SDG&E Home Energy Reports Program

Savings Results

Prepared by KEMA, Inc.

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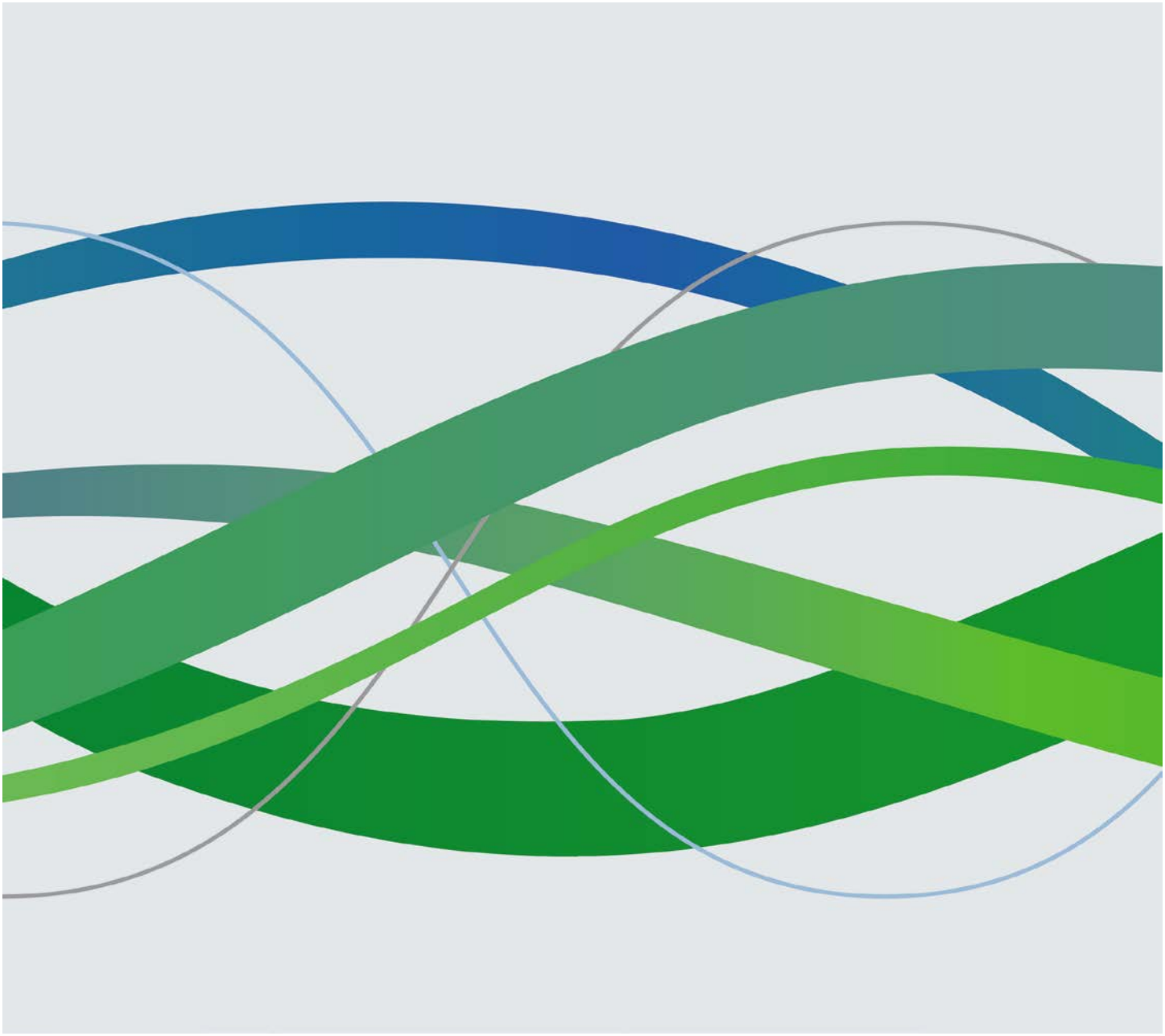

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1. Executive Summary

This report summarizes the results of DNV KEMA's impact evaluation of San Diego Gas & Electric's (SDG&E) Home Energy Reports (HERS) program. The pilot program was implemented by Opower in compliance with CPUC Decision 10-04-029 requiring California IOUs to initiate a behavior program using experimental design during the 2010-2012 program cycle. The evaluation uses consumption and program tracking data provided by SDG&E to the CPUC to conduct pre and post assessment of the experimental design to determine program impacts. The evaluation provides independent confirmation of gas and electricity savings attributable to the HER program.

1.1 Key Findings

SDG&E sent the first set of HERs to the treatment group in June and July of 2011. The program-level results presented here include all savings from July 2011, through December 2012. These results represent the full amount of savings identified from the HER program in the 2010-2012 timeframe. We also provide calendar year results as well as first 12 months results.

Table 1-1 provides the program level savings for the HER Program and includes the following results for gas and electric impacts:

- Overall savings – the unadjusted treatment effect from the difference of difference billing analysis
- Joint savings achieved in concert with other energy efficiency programs and claimed by SDG&E under those programs. Joint savings occur in two areas:
  - Downstream - increased savings in standard, tracked energy efficiency program due to the HER program.
  - Upstream– increased savings in upstream programs, primarily the Upstream Lighting Program and the related interactive effects on gas savings.
- Adjusted Savings – overall savings net of potential double-counted joint savings.

Table 1-1: Program-Level Savings Estimates Through 2012

Evaluation Period	Source	Electric (MWh)	Gas (,000 Therms)
July 2011 - December 2012	Unadjusted Savings	5,744.1	218.2
	Tracked, Downstream Joint Savings	116.7	0
	Untracked, Upstream Lighting Joint Savings	197.7	-2.7
	Adjusted Savings	5,429.7	221.0
July 2011 - June 2012	Unadjusted Savings	3,059.6	166.2
	Tracked, Downstream Joint Savings	54.4	0
	Untracked, Upstream Lighting Joint Savings	135.1	-1.9
	Adjusted Savings	2,870.1	168.1
January 2012 - December 2012	Unadjusted Savings	4,459.0	189.7
	Tracked, Downstream Joint Savings	116.7	0
	Untracked, Upstream Lighting Joint Savings	197.7	-1.8
	Adjusted Savings	4,144.6	191.5

The HER program achieved a reduction of 5,744 MWh across the treatment group households. A portion of those savings occurred due to increased activity in other SDG&E programs. We estimated joint savings at 117 and 198 MWh for downstream and upstream programs, respectively. These amounts are removed from the overall measured savings estimate. The estimate of total credited electric savings is 5,430 MWh.

The program also generated 218,200 therms of gas savings. There was no evidence of a statistically significant increase in downstream energy efficiency program gas savings. The upstream lighting program has a small interactive effect on gas savings which has the effect of increasing the unadjusted gas savings slightly rather than lowering it as with joint savings.

Table 1-1 also provides unadjusted and adjusted results for the first 12 months of the program (July, 2011 to Jun, 2010) and the last 12 months of the program (calendar year 2012).

Table 1-2 provides estimates of unadjusted and adjusted household level as a fraction of control group, post-period consumption. Over the full 16 months, unadjusted electric savings at the household level was 309.8 kWh, approximately 2.0% of electric consumption for that period.[1] Adjusted savings drop to 292.8

[1] Per customer savings are calculated by dividing the total aggregate savings by the average number of customers during that time period.

kWh and 1.9%, respectively. Unadjusted and adjusted gas savings are 11.8 and 11.9 therms per housheold or about 1.5% of gas consumption, for that period.

Table 1-2: Savings per Household as a Percent of Consumption

Evaluation Period	Units	Unadjusted, Per Customer Savings	Adjusted, Per Customer Savings	Per Customer Consumption	Unadjusted Savings as Percentage of Consumption	Adjusted Savings as Percentage of Consumption
July 2011 - December 2012	kWh	309.8	292.8	15,543	2.0%	1.9%
	Therns	11.8	11.9	798	1.5%	1.5%
July 2011 - June 2012	kWh	161.0	151.0	10,036	1.6%	1.5%
	Therns	8.7	8.8	605	1.4%	1.5%
January 2012 - December 2012	kWh	246.4	229.0	10,367	2.4%	2.2%
	Therns	10.5	10.6	562	1.9%	1.9%

This evaluation did not obtain feedback from participants regarding the source of the savings, and thus the exact composition (behavioral or adoption of energy efficiency measures) of the savings is unknown. However, the joint savings results provide some insight into the magnitude and nature of the HER effect on measures supported by energy efficiency program funds. The reports caused a greater than 20% increase in downstream rebate activity savings. Those savings are a relatively small portion of the overall measured savings but represent a dramatic improvement in program activity. In general, the reports appear to not increase participation in any particular subset of measures but tend to increase downstream program activity across measures proportionally to existing activity in households that did not receive the HERs.

2. Introduction

This report summarizes the results of DNV KEMA's impact evaluation of San Diego Gas & Electric's (SDG&E) Home Energy Reports (HERS) program. SDG&E began sending HERs in July, 2011. After a three month initial period of monthly reports, SDG&E switched to a sending HERs bi-monthly. The reports contain a mix of consumption information, comparison with similar neighbors and customized tips for saving energy.

3. Evaluation Methodology

3.1 Randomized Controlled Trial Experimental Design

The HER Program uses a randomized controlled trial (RCT) experimental design. The RCT experimental design is widely considered the most effective way to establish causality between a treatment and its effect. In combination with the substantial numbers of households in both treatment and control groups, the approach produces an un-biased estimate of savings with a high level of statistical precision. Opower has used the RCT approach to support the credibility of program-related savings despite their relatively small magnitude of one to three percent of consumption.

This evaluation takes full advantage of the RCT experimental design in every phase of the analysis. We estimate savings using a regression approach that applied the RCT design to estimate the overall change in consumption attributed to the reports. In addition, the RCT design provides the basis for the analysis of increased activity in both downstream and upstream energy efficiency programs. The comparison of activity between the treatment and control groups for both of these kinds of joint savings yields an estimate of the effect of the reports.

DNV KEMA participated in the establishment of the RCT experimental design for the SDG&E HER Program. Opower identified a population of approximately 40 thousand households that were eligible to take part in the program. DNV KEMA randomly assigned half of these households to a treatment group that received the reports. The remainder of the households did not receive reports. Assigning the responsibility of randomizing the sample to an independent evaluator minimizes concerns regarding the validity of the experimental design. However, this does not guarantee perfectly balanced treatment and control groups, as is discussed in section 4.1

3.2 Calculated Savings

3.2.1 Fixed Effects Regression Model

This evaluation uses a fixed effects regression model specification that is the standard for the evaluation of behavioral programs like this one. The model produces a difference of difference calculation in the regression context. The pre- to post-July 2011 difference for the treatment group is compared to the pre- to post-July 2011 difference for the control group. The change that occurs in the treatment group is adjusted to reflect any change that occurred in the control group. The experimental design ensures that the control group is the best possible estimator of what the treatment group would have done in the absence of the reports.

The fixed-effects equation is:

$$E_{it} = \mu_i + \lambda_t + \beta P_{it} + \varepsilon_{it}$$

where

E_{it} = Average daily energy consumption for account i during month t
T_i = Binary variable: one for households in the treatment group, zero otherwise
P_{it} = Binary variable: one for households in the treatment group in the post period month t, zero otherwise
λ_t = Binary variable: one for a specific month/year, zero otherwise
μ_i = Account level fixed effect
ε_{it} = Regression residual

This model produces estimates of average monthly savings

$$\bar{S}_t = \hat{\beta}_t$$

where

$\bar{S}_t$ = Average treatment related consumption reduction during month t;
$\hat{\beta}_t$ = Estimated parameter measuring the treatment group difference in the post period month t;

The model includes site-specific and month/year fixed effects. The site-specific effects control for mean differences between the treatment and control groups that do not change over time. The month/year fixed effects control for change over time that is common to both treatment and control groups. The monthly post-July 2011 dummy variables pick up the average monthly effects of the treatment. Households that move are dropped from the model. The total savings are a sum of the monthly average savings combined with the count of households still eligible for the program. Households that actively opt out of the program remain in the model as long as they remain in their house. In this respect, the treatment can be considered an "intent to treat". This model is consistent with best practices as delineated in State and Local Energy Efficiency Action Network's *Evaluation, Measurement, and Verification (EM&V) of Residential Behavior-Based Energy Efficiency Programs: Issues and Recommendations*[2]

[2] State and Local Energy Efficiency Action Network. 2012. *Evaluation, Measurement, and Verification (EM&V) of Residential Behavior-Based Energy Efficiency Programs: Issues and Recommendations*. Prepared by A. Todd, E. Stuart, S. Schiller, and C. Goldman, Lawrence Berkeley National Laboratory. http://behavioranalytics.lbl.gov.

3.3 Downstream Rebate Joint Savings

One possible effect of the HER Program is to increase rebate activity in other SDG&E energy efficiency programs. The RCT experimental design facilitates the measurement of this effect. We compare the rebate program savings installed by the average treatment group home with the savings installed by the average control group home. An increase in treatment group rebate program savings represents savings caused by the HER Program jointly with the rebate program. While these additional savings are an added benefit of the HER Program, it is essential that the associated savings are only reported once. The most common and simple approach is to remove all joint savings from the HER Program savings rather than remove program specific joint savings from all of the affected rebate programs. The fact that the joint savings are removed from the HER program savings should not obscure the fact that these are real savings that would not have occurred without the HER program.

The estimated savings estimates from the fixed effects regressions identify all differences between the treatment and control group in the post-report period. Any joint savings are picked up by the regressions and included in the overall savings estimate. These savings are also included in the rebate program tracking databases. Counting the savings in both places results in double counting program savings. While it is possible to remove joint savings from either place, the most simple accounting is to remove savings from the estimated HER Program savings. Removing the savings from HER allows for the calculation of a single joint savings for all rebate programs that are tracked at the customer level. We then remove this amount from the HER Program savings.

Our approach for calculating joint savings captures individual rebate savings, and is the following:

- Use accepted deemed savings values
- Start from the installation date
- Project forward on a load-shape-weighted basis, and
- Maintain the load-shape-weighted savings over the life of the measure

This approach takes the deemed annual savings values and transforms them into realistic day to day savings values given the installation of that measure. We determine the daily share of annual savings using hourly 2011 DEER load shapes[3] for SDG&E[4]. These load-shapes indicate when a measure is used during the year and also when efficiency savings would occur.[5]

[3] DEER load shapes are in an 8760 hourly format. DNV KEMA aggregated the hourly shares to daily shares in order to estimate daily savings.

[4] http://deeresources.com/DEER2011/download/DEER2011-UpdatedImpactProfiles-v2.zip

[5] This is more accurate and equitable than subtracting out the first year savings values that are used in DEER, because most measures are not in place from the first day to the last day of the year.

Savings for each installed measure start to accrue at the time of installation (or removal for refrigerator recycling). We calculate average monthly household rebate program savings for the treatment and control groups including zeroes for the majority of households that do not take part in any rebate program. An increase in average per household tracked program savings among the treatment group versus the control group indicates joint savings.

3.4 Upstream Joint Savings

Upstream joint savings are similar to downstream joint savings except that they are not tracked at the customer level. They represent a source of savings that SDG&E could potentially double count. Unlike tracked programs, it not possible to directly compare all treatment and control group member activity. This makes it more challenging to determine if the HER program does increase savings in upstream programs.

The alternative to the downstream, census-level approach is to do a comparison of treatment and control group uptake of the upstream program measures on a sample basis. This approach also takes advantage of the RCT experimental design which provides the structure to produce an un-biased estimate of upstream savings. PG&E recently conducted in-home surveys to assess uptake of upstream measures (specifically, CFLs and flat screen TVs). The surveys included samples of treatment and control customers from their HER program. Because of the expected similarity between upstream savings between SDG&E and PG&E and the prohibitive cost of performing a similar survey for the relatively small SDG&E program, DNV KEMA used results from this study as the basis for a unique, SDG&E estimate of upstream joint savings. This approach is described in more detail in Section 5.2.2.

4. Data Management

The billing analysis that underlies the HER program savings estimates relies on consumption data from the SDG&E billing system. On the one hand, because consumption data are closely tied to the billing function, the data are generally considered accurate. On the other hand, missed reads, estimated reads and corrections do occur, undermining the validity of some readings. In non-RCT billing analysis evaluations, it is common to apply a range of consumption data checks in an attempt to limit invalid data. This can lead to the removal of customers from the analysis because of limitations in their billing data.

However, an analysis based on an RCT experimental design does not have this concern. In theory, issues that exist in the data are shared approximately equally by the treatment and control group. A premise of the RCT is that whatever effects these potential billing issues have on the treatment group consumption are present also in the control group. With results of the relatively small magnitude expected from HER programs in general, the active removal of data has the potential to affect the final results in non-trivial ways. This justifies the use of unedited billing data. Table 4-1 provides an overview of the data issues identified in the billing data. The incidence of issues is small across treatment and control group and both fuel types. The zero reads for gas houses are not uncommon in the summer and are not real issues; they are included only for completeness. Comparing all issues across the treatment and control groups the differences are extremely small. These finding indicate that data issues are infrequent and that the treatment control difference inherent in the RCT structure will control for the majority of what issues exist.

Table 4-1: Summary of Billing Data Issues

	Electric		Gas	
	Control	Treatment	Control	Treatment
Bad Read Dates	0.14%	0.16%	0.09%	0.07%
Zero Reads	0.78%	0.78%	3.80%	4.09%
Negative Reads	0.00%	0.00%	0.00%	0.00%
Missing Reads	0.00%	0.00%	0.00%	0.00%
Extreme Reads	0.01%	0.02%	0.17%	0.15%
No Issues	99.07%	99.09%	95.97%	95.72%

4.1 Experimental Design Validation

DNV KEMA performed the randomized selection of the treatment and control groups for the SDG&E program. We randomized customer IDs using a standard process and supplied them to SDG&E for

application to the customer data[6]. At the time of randomization, confidentiality issues kept DNV KEMA from having the customer account numbers. For this reason, we were unable to either confirm the randomization at the time or consider alternative randomization options like stratification on pre-program consumption.

To test the randomness of the treatment and control group allocations we compared pre-program annual electric and gas consumption for the 12 months prior to July 2011, the month the reports were first sent. For both gas and electric consumption, we calculated consumption quintile cut-offs from the overall datasets (separately for the SDG&E system and the Opower datasets, but calculated over the combined treatment and control sample). For overall consumption and for each quintile group we looked at treatment and control differences. Most importantly, we looked at mean difference and the associated p-value of that difference. These differences are expected to be zero. A small p-value indicates an increased probability that the difference is not zero. In addition, we provide differences in counts and median consumption. A dataset containing data gathered by Opower providing house value, size, income, number of occupants, etc., was not provided. Table 4-2 provides the summary statistics for the two datasets.

Table 4-2 Test of Randomness of Experimental Design (Treatment vs. Control Groups)

Service Type	Quintile	% Difference Counts	% Difference Median Consumption	% Difference Mean Consumption	Mean Consumption Difference P-value
Electric	1	-5%	-0.10%	-1.00%	0.142
	2	2%	-0.40%	-0.10%	0.437
	3	0%	-0.30%	-0.10%	0.361
	4	0%	-0.40%	-0.30%	0.048
	5	2%	0.00%	-0.10%	0.881
	ALL	0%	-0.80%	-1.30%	0.008
Gas	1	-2%	-1.20%	-0.80%	0.586
	2	2%	-0.30%	-0.10%	0.306
	3	-2%	0.00%	0.00%	0.836
	4	0%	-0.10%	-0.20%	0.175
	5	2%	0.30%	-0.20%	0.518
	ALL	0%	-0.20%	-0.80%	0.137

The results of the test indicate systematic differences in consumption between the treatment and control groups. This is despite the fact that a verified randomization process was implemented. Overall, the treatment group electric consumption was 1.3 percent smaller than the control group. This difference is statistically significant at 95 percent confidence. Gas consumption for the treatment group was 0.8

[6] At that time, confidentiality agreements were not in place. SDG&E applied the random customer IDs to the program and billing data. Opower was not involved in the randomization process.

percent smaller than the control group. This difference is not statistically significantly different than zero at 95 percent confidence.

The quintile analysis sheds some light on the imbalance behind the difference between the two groups. Counter-intuitively, quintile-level treatment-v-control differences are all smaller than the overall difference. However, the top quintile is the source of the overall difference. Not only do the households from the top quintile of the treatment group use less electricity, but unlike all the other quintiles, there are fewer treatment households relative to the control group. The combination of these two occurrences leads to an overall difference that is bigger than the first quintile difference and also statistically different than zero. If Opower had provided the additional site level characteristics data, our ability to understand and perhaps address the balance of the sample would have been enhanced. There is less than one in one-hundred chance of a sample this unbalanced happening in a random sample. However, because we controlled the randomization process, we know that this outcome is, in fact, the result of such a low probability event. This makes the savings estimation methods particularly important. The difference of difference framework that underlies the calculations of monthly savings provides control for any such differences between the treatment and control groups with respect to consumption. While it is unfortunate that the sample is not better balanced, this fact does not undermine the strength of the savings estimates produced here.

4.2 Customer Move-Outs and Program Attrition

The RCT experimental design requires that participating households in either treatment or control group be removed if the customers move. This kind of attrition is not ideal within the RCT but is unavoidable. The estimates of savings produced by the fixed effects model reflect the consumption data of those households remaining in the program (treatment or control group). Unlike attrition due to move-outs, households that opt-out of receiving the report remain in the treatment group despite the fact that they no longer receive the reports. Removing opt-out households would undermine the similarity between the two groups that is established by the RCT design.

Customers who installed solar panels and switched to net metering posed a dilemma for this evaluation. Whereas true move-outs are unlikely to have a causal relationship with the Reports, it is possible that installing solar represents an activity motivated at least partially by the reports. Unfortunately, how net metering is addressed in the billing data creates challenges for either including them in the analysis or fully understanding the extent of the issue.

For households with load served by SDG&E, a switch to net-metering causes a change in account numbers that would stop the mailing of the report to that address. For households with load served by Direct Access, SDG&E does not change the account number so the household continues to receive the reports. For this evaluation, all net-metered customers were left out of the analysis, effectively treated as move-outs.

If the solar households were included in the analysis it would be necessary to incorporate household level energy production data. Otherwise potential differences in solar energy production could be conflated with program-related savings biasing the results up or down. The end result of such an analysis would be to quantify what subset of HER program savings are related to increased solar production in HER treatment households relative to the control group. The attribution of these savings would need to be determined in regulatory context. The available data on Direct access customers indicated a slight but non-statistically significant increase in solar installation among treatment group member.

Table 4-3 provides the monthly eligible population for the HER Program through December 2012. The table provides count of eligible households for the treatment group that is used to calculate total savings. The count of move-outs per month and cumulatively is also provided. For the sake of comparison, the control group move-out counts are also provided.

Table 4-3: Move-Outs Based on Electric Account

Month	Treatment Group			Control Group		
	Open Accounts	Closed Accounts		Open Accounts	Closed Accounts	
		Cumulative	Monthly		Cumulative	Monthly
Jul-11	19,896	300	174	19,924	271	170
Aug-11	19,666	530	230	19,710	485	214
Sep-11	19,466	730	200	19,486	709	224
Oct-11	19,323	873	143	19,333	862	153
Nov-11	19,192	1,004	131	19,206	989	127
Dec-11	19,053	1,143	139	19,065	1,130	141
Jan-12	18,907	1,289	146	18,947	1,248	118
Feb-12	18,792	1,404	115	18,810	1,385	137
Mar-12	18,660	1,536	132	18,691	1,504	119
Apr-12	18,510	1,686	150	18,558	1,637	133
May-12	18,376	1,820	134	18,420	1,775	138
Jun-12	18,216	1,980	160	18,272	1,923	148
Jul-12	18,019	2,177	197	18,096	2,099	176
Aug-12	17,841	2,355	178	17,906	2,289	190
Sep-12	17,672	2,524	169	17,728	2,467	178
Oct-12	17,535	2,661	137	17,591	2,604	137
Nov-12	17,371	2,825	164	17,432	2,763	159
Dec-12	17,249	2,947	122	17,299	2,896	133

The electric and gas accounts for a household do not always end on the same day. We used electric to establish eligible household counts. The counts based on the gas account information were similar and did not justify establishing a second set of household counts for the purpose of calculating total gas savings.

5. Results Summary

The following section provides the components of final reported savings estimate for the SDG&E HER Program. The overall average savings are the full, unadjusted effect of the HERs on treatment group consumption. The joint savings estimates identify savings included in the overall savings estimate that are reported by some other program, either downstream rebate programs or upstream programs. The final subsection combines these estimates, removing the joint savings from the overall savings, producing a HER Program savings estimate that does not double-count energy savings from other programs.

5.1 HER Program Overall Savings Estimates

5.1.1 Electric

Figure 5-1 provides a graph of monthly electric savings. Savings jumped to 13.3 kWh per month immediately following the first Report and maintained between 11 and 19 kWh savings per month for the remainder of the first year.

About 69% of the HERs were distributed to Coastal customers, and 31% to Desert customers[7]. The late summer and early fall of 2012 saw unusually hot weather in the San Diego area and savings increased substantially during the months of August, September and October.[8]

[7] Coastal is SDG&E's baseline climate zone 1, and Desert is SDG&E's baseline climate zone 4. As expected, the percent of Coastal and Desert customers is the same in the control and treatment groups.

[8] The following data visualizations are representative:
For the San Diego area:
http://weatherspark.com/history/31050/2011/San-Diego-California-United-States,
http://weatherspark.com/history/31050/2012/San-Diego-California-United-States

For the Desert area:

http://weatherspark.com/history/30605/2011/Imperial-California-United-States

http://weatherspark.com/history/30605/2012/Imperial-California-United-States

In San Diego, the high temperatures for the fall months 2012 were almost entirely well above average high temperatures. The high of 109° F was 28 degrees higher than the average high temperature for that date. The desert was also hotter than average in fall 2012. Fall 2011 was relatively more mild near the coast and was also early in the tenure of the reports.

Figure 5-1: Average Monthly kWh Savings per Household

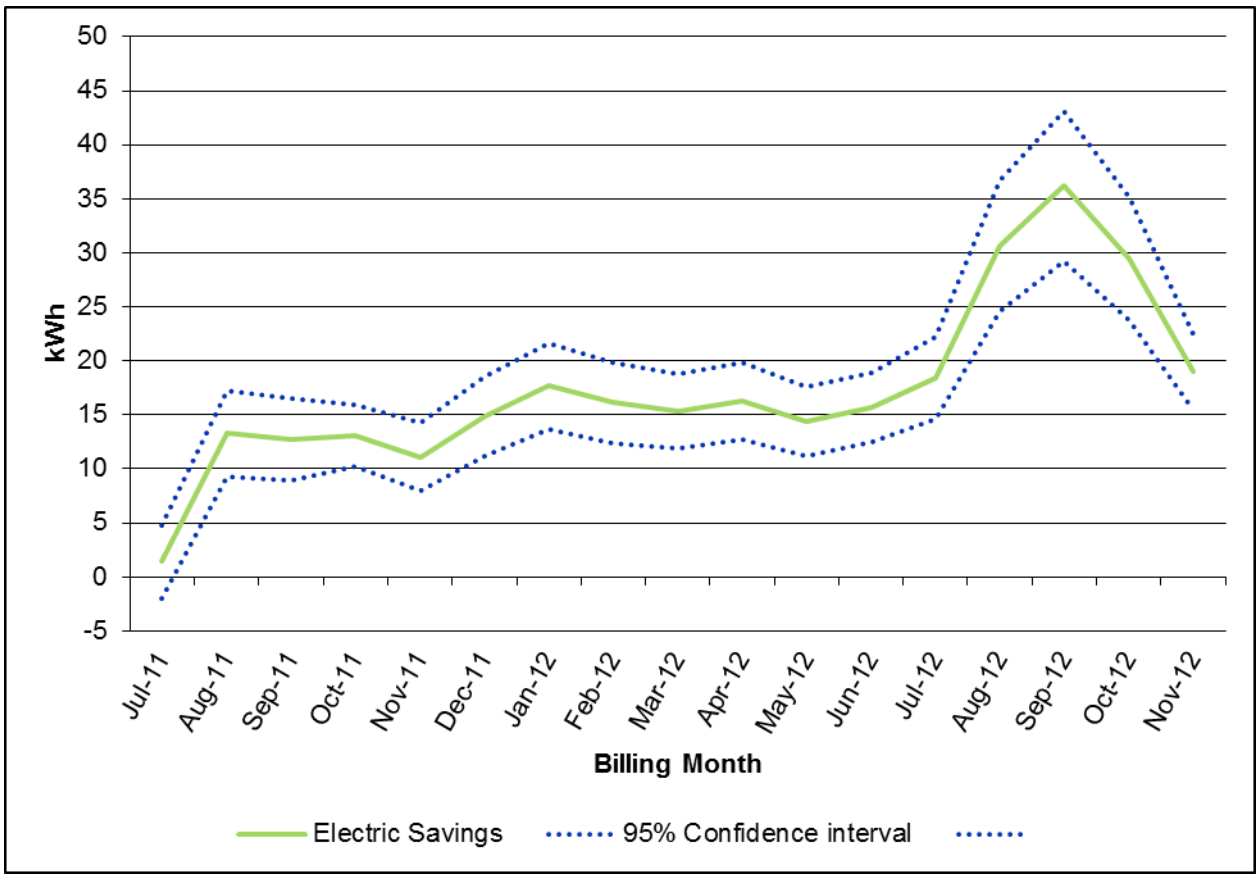


Table 5-1 provides the monthly electric savings in tabular form along with the count of treatment group households for that month. In combination, these numbers generate the total monthly estimated electric savings for the HER Program. Totals at the bottom of the table provide the total and annual savings along with confidence intervals for the aggregate numbers. For the total savings, the relative precision is 17% at 95% confidence.[9]

[9] A 90% confidence interval would be provide an even narrower bracketing of the series of month estimates.

Table 5-1: Average Monthly and Total Electric Savings

Month	Unadjusted Savings per Household (kWh)	Count of Treatment group Participants	Program Unadjusted Savings (MWh)
Jul-11	1.4	19,896	28.2
Aug-11	13.3	19,666	261.2
Sep-11	12.7	19,466	247.2
Oct-11	13.1	19,323	252.3
Nov-11	11.1	19,192	213.3
Dec-11	14.8	19,053	282.8
Jan-12	17.7	18,907	333.7
Feb-12	16.1	18,792	302.7
Mar-12	15.4	18,660	286.6
Apr-12	16.3	18,510	302.2
May-12	14.4	18,376	264.0
Jun-12	15.7	18,216	285.3
Jul-12	18.4	18,019	332.1
Aug-12	30.7	17,841	547.4
Sep-12	36.2	17,672	639.5
Oct-12	29.5	17,535	516.7
Nov-12	19.0	17,371	329.6
Dec-12	18.5	17,249	319.2
Program Period Savings			5,744.1 +/- 16.7%
			(4783.1, 6705)
2011 Savings			1,285.1 +/- 25.8%
			(953.7, 1616.6)
2012 Savings			4,459.0 +/- 16.1%
			(3742.3, 5175.7)

5.1.2 Gas

Figure 5-2 provides a graph of monthly gas savings. Gas savings follow a strong seasonal pattern. There are no apparent savings during the summer, when savings are not statistically different from zero. During the winter and spring months, savings increased up to over 1.9 therms in February, and while minute, were statistically different from zero.

Figure 5-2: Average Monthly Therm Savings per Household

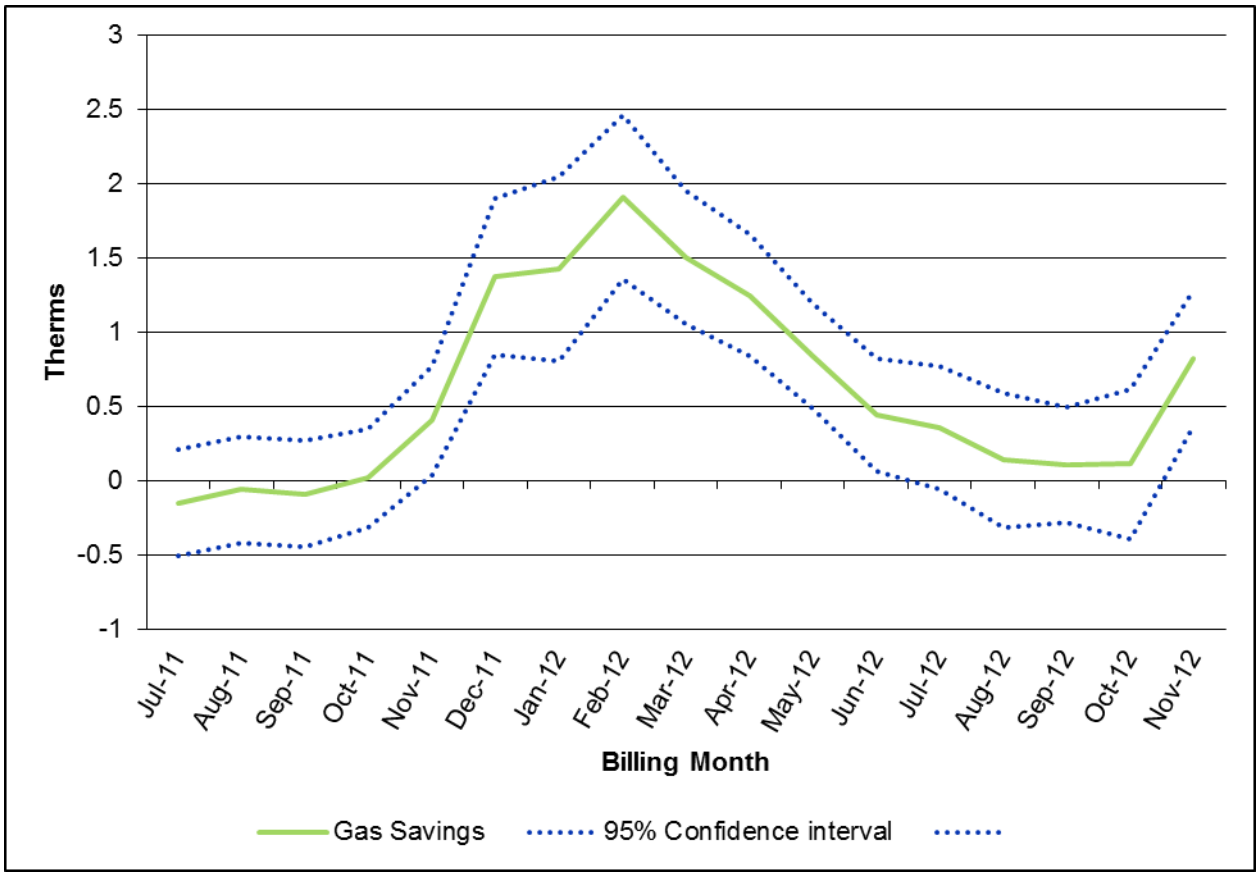


Table 5-2 provides the monthly gas savings in tabular form along with the count of treatment group households for that month. In combination, these number generate the total monthly estimated gas savings for the HER Program. Totals at the bottom of the table provide the total and annual savings along with confidence intervals for the aggregate numbers. Though some of the monthly savings are negative, indicating no treatment effect, the aggregate numbers are a simple sum across the monthly savings regardless of sign. For the total savings, the relative precision is 38% at 95% confidence.

Table 5-2: Average Monthly and Total Therms Savings

Month	Unadjusted Savings per Household (therms)	Count of Treatment group Participants	Program Unadjusted Savings (,000 Therms)
Jul-11	-0.2	19,896	-3.0
Aug-11	-0.1	19,666	-1.2
Sep-11	-0.1	19,466	-1.7
Oct-11	0.0	19,323	0.4
Nov-11	0.4	19,192	7.8
Dec-11	1.4	19,053	26.3
Jan-12	1.4	18,907	27.0
Feb-12	1.9	18,792	35.9
Mar-12	1.5	18,660	28.1
Apr-12	1.2	18,510	23.1
May-12	0.8	18,376	15.5
Jun-12	0.4	18,216	8.1
Jul-12	0.4	18,019	6.4
Aug-12	0.1	17,841	2.5
Sep-12	0.1	17,672	1.9
Oct-12	0.1	17,535	2.0
Nov-12	0.8	17,371	14.3
Dec-12	1.4	17,249	24.9
Program Period Savings			218.2 +/- 37.8%
			(135.8, 300.7)
2011 Savings			28.6 +/- 111.1%
			(-3.3, 60.4)
2012 Savings			189.7 +/- 32.4%
			(128.1, 251.2)

5.2 HER Program Joint Savings Estimates

5.2.1 Downstream Joint Savings

The CPUC provide DNV KEMA with a full set of SDG&E energy efficiency program tracking data. We refer to these programs as downstream programs because, unlike upstream programs, participation and expected savings are tracked to the individual household.

Downstream joint savings are identified by comparing treatment and control savings from downstream program installations. The measure-based savings by customers in each group build up over time in the post-treatment period. If the Reports motivate increased activity, then the treatment group downstream savings will accrue faster than the control group. The difference represents the savings jointly attributable to both the HER program and the downstream programs.

Figure 5.3 plots the downstream rebate program electric savings through the post-report period. The electric savings for the treatment group increases faster than the control group indicating an increase in activity due to the reports. The reports motivate a 20 to 25% increase in downstream rebate program savings. To get a sense of the magnitude of the rebate program savings in general, the control group monthly downstream savings in December, 2012 are approximately 0.21% of monthly consumption.

Figure 5-4 plots the downstream rebate program gas savings through the post-report period. This plot shows that the effect of the reports on downstream gas savings is minimal. Downstream rebate program gas savings in general, as illustrated by the control group monthly downstream savings in December, 2012, are a third the relative magnitude of electric rebate savings at 0.07%.

Figure 5-5 provides the monthly estimates of average joint electric savings per customer. This is simply a plot of the difference between the two groups displayed in Figure 5-3. The addition of the confidence intervals illustrates that electric joint savings are clearly statistically significantly different than zero.

Figure 5-3: Treatment and Control Group Downstream Rebate Program Electric Savings

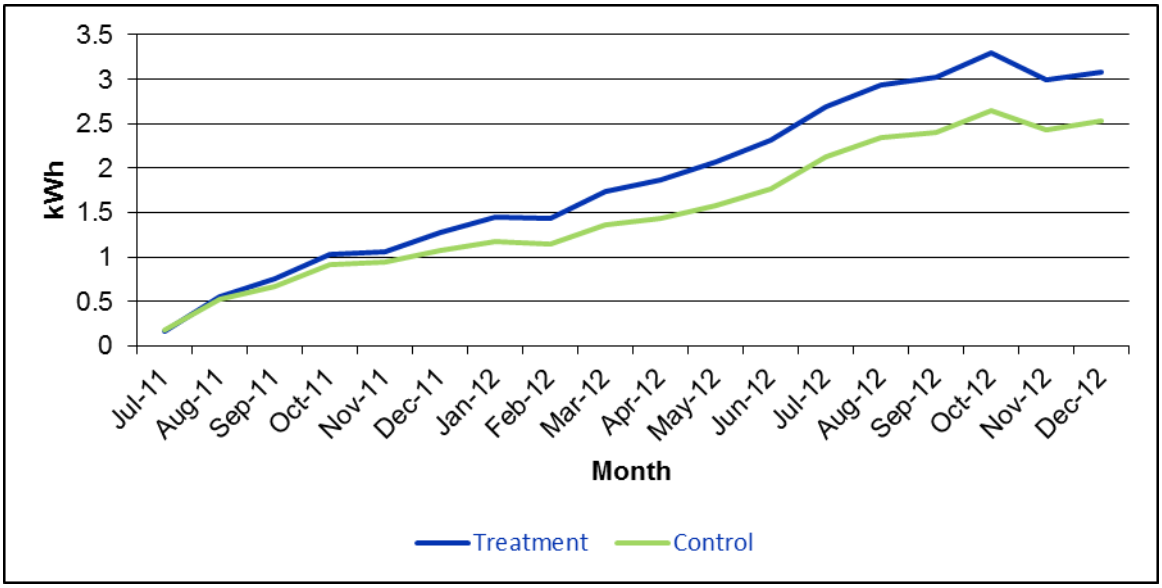


Figure 5-4: Treatment and Control Group Downstream Rebate Program Gas Savings

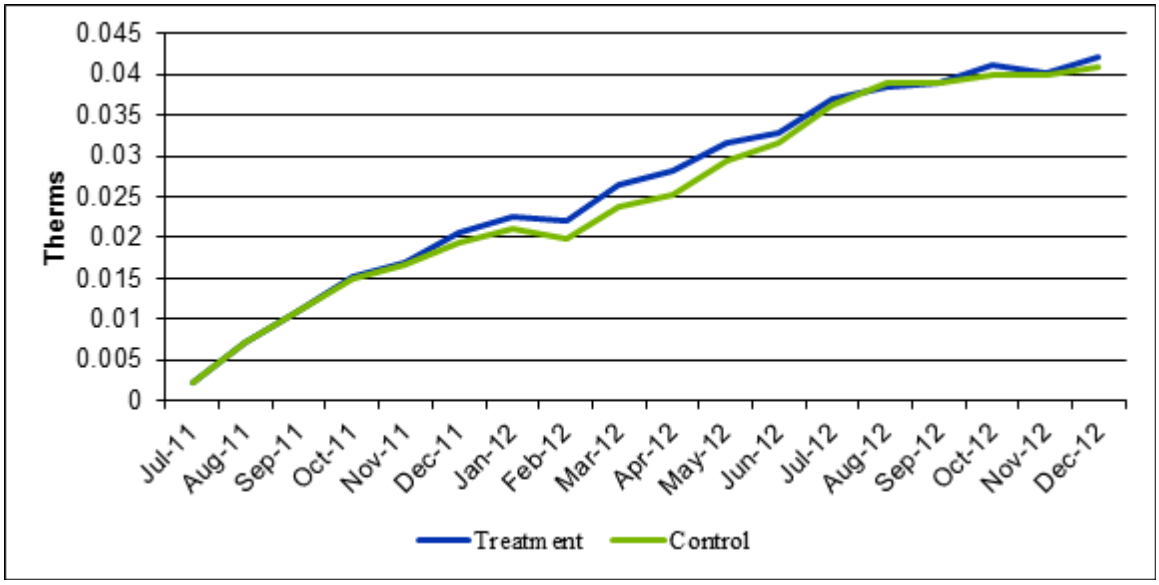


Figure 5-5: Average Monthly kWh Joint Savings Per Customer

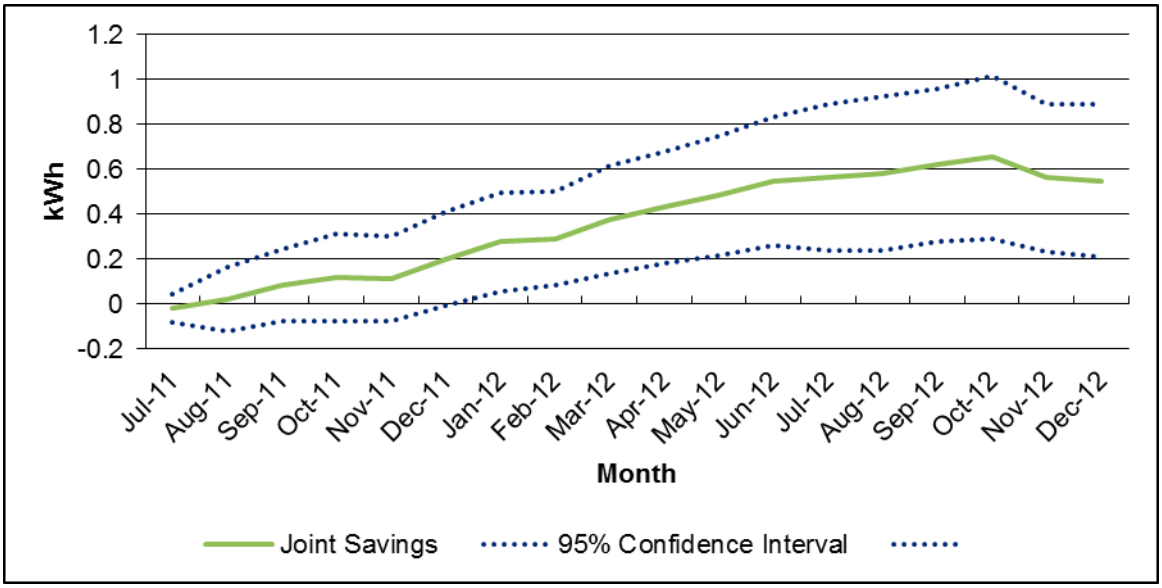


Table 5-3 provides the tabular joint savings along with the monthly count of treatment group customers. The monthly joint savings are the combination of the average per customer savings and the customer counts.[10] Annual and overall savings estimates are provided along with confidence intervals. The downstream electric joint savings will be removed from the overall electric savings estimate for the HER program.

[10] If a household installs a downstream program measure and then subsequently moves out, the savings accrue to the point of the move-out and then are removed. This is consistent with how a particular customer's data enter into the fixed effects regression.

Table 5-3: Monthly kWh Joint Savings

Month	Joint Savings per Household - Tracked /Downstream Programs (kWh)	Count of Treatment group Participants	Program Tracked Joint savings (MWh)
Jul-11	0.0	19,896	(0.4)
Aug-11	0.0	19,666	0.4
Sep-11	0.1	19,466	1.6
Oct-11	0.1	19,323	2.3
Nov-11	0.1	19,192	2.2
Dec-11	0.2	19,053	3.8
Jan-12	0.3	18,908	5.2
Feb-12	0.3	18,792	5.5
Mar-12	0.4	18,660	7.0
Apr-12	0.4	18,511	8.0
May-12	0.5	18,376	8.9
Jun-12	0.5	18,216	9.9
Jul-12	0.6	18,020	10.2
Aug-12	0.6	17,841	10.4
Sep-12	0.6	17,673	10.9
Oct-12	0.7	17,535	11.5
Nov-12	0.6	17,371	9.8
Dec-12	0.5	17,250	9.5
Program Period Savings			116.7 +/- 57.5%
			(49.6, 183.8)
2011 Savings			9.9 +/- 164.6%
			(-6.5, 26.2)
2012 Savings			106.8 +/- 52.6%
			(50.6, 163)

Figure 5-6 provides the monthly estimates of average per customer downstream program joint gas savings. This is a plot of the difference between the treatment and control groups displayed in Figure 5-4. In this Figure, the addition of the confidence intervals illustrates that gas joint savings are clearly not statistically significantly different than zero.

Figure 5-6: Average Monthly Therm Savings Estimates per Customer

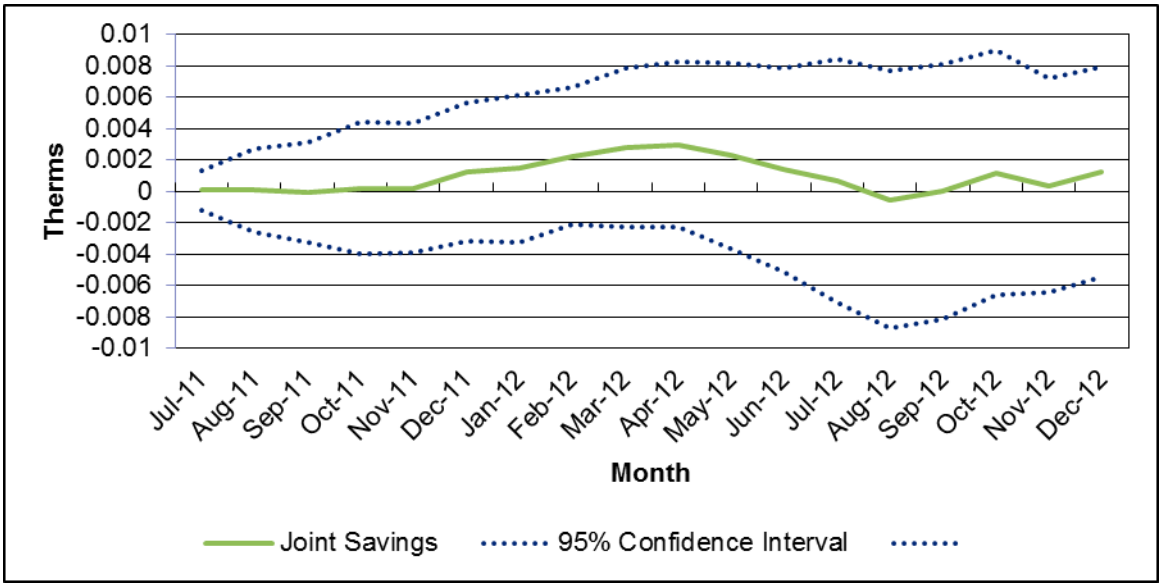


Table 5-4 provides the tabular gas joint savings along with the monthly count of treatment group customers. The monthly joint savings are the combination of the average per customer savings and the customer counts. Annual and overall savings estimates are provided along with confidence intervals. Though the aggregate downstream gas joint savings is slightly positive, it is not statistically different than zero. As a result, downstream rebate program gas joint savings will not be removed from the overall gas savings estimate for the HER program.[11]

[11] Because the downstream joint savings estimate is census-based (that is, the full set of treatment group installations are compared to the full set of control group installations), the lack of statistical significance is a valid basis for not removing the gas joint savings. This is in contrast to the upstream savings which are removed despite estimated joint savings that are highly non-statistically significant. The sample-based upstream approach makes the attainment of statistical significance challenging.

Table 5-4: Monthly Therms Joint Savings

Month	Joint Savings per Household - Tracked /Downstream Programs (Therms)	Count of Treatment group Participants	Program Tracked Joint savings (,000 Therms)
Jul-11	0.0	19,896	0.0
Aug-11	0.0	19,666	0.0
Sep-11	0.0	19,466	(0.0)
Oct-11	0.0	19,323	0.0
Nov-11	0.0	19,192	0.0
Dec-11	0.0	19,053	0.0
Jan-12	0.0	18,908	0.0
Feb-12	0.0	18,792	0.0
Mar-12	0.0	18,660	0.1
Apr-12	0.0	18,511	0.1
May-12	0.0	18,376	0.0
Jun-12	0.0	18,216	0.0
Jul-12	0.0	18,020	0.0
Aug-12	0.0	17,841	(0.0)
Sep-12	0.0	17,673	(0.0)
Oct-12	0.0	17,535	0.0
Nov-12	0.0	17,371	0.0
Dec-12	0.0	17,250	0.0
Program Period Savings			0.3
			(-1.1, 1.8)
2011 Savings			0.0
			(-0.3, 0.4)
2012 Savings			0
			(-0.9, 1.5)

The downstream joint savings estimation process has the added advantage of tracking measure specific savings. That is, unlike the overall savings (where the source of the reductions are unknown), with the downstream joint savings it is possible to see what measures produce the additional savings. Figure 5-7 provides a chart of the electric savings by measure. The chart reveals that refrigerator recycling and pool pumps dominate the downstream savings for both treatment and control groups. The treatment group increased their uptake of these measures by 24% and 19% respectively. The savings for all the other measures combined are very small compared to the savings from recycled refrigerators and pool pumps.

Figure 5-7: Annual MWh Savings by Measure from Tracked Measures

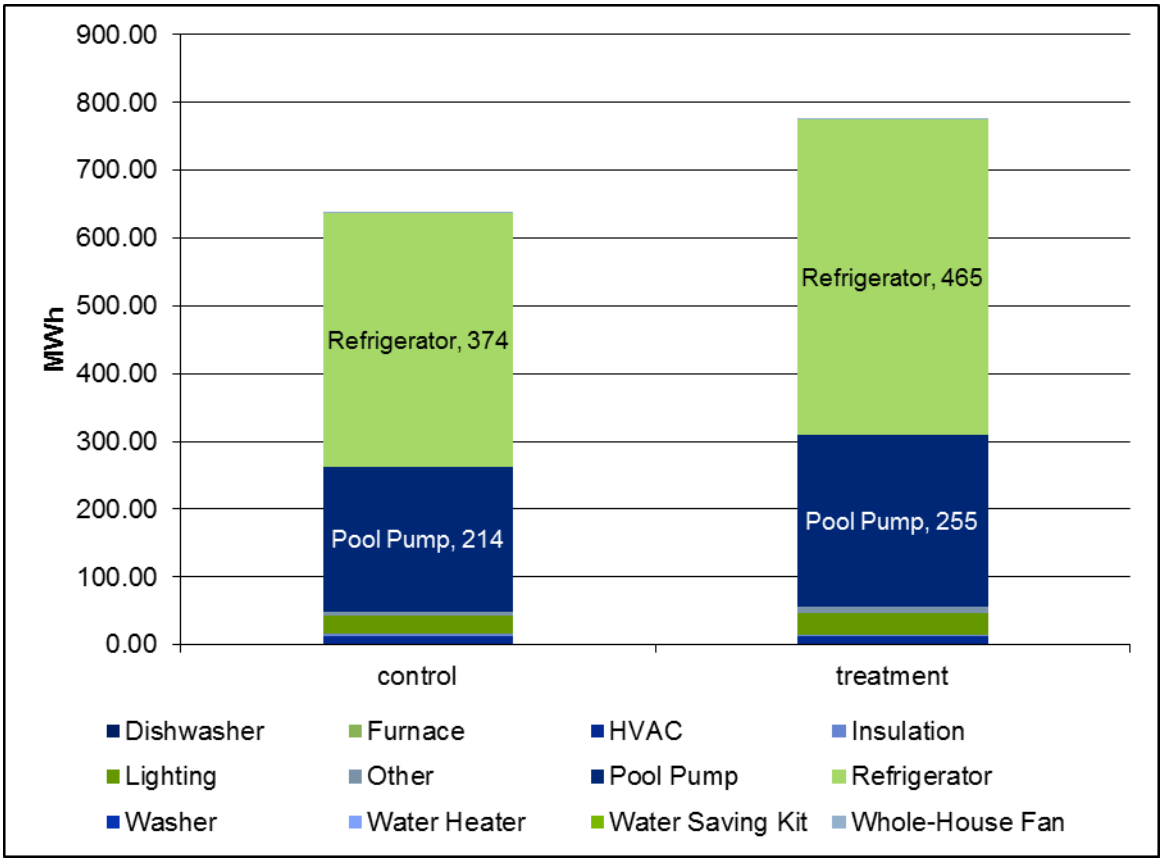
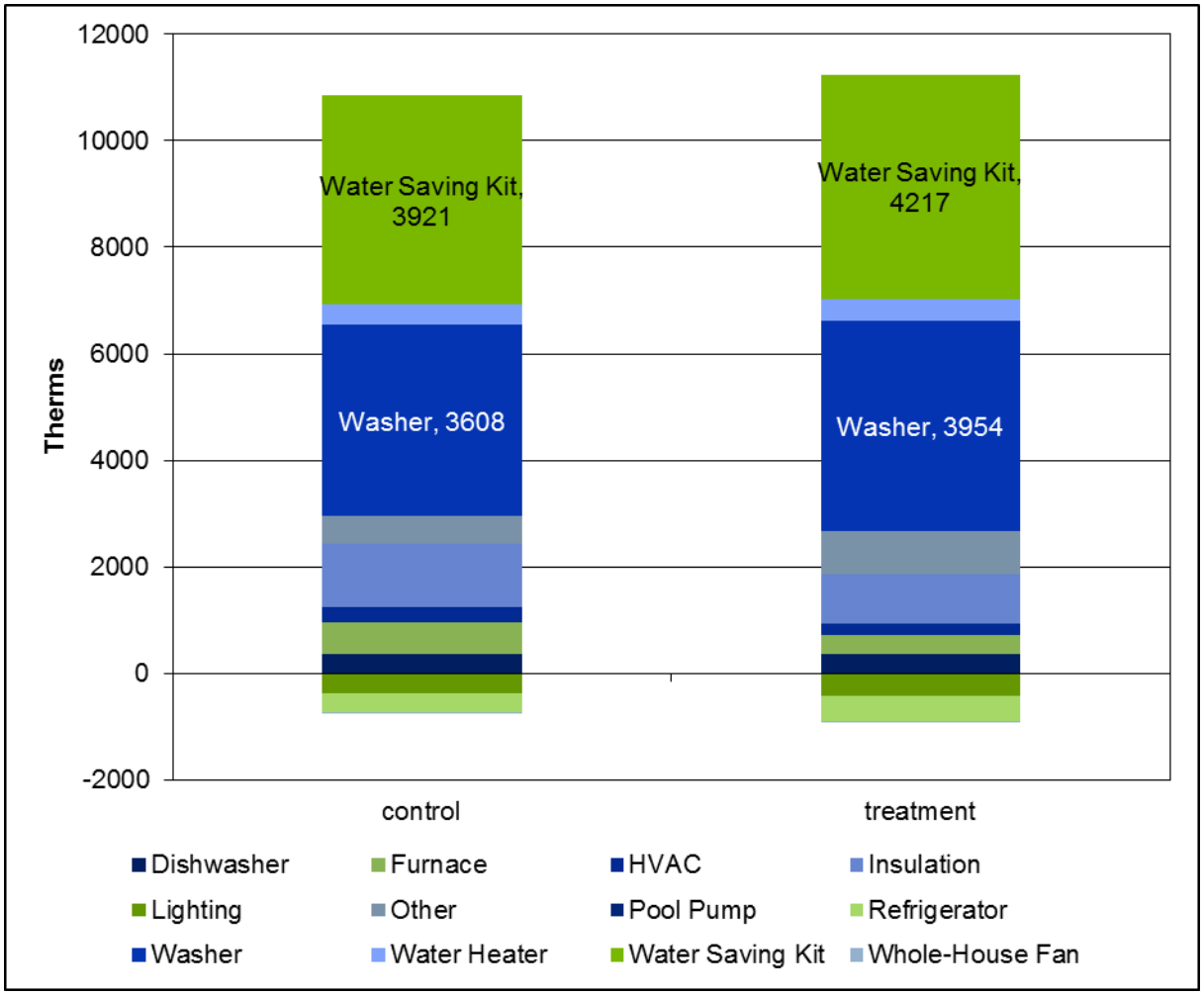


Figure 5-8 provides the gas savings from downstream programs. Water savings kits and clothes washers are the measures with the greatest savings and both show modest increases for the treatment group. The remaining measures combine to represent similar magnitudes of savings. Furthermore, some of those measures were installed at a higher rate by the control group than the treatment group. Finally, the control group has a slightly greater negative savings total. This is the result of greater rates of refrigerator recycling in the treatment group. Refrigerators produce waste heat. Disposal of an inefficient unit decrease the production of waste heat while it increases the heating load of a house. In total, this results in total gas annual savings from tracked measures that are almost identical between the treatment and control groups.

Figure 5-8: Annual Therm Savings by Measure for the Tracking Database



5.2.2 Upstream Joint Savings

PG&E completed 702 home inventories[12] in their service territory spread across its HER program Treatment and Control groups. The analysis identified additional CFL bulbs installed in treatment households representing, on average, just under one bulb per household. This estimate is not statistically significant due to the prohibitive cost of completing sufficiently large samples. However, it is standard to

[12] Evaluation of Pacific Gas and Electric Company's Home Energy Report Initiative for the 2010–2012 Program; Freeman, Sullivan & Co., April 25, 2012

use this estimate in this type of evaluation. The same inventory found a slight decrease in the uptake of rebated televisions by the treatment groups. In this case, the upstream savings is considered to be zero.

The additional bulbs represent savings that could be counted both by the Upstream Lighting Program (ULP) and could also be present in the overall savings estimate for the SDG&E HER Program. To determine appropriate adjustments, first the estimate of additional bulbs per treatment household must be modified to represent the savings that would be claimed by the upstream light program for those bulbs. Not all CFL bulbs purchased in California are supported by the ULP and the ULP does not claim full savings for the purchased bulbs where the program was responsible for reducing the price. Since it is not possible to know the exact source of all of the bulbs, the modification relies on aggregate estimates regarding the source of bulbs. The expected savings, hours of use and net-to-gross values are the most current evaluation results available. All of these values could be updated when the next ULP evaluation is released. Table 5-5 provides the upstream joint savings inputs.

Table 5-5: Upstream Joint Savings Inputs

Additional CFLs in Treatment Households	0.95
% of all CFLs sold in SDG&E territory sold through the ULP	74%
% of bulb savings attributed to the ULP.	48%
% CFL bulbs purchased in SDG&E Territory claimed by the ULP	36%
Delta watts per bulb	44
Average SDG&E Hours of Use (per day)	1.3
Per Bulb Savings (kWh per month)	1.8
Per Household Monthly Upstream Joint Savings (kWh per customer)	0.59

CFLs sold with the support of the ULP represent 74% of the bulbs sold in SDG&E territory. In addition, the ULP claims 48% of the deemed savings per bulb. In combination, using these SDG&E-specific numbers, the ULP claims savings for approximately 36% of all bulb-related savings in SDG&E territory.

Using SDG&E-specific hours of use, a CFL generates 58 watt-hours of savings per day or 1.76 kWh per month. These two numbers combine with the estimate of 0.95 additional CFL bulbs per household to produce an estimate of ULP joint savings for the SDG&E HER Program. The upstream joint savings for each household per month are calculated as 0.95 bulbs x 36% claimed x 1.76 kWh savings per month or 0.59 kWh joint savings per household per month. Table 5-6 provides the source references for all the values used in the upstream calculations.

Table 5-6: Upstream Joint Savings Source References

Values	Report	Page	Table
% of Bulbs in program	Compact Fluorescent Lamps Market Effects Final Report Prepared by The Cadmus Group, Inc.: Energy Services Group (formerly Quantec, LLC) KEMA Itron, Inc.	71	Table 23. California IOU Program CFL Shipment Estimates
		71	Table 22. Market-Level CFL Sales Estimates for California (2005-2008)
Net-to-gross	Final Evaluation Report: Upstream Lighting Program Volume 1 CALMAC Study ID: CPU0015.01	58	Table 26: Ex-ante v. Ex-post Savings Parameters – Upstream Screw-in CFLs
Delta watts		80	Table 44: Average Delta Watts (W) by IOU – CFLs, Fixtures and LEDs
Daily HOU		42	Table 18: Final Gross Savings Inputs – Residential

Table 5-7 combines the monthly per bulb upstream joint savings estimate with the monthly treatment group counts. This generates an estimate of upstream joint savings for the duration of the program using the conservative assumption that all additional bulbs were installed during the first month of the program.

Table 5-7: Monthly Upstream Lighting Savings

Month	Joint Savings per Customer - Untracked/ Upstream Programs (kWh)	Count of Treatment group Participants	Program savings (MWh)
Jul-11	0.6	19,896	11.8
Aug-11	0.6	19,666	11.7
Sep-11	0.6	19,466	11.5
Oct-11	0.6	19,323	11.4
Nov-11	0.6	19,192	11.4
Dec-11	0.6	19,053	11.3
Jan-12	0.6	18,907	11.2
Feb-12	0.6	18,792	11.1
Mar-12	0.6	18,660	11.1
Apr-12	0.6	18,510	11.0
May-12	0.6	18,376	10.9
Jun-12	0.6	18,216	10.8
Jul-12	0.6	18,019	10.7
Aug-12	0.6	17,841	10.6
Sep-12	0.6	17,672	10.5
Oct-12	0.6	17,535	10.4
Nov-12	0.6	17,371	10.3
Dec-12	0.6	17,249	10.2
Program Period Savings			197.7
			(-203.6, 597.4)
2011 Savings			69.1
			(-71.1, 208.7)
2012 Savings			129
			(-132.5, 388.7)

5.2.2.1 Upstream Interactive Effects

California recognizes the potential for interactive effects across fuels when assigning savings. Interactive effects are explicitly accounted for in the tracked rebate program savings tracking database. These are included in Figure 5-8, for instance, where lighting and refrigerator electric savings cause a proportional, negative gas effect. In this case, the interactive gas effects simply lower the overall estimate of gas savings for the treatment and control groups

For the un-tracked, upstream program savings we need to establish a similar estimate of interactive effects for gas. Similar to the tracked rebate program joint savings, the interactive gas effects have the opposite sign of the joint savings. In the case of the ULP, there are no gas joint savings. Rather than diminishing the effect of other gas joint savings, the interactive effect produce negative gas joint savings. In the context of ULP joint savings, interactive savings increase the gas savings measured in the billing analysis.

To calculate this value we use the ratio of kWh and therms savings per watt from DEER[13]. The relationship is described in the following equation.

$$Therm\ effect = \frac{\frac{-0.02Th}{w}}{\frac{1.44\ kWh}{w}} * kWh\ effect$$

$$= \frac{-0.02Th}{1.44kWh} * kWh\ upstream\ savings$$

This approach directly estimates the gas effect from the estimated un-tracked, upstream electric joint savings that we removing as potential double counting from HER program unadjusted electric savings. The only additional assumption contained herein is that DEER offers the correct relationship between CFL savings and gas interactive effects. This is the best source for this relationship at this time. This approach assumes that SDG&E HER Program treatment group members, all of which are dual-fuel households, have gas heat.

Table 5-8 provides the stream of Upstream Lighting Program interactive effects through the months of the program.

[13] http://deeresources.com/DEER2011

Table 5-8: Monthly Upstream Lighting Gas interactive Effect

Month	Joint Savings per Customer - Untracked/Upstream Programs (therms)	Count of Treatment Group Participants	Program Joint savings (1000 Therms)
Jul-11	-0.01	19,896	-0.2
Aug-11	-0.01	19,666	-0.2
Sep-11	-0.01	19,466	-0.2
Oct-11	-0.01	19,323	-0.2
Nov-11	-0.01	19,192	-0.2
Dec-11	-0.01	19,053	-0.2
Jan-12	-0.01	18,907	-0.2
Feb-12	-0.01	18,792	-0.2
Mar-12	-0.01	18,660	-0.2
Apr-12	-0.01	18,510	-0.2
May-12	-0.01	18,376	-0.2
Jun-12	-0.01	18,216	-0.1
Jul-12	-0.01	18,019	-0.1
Aug-12	-0.01	17,841	-0.1
Sep-12	-0.01	17,672	-0.1
Oct-12	-0.01	17,535	-0.1
Nov-12	-0.01	17,371	-0.1
Dec-12	-0.01	17,249	-0.1
Program Period Savings			-2.7
			(-191.4, 561.8)
2011 Savings			-1.0
			(-59, 173.1)
2012 Savings			-1.8
			(-132.5, 388.7)

5.3 Combined Results

This section combines the results in the prior two sections to provide the final savings estimates for the program. Table 5-9 lists the unadjusted HER electric savings along with the two forms of joint savings that will be, for this evaluation, removed from the unadjusted savings. The adjusted savings column provides the monthly household-level savings for the HER program with all potentially double-counted savings removed. Overall program adjusted savings are calculated using the monthly count of active treatment group participants.

Table 5-9 Combined Monthly Electric HER Program Results

Month	kWh per Household				Count of Treatment Group Participants	Adjusted Program Savings (MWh)
	Unadjusted Savings	Joint Savings - Tracked /Downstream Programs	Joint Savings - Untracked/ Upstream Programs	Adjusted Savings		
Jul-11	1.4	0.0	0.6	0.8	19,896	16.8
Aug-11	13.3	0.0	0.6	12.7	19,666	249.2
Sep-11	12.7	0.1	0.6	12.0	19,466	234.1
Oct-11	13.1	0.1	0.6	12.3	19,323	238.6
Nov-11	11.1	0.1	0.6	10.4	19,192	199.8
Dec-11	14.8	0.2	0.6	14.1	19,053	267.7
Jan-12	17.7	0.3	0.6	16.8	18,907	317.3
Feb-12	16.1	0.3	0.6	15.2	18,792	286.1
Mar-12	15.4	0.4	0.6	14.4	18,660	268.5
Apr-12	16.3	0.4	0.6	15.3	18,510	283.2
May-12	14.4	0.5	0.6	13.3	18,376	244.2
Jun-12	15.7	0.5	0.6	14.5	18,216	264.6
Jul-12	18.4	0.6	0.6	17.3	18,019	311.2
Aug-12	30.7	0.6	0.6	29.5	17,841	526.4
Sep-12	36.2	0.6	0.6	35.0	17,672	618.1
Oct-12	29.5	0.7	0.6	28.2	17,535	494.8
Nov-12	19.0	0.6	0.6	17.8	17,371	309.6
Dec-12	18.5	0.5	0.6	17.4	17,249	299.5

Table 5-10 provides the same set of data for HER program gas savings. Joint savings are a non-issue for gas savings. There are no upstream, un-tracked gas savings in the SDG&E portfolio and the downstream savings were not statistically significantly different than zero. The downstream, tracked savings are included here as a true zero to be consistent with aggregate results.

Table 5-10 Combined Monthly Gas HER Program Results

Month	Therms per Household		Adjusted Savings	Count of Treatment Group Participants	Adjusted Program Savings (,000 Therms)
	Unadjusted Savings	Joint Savings - Tracked /Downstream Programs*			
Jul-11	-0.2	-0.01	-0.1	19,896	-2.8
Aug-11	-0.1	-0.01	-0.1	19,666	-1.0
Sep-11	-0.1	-0.01	-0.1	19,466	-1.6
Oct-11	0.0	-0.01	0.0	19,323	0.5
Nov-11	0.4	-0.01	0.4	19,192	8.0
Dec-11	1.4	-0.01	1.4	19,053	26.4
Jan-12	1.4	-0.01	1.4	18,907	27.1
Feb-12	1.9	-0.01	1.9	18,792	36.0
Mar-12	1.5	-0.01	1.5	18,660	28.3
Apr-12	1.2	-0.01	1.3	18,510	23.3
May-12	0.8	-0.01	0.9	18,376	15.6
Jun-12	0.4	-0.01	0.5	18,216	8.2
Jul-12	0.4	-0.01	0.4	18,019	6.6
Aug-12	0.1	-0.01	0.1	17,841	2.6
Sep-12	0.1	-0.01	0.1	17,672	2.1
Oct-12	0.1	-0.01	0.1	17,535	2.1
Nov-12	0.8	-0.01	0.8	17,371	14.5
Dec-12	1.4	-0.01	1.5	17,249	25.1

* Upstream Lighting Program interactive effects are included as a negative number because they increase overall gas savings.

Aggregate savings are reported in Table 5-11. Adjusted savings represents the HER program savings net of any savings claimed by any other SDG&E energy efficiency programs.

Table 5-11: Program-Level Savings Estimates Through 2012

Evaluation Period	Source	Electric (MWh)	Gas (,000 Therms)
July 2011 - December 2012	Unadjusted Savings	5,744.1	218.2
	Tracked, Downstream Joint Savings	116.7	0
	Untracked, Upstream Lighting Joint Savings	197.7	-2.7
	Adjusted Savings	5,429.7	221.0
July 2011 - June 2012	Unadjusted Savings	3,059.6	166.2
	Tracked, Downstream Joint Savings	54.4	0
	Untracked, Upstream Lighting Joint Savings	135.1	-1.9
	Adjusted Savings	2,870.1	168.1

January 2012 - December 2012	Unadjusted Savings	4,459.0	189.7
	Tracked, Downstream Joint Savings	116.7	0
	Untracked, Upstream Lighting Joint Savings	197.7	-1.8
	Adjusted Savings	4,144.6	191.5

Table 5-12 presents the unadjusted and adjusted savings as a fraction of control group, post-period consumption. [14] Percentage savings are widely used to describe OPower program savings across utilities. As reported in other venues, these percentages may be adjusted or unadjusted savings. These results are consistent, in magnitude, with savings reported by other Opower programs.

Table 5-12: Savings per Household as a Percent of Consumption

Evaluation Period	Fuel	Unadjusted, Per Customer Savings	Adjusted, Per Customer Savings	Per Customer Consumption	Unadjusted Savings as Percentage of Consumption	Adjusted Savings as Percentage of Consumption
July 2011 - December 2012	Electric	309.8	292.8	15,543	2.0%	1.9%
	Gas	11.8	11.9	798	1.5%	1.5%
July 2011 - June 2012	Electric	161.0	151.0	10,036	1.6%	1.5%
	Gas	8.7	8.8	605	1.4%	1.5%
January 2012 - December 2012	Electric	246.4	229.0	10,367	2.4%	2.2%
	Gas	10.5	10.6	562	1.9%	1.9%

[14] Per customer savings are calculated by dividing the total aggregate savings by the average number of customers during that time period.