Steam Trap
Impact Assessment
FINAL REPORT

Table of Contents

1.   Executive Summary

As part of their 2006-2008 Mass Markets Program, PG&E has offered financial incentives to customers for the installation of steam traps. Installations occur in both industrial and commercial facilities. For the commercial facilities, dry cleaning operations account for the bulk of the installations. Ex ante savings for this measure are deemed, on a per unit basis, and do not take into account site-specific operating conditions. Findings from an initial review by PG&E did not provide significant evidence to support the ex ante impact estimates.

KEMA was contracted by PG&E to conduct a more rigorous analysis of customer bills to better assess steam trap impacts, particularly in dry cleaning/laundry facilities. The study utilized a billing analysis approach that consisted of both simple pre-retrofit/post-retrofit bill comparisons and a regression-based billing analysis. For both types of analyses, we utilized all available participants with adequate billing histories, as well as a subset of participants who bills showed declines between the pre-retrofit and post-retrofit periods. The subset of participants was used in order to filter out sites where there was a strong likelihood that non-program factors were occurring that could obscure the energy-saving effects of the steam trap installations (and hence causing increases rather than decreases in bills).

Overall, there were 490 participants in the tracking dataset provided by PG&E. Commercial dry cleaning/laundry facilities account for 458 of these applications. Table 1 summarizes the tracking system data. While the dry cleaning/laundry facilities account for most of the applications, units installed and rebate expenditures, they account for less that half the ex ante program savings. This results because a limited number of large industrial projects are associated with much of the program savings. These larger projects were are not suited to the billing analysis savings methodology and are not a focus of this study.

Table 1: Summary of Program Tracking Data

Facility Type	Applications	Units Installed	Expected Savings	Rebate
All Facilities	490	11,657	2,837,450	$1,195,626
Commercial Dry Cleaning/Laundry Facilities	458	8,275	1,103,995	$815,773

Focusing on the commercial dry cleaning/laundry facilities, the different billing analysis models explored in the study provided a range of possible savings. Regression equations that modeled natural gas usage as a function of tracking system savings and facility electricity use (in addition to other variables) provided the best statistical fit to the data. These models did not use all 458 commercial dry cleaning/laundry participants due to billing data limitations. Results of the better fitting regression models are provided in Table 2. The results are shown for an equation that utilized all available participants and for an equation that included only participants whose bills declined from the pre-retrofit to post-retrofit period.

Table 2: Billing Analysis Results – Preferred Models

Model	# Participants	Tracking Savings	Bill Savings	Realization Rate	RR2*
Model using all participants	310	720,962	77,838	0.11	
Model using participants with bill declines	175	411,314	137,715	0.33	0.19

* RR2 = Realization rate for all participants, assuming participants with bill increases have zero savings.

As Table 2 shows, bill savings range from a total of 77,838 therms for the model using all participants up to 137,715 therms for the model that included only participants with bill declines. The second model shows higher total savings although it utilizes only 175 of the 310 participants with adequate billing histories. This results because the first model includes customers with unexplained bill increases that confound the overall savings estimates, making it difficult for the bill analysis models to correlate bill declines with expected savings from the tracking system.

Ultimately, the billing analysis model that utilizes all participants provides a realization rate of 0.11 meaning only 11% of tracking system savings could be realized in billing, using the billing analysis methods employed in this study (77,838 therms compared to 720,962 therms in Table 2). The realization rate for the model utilizing only participants with bill declines is estimated to be 0.33 (137,715 therms compared to 411,314 therms in Table 2). However, since this model excludes participants with bill increases, the realization rate could be recalculated to include these customers with a savings assumed to be zero. Assuming the excluded sites had zero savings, the adjusted realization rate (RR2 in Table 2) is 0.19, indicating 19% of expected savings are realized in bills (137,715 therms compared to 720,962 therms). This is a conservative approach since savings could be masked by other unknown factors, and it may be reasonable to exclude these customers from the billing analysis but still apply the 0.33 realization rate to all participants.

Depending on the choice of model, the evaluated annual savings for all commercial dry cleaning/laundry participants ranges from 119, 192 therms to 369,637 therms compared to tracking system ex ante estimates of 1,103,995 therms. These results are summarized in Table 3.

Table 3: Billing Analysis Savings Summary, Commercial Dry Cleaning/Laundry Participants

Model	Realization Rate	Tracking System Savings	Evaluation Savings
Model using all participants	0.11	1,103,995	119,192
Model using participants with bill declines, assuming participants with bill increases have zero savings	0.19	1,103,995	210,880
Model using participants with bill declines, assuming participants will bill increases have savings that are masked by other factors	0.33	1,103,995	369,637

2. Introduction

As part of their 2006-2008 Mass Markets Program, PG&E has offered financial incentives to customers for the installation of steam traps. Installations occur in both industrial and commercial facilities. For the commercial facilities, dry cleaning operations account for the bulk of the installations. Ex ante savings for this measure are deemed, on a per unit basis, and do not take into account site-specific operating conditions. These savings are based on a study, prepared for Southern California Gas Company, that evaluated impacts for over 30,000 steam traps.

As an interim check on measure performance, PG&E reviewed bills of a sample of facilities. Findings from this initial review did not provide significant evidence to support the ex ante impact estimates. KEMA was contracted by PG&E to conduct a more rigorous analysis of customer bills to better assess steam trap impacts, particularly in Dry Cleaning/Laundry facilities.

2.1 Study Approach

The approach used for this study is a regression-based billing analysis utilizing time-series/cross-sectional billing analysis models. A preliminary bill comparison was performed to identify sites that were most likely to be saving natural gas as a result of the steam trap measures versus sites where savings achievements were not as identifiable. The preliminary results were integrated into the regression analysis. Data for the project included tracking system and billing system data provided by PG&E.

2.2 Report Organization

The remainder of this report is organized as follows:

- Section 3 presents the study methodology
- Section 4 discusses data development activities, and
- Section 5 presents the results of the analysis.
- Appendix A provides the billing analysis model details

3.   Methodology

This section provides a discussion of the approach used to assess natural gas savings from installation of steam traps. This discussion addresses:

- the preliminary billing data analysis used to identify useful and problematic billing histories for the program participant sites; and

- the regression-based billing analysis that was used to improve upon the preliminary assessment by controlling for factors such as seasonality and trends in energy usage.

3.1   Preliminary Billing Data Analysis

The preliminary billing data analysis consisted of annualizing and comparing pre-retrofit bills to post-retrofit bills. The pre-retrofit period was considered the 12-month period prior to the measure install date. The post-retrofit period was the period starting with read dates that were at least 30 days past the measure install date. The billing data for the period near the install date were "blacked out" and not used in the analysis. Annualized usage for the each of the pre- and post-retrofit periods was calculated as:

$$annualized\ therms = 365 \times \frac{\sum therms}{\sum billing\ days}$$

where the *therms* and *billing days* are summed across all the reads in the pre- and post-retrofit periods.

Preliminary bill savings for a given site were then calculated as:

$$preliminary\ savings = annualized\ therms_{pre} - annualized\ therms_{post}$$

Once annualized therms and preliminary savings were developed for each site, they were aggregated across measure groups and market segments to provide an initial indication of how tracking system ex ante savings were comparing to changes in bills.

3.2   Regression-Based Billing Analysis

For the regression-based billing analysis models, we utilized pooled time series/cross-sectional models that make use of monthly consumption. The basic models investigated were:

Model 1: $Therms_{it} = m_i + t_t + b_1 \times PART_{it} + \sum_{j=2}^{n} b_j X_{itj} + e_{it}$, and

Model 2: $Therms_{it} = m_i + t_t + b_1 \times THMSAV_{it} + \sum_{j=2}^{n} b_j X_{itj} + e_{it}$

where:

$Therms_{it}$	=	Average daily gas use for customer i in time period t
$PART_{it}$	=	Program participation for customer i in time period t, zero prior to implementation
$THMSAV_{it}$	=	Expected program savings from the tracking system (in therms per day) for customer i in time period t, zero prior to implementation
X_{itj}	=	Other explanatory variables that could affect energy use (mainly electricity consumption, which serves as a proxy for changes in facility activity)
m_i	=	Dummy variable, 1 for customer i, 0 otherwise
t_t	=	Dummy variable, 1 for time period t, 0 otherwise
b's	=	Estimated parameters
e_{it}	=	Error term

The parameter of interest in Model 1 is b_1, the coefficient for the $PART_{it}$ variable, reflecting impacts of program participation and installing measures. This coefficient reflects the average therms per day savings for the customers included in the billing analysis.

For Model 2, b_1 is the coefficient for the $THMSAV_{it}$ variable. In this case, the billing analysis model becomes an SAE (statistically adjusted engineering) model, and the estimated parameter, b_1, is interpreted as the realization rate, the fraction of tracking system savings that is reflected in the customer bills.

The customer-specific level variables, m_i, and the time-specific level variables, t_t, are included to control for "fixed-effects," the stable but unmeasured characteristics of each customer and time period. The fitting of these two sets of fixed effects eliminates two important potential sources of intercorrelation among the model residuals. The customer-specific variables adjust for each customer's base use facilitating the calibration to customer bills.

Overall, we estimated 2 sets of models. One set included all dry cleaning/laundry participants who had adequate billing histories to support the analysis. The second set of models utilized the same structure as the first set of models, but they we only estimated for the subset of dry cleaning/laundry participants who had bill declines subsequent to measure implementation, as determined by the preliminary bill screening analysis. Each set of models included 4 model variations:

1. Model 1 using the *PART* variable and an electricity consumption explanatory variable
2. Model 1 using the *PART* variable without the electricity consumption explanatory variable
3. Model 2 using the *THMSAV* variable and an electricity consumption explanatory variable
4. Model 2 using the *THMSAV* variable without the electricity consumption explanatory variable

4.   Data Development

Data from the PG&E program tracking system and data from the PG&E billing system were required for the analysis. Both sets of data were provided by PG&E.

4.1   Program Tracking Data

An initial tracking system data extract was received on July 31, 2007. The dataset contained 683 records and included paid and some unpaid projects. KEMA identified some problems with this dataset, such as inconsistencies between the number of units installed at a site and the expected therm savings for that site.

A second tracking data extract was received on August 14, 2007. This dataset contains 519 records for projects that have been paid. KEMA identified 29 duplicate records that were removed from this dataset, and a total of 490 records were included in further analysis. The following table summarizes key tracking data:

Table 4: Tracking Data Summary by Measure and Facility Type

Measure Code	Facility Type	Applications	Units Installed	Expected Savings	Rebate
H201	Mushroom Production	1	2	1,224	$200
	Nursery	1	5	3,062	$357
	Subtotal	2	7	4,286	$557
H202	Sewage Treatment	1	2	4,496	$400
	Steam and AC Supply	1	21	47,214	$2,910
	Manufacturing (excl. Refineries)	8	79	177,613	$14,295
	Petroleum Refineries	5	522	1,173,621	$84,149
	Dry Cleaning/Laundry	4	28	62,951	$5,395
	Subtotal	19	652	1,465,895	$107,149
H221	Nursery	4	2,638	251,934	$263,800
	Manufacturing	2	13	1,734	$1,298
	Commercial (excl. Laundry)	5	72	9,606	$7,049
	Dry Cleaning/Laundry	458	8,275	1,103,995	$815,773
	Subtotal	469	10,998	1,367,269	$1,087,920
Total		490	11,657	2,837,450	$1,195,626

Measure code definitions[1]:

   H201 - Steam Trap - Industrial Low Pressure Steam (< 15 psig)

   H202 - Steam Trap - Industrial High Pressure Steam (> 15 psig)

   H221 - Steam Trap - Commercial - Any Pressure

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[1] PG&E has used incorrect measure code definitions in some tracking data workbooks due to changes in underlying workpapers that weren't adjusted for. Incorrect measure descriptions that should not be relied on are: H201: Steam Trap – Commercial 24 hours/day operation; H202: Steam Trap - Industrial 24 hours/day operation; and H221: Steam Trap – Commercial < 24 hours/day operation

Table 5 summarizes the tracking system data by install date. Note that most of the program participation occurred between March and May of 2007. Hence most of the projects did not a complete 12 months of post-retrofit billing histories.

Table 5: Tracking Data Summary by Install Date

Install Date	Applications	Units Installed	Expected Savings	Rebate
Oct 2006	2	65	135,566	$6,475
Nov 2006	2	14	4,262	$1,059
Dec 2006	13	336	347,258	$25,864
Jan 2007	17	244	131,949	$27,337
Feb 2007	112	3,500	659,722	$363,148
Mar 2007	173	3,078	423,330	$307,554
Apr 2007	64	1,074	179,237	$109,100
May 2007	65	2,530	794,387	$271,000
Jun 2007	35	658	140,659	$68,289
Jul 2007	7	158	21,080	$15,800
Total	490	11,657	2,837,450	$1,195,626

4.2   Billing Data

Two rounds of billing data were delivered by PG&E. In the first round, it was discovered that many of the steam trap sites did not have electric usage data associated with the same account as for the natural gas data. Hence a second data pull was made that took all of the accounts associated with the same "Person ID" as for the account linked to the tracking data. Accounts were then matched to the steam trap sites based on service address.

The initial billing dataset contained 29,069 records (one record for each account for each month of billing data). Thirty duplicate records for one account were removed. Of the remaining 29,039 records, 13,085 were matched to tracking data. The remaining 15,954 records were excluded from the analysis. There were a total of 26 service accounts from the tracking data that were not matched to customer bills.

In the second billing extract, 40,883 records were received. These were compressed to 25,170 records by aggregating over service addresses. Of the 25,145 compressed records, 13,117 were matched to tracking data, and the remaining 12,027 were excluded from the analysis. This second data extract did a much better job of pulling in billing data appropriate for the analysis, as shown in Table 6.

Table 6: Summary of Billing Data Availability

	Billing Data Extract 1	Billing Data Extract 2
Unique Accounts in Tracking Data	476	476
Accounts Matched to Billing Data	450	450
Matched Accounts with Gas Data	418	448
Matched Accounts with Electric Data	31	353

5.   Results

This section presents results of the preliminary billing data analysis and results of the regression-based billing analysis.

5.1   Preliminary Billing Data Analysis Results

Results are presented in Table 7. Overall, 232 sites saw decreases in bills between the pre- and post-retrofit periods (averaging 102,498 therms per year), and 175 sites saw increases in bills (averaging 230,885 therms, as shown by the negative savings figure). While the average changes are obscured by the large sites, it is clear that a large number of sites (43%) still had higher usage in the post retrofit period. Overall, bill increases outweighed bill decreases, as shown by negative savings of 40,849 in the total row of the overall analysis group results.

Table 7: Preliminary Bill Screening Results - Therms

Analysis Group	Bill Direction	Number of Sites	Average Annual Pre-retrofit bill	Average Annual Post-retrofit bill	Average Annual Bill Savings	Tracking System Savings	Realization Rate
Overall	Sites with bill decreases	232	1,787,131	1,684,633	102,498	3,417	30.00
	Sites with bill increases	175	718,762	949,702	-230,885	5,153	-44.81
	Total	407	1,327,759	1,368,631	-40,849	4,163	-9.81
H201 (Com 24 Hr.)	Sites with bill decreases	1	117,049	106,706	10,343	1,224	8.45
	Sites with bill increases	1	1,101,961	1,305,494	-203,533	3,062	-66.47
	Total	2	609,505	706,100	-96,595	2,143	-45.07
H202 (Ind 24 Hr.)	Sites with bill decreases	7	58,912,809	55,550,979	3,361,830	35,009	96.03
	Sites with bill increases	2	59,591,140	79,476,661	-19,885,521	245,067	-81.14
	Total	9	59,063,549	60,867,797	-1,804,248	81,688	-22.09
H221 (Com <24 Hr.) Total	Sites with bill decreases	224	9,409	8,354	1,055	2,440	0.43
	Sites with bill increases	172	31,972	34,529	-2,502	2,375	-1.05
	Total	396	19,209	19,723	-490	2,412	-0.20
H221 (Com <24 Hr.) Non Dry Cleaning/ Laundry	Sites with bill decreases	2	17,685	13,741	3,944	767	0.89
	Sites with bill increases	3	468,733	501,771	-33,038	400	-17.20
	Total	5	171,573	182,836	-11,263	267	-6.80
H221 (Com <24 Hr.) Dry Cleaning/ Laundry	Sites with bill decreases	222	9,175	8,182	994	2,448	0.41
	Sites with bill increases	169	7,577	8,421	-787	2,396	-0.33
	Total	391	8,485	8,285	224	2,425	0.09

Measure code definitions:

H201 - Steam Trap - Industrial Low Pressure Steam (< 15 psig)

H202 - Steam Trap - Industrial High Pressure Steam (> 15 psig)

H221 - Steam Trap - Commercial - Any Pressure

For measure H201 (for industrial low pressure steam), one customer's bills declined, while the second customer's bills increased. For measure H202 (for industrial high pressure steam), 7

customers' bills declined, while 2 customers' bills increased. The bill increases for these last 2 customers more than offset the bill declines of the other 7 customers. Note, that with the many operations changes that are likely at larger industrial facilities, a billing analysis is not an appropriate impact estimation technique for this group. Also note that the measure H202 customers are considerably larger that customers in other measure categories.

Finally, for measure H221 (for commercial customers) the total results are dominated by the dry cleaning/laundry facilities, with the exception of several large non-dry cleaning/laundry sites that experienced bill increases. For the dry cleaning/laundry group (the last set of figures in Table 7), 222 sites (57%) saw decreases in bills. These decreases average 994 therms per year, which is only 41% of the amount estimated by PG&E in the tracking system. The remaining 169 sites saw bill increases averaging 787 therms per year. This second group of sites tended to offset the apparent savings from the first group. Overall, for the H221 dry cleaning/laundry group, average savings of 224 therms per year are only about 9% of the initial PG&E estimates.

5.2   Regression-Based Billing Analysis Results

5.2.1   Model Results

Table 8 summarizes modeling results as they pertain to savings estimates. Complete modeling results are provided in Appendix A. See Section 3.2 above for a description of the models.

Table 8 shows the estimated coefficient and t-statistic for the key savings variables (PART and THMSAV) for the various models that were estimated. The number of participants included in each model is also shown. The models with the electric usage variable have less participants because some sites were missing electric data – either because they were served by another electric utility or because we were not able to match electric data to the gas data at their site.

For Model 1, which includes the PART (0/1) savings variable and electric usage, estimated savings average 0.407 therms per day over all modeled participants and 1.467 therms per day for the subset of participants who saw declines in their gas bills. Results did not vary much for the models without the electric use variable. Statistical significance is marginal for the models that include all participants.

Table 8: Billing Analysis Parameter Summary

Model	Statistic	All Participants		Participants with Bill Declines	
		PART	THMSAV	PART	THMSAV
Model 1	Savings Parameter Estimate	-0.407		-1.467	
with Electric	t-Statistic	-1.4		-3.5	
Use Variable	R^2	0.9808		0.9853	
	# Participants	310		175	
Model 1	Savings Parameter Estimate	-0.371		-1.489	
without Electric	t-Statistic	-1.3		-4.1	
Use Variable	R^2	0.9748		0.9832	
	# Participants	391		222	
Model 2	Savings Parameter Estimate		-0.108		-0.335
with Electric	t-Statistic		-3.1		-6.9
Use Variable	R^2		0.9808		0.9855
	# Participants		310		175
Model 2	Savings Parameter Estimate		0.036		-0.268
without Electric	t-Statistic		1.2		-6.7
Use Variable	R^2		0.9748		0.9833
	# Participants		391		222

For Model 2, which includes the THMSAV savings variable and electric usage, the estimated realization rate is about 11% for the model that includes all 310 participants who have adequate gas and electric bills. The realization rate increased to 34% for the subset of 175 participants whose bill decline from the pre-retrofit to the post-retrofit period. Both realization rates are statistically significant. For the Model 2 runs without the electric usage variable, realization rates were lower. For the all-participant model, savings were essentially zero. For the model that only included customers with bill declines, the estimated realization rate is 27%, and is statistically significant.

In reviewing the various billing analysis models that were estimated in the analysis, it appears that the "Model 2 with Electric Use Variable" models did the best job at explaining bills. They tend to show the higher R^2 statistics, which reflect the percent of variation in the therm-per-day usage variable that is explained in the model. In addition, the t-statistics on the savings variables (THMSAV and PART variables) are highest with these models, showing they have the best fit for these variables. The fact that these models perform the best is not unexpected. They utilize the most information in that they include tracking system savings that should better track savings across participants versus a simple 0/1 variable (PART), and they include the electric use variable which can help explain variations at a site that occurs over time.

The billing analysis models that include only participants with bill declines from the pre-retrofit to post-retrofit also tend to perform best. The model fit statistics (t-statistics and R^2) are higher and the savings parameters are higher. These results can also be expected, since customers with bill increases are likely to have things going on at the site that cannot be explained with the variables available for the analysis. These other effects can also serve to obscure the savings

parameter estimates. Given that it is unlikely that the steam trap retrofits would lead to increases in bills, is reasonable to believe that the participants with bill increases either had zero or little savings from the new steam traps or that the savings were totally masked by other factors that occurred at these sites over the model estimation period.

5.2.2   Savings Estimates

Using results of the billing analysis models we calculated estimated program savings as compare to tracking system savings. These results are shown in Table 9. Realization rates are shown in the last two columns of the table. In order to calculate overall realization rates for the models that excluded participants with bill increases, we assumed that savings at these facilities were zero. Even with this conservative assumption, the models that exclude the participants with bill increase still provide for the largest estimates of savings.

Overall, realization rates, the fraction of savings realized in the bills range from -0.04 for the "All Participant, Model 2 without Electric Use" equation to 0.19 for the "Participant with Bill Decline, Model 2 with Electric Use" equation. The analysis reveals that, even with the model that shows the most savings, bills for the dry cleaning/laundry participants are showing decline that are less than 20% of what PG&E's initial tracking system estimates would predict.

Table 9: Savings Estimates for Participants in the Bill Analysis

Model	# Participants	Parameter	Tracking Savings	Bill Savings	Realization Rate	RR2*
All Participant Models						
Model 1 with Electric Use Variable	310	-0.407	720,962	45,996	0.06	
Model 1 without Electric Use Variable	391	-0.371	948,304	52,922	0.06	
Model 2 with Electric Use Variable	310	-0.108	720,962	77,838	0.11	
Model 2 without Electric Use Variable	391	0.036	948,304	-33,988	-0.04	
Participant with Bill Decline Models						
Model 1 with Electric Use Variable	175	-1.467	411,314	93,676	0.23	0.13
Model 1 without Electric Use Variable	222	-1.489	543,395	120,691	0.22	0.13
Model 2 with Electric Use Variable	175	-0.335	411,314	137,715	0.33	0.19
Model 2 without Electric Use Variable	222	-0.268	543,395	145,374	0.27	0.15

* RR2 = Realization rate for all participants, assuming participants with bill increases have zero savings.

6. Appendix A: Billing Analysis Models

This appendix presents statistics for the eight billing analysis models that were estimated for this project:

Table 10 shows models estimated over all dry cleaning/laundry participants that had adequate billing histories. Table 11 shows models estimated of a subset of these participants that saw bill declines between the pre-retrofit and post-retrofit periods. See Section 3.2 above for a discussion of the models.

Table 10: Billing Analysis Results – Models with All Participants

Variable	Model 1 with Electric Use Parameter Estimate	Model 1 with Electric Use t-Statistic	Model 1 without Electric Use Parameter Estimate	Model 1 without Electric Use t-Statistic	Model 2 with Electric Use Parameter Estimate	Model 2 with Electric Use t-Statistic	Model 2 without Electric Use Parameter Estimate	Model 2 without Electric Use t-Statistic
PART	-0.407	-1.4	-0.371	-1.3				
THMSAV					-0.108	-3.1	0.036	1.2
kWh per day	0.031	7.8			0.030	7.6		
Monthly Dummy Variables:								
D2005_11	0.046	0.0	-0.233	-0.1	-0.171	-0.1	0.489	0.1
D2005_12	13.658	7.2	10.440	5.7	13.245	7.1	11.205	6.1
D2006_1	2.733	2.1	1.317	1.0	2.345	1.8	2.047	1.6
D2006_2	2.425	3.3	2.083	2.8	2.100	3.0	2.763	4.0
D2006_3	0.963	2.1	0.661	1.5	0.666	1.6	1.309	3.3
D2006_4	1.848	4.1	1.529	3.5	1.555	3.9	2.163	5.7
D2006_5	1.650	3.9	1.410	3.4	1.365	3.7	2.035	5.8
D2006_6	1.232	3.0	1.481	3.8	0.956	2.7	2.092	6.2
D2006_7	-0.029	-0.1	-0.204	-0.5	-0.307	-0.9	0.403	1.2
D2006_8	0.409	1.0	0.245	0.6	0.129	0.4	0.854	2.6
D2006_9	0.232	0.6	-0.064	-0.2	-0.048	-0.1	0.543	1.6
D2006_10	1.533	3.8	1.376	3.5	1.254	3.6	1.983	6.0
D2006_11	1.411	3.4	1.246	3.1	1.130	3.2	1.855	5.4
D2006_12	0.773	1.9	0.513	1.3	0.492	1.4	1.118	3.3
D2007_1	-0.246	-0.6	-0.529	-1.4	-0.519	-1.5	0.066	0.2
D2007_2	0.809	2.0	0.553	1.4	0.548	1.6	1.127	3.3
D2007_3	0.767	2.2	0.759	2.3	0.565	1.8	1.192	4.0
D2007_4	1.195	4.0	1.147	4.0	1.104	3.8	1.365	4.9
D2007_5	1.333	4.8	1.447	5.4	1.279	4.6	1.572	5.9
D2007_6	0.661	2.4	0.634	2.4	0.648	2.4	0.682	2.6
R-Square		0.9808		0.9748		0.9808		0.9748
Customer Dummy F-stat		755.2		577.9		756.5		577.8
Number of Participants		310		391		310		391
Number of Observations		4,912		6,239		4,912		6,239

Table 11: Billing Analysis Results – Models Using Participants with Bill Declines

Variable	Model 1 with Electric Use		Model 1 without Electric Use		Model 2 with Electric Use		Model 2 without Electric Use	
	Parameter Estimate	t-Statistic	Parameter Estimate	t-Statistic	Parameter Estimate	t-Statistic	Parameter Estimate	t-Statistic
PART	-1.467	-3.5	-1.489	-4.1				
THMSAV					-0.335	-6.9	-0.268	-6.7
kWh per day	0.011	1.9			0.008	1.5		
Monthly Dummy Variables:								
D2005_12	18.319	7.5	13.467	6.6	17.033	7.1	12.768	6.3
D2006_1	3.822	2.1	2.329	1.5	2.702	1.6	1.776	1.1
D2006_2	5.275	4.5	4.583	4.6	4.397	3.9	4.194	4.4
D2006_3	1.856	2.6	1.828	3.0	1.126	1.8	1.519	2.8
D2006_4	3.225	4.9	3.002	5.3	2.509	4.3	2.697	5.4
D2006_5	2.571	4.1	2.384	4.5	1.874	3.5	2.083	4.5
D2006_6	2.242	3.8	2.403	4.7	1.576	3.1	2.109	4.8
D2006_7	0.748	1.3	0.570	1.1	0.075	0.1	0.279	0.6
D2006_8	1.198	2.1	0.988	2.0	0.518	1.0	0.694	1.6
D2006_9	0.847	1.4	0.646	1.3	0.161	0.3	0.348	0.8
D2006_10	2.292	3.9	2.131	4.2	1.610	3.2	1.834	4.2
D2006_11	2.320	3.9	2.166	4.2	1.635	3.2	1.868	4.2
D2006_12	1.420	2.4	1.163	2.3	0.737	1.4	0.872	2.0
D2007_1	0.132	0.2	-0.019	0.0	-0.522	-1.0	-0.287	-0.7
D2007_2	0.954	1.6	0.846	1.7	0.314	0.6	0.580	1.3
D2007_3	0.811	1.6	0.666	1.5	0.298	0.7	0.447	1.1
D2007_4	1.223	2.7	1.137	3.0	0.973	2.3	1.028	2.8
D2007_5	1.148	2.7	1.200	3.4	0.976	2.4	1.136	3.3
D2007_6	0.185	0.5	0.184	0.5	0.146	0.4	0.173	0.5
R-Square		0.9853		0.9832		0.9855		0.9833
Customer Dummy F-stat		993.0		872.5		1,006.6		880.1
Number of Participants		175		222		175		222
Number of Observations		2,780		3,352		2,780		3,352