standards for quality of materials and installation for all participating contractors, and is expected to inspect a random sample of 15-25% of the jobs of each participating contractor each year. Inspectors check the safety and quality of the installation, and check to assure that installed R-values are as shown on the rebate application.

Scope

This evaluation project was undertaken to quantify the impacts in terms of both energy and demand of PG&E's Ceiling Insulation Rebate Program. Since PG&E provides both electricity and natural gas, this analysis includes evaluation of kWh, kW, and therm impacts. Calendar years 1991 and 1992 are the two program years considered for this evaluation. The objectives of this project include:

- Estimation of kWh and therm impacts by end-use category using multiple regression analysis of billing, survey, and program tracking data.
- Determination of the net-to-gross ratio using survey responses.
- Estimation of peak (kW) impacts by end-use category using engineering simulation models based on the results of on-site surveys of participants.

One additional component of this project was to test the Joint Protocols for Measurement and Evaluation developed for the California Public Utilities Commission (CPUC). These protocols will be fully effective for all impact evaluations conducted in 1994. However, PG&E staff felt that an initial test of the methods would provide them with practical experience in preparation of their full-scale application. This paper details those areas that were conducted in accordance with the Protocols, as well as those areas that diverge from the approach suggested by the Protocols, and the reasons for this divergence.

Methodology

Summary of Data Collection

The impact evaluation required the collection of a large amount of diverse data. These data included information from records maintained by the utility on each year of the program, billing data on participants and non-participants, and direct customer survey data. To present an overview of the data collection effort, the basic steps performed to compile the data for this analysis are summarized below.

Step 1: Compilation of data from utility program records. This effort involved obtaining the data maintained by PG&E and EGIA on program participants. Data elements included such items as account/control numbers of participants, program tracking records, and weather data.

Step 2: Collect customer billing data on program participants and non-participants. This task involved obtaining billing records of all the participants for all the programs. Billing records were also obtained for a group of non-participants.

Step 3: Screen billing data. Following the specification in the Protocols, three years of billing data were required for the project: one year of data before program participation, one year of data for the participation time period, and at least nine months post-participation data. Customers without a complete billing history were dropped from the analysis.

Step 4: Construct sample frame and design, and select samples. The sample frame was constructed following the guidelines in the Protocols.

Step 5: Design survey instruments. Two versions of the survey questionnaire were designed: one for participants and another for non-participants.

Step 6: Implement the survey. A telephone survey was used and targets were established for each of the stratification cells (i.e., HVAC and climate zone) used in the sample design to insure that the final sample would conform to the Protocols.

Step 7: Prepare survey data files. A separate series of ASCII files was produced for each respondent group (1992 participants, 1991 participants, and non-participants). This information was then linked with the billing data and program data to develop the inputs for the regression analysis.

Sample Selection

Energy Impacts Assessment. This section describes the sample selection procedure for the 1991 and 1992 participants and for the non-participant comparison group. The samples were formed by first defining strata based on HVAC technology and climate zone and, where sufficient numbers existed, perform simple random sampling within each strata.

The two-stage sample design used five HVAC technology strata:

- Gas heat
- Gas heat with central air conditioning
- Electric heat
- Electric heat with central air conditioning
- Heat pumps.

For the 1991 participants, the rebate form did not track heat pumps as a separate HVAC technology, and so the 1991 participant sample was only stratified on the first four HVAC technologies. In addition, since there was no information on non-participant HVAC technologies, assumptions based on consumption patterns were used to place customers into the first four segments It should be noted that determination of heat pump could not be accomplished by using only consumption data.

There were four climate zone strata used for the sample design. These strata correspond to the PG&E climate zones and include:

- Outer Valley
- Inner Valley
- Hill
- Coastal.

The Protocol has specific requirements for the sample design (see Table 5, section C in the Protocols). These protocols require that if the number of participants is greater than 450, a representative sample will be drawn in such a way that there is a minimum precision of ±10% at the 90% confidence level, based on total annual energy use. The Protocols go on to state that a minimum of 450 must be included in the analysis dataset for each applicable end use study element.

Based on the total annual energy use for both 1991 and 1992 participants, it was found that a sample that would give a minimum precision of ±10% at the 90% confidence level would be 101 for 1991 electric customers, 54 for 1991 gas customers, 88 for 1992 electric customers, and 61 for 1992 gas customers. Therefore, in order to satisfy the Protocols, the sample size for each of the 1991 and 1992 participants and non-participant samples was set to 900: 450 for gas customers and 450 for electric customers. The resulting sample design is presented in Table 1.

Table 2 presents the distribution of the final sample that was obtained after the completion of the seven steps outlined above. As can be seen when comparing Table 1 with Table 2, the final sample was short on both 1991 and 1992 participants who had electric heat and those who had heat pumps. Conversely, the sample is rich in participants who had gas heat. The reason for this discrepancy between the sample design and the final sample is due to the small number of participants who had electric heat (with and without central air conditioning) or heat pumps. The final sample represented a census of all these participants. In order to keep the total number of surveys as close as possible to the sample design, the gas heat cells were oversampled to counteract the deficit in the electric heat and heat pump cells.

Peak Impacts Assessment. The sample selected for the on-site inspections of 1991 and 1992 participants' homes was determined from a two-stage sampling procedure similar to that described above for the telephone survey research (i.e., by both HVAC technology and climate zone). Where sufficient numbers of participants were available, simple random sampling was completed within each strata. The final on-site inspection sample was nested within the telephone survey samples also described above. The on-site samples for 1991 and 1992 participants were designed to include 75 customers per year, distributed across technologies and climate zones.

The final on-site sample included 150 participant sites over the 1991 and 1992 participation period, distributed across each of the four climate zones and the HVAC technology categories. Table 3 provides the final sample that represents the number of completed participant on-site inspections. One consequence of the nested sample design and customer refusals was that it was not possible to fill all technology and climate zone cells for each year. To meet the on-site sample requirement of 150 participants, 1991 and 1992 program years were combined.

The Protocol includes recommended requirements for engineering studies supporting the primary statistical analysis. These requirements included performing a minimum of 150 participant and 150 non-participant on-site inspections and simulations. However, it became apparent that little, if anything, would be gained by performing engineering simulations on non-participants as no program related impacts were assumed. By the nature of the engineering modeling approach, where all variables in each building are held constant except ceiling insulation level, a comparison group was therefore created within the participant sample. Separate simulations were run for each home with initial levels of ceiling insulation (pre-installation), and then re-run with the added insulation modelled (post-installation). A comparable sample of 150 non-participant on-site inspections was, therefore, unnecessary and inappropriate since simulations were not performed during this evaluation using non-participant on-site data.

Instead, on-site inspections were performed for a sample of 30 non-participants to (a) verify customer self-reported data during the telephone survey, and (b) obtain insight for the process and impact evaluations regarding the similarities and differences among the participant and non-participant populations.

Statistical Estimation of Energy Savings

This section addresses the statistical estimation of the energy savings associated with the PG&E Ceiling Insulation Rebate Program for program years 1991 and 1992 using billing data. Three types of statistical analyses were conducted. The first used the Princeton Scorekeeping Method to obtain estimates of the change in consumption related to the program after controlling for the effect of weather. The second used a conditional demand analysis (CDA) model of the change in energy use to control for the effects of weather and other non-program variables. The third determined the level of free riders by specifying a behavioral model for taking the energy efficiency action promoted by the program. These approaches were used to better understand the differences between the results from PRISM-based analysis and those from the protocol requirements.

Princeton Scorekeeping Method. The Princeton Scorekeeping Method (PRISM) is a statistical method of controlling for the effect of weather on energy consumption. The basic approach used by PRISM is to determine the reference temperature for each household (i.e., the temperature at which point the household begins heating or cooling) which produces the highest R-squared for a regression model with the average daily consumption as the dependent variable, and the heating degree days (or

Table 1. Sample Design

HVAC System	Outer Valley	Inner Valley	Hill	Coastal	Total
	Climate Zone				
1991 Participants					
Gas heat, no AC	56	56	56	57	225
Gas heat, AC	56	56	56	57	225
Electric heat, no AC	56	56	56	57	225
Electric heat, AC	56	56	56	57	225
Total	224	224	224	228	900
1992 Participants					
Gas heat, no AC	56	56	56	57	225
Gas heat, AC	56	56	56	57	225
Electric heat, no AC	38	37	37	38	150
Electric heat, AC	38	37	37	38	150
Heat Pump	38	37	37	38	150
Total	226	223	223	228	900
Non-participants					
Gas heat, no AC	56	56	56	57	225
Gas heat, AC	56	56	56	57	225
Electric heat, no AC	56	56	56	57	225
Electric heat, AC	56	56	56	57	225
Total	**224**	**224**	**224**	**228**	**900**

Table 2. Analysis Sample

HVAC System	Outer Valley	Inner Valley	Hill	Coastal	Total
	Climate Zone				
1991 Participants					
Gas heat, no AC	22	37	84	208	351
Gas heat, AC	90	112	10	88	300
Electric heat, no AC	15	22	26	36	99
Electric heat, AC	67	61	5	18	151
Total	194	232	125	350	901
1992 Participants					
Gas heat, no AC	29	54	110	182	375
Gas heat, AC	98	147	8	119	372
Electric heat, no AC	5	12	7	17	41
Electric heat, AC	10	11	0	11	32
Heat Pump	24	51	0	7	82
Total	166	275	125	336	902
Non-participants					
Gas heat, no AC	30	57	77	61	225
Gas heat, AC	66	62	40	60	228
Electric heat, no AC	51	60	57	57	225
Electric heat, AC	56	58	57	55	226
Total	**203**	**237**	**231**	**233**	**904**

Table 3. Final Sample for On-Site Inspections

HVAC System	Outer Valley	Inner Valley	Coastal	Hill	Total
	Climate Zone				
Gas heat, no AC	10	10	10	10	40
Gas heat, AC	9	13	5	13	40
Electric heat, no AC	6	9	9	8	32
Electric heat, AC	7	13	1	6	27
Heat pumps	3	5	0	3	11
Total	**35**	**50**	**25**	**40**	**150**

cooling degree days for the cooling model) relative to this reference temperature as the independent variable. Once this relationship has been estimated, the degree days in a "typical" year relative to the reference temperature are used to compute the weather Normalized Annual Consumption (NAC).

PRISM was used in this project by computing the change in the pre- and post-participation normalized annual consumption for participants, and comparing this to the change in normalized consumption over the same time period for non-participants.

CDA Estimation. This section describes the methods used to estimate the energy savings impacts from the program using CDA models. Five equations were estimated:

- The change in gas use over the heating season (October through March) for 1992 participants
- The change in gas use over the heating season for 1991 participants
- The change in electricity use over the heating season for 1992 participants
- The change in electricity use over the heating season for 1991 participants
- The change in electricity use over the cooling season (May through September) for 1991 participants.

The distinction was made between the heating and cooling seasons (versus developing monthly models) because aggregating up from monthly data helps control the influence of short-term fluctuations in consumption, and seasonal data decrease the number of end uses which must be incorporated into each model.

For each fuel type, two models were developed. One model investigated the change in energy use between a pre-program heating season and a post-program heating season. For the 1991 participation year, the pre-program heating season consisted of the period from October 1, 1989 to March 30, 1990, and the post-program season spanned the period from October 1,1992 to March 30, 1993. While we would have preferred to included the month of April in the heating season, only half of the observations in the sample had billing data for April 1993, because the billing data were pulled before all April readings were in the system. The pre/post-prograrn heating seasons for the 1992 analysis was identical to the periods used for the 1991 analysis. However, this implies that only the 1992 participants who participated prior to October 1, 1992 would have unadulterated pre- and post-program heating seasons. Therefore, the 1992 heating season models determined the impacts of the program only for those participants who participated prior to October 1992. Because there was no substantive change in the program or the characteristics of participants between early 1992 and the end of 1992, this abbreviated participant group should not produce any bias.

The other model investigated the change in energy use between a pre-program cooling season and a post-program cooling season. For the analysis of the 1991 participation year, participants could have undertaken the program actions anytime during the 1991 calendar year. Therefore, the pre-program cooling season consisted of the period from May 1, 1990 to September 30, 1990 and the post-program cooling season was defined as the period from May 1, 1992 to September 30, 1992. For the 1992 participation year analysis, the post-participation cooling season would have to span the period from May 1, 1993 to September 30, 1993. Since these data were unavailable, no cooling season model was developed for 1992 participants.

Free Ridership Analysis. Net load impacts are defined in the Protocols as "the total change in load that is attributable to the utility DSM program. " The Protocols note that this may include the effects of free drivers, free riders, energy efficiency standards, changes in the level of energy service, and natural change effects. The statistical CDA model used in this analysis implicitly accounts for all of these effects except for free riders (see Ozog and Waldman, 1993).

Alternatively, the level of free riders is determined by specifying a behavioral model for taking the energy efficiency action promoted by the program. This is a relatively new approach to estimating free riders, and it is important, because it provides a framework for the analysis and interpretation of the supporting statistical work. Unlike other approaches which rely on participants to report what they would have done without the program, behavioral models are not subject to cognitive dissonance or hypothetical bias.

The first step in developing the free-rider model involves specifying and incorporating the program effect, which was modeled as the cost reduction of undertaking energy efficient actions due to the program. For this program, the cost reduction due to the program is the rebate amount. Therefore, the program effect variable for participants and non-participants who are aware of the program is set equal to the rebate. For non-participants who are not aware of the program, the cost savings from the program does not affect their net utility. Therefore, the value of the program effect variable for these households is zero. The presence of non-participants who are unaware of the program is essential to the analysis, since these individuals can be used to model the behavior of participants without the program.

The dependent variable in the model is whether or not that individual installed ceiling insulation irrespective of whether or not this was done through the Ceiling Insulation Rebate Program. This implies that the free rider estimates may be overstated because the actions of non-participants may not be sufficient to qualify under the program. This dependent variable (whether or not ceiling insulation was installed) is a binary variable. Therefore, to estimate this type of discrete-choice model, the probit technique was used.

The derivation of the level of free riders in the program is found by using the model to simulate the probability that the customer will install ceiling insulation under the assumption that the household is unaware of the program. This represents the free-rider level. This amount divided by the probability of installing ceiling insulation under the assumption that the household is aware of the program, is the free-rider percentage.

Peak Impact Assessment

The primary objective of this study was to estimate electric peak load impacts for 1991 and 1992 program participants. These estimates were broken down further into estimates for PG&E's Outer Valley, Inner Valley, Coastal, and Hill climate zones for both electric space cooling and heating end-use technologies. The technologies addressed include:

- Central Air Conditioning
- Wall and Window Air Conditioning
- Heat Pumps
- Electric Resistance Space Heating.

The study utilized the MICROPAS 4.0 engineering simulation model to estimate hourly kW demand impacts. Building envelope, equipment, and occupant behavior data were collected during on-site visits to a sample of 150 program participants. The detailed on-site data were then used to model each pre-retrofit building. A second model using post-retrofit insulation levels was also created, holding all variables constant except the post-retrofit insulation R-value of the ceiling. Simulations were then run for each participant for both pre- and post-retrofit conditions. Each modelling run produced heating and cooling profiles for each of the 8760 hours of the year, using 1992 weather data for 16 California Energy Commission (CEC) climate zones. Results were condensed into four standard climate zones relevant to PG&E. These profiles were then used to create pre-retrofit and post-retrofit average peak kW and average kW profiles for each climate zone and technology type.

Several validations of the models were performed. First, the peak day and average day profiles for selected technologies were compared with metered peak and average profiles produced by PG&E's Appliance Metering Program (AMP). Second, profiles were also compared with recently developed and unpublished PG&E AMP profiles developed for individual climate zones and technologies.

Results

PRISM Analysis

The PRISM analysis was conducted for this study to better understand the differences between the PRISM analysis and the protocol requirements.[2] Therefore, the PRISM analysis was conducted only on the 1991 participants. The results of the PRISM analysis are presented in Table 4. This table shows that the PRISM analysis produced savings estimates for all end-uses that were statistically significant at the 95% confidence level.

Table 4. Gross Energy Impacts: Based on PRISM Analysis (1991 Participants)

Heating/AC System	Savings Estimate	T-Value[1]
Cooling Only Model for 1991 Electric Cooling		
Central Air Conditioning	664 kWh	3.92
Heating Only Model for Electric Heating		
Electric Heat	632 kWh	3.13
Heating Only Model for Gas Heating		
Gas Heat	73 Therms	8.07

1 This t-value tests the significance of the difference between the mean difference in NAC for participants and the mean difference in NAC for non-participants.

CDA Analysis

The gross impact results based on the CDA models are presented in Table 5. These estimates are gross estimates and must be multiplied by the net-to-gross ratio to get an estimate of the net impacts. Based on these results, it is clear that estimates obtained from PRISM are higher than the estimates obtained from the CDA model for gas heating and electric cooling, but are lower than the CDA-derived estimates for electric heating. Because the CDA model controls for many other confounding factors including weather, the estimates from the CDA are more likely to be representative of the actual program impacts.

Table 5 also shows that all the estimated impacts are statistically significant at the 90% level, with the average gas savings across participation years being over 8% of pre-participation usage, and the electric heating season

Table 5. Gross Energy Impact Estimates: Based on CDA Analysis

		Confidence Interval			
	Savings % of Pre-	**80%**		**80%**	
Savings	**Part Consumption**	**Low**	**High**	**Low**	**High**
	1992 Gas Heat Savings During the Heating Season				
51.2 Therms	9.0%	40.7	61.7	38.7	63.7
	1991 Gas Heat Savings During the Heating Season				
45.2 Therms	7.9%	33.7	56.7	31.5	58.9
	1992 Electric Heat Savings During the Heating Season				
863 kWh	10.2%	299	1427	192	1534
	1991 Electric Heat Savings During the Heating Season				
908 kWh	11.2%	177	1639	37	1779
	1991 Electric Savings During the Cooling Season				
Central Air Conditioner					
209 kWh	4.6%	88	330	65	353
Heat Pump					
289 kWh	5.3%	57	521	12	566

impacts being over 10% of pre-participation consumption and electric cooling season impacts being over 4%.

Net-to-Gross Results

The estimated free ridership behavioral model is presented in Table 6. Most of the variables in the model were significant at the 95% level and had the expected sign. The program effect variable is highly significant (with a t-value of 17.4, indicating statistical significance above the 95% level) and has a positive sign, indicating that the program increased the probability of an individual installing ceiling insulation.

Table 6. Probit Estimation of Free Riders in the Ceiling Insulation Rebate Program

Dependent Variable: Installed Ceiling Insulation

Variable	Coefficient (t-value)
Constant	-2.04 (-6.76)
Z (Program Effect)	2.00 (17.4)
Age of House	-0.04 (-2.61)
Income	0.67 (4.26)
Energy Efficiency of Home Three Years Ago	0.418 (9.78)
Education Level	0.024 (0.86)
Remodeled House Within the Past Three Years	0.294 (3.40)
Single Family Home	0.302 (2.57)
Renter	-0.920 (-5.91)
Changed Heating System within the Past Three Years	0.311 (3.11)
Expect to Live in the House in the Next Two Years	0.353 (3.51)
Number of Observations	2325
Log likelihood Ratio	1,192
Overall Percent Correctly Predicted	82%

These estimated coefficients were used to determine the free-rider level for a typical participant.[3] The resulting estimate of the free riders level is 15%. This implies a net-to-gross ratio of (1 - . 15) or 85%.

Peak Impact Results

Table 7 presents the results of the peak impact assessment for both cooling and heating technologies for the 1991 and 1992 Residential Ceiling Insulation Program. Findings are reported in kW savings by end-use technology. Impacts were calculated for PG&E's system peak day, August 11, 1992 at 4:00 pm. Savings estimates are relatively stable for central and window/wall air conditioning technologies. Summer peak day savings were found to be .67 kW for the central air conditioning population, .60 kW for the window/wall air conditioning population, and .54 kW for the heat pump population. Summer average day impacts were also estimated. The summer average day has been developed by computing an average of savings across all summer days from May 1 through October 31, 1992. The hourly values are then averaged across the customers for each climate zone and technology. This allows findings to be presented in a manner consistent with PG&E Load Research Department practice. The summer average day impacts varied from .58 kW for central air conditioners to .33 kW for heat pumps.

Demand impacts for heating technologies were found to be lower than cooling technology impacts. Since PG&E is a summer peaking utility, the concept of a winter peak day is not typically used in its load research practice. Electric heating technologies are studied more frequently on the winter average day, which is determined by computing an average across all days from November 1 through April 30, 1992. For purposes of this example, impacts for a "typical" winter day (January 14, 1992) are reported. The winter average kW impact for electric resistance heating was 0.19 kW, while heat pump savings were found to be 0.28 kW. Electric resistance/radiant heating and heat pumps were the only electric heating technologies present in the sample.

Conclusions

Recommendations for Improving Impact Estimates

For the estimation of the energy impacts associated with the Ceiling Insulation Rebate Program, the billing analysis produced very accurate (i.e., statistically significant results) only for those segments that had a large number of participants from which it was possible to draw a large sample size (e.g., the gas heating segment). However, for those HVAC technologies which were not well represented in the sample, namely the electric heating and to a lesser degree the central air conditioner sample, the savings estimates were not as precise. This imprecision can be reduced by increasing the sample size (which requires obtaining higher quality/complete data for all participants and/or waiting to do an analysis until a larger participant population of this segment is available), or conducting end-use metering (which reduces the "noise" in the data, allowing the researcher to separate out non-program variation across customers and over time).

With regard to the peak impact assessment, the use of a simple hourly engineering simulation model to estimate kW savings impacts for residential ceiling insulation

Table 7. Demand Impacts by HVAC Technology and Climate Zone

	Sample	kW Savings
Cooling Season Summer Peak Day Demand Impacts:		
Central air conditioning	47	0.67
Wall air conditioning	11	0.60
Heat pump	14	0.54
Cooling Season Summer Average Day Demand Impacts:		
Central air conditioning	47	0.58
Wall air conditioning	11	0.37
Heat pump	14	0.33
Heating Season Demand Impacts:		
Electric resistance	8	0.19
Heat pump	10	0.28

program participants was both quick and relatively inexpensive.

Recommendations for the Protocols

One of the purposes of this analysis was to review the Joint Protocols for Measurement and Evaluation developed by the CPUC to assess their practicality for a full-scale application. Based on the experience of this project, much of the Protocols are both reasonable and useful. In order to comply with the Protocols, the sample size for each of the 1991 and 1992 participant and the non-participant samples was 900, 450 for gas customers and 450 for electric customers. This resulted in a large (and expensive) sample size of 2,700. This sample size criteria may become prohibitively expensive for multi-year evaluations of programs which target several end uses.

This sample size did produce statistically significant estimates of impacts for all the end uses. However, it is important to note that the resulting level of precision of these estimates while relatively high, is significantly below the precision of ±10% at the 90% confidence level.

Another viable aspect of the Protocols is the requirement of using conditional demand analysis (CDA) rather than relying on a PRISM-based analysis. This analysis revealed that there is a significant difference between the PRISM-based estimates and the CDA estimates. Since the CDA model controls for other confounding factors in addition to weather, it may be assumed that these results are more indicative of the actual program impacts. Therefore, relying on PRISM-based approaches alone would not be appropriate in this case.

One of the primary issues associated with the Protocols concerns the development of net impacts. The Protocols state that net load impacts can be determined from a statistical billing data analysis using both participants and a comparison group. However, it is our opinion that this may not be the case, and under most conditions, a statistical analysis will produce estimates of gross savings (or a reduced form of gross savings) and not net savings. This issue needs further examination in subsequent research studies.

Acknowledgements

We would like to thank RLW Analytics for their work on the engineering simulation analysis of this program.

Endnotes

1. The Electric and Gas Industries Association (EGIA) is an association of appliance and insulation retailers, distributors and manufacturers of which PG&E is also a member. EGIA manages several rebate programs for PG&E, including the ceiling insulation rebate program.

2. The Protocols require some type of weather normalization. In the CDA model, this is accomplished by including degree day terms as independent variables within the model.

3. Typical in that the values for the independent variables are near the average value for participants. The values were chosen to the nearest whole number. For example, the mean value for the single-family variable is .95, so for the purposes of this table, the value of 1 was chosen for the single-family variable.

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