

Southern California Gas Company

Steam Trap Billing Analysis

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Steam Trap Billing Analysis Results

Executive Summary

Analysis of gas usage to assess the accuracy of ex-ante per unit therm savings was performed for 1,725 dry cleaning/laundry customers participating in the Southern California Gas Company Steam Trap energy efficiency program. The billing analysis included a simple pre installation period/ post installation period usage comparison analysis as well as a regression model.

The pre installation period/post installation period analysis yielded an increase in gas usage per customer of 302 therms per year. The regression analysis employed a fixed-effects model (a technique to account for variations in business and building characteristics when survey data is not available) with an expected daily savings per customer term based upon the number of traps installed. The participating dry cleaning/laundry customers installed 16.2 steam traps on average and the regression model estimated an increase in gas usage of 9.3 therms per trap (151 therm annual increase per customer).

Each approach revealed that dry cleaning/laundry customer usage actually increased slightly as a result of steam trap replacement. The first analysis estimated increase of 302 therms is less than 0.50% of annual consumption and in the regression analysis the annual consumption increase of 151 therms is less than 0.25% of annual consumption.

The remainder of this report is organized in the following manner. An overview of when the steam traps were replaced is provided in section I. Section II presents a description of the statistical analyses performed. Finally, section III supplies the results of the analyses.

Section I

Table 1 lists the number of dry cleaning/laundry customers participating in the steam trap program by month and the number of steam traps installed. The numbers suggest that most of the installations occurred from September 2006 through January 2007.

Table 1
Steam Trap Installations

Year	Month	Customers	Traps	Average # of Traps per Customer
2006	1	3	32	10.667
2006	2	1	7	7.000
2006	3	2	17	8.500
2006	4	4	35	8.750
2006	5	1	8	8.000
2006	6	3	23	7.667
2006	7	13	172	13.231
2006	8	42	818	19.476
2006	9	162	2,488	15.358
2006	10	349	5,376	15.404
2006	11	334	5,135	15.374
2006	12	344	6,040	17.558
2007	1	162	2,741	16.920
2007	2	41	613	14.951
2007	3	41	625	15.244
2007	4	29	495	17.069
2007	5	28	436	15.571
2007	6	68	1,159	17.044
2007	7	48	834	17.375
2007	8	19	315	16.579
2007	9	24	390	16.250
2007	10	7	132	18.857
Total		1,725	27,891	16.169

The average number of traps installed per customer is 16.169. The ex-ante annual energy savings per trap is estimated to equal 139 therms. The annual ex-ante savings per customer based on the average number of traps installed is 2,247 therms. The 2006 average use for the 1,725 dry cleaning/laundry customers totaled 7,528 therms. The ex-ante annual percent savings per participant equaled 29.86%. Section II below describes the approaches employed to measure the achieved energy savings from the installation of

steam traps based on historic monthly billing history for the dry cleaning/laundry participants.

Section II

The two analyses performed for the dry cleaning/laundry steam trap customers were pre/post usage comparison and regression analysis. These analyses provide estimates of the actual (realized) savings from the installation of the steam traps.

The pre/post usage comparison utilized customers that had at least 12 months of pre installation therm usage and 12 months of post installation usage. The billing month when the steam traps (based on the first steam trap installation date for the customer) were installed was eliminated from the usage comparison. The 12 most months before and after the steam trap installation were used to perform the usage comparison. In order to normalize for different number of days in billing months, monthly use per day was calculated for each customer. The average use per day by customer was computed for both the pre and post installation period. Difference in pre and post period average use per day was derived for each customer and then an overall average difference was computed. A positive change means that savings have occurred.

The regression analysis provides a means to account for factors other than the installation of steam traps on energy use. Each customer has different operating hours, equipment stock, amount of clothes to process, and building characteristics. Such information can only be attained using a survey questionnaire. A fixed-effects regression approach is utilized when survey data is not available to account for variations in business and building characteristics. The fixed-effects regression allows for separate intercept terms per customer. In addition to the individual intercepts, monthly indicators starting from the second month of usage history (February 2005 in this analysis) are included to capture any changes in the business climate. Monthly laundry sector employment and total heating degree days occurring during each billing period are also included in the regression model. Finally, the expected savings from the steam trap installations (number of traps times 139 therms per year divided by 365 to derive a customer savings per day) is added to the regression model. A negative coefficient value for the expected savings term indicates savings have occurred (a value of -1 would mean that the actual savings were equal to the expected savings value). As in the case of the billing comparison analysis, the monthly gas usage is divided by the number of billing days in the month.

The next section details the number of customers included in both analyses, the results of the analyses and the overall savings amount from the steam trap installations.

Section III

III.a Pre/Post Installation Billing Comparison

The pre/post installation period billing comparison results are discussed first followed by the regression model results.

As explained in Section II, customers had to have at least 12 months of pre period and post installation period usage to be included in this analysis. Table 2 below shows the number of customers included in the analysis. The numbers reveal that less than half of the dry cleaning/laundry customers (845 out of 1,725) had 12 months of pre and post period use.

Table 2
Pre/Post Billing Comparison Customers

12 Months	12 Months	Number of Customers	Percent	Number of Traps	Percent	Traps per Customer
Pre Usage Flag	Post Usage Flag					
Not Good	Not Good	104	6.03	1,731	6.2	16.6
Not Good	Good	672	38.96	11,486	41.2	17.1
Good	Not Good	104	6.03	1,526	5.5	14.7
Good	Good	845	48.98	13,148	47.1	15.6
Total		1,725	100	27,891	100	16.2

The customers participating in the pre/post billing comparison were separated into two groups. The groups were non-savers and savers. Table 3 displays the results of the pre/post billing comparison for the two groups. The numbers in the table reveal that **nearly twice as many customers had an increase in usage during the post period than had a decrease** although those customers that did experience savings actually saved more therms per day than the non-savers increased.

Table 3
Billing Comparison Results

	Number of Customers	Difference per Day	Pre Use per Day	Post Use per Day	Avg Traps
Non Savers	560	-2.85	19.63	22.48	15.37
Savers	285	3.15	24.92	21.76	15.93
Total Difference per Year	845	-254861			
Difference per Customer		-301.611			

The overall result of the pre/post billing comparison is an increase of just under 302 therms per year per customer. The dry cleaning/laundry customers were further disaggregated according to average monthly use. Customers that use more than 2,083

therms per month (i.e., 25,000 therms per year or more) were separated from the other customers. Table 4 lists the results of the pre/post installation period billing analysis by usage group. The numbers in the table show that the larger customers actually save more than 2,200 therms per year than the smaller customers and also use close to five times the amount of gas per day than the customers under 25,000 therms per year. However, only 3 percent of the pre post billing analysis customers used over 25,000 per year.

Table 4
Billing Comparison Results by Size of Customer Group

		Number of Customers	Difference per Day	Pre Use per Day	Post Use per Day	Avg Traps
Under 25,000 per Year	Non Savers	548	-2.6914	18.067	20.758	14.86
Under 25,000 per Year	Savers	274	2.3146	21.073	18.759	14.94
Over 25,000 per Year	Non Savers	12	-10.3233	90.963	101.286	38.58
Over 25,000 per Year	Savers	11	24.0182	120.641	96.623	40.64
Under 25,000 per Year	Total Difference per Year	822	-306,850.68			
Under 25,000 per Year	Difference per Customer		-373.30			
Over 25,000 per Year	Total Difference per Year	23	51,217.02			
Over 25,000 per Year	Difference per Customer		2,226.83			

III.b Regression Analysis

The regression analysis included customers with at least 12 months of pre installation period usage history and 9 months of post installation period billing history. These minimum numbers are in accordance with standard program measurement protocols. Unlike the billing comparison analysis, all billing data is used for those customers having the minimum. Table 5 shows the number of customers included in the regression analysis. Slightly less than 51 percent of the total dry cleaning/laundry participants had the minimum amount of billing history for inclusion in the regression analysis.

Table 5
Regression Model Customers

12 Months	9 Months	Number of Customers	Percent	Number of Traps	Percent	Traps per Customer
Pre Usage Flag	Post Usage Flag					r
Not Good	Not Good	82	4.75	1,363	4.9	16.6
Not Good	Good	694	40.23	11,854	42.5	17.1
Good	Not Good	73	4.23	1,050	3.8	14.4
Good	Good	876	50.79	13,624	48.8	15.6
Total		1,725	100	27,891	100	16.2

As section II described, the regression model included monthly indicators from February 2005 through December 2007, monthly heating degree days, employment and expected savings. There were over 29,900 monthly observations included in the regression analysis. Table 6 shows the regression results.

Table 6
Single Savings Adjustment Regression Model Results

R-Squared	0.954847		
		Standard	
Variable	Coefficient	Error	t Value
Intercept Term Overall F-Value	699.92		
February 2005 indicator	1.037631	0.212563	4.88
March 2005 indicator	1.37996	0.236644	5.83
April 2005 indicator	1.626513	0.2577	6.31
May 2005 indicator	1.619684	0.295299	5.48
June 2005 indicator	0.956733	0.345185	2.77
July 2005 indicator	0.427873	0.302304	1.42
August 2005 indicator	0.482756	0.299321	1.61
September 2005 indicator	-0.12905	0.302711	-0.43
October 2005 indicator	0.727778	0.291602	2.5
November 2005 indicator	0.812566	0.266729	3.05
December 2005 indicator	0.373251	0.256819	1.45
January 2006 indicator	0.006749	0.208194	0.03
February 2006 indicator	1.279221	0.22418	5.71
March 2006 indicator	1.342836	0.2758	4.87
April 2006 indicator	1.535166	0.269411	5.7
May 2006 indicator	1.521608	0.327491	4.65
June 2006 indicator	1.112783	0.404818	2.75
July 2006 indicator	-0.00996	0.36943	-0.03
August 2006 indicator	0.030358	0.385045	0.08
September 2006 indicator	-0.29266	0.422539	-0.69
October 2006 indicator	0.724848	0.414593	1.75
November 2006 indicator	0.551611	0.410987	1.34
December 2006 indicator	0.519269	0.406155	1.28
January 2007 indicator	0.060946	0.274812	0.22
February 2007 indicator	0.773755	0.30308	2.55
March 2007 indicator	0.871809	0.366508	2.38
April 2007 indicator	1.118072	0.388798	2.88
May 2007 indicator	1.087775	0.423944	2.57
June 2007 indicator	0.68055	0.474645	1.43
July 2007 indicator	-0.1586	0.438463	-0.36
August 2007 indicator	-0.23289	0.44236	-0.53
September 2007 indicator	-1.21654	0.460308	-2.64
October 2007 indicator	-0.03395	0.429664	-0.08
November 2007 indicator	-0.2098	0.410922	-0.51
December 2007 indicator	-0.20052	0.429552	-0.47
Monthly HDD per Day	-0.02616	0.021452	-1.22
Post installation expected savings term	0.067225	0.015376	4.37
Laundry Sector Monthly Employment	0.050458	0.071774	0.7

The overall model R-Squared value is .9548 which is very high for a fixed-effects gas usage model. The post installation expected savings term has the wrong sign and is significant. This result is consistent with pre/post billing comparison. The overall fixed-effects intercept F- Value is very strong which suggests that the individual customer intercepts is accounting for a lot of variation in usage across customers. The monthly indicator terms show some negative values during the last half of 2007 but only significant in September. The heating degree day term is negative but not significant. The employment term is positive but also not significant.

A regression model was also estimated that separated the expected savings by size of customer (monthly consumption > or < 2,083; annual consumption > or < 25,000 therms). Table 7 on the next page provides the regression equation for that model. The R-Squared value of .9550 is just a little higher than the first model. The expected savings for the larger customers is negative and significant although the overall impact for large customers is the sum of both terms. The overall fixed-effects intercept F- Value is stronger than the similar value in the first model. The monthly indicator terms don't reveal any downward trend in the last half of 2007 as was estimated in the first model. As the case with the first model, the heating degree day term is negative but not significant and the employment term is positive but also not significant.

Table 7
Regression Model Results By Customer Size

R-Squared	0.955001		
		Standard	
Variable	Coefficient	Error	t Value
Intercept Term Overall F-Value	702.28		
February 2005 indicator	1.027611	0.212207	4.84
March 2005 indicator	1.359025	0.236256	5.75
April 2005 indicator	1.601446	0.257279	6.22
May 2005 indicator	1.586373	0.294822	5.38
June 2005 indicator	0.914784	0.34463	2.65
July 2005 indicator	0.399664	0.301809	1.32
August 2005 indicator	0.456476	0.298829	1.53
September 2005 indicator	-0.15797	0.302216	-0.52
October 2005 indicator	0.700484	0.291125	2.41
November 2005 indicator	0.78846	0.266291	2.96
December 2005 indicator	0.342139	0.256407	1.33
January 2006 indicator	-0.00723	0.207848	-0.03
February 2006 indicator	1.257094	0.223814	5.62
March 2006 indicator	1.307211	0.27536	4.75
April 2006 indicator	1.501183	0.268979	5.58
May 2006 indicator	1.478699	0.326969	4.52
June 2006 indicator	1.05684	0.404176	2.61
July 2006 indicator	-0.0559	0.368837	-0.15
August 2006 indicator	-0.01233	0.384422	-0.03
September 2006 indicator	-0.32394	0.42184	-0.77
October 2006 indicator	0.770384	0.413921	1.86
November 2006 indicator	0.832114	0.411265	2.02
December 2006 indicator	1.081703	0.409399	2.64
January 2007 indicator	0.680111	0.28133	2.42
February 2007 indicator	1.38642	0.308783	4.49
March 2007 indicator	1.47044	0.370813	3.97
April 2007 indicator	1.713391	0.392736	4.36
May 2007 indicator	1.676945	0.42736	3.92
June 2007 indicator	1.261267	0.477433	2.64
July 2007 indicator	0.431015	0.441725	0.98
August 2007 indicator	0.356273	0.445574	0.8
September 2007 indicator	-0.63291	0.463268	-1.37
October 2007 indicator	0.557875	0.433053	1.29
November 2007 indicator	0.384128	0.414558	0.93
December 2007 indicator	0.388396	0.432901	0.9
Monthly HDD per Day	-0.02672	0.021416	-1.25
Post installation expected savings term small customers (< 25,000 therms)	0.192493	0.01986	9.69
Post installation expected savings term large customers (> 25,000 therms)	-0.22297	0.022428	-9.94
Laundry Sector Monthly Employment	0.06224	0.071663	0.87

Using the coefficients shown in tables 6 and 7, table 8 below provides a summary of actual savings generated from the regression models. The entire dry cleaning /laundry population is represented in this table. The model 1 customer count is 1,725, the model 2 small customer count is 1,680, and the model 2 large customer count is 45. The numbers show that **only customers using over 25,000 therms per year actually saved energy** after the installation of the steam traps. **The realization rate for the high use customers is just 3 percent of the ex-ante estimate.**

Table 8
Computed Realization Rates From Regression Analyses

	# of Custs	Coefficient	T-Stat	Avg Use Per Day	Average Traps Installed	Computed Savings (Per Day)	Annual Savings Per Customer	Annual Savings Per Trap	Realization Rate
Model 1									
Single Savings Term									
(Post installation expected savings term)	1,725	0.067	4.37	21.96	16.169	0.412553	150.58	9.31	-7%
Model 2									
Multiple Savings Term Interactions									
Post installation expected savings term small customers (< 25,000 therms)	1,680	0.192	9.69	19.7	15.52	1.134788	414.20	26.69	-19%
Post installation expected savings term large customers (> 25,000 therms)	45	-0.0304	-1.67	103.89	40.2	-0.46539	(169.87)	-4.23	3%