DNV·GL

SDG&E Home Energy Reports Program

2013 Impact Evaluation

ED Res 3.3

California Public Utility Commission, Energy Division
Prepared by DNV GL - Energy
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1 EXECUTIVE SUMMARY

This report summarizes the results of DNV GL's impact evaluation of San Diego Gas & Electric's (SDG&E) Home Energy Reports (HER) program for year 2013. This impact evaluation uses consumption and program tracking data provided by SDG&E to the CPUC. The evaluation provides independent confirmation of gas and electricity savings attributable to the HER program.

1.1 Key Findings

SDG&E began sending HER to approximately 20,000 customers in the treatment group in June and July of 2011. SDG&E continues to send the reports to the same treatment group through 2013-14. DNV GL conducted an impact evaluation for the first eighteen months of the program covering the 2011-2012 program periods. Results presented here are for the second program period from Jan 2013, through December 2013.

The HER program was structured as a randomized controlled trial wherein the initial eligible population was randomly assigned to the treatment and control groups. In July 2013, SDG&E implemented another program known as Simple Energy's Manage Act Save (MAS)[1] which enrolled a subset of the initial HER control group due to a processing error. The enrollment of HER control group may have had some influence on the results of this impact evaluation to the extent that MAS program causes substantial impact on customers energy consumption. DNV GL used several approaches to investigate the effect of contamination but is unable to estimate the degree of impact of MAS contamination in the HER program

DNV GL's impact evaluation of HER program is based on the full sample. Because of MAS contamination, savings reported during MAS treatment period (Jul 2013 onwards) are potentially lower than the true program savings because of lower baseline consumption.

Table **1** provides program level savings for the 2013 HER Program and addresses the following results for gas and electric impacts:

- Overall savings – the unadjusted treatment effect from billing analysis
- Joint savings achieved in concert with other energy efficiency programs and claimed by SDG&E under those programs 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 (ULP) and the related interactive effects on gas savings.

[1] Manage Act Save (MAS) is an energy efficiency program made available to SDG&E residential customers on Jun 2013 to help customers reduce their energy consumption. The program provides customers information on their personal consumption and tools to manage their consumption. Also, MAS program provides participants with information and programs that can help them to save energy. Customers get rewards from reducing energy consumption.

- Adjusted Savings – overall savings net of potential double-counted joint savings.

Table 1. Program-Level Savings Estimates for 2013

Evaluation Period	Source	Electric (MWh)	Gas (,000 Therms)
January 2013 - December 2013	Unadjusted Savings	4,539.8	184.4
	Tracked, Downstream Joint Savings	114.0	-1.0
	Untracked, Upstream Lighting Joint Savings	232.6	-3.9
	Adjusted Savings	4,193.3	189.3

In 2013, the HER program achieved a reduction of 4,540 MWh across the treatment households. A portion of these savings occurred due to increased activity in other SDG&E energy efficiency programs. We estimated electric joint savings at 114 and 233 MWh for downstream and upstream programs, respectively. These amounts are removed from the overall measured savings estimate. The estimated total credited electric savings are 4,193 MWh.

The program also generated 184,400 therms of gas savings. There was no evidence of increase in gas savings from downstream energy efficiency programs. The upstream lighting program has a small interactive effect on gas savings that has the effect of increasing the unadjusted gas savings slightly rather than lowering it as with joint savings.

Table 2 provides estimates of unadjusted and adjusted savings at the household level as a fraction of control group, post-period consumption. Over the full 12 months, unadjusted electric savings at the household level were 282 kWh, approximately 2.8% of electric consumption for that period[2]. Electric savings drop to 260 kWh or 2.6% after removing joint savings. Unadjusted and adjusted gas savings are 11.3 and 11.6 therms per household or about 2.0% of gas consumption, for that period.

Table 2. Average Savings per Household as a Percent of Consumption

Evaluation Period	Fuel	Unadjusted, Per Customer Savings	Adjusted, Per Customer Savings	Average Per Customer Consumption	Unadjusted Savings as Percentage of Consumption	Adjusted Savings as Percentage of Consumption
January 2013 - December 2013	Electric	281.9	260.4	10,023	2.81%	2.60%
	Gas	11.3	11.6	580	1.95%	2.00%

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

Electric savings per household due to HER program has increased from 246 kWh to 282 kWh while gas savings per household increased from 10.5 therms to 11.3 therms from program years 2012 to 2013. Specifically, monthly electric savings from January 2013 to July 2013 were higher than monthly savings for the same months in 2012. However, DNV GL observed that 2012 and 2013 monthly savings were similar from September 2013 to December 2013 because of a relatively milder climate in 2013 and the potential effect of MAS contamination.

Similar to last year's evaluation, 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. Results show that there is limited evidence of increased uptake of rebate activities in 2013. The joint savings captured this year are primarily carryover savings from rebate activities induced by the HER program last year. The estimated joint savings are a relatively small portion of the overall measured savings.

2 INTRODUCTION

This report summarizes the results of DNV GL's impact evaluation of San Diego Gas & Electric's (SDG&E) Home Energy Reports (HER) program for calendar year 2013. SDG&E began sending HER in July, 2011. After a three month initial period of monthly reports, SDG&E switched to sending HER bi-monthly. The reports contain a mix of consumption information, comparison with similar neighbors and customized tips for saving energy.

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.

DNV GL participated in the establishment of the RCT experimental design for the SDG&E HER Program. Opower identified a population of approximately 40,000 households that were eligible to take part in the program. DNV GL randomly assigned half of these households to a treatment group that received the reports. The remainder of the households did not receive reports.

DNV GL conducted impact evaluation of the HER Program over the full 18 months of the program (July 2011 to Dec 2012). For calendar year 2012, the estimated unadjusted HER savings were 246 kWh and 10.5 therms per customer. These savings were approximately 2.4% and 1.9% of the baseline electric and gas consumption in 2012

SDG&E implemented another behavioral program known as Manage Act Save (MAS) program on July 2013. The MAS program included a subset of the HER control group (whose usage belong to Tiers 3 and 4). As MAS was launch, approximately thirty-eight percent of the initial HER control

group received the MAS intervention due to a processing error. Contamination complicates the evaluation by introducing potentially biasing the results downward if the MAS program successfully motivates savings among the control group.

DNV GL investigated the potential implication of MAS contamination to this year's evaluation. We determined that estimation of partial HER savings in the last six months of 2013 is still possible since none of the customers in the HER treatment group were enrolled in other behavioral programs. To the extent that MAS program is successful in reducing consumption, we expect a decrease in average consumption in the HER control group in 2013.

DNV GL observed that there was an increase in savings from January to July of 2013 when compared to the same period in 2012. However, during the last 5 months of 2013, coinciding with MAS treatment period, the 2012 and 2013 savings estimates are similar indicating that the incremental increase in saving is almost zero. The observed HER program savings estimated for calendar year 2013 is lower than the true program savings over this period, likely due to a lower baseline consumption from the control group. See Appendix of the report for more details.

3 EVALUATION METHODOLOGY

3.1 Methodology

For this evaluation we used 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. Within the model specification, 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 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 in that month. 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 "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*[3]

3.2 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 savings estimates from the fixed effects regressions include 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 joint savings are also included in affected rebate program tracking databases and, unless further action were taken to remove them, are claimed as part of those programs' savings. Counting the savings in both places results in double counting of those additional HER-motivated rebate 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.

[3] 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.

DNV GL use the following approach for rolling up individual rebates savings and calculating joint savings overall:

- Use accepted deemed savings values (those being used to claim the savings for the rebate program),
- Start accumulating savings from the installation date moving forward in time
- Assign daily savings on a load-shape-weighted basis, (more savings when we expect the measure to be used more) 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[4] for SDG&E[5]. These load-shapes indicate when a measure is used during the year and, by proxy, when efficiency savings would occur.[6]

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.

3.3 Upstream Joint Savings

Upstream joint savings are similar to downstream joint savings except that they are not tracked at the customer level. They still 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 that provides the structure to produce an un-biased estimate of upstream savings. PG&E conducted in-home surveys in 2013 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 GL 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 5.3.

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

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

[6] 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.

4 DATA MANAGEMENT

The billing analysis that underlies the HER program savings estimates rely 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 customers has the potential to affect the final results in non-trivial ways. Table 3 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. For large reads, extreme average daily consumption was observed in less than 30 households. For sites with daily consumption greater than 1000 kWh per day, consumption was excluded for the billing period. 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 3. Summary of Billing Data Issues

	Electric		Gas	
	Control	Treatment	Control	Treatment
Bad Read Dates	0.00%	0.00%	0.00%	0.00%
Zero Reads	0.11%	0.08%	1.17%	1.26%
Negative Reads	1.46%	1.56%	0.00%	0.00%
Missing Reads	0.00%	0.00%	0.00%	0.00%
Extreme Reads	0.09%	0.05%	0.00%	0.00%
No Issues	98.39%	98.35%	98.83%	98.74%

4.1 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, the way that 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[7]. 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** provides the monthly eligible population for the HER Program through December 2013. 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. Move-Outs Based on Electric Account

[7] It is instructive to compare solar-installing households to HER opt-outs with respect to their effect on the analysis results. The removal of opt-outs from the treatment group would likely remove households with lower savings effects thus artificially increasing the savings estimate for those households remaining in the treatment group. This potential upward bias in the savings result is a clear reason for including these households despite their opting out. The solar-installing households have a less clearly defined HER program savings effect so it is more difficult to assess the effect of their removal on the HER savings of remaining households. More importantly, energy generated by solar systems would dwarf the amount of HER program savings at most households HER program effect net of the solar installation effect. The decision to remove these households is based on a lack of clear evidence of a biasing effect in the savings estimate and the concern that their inclusion would be practically speaking infeasible and would have the potential to inject

Month	Treatment Group			Control Group		
	Open Accounts	Closed Accounts		Open Accounts	Closed Accounts	
		Cumulative	Monthly		Cumulative	Monthly
13-Jan	3,070	123	16,810	3,011	115	3,070
13-Feb	3,158	88	16,706	3,115	104	3,158
13-Mar	3,241	83	16,608	3,213	98	3,241
13-Apr	3,328	87	16,491	3,330	117	3,328
13-May	3,443	115	16,378	3,443	113	3,443
13-Jun	3,563	120	16,234	3,587	144	3,563
13-Jul	3,719	156	16,109	3,712	125	3,719
13-Aug	3,879	160	15,975	3,846	134	3,879
13-Sep	4,018	139	15,830	3,991	145	4,018
13-Oct	4,120	102	15,735	4,086	95	4,120
13-Nov	4,225	105	15,625	4,196	110	4,225
13-Dec	4,319	94	15,539	4,282	86	4,319

Note: The monthly counts provided excludes sites with net metering

The electric and gas accounts for a household do not always end on the same day. We used electric accounts 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 2013 SDG&E HER Program. The overall average savings are the unadjusted effect of the HER 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 2013 HER Program savings estimate that does not double-count energy savings from other programs.

5.1 HER Program Overall Savings Estimates - Electric

Figure 1 provides a graph of monthly electric savings for 2013. The average monthly savings are between 17 kWh and 38 kWh per household. We expect the reported program savings estimate for 2013 to be relatively lower than the true savings from the program because of the enrollment of a subset of the HER control group in the MAS program.

Figure 1. Average Monthly kWh Savings per Household

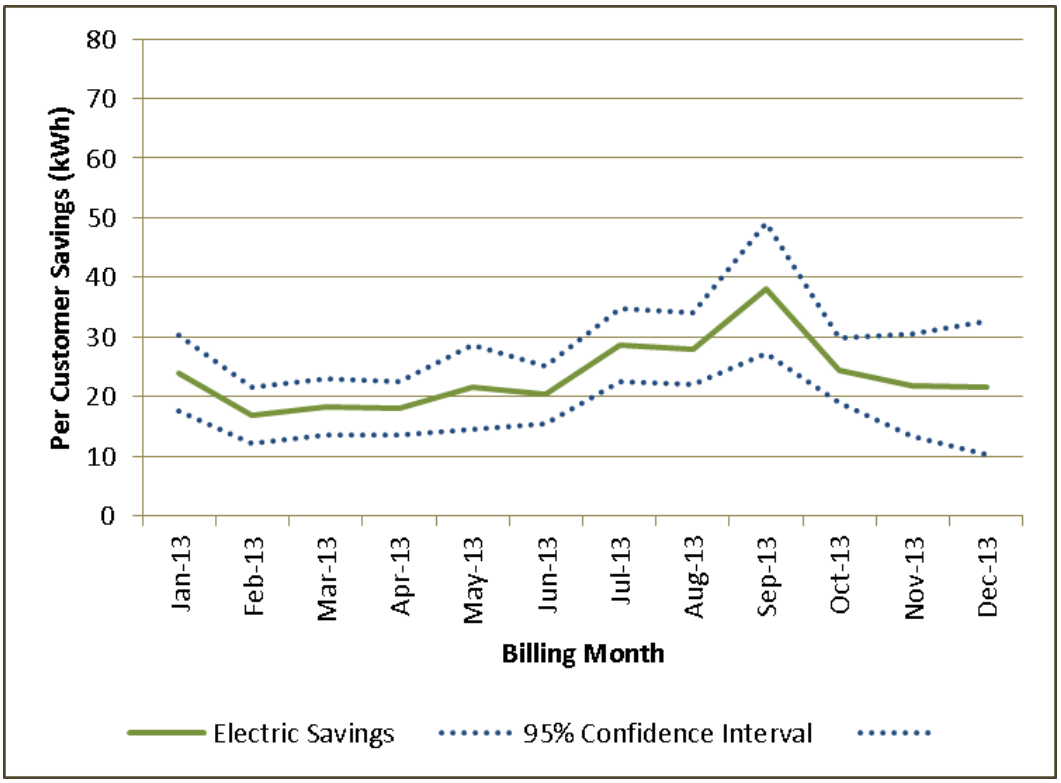


Table 5 provides the monthly electric savings in tabular form along with the count of treatment group households for that month. In combination, these numbers generate the total monthly estimated electric savings for the HER Program. Totals at the bottom of the table provide the total and annual savings along with confidence intervals for the aggregate numbers

Table 5. Average Monthly and Total Electric Savings

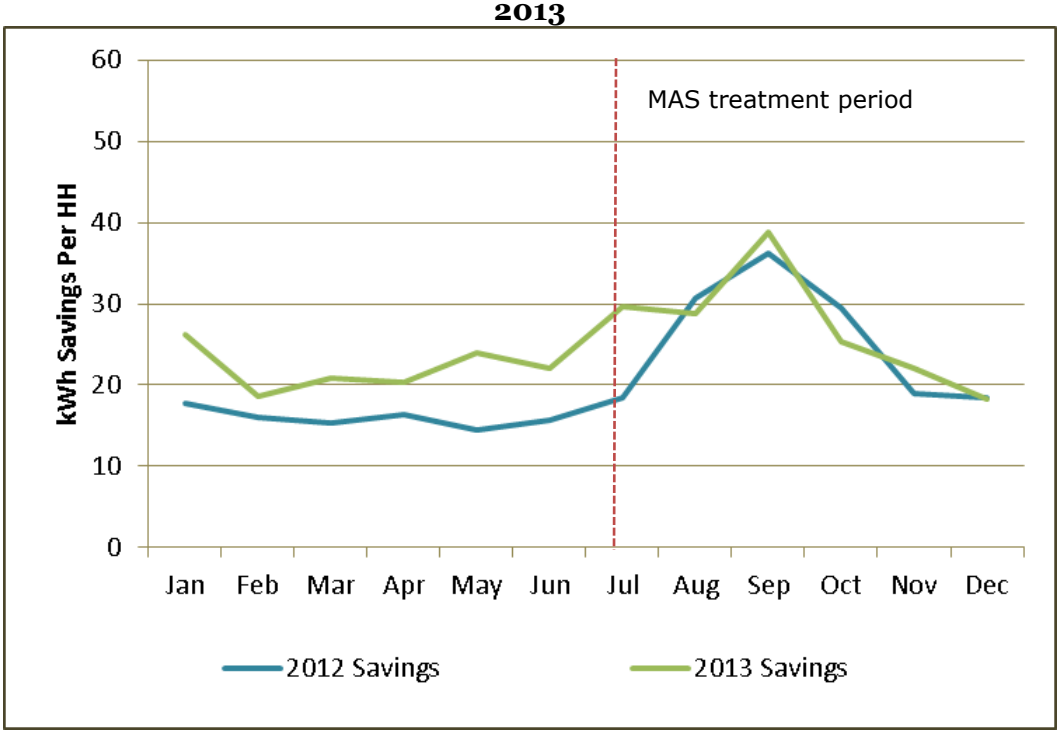
Month	Unadjusted Savings per Household (kWh)	Count of Treatment group Participants	Program Unadjusted Savings (MWh)
13-Jan	23.9	16,754	401
13-Feb	16.9	16,666	282
13-Mar	18.3	16,583	304
13-Apr	18.1	16,496	298
13-May	21.6	16,381	353
13-Jun	20.3	16,261	330
13-Jul	28.8	16,105	463
13-Aug	28.0	15,945	446
13-Sep	38.2	15,806	604
13-Oct	24.4	15,704	383
13-Nov	21.9	15,599	342
13-Dec	21.5	15,505	334
2013 Program Savings			4,540 (3,670, 5,410)

The overall electric savings in 2013 were 15% higher than 2012 savings.

Figure 2 presents a comparison of monthly savings estimates between program years 2012 and 2013. Based on the graph, 2013 savings are higher than 2012 savings from January to July. However, during the MAS treatment period, we observed that 2012 and 2013 savings are similar. The following may have contributed to the drop in savings:

- Lower baseline due to MAS contamination in the control group
- Relatively milder climatic conditions in 2013 when compared to late summer and early fall of 2012 which was unusually hot weather in the San Diego area.

Figure 2. Comparison of Average Monthly kWh Savings per Household, 2012 and 2013



Section 6.1 of the Appendix shows a comparison of the HER savings per household in 2012 and 2013.

5.2 HER Program Overall Savings Estimates - Gas

Figure 3 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 around 2.7 therms in January and while small, savings are statistically different from zero.

Figure 3. Average Monthly Therm Savings per Household

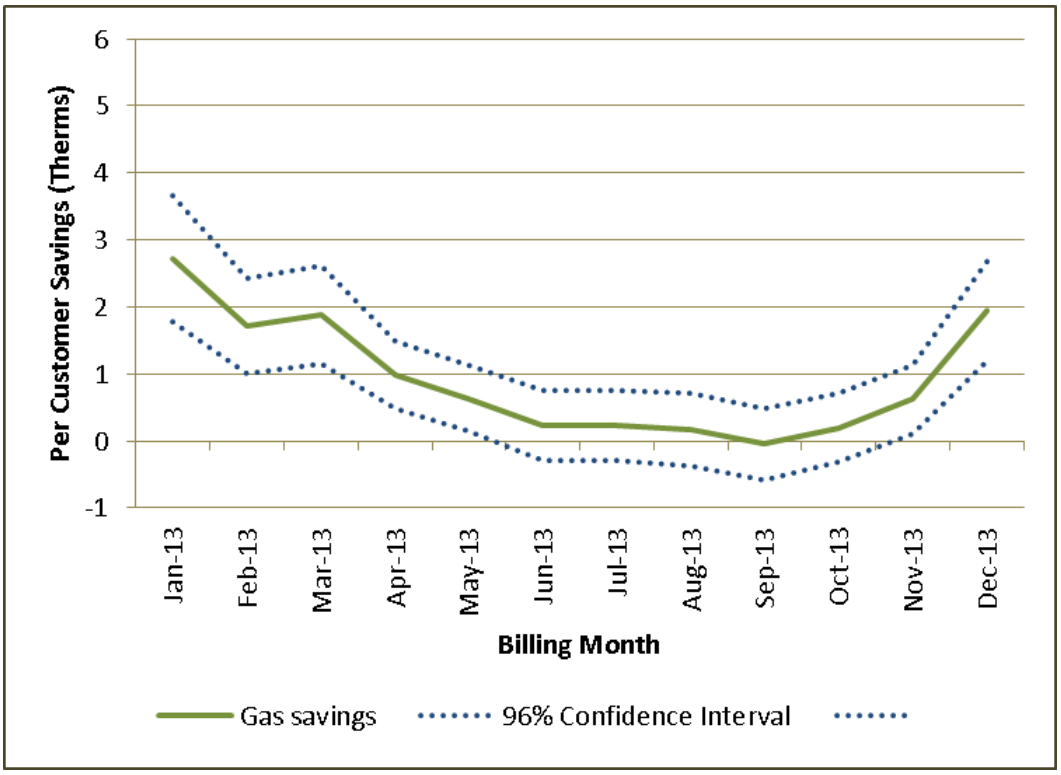


Table 6 provides the monthly gas savings in tabular form along with the count of treatment group households for that month. In combination, these number generate the total monthly estimated gas savings for the HER Program. Totals at the bottom of the table provide the total and annual savings along with 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.

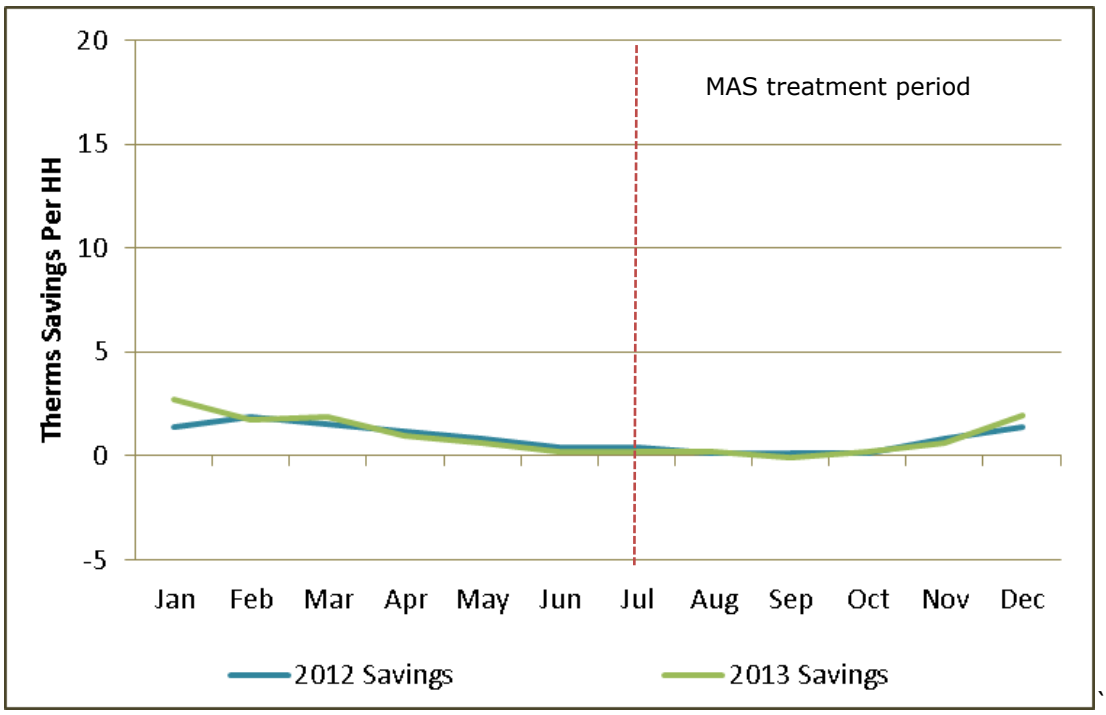
Table 6. Average Monthly and Total Therms Savings

Month	Unadjusted Savings per Household (therms)	Count of Treatment group Participants	Program Unadjusted Savings (,000 Therms)
13-Jan	2.7	16,754	45.5
13-Feb	1.7	16,666	28.7
13-Mar	1.9	16,583	31.3
13-Apr	1.0	16,496	16.1
13-May	0.6	16,381	10.4
13-Jun	0.2	16,261	3.8
13-Jul	0.2	16,105	3.6
13-Aug	0.2	15,945	2.8
13-Sep	0.0	15,806	-0.7
13-Oct	0.2	15,704	3.1
13-Nov	0.6	15,599	9.7
13-Dec	1.9	15,505	30.1
2013 Program Savings			184
			(118.3, 250.6)

The overall gas savings per household in 2013 were 2.1 therms or 12% higher than 2012 savings.

Figure 4 presents a comparison of monthly savings estimates between program years 2012 and 2013. Based on the graph, monthly savings estimates for program years 2012 and 2013 were similar for most months except for January and December.

Figure 4. Comparison of Average Monthly Therms Savings per Household, 2012 and 2013



5.3 HER Program Joint Savings

5.3.1 Downstream Joint Savings

To determine downstream savings, DNV GL used SDG&E energy efficiency program tracking data received via data request from the CPUC. 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 comparative reports generated by the HER program 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 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 during 2012,

the first year of the program indicating an increase in activity due to the reports. However, there was no evidence of increased uptake in downstream program participation in the treatment group in 2013. As illustrated in the plot, the difference in savings between treatment and control groups in Dec 2012 is more or less similar to the difference in savings in Dec 2013. This implies that by the end of 2013, joint savings attributed to HER program are mostly due to energy efficiency measures installed in the previous year.

Figure 6 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 negative. Downstream rebate program gas savings in general are higher for the control group.

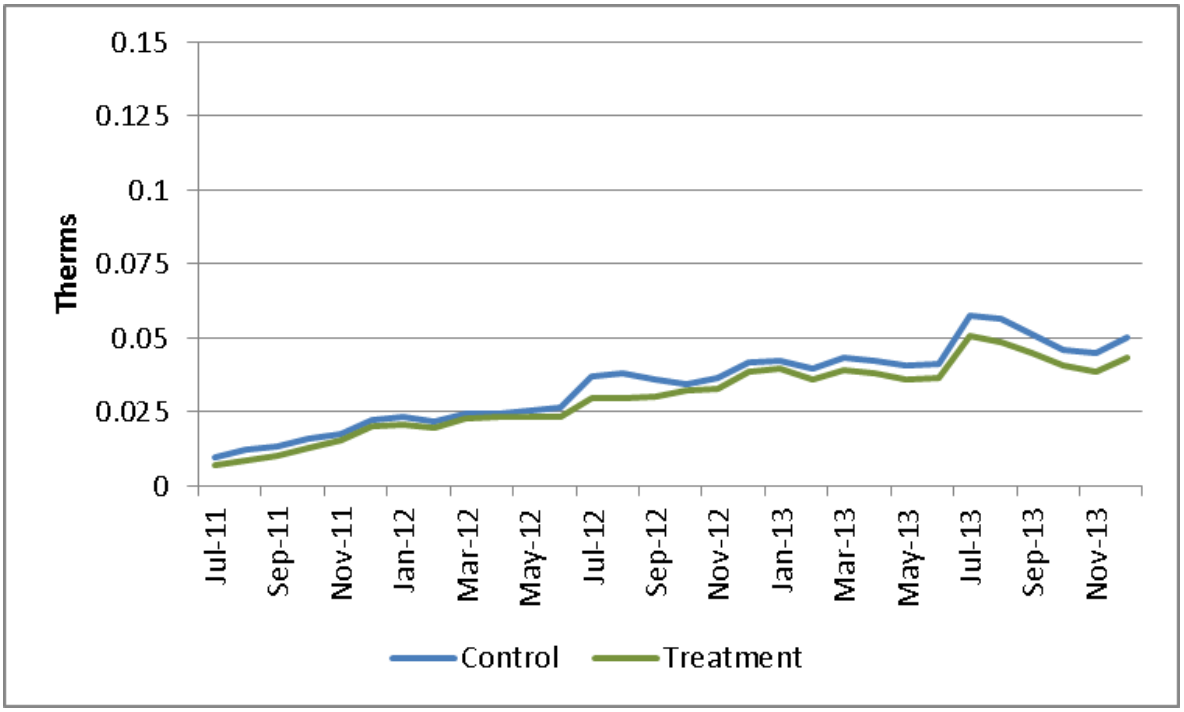


Figure 7 provides the monthly estimates of average joint electric savings per customer. This is simply a plot of the difference between the two groups displayed in

Figure 5. The addition of the confidence intervals illustrates that electric joint savings are significantly different than zero. However, as noted above, joint savings in 2013 are mostly from carryover savings during 2012.

Figure 5. Treatment and Control Group Downstream Rebate Program Electric Savings

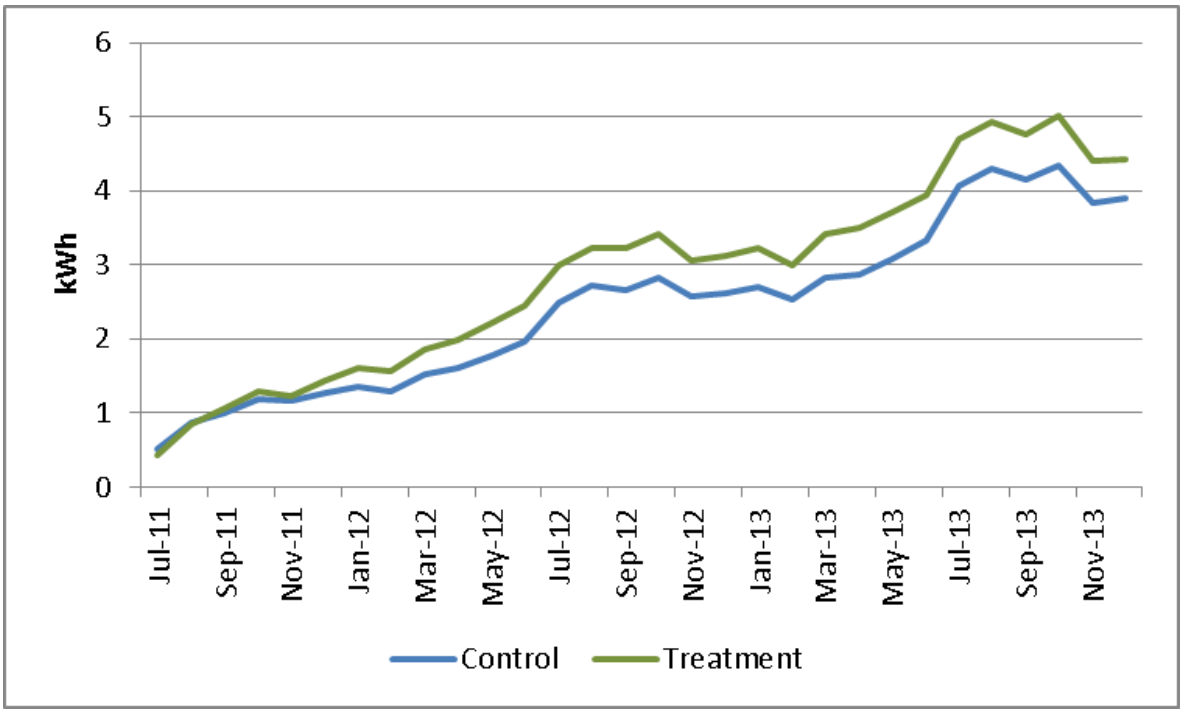

6
5
4
3
2
1
0
kWh
Jul-11
Sep-11
Nov-11
Jan-12
Mar-12
May-12
Jul-12
Sep-12
Nov-12
Jan-13
Mar-13
May-13
Jul-13
Sep-13
Nov-13
Control
Treatment

Figure 6. Treatment and Control Group Downstream Rebate Program Gas Savings

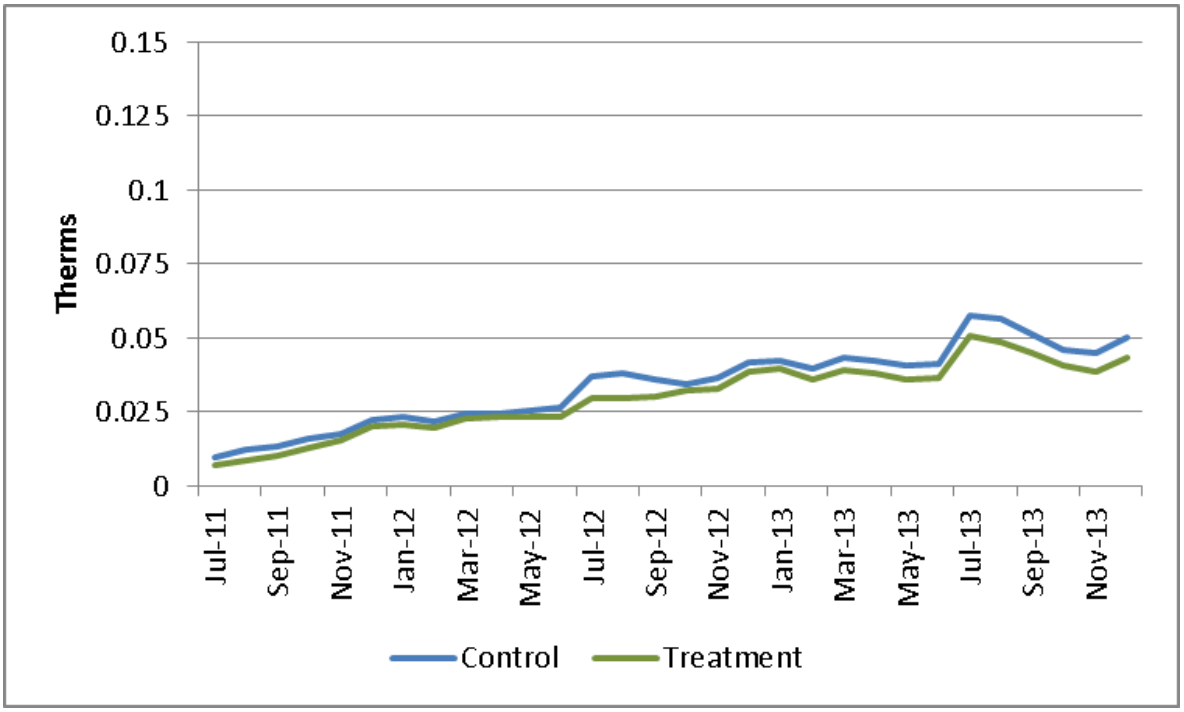


Figure 7. Average Monthly kWh Joint Savings per Customer

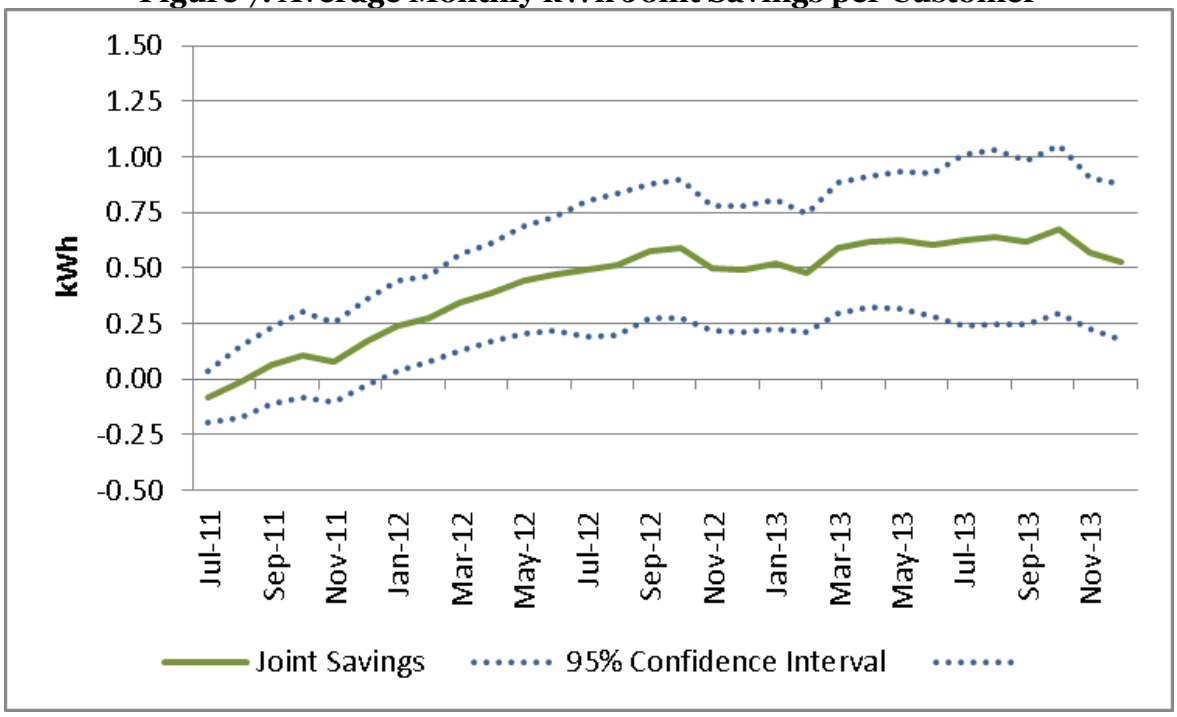


Table 7 provides the tabular joint savings along with the monthly count of treatment group customers. The monthly joint savings are the combination of the average per customer savings and the customer counts.[8] Annual and overall savings estimates are provided along with confidence intervals. The downstream electric joint savings will be removed from the overall electric savings estimate for the HER program.

Table 7. Monthly kWh Joint Savings

Month	Joint Savings per Household - Tracked /Downstream Programs (kWh)	Count of Treatment group Participants	Program Tracked Joint savings (MWh)
13-Jan	0.52	16,754	8.7
13-Feb	0.47	16,666	7.9
13-Mar	0.59	16,583	9.8
13-Apr	0.62	16,496	10.1
13-May	0.62	16,381	10.2
13-Jun	0.60	16,261	9.8
13-Jul	0.62	16,105	10.0
13-Aug	0.64	15,945	10.2
13-Sep	0.61	15,806	9.7
13-Oct	0.67	15,704	10.6
13-Nov	0.57	15,599	8.8
13-Dec	0.53	15,505	8.1
2013 Savings			114.0 (46.6, 181.4)

Figure 8 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

[8] 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.

Figure 6. In this Figure, the addition of the confidence intervals illustrates that gas joint savings are clearly not statistically different than zero.

Figure 8. Average Monthly Therm Savings Estimates per Customer

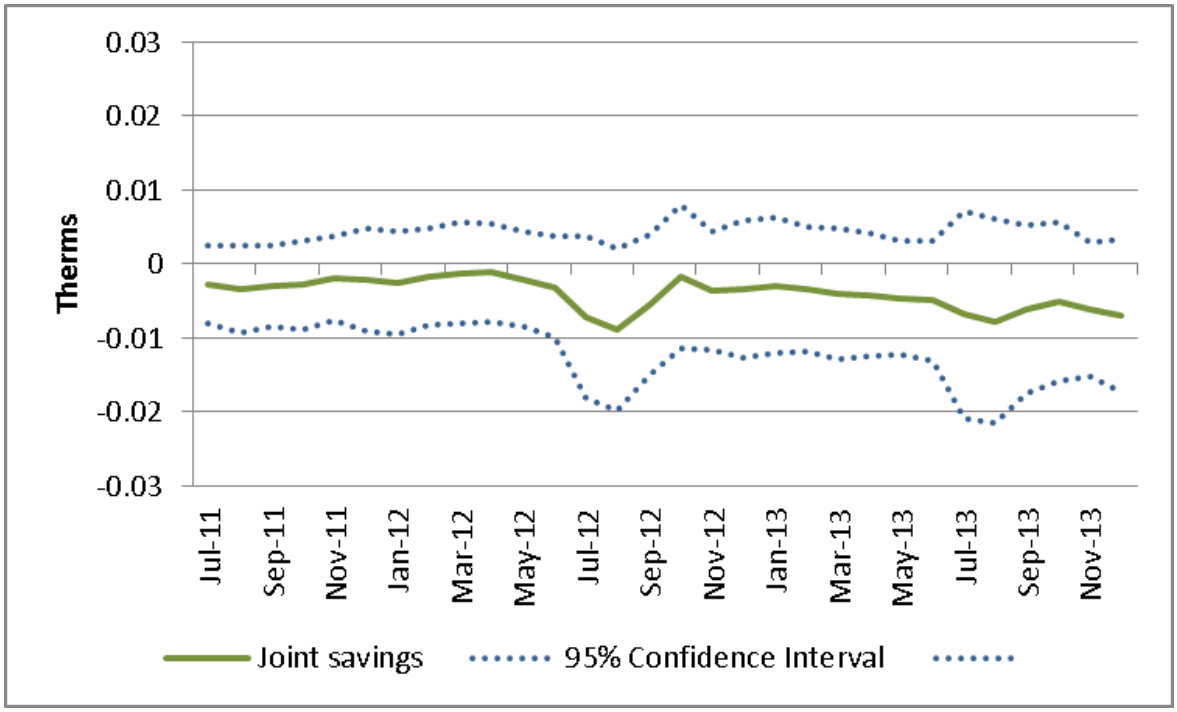


Table 8 provides the tabular gas joint savings along with the monthly count of treatment group customers. The monthly joint savings are the combination of the average per customer savings and the customer counts. Annual and overall savings estimates are provided along with confidence intervals. Though the aggregate downstream gas joint savings are negative, savings are not statistically different than zero.

Table 8. Monthly Therms Joint Savings

Month	Joint Savings per Household - Tracked /Downstream Programs (Therms)	Count of Treatment group Participants	Program Tracked Joint savings (,000 Therms)
13-Jan	0.00	16,754	0.0
13-Feb	0.00	16,666	-0.1
13-Mar	0.00	16,583	-0.1
13-Apr	0.00	16,496	-0.1
13-May	0.00	16,381	-0.1
13-Jun	0.00	16,261	-0.1
13-Jul	-0.01	16,105	-0.1
13-Aug	-0.01	15,945	-0.1
13-Sep	-0.01	15,806	-0.1
13-Oct	-0.01	15,704	-0.1
13-Nov	-0.01	15,599	-0.1
13-Dec	-0.01	15,505	-0.1
2013 Savings			-1.0
			(-2.9, 0.9)

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 9 provides a chart of the electric savings by measure installed in 2013. Similar to last year's findings, the chart reveals that refrigerator recycling and pool pumps dominate the downstream savings for both treatment and control groups. The savings for all the other measures combined are very small compared to the savings from recycled refrigerators and pool pumps.

Figure 9. Annual MWh Savings by Measure from Tracked Measures

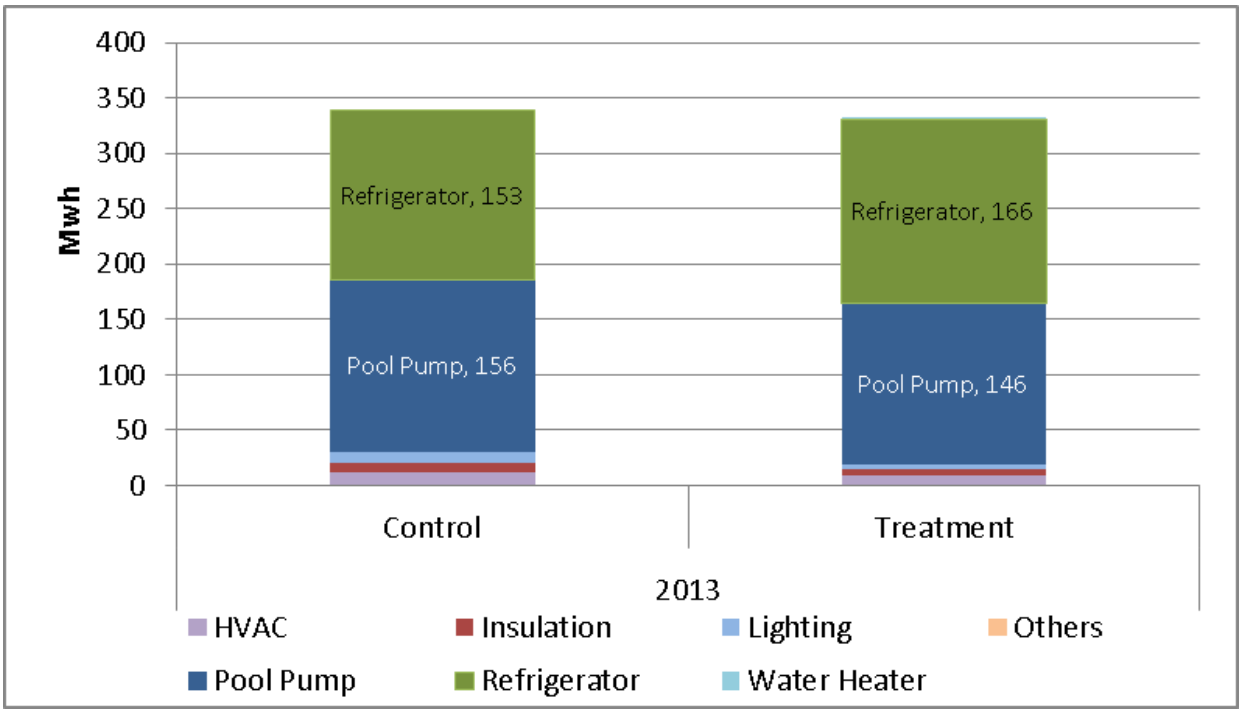
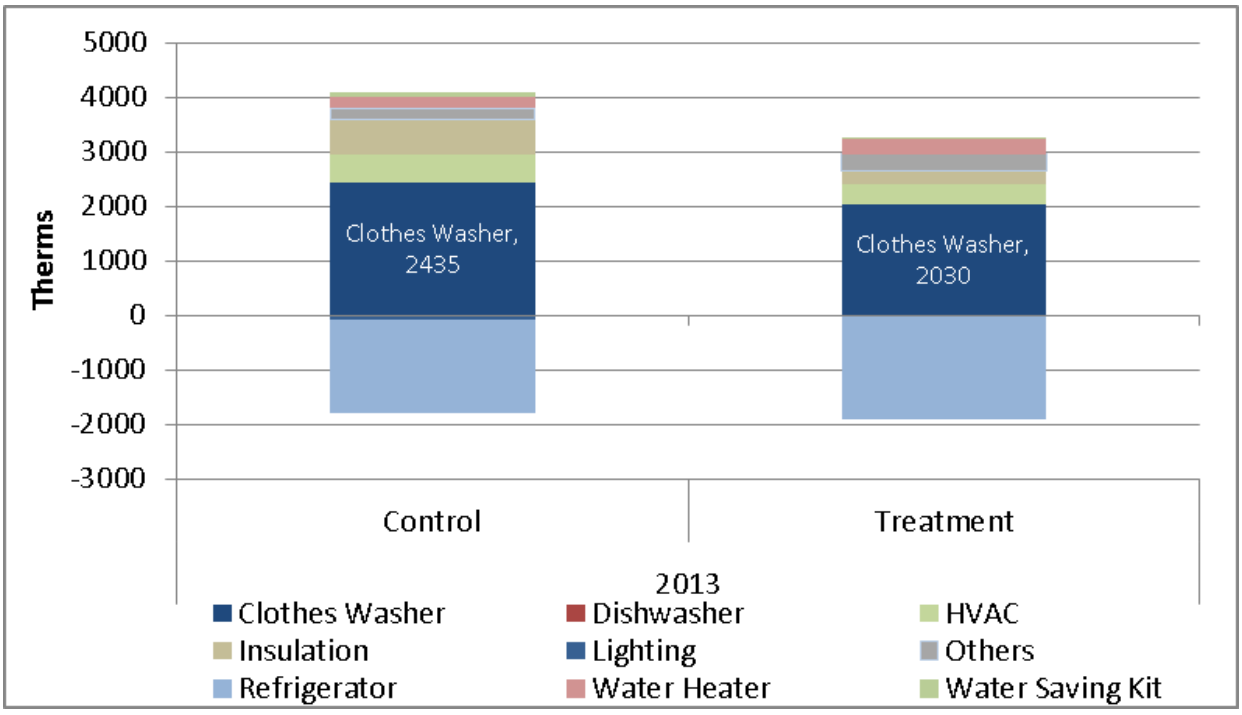


Figure 10 provides the gas savings from downstream programs. Clothes washers are the measures with the greatest savings for both treatment and control groups. Overall, the chart shows that most measures were installed at a higher rate by the control group than the treatment group. In addition, the control group has a slightly smaller negative savings total that also implies greater rates of refrigerator recycling in the control group. Refrigerators produce waste heat and disposal of an inefficient unit will decrease the production of waste heat while it increases the heating load of a house.

Figure 10. Annual Therm Savings by Measure for the Tracking Database



Contrary to findings in 2012, we observed that in 2013 the control group accrued higher electric and gas savings from downstream rebate program participation than the treatment group. This finding may be attributed to the MAS contamination that may have encouraged a sample of the HER control group to increase their uptake of the SDG&E rebate programs through the MAS program. Because joint savings are removed from the program savings estimates, the effect of the increased uptake among the control group has a slight positive effect on program savings.

5.3.2 Upstream Joint Savings

In 2012, PG&E completed 702 home inventories[9] 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, less than one bulb per household. This estimate is not statistically significant due to the prohibitive cost of completing sufficiently large samples. 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.

Any additional bulbs encouraged by the HER program 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 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

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

source of all of the bulbs, the modification relies on aggregate estimates regarding the source of bulbs. Table 9 provides the upstream joint savings inputs.

Table 9. Upstream Joint Savings Inputs

Additional CFLs in Treatment Households in 2012	0.95
Additional CFLs in Treatment Households in 2013	0.95
Total CFLs in Treatment Households in 2013	1.9
% 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)	1.2

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 10. 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. (Apr 2010)	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 (Feb 2010)	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 11 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 11. Monthly Upstream Lighting Savings

Month	Joint Savings per Customer - Untracked/ Upstream Programs (kWh)	Count of Treatment group Participants	Program savings (MWh)
13-Jan	1.2	16,754	20.1
13-Feb	1.2	16,666	20.0
13-Mar	1.2	16,583	19.9
13-Apr	1.2	16,496	19.8
13-May	1.2	16,381	19.7
13-Jun	1.2	16,261	19.5
13-Jul	1.2	16,105	19.3
13-Aug	1.2	15,945	19.1
13-Sep	1.2	15,806	19.0
13-Oct	1.2	15,704	18.8
13-Nov	1.2	15,599	18.7
13-Dec	1.2	15,505	18.6
2013 Savings			232.6
			(-230.6, 697.7)

5.3.3 Upstream Interactive Effects

California recognizes the potential for interactive effects across fuels when assigning savings. Interactive effects are explicitly accounted for in the rebate program savings tracking database. For example, as indicated in Figure 10 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 HER program gas savings as measured in the billing analysis.

To calculate this value we use the ratio of kWh and therms savings per watt from DEER[10]. The relationship is described in the following equation.

$$Therm\ effect = \frac{\frac{-0.02Th}{w}}{\frac{1.44\ kWh}{w}} * kWh\ effect = {}^{-0.02Th}/_{1.44kWh} * kWh\ upstream\ savings$$

This approach directly estimates the gas effect from the estimated un-tracked, upstream electric joint savings that are removed 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 12 provides the stream of Upstream Lighting Program interactive effects through the months of the program.

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

Table 12. 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)
13-Jan	-0.02	16,754	-0.3
13-Feb	-0.02	16,666	-0.3
13-Mar	-0.02	16,583	-0.3
13-Apr	-0.02	16,496	-0.3
13-May	-0.02	16,381	-0.3
13-Jun	-0.02	16,261	-0.3
13-Jul	-0.02	16,105	-0.3
13-Aug	-0.02	15,945	-0.3
13-Sep	-0.02	15,806	-0.3
13-Oct	-0.02	15,704	-0.3
13-Nov	-0.02	15,599	-0.3
13-Dec	-0.02	15,505	-0.3
2013 Savings			-3.2^{ns}

5.4 Combined Results

This section combines the results in the prior three sections to provide the final savings estimates for the program. Program savings reported in this section may not reflect the true program savings due to the control group's exposure to the MAS behavior program. We expect that due to the contamination, the savings may be lower due to a lower baseline in the control group to the extent that MAS successfully reduced electric and gas consumption.

Table 13 lists the unadjusted HER electric savings along with the two forms of joint savings that we 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 13. Combined Monthly Electric HER Program Results

Month	kWh per Household				Count of Treatment Group Participants	Adjusted Program Savings (MWh)
	Unadjusted Savings	Joint Savings - Tracked	Joint Savings - Untracked	Adjusted Savings		
		Downstream Programs	Upstream Programs			
13-Jan	23.9	0.5	1.2	22.2	16,754	372
13-Feb	16.9	0.5	1.2	15.2	16,666	254
13-Mar	18.3	0.6	1.2	16.5	16,583	274
13-Apr	18.1	0.6	1.2	16.3	16,496	268
13-May	21.6	0.6	1.2	19.7	16,381	323
13-Jun	20.3	0.6	1.2	18.5	16,261	301
13-Jul	28.8	0.6	1.2	26.9	16,105	434
13-Aug	28.0	0.6	1.2	26.2	15,945	417
13-Sep	38.2	0.6	1.2	36.4	15,806	575
13-Oct	24.4	0.7	1.2	22.5	15,704	354
13-Nov	21.9	0.6	1.2	20.2	15,599	314
13-Dec	21.5	0.5	1.2	19.8	15,505	307

Table 14 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 14. 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*			
13-Jan	2.7	-0.02	2.7	16,754	45.9
13-Feb	1.7	-0.02	1.7	16,666	29.1
13-Mar	1.9	-0.02	1.9	16,583	31.7
13-Apr	1.0	-0.02	1.0	16,496	16.5
13-May	0.6	-0.02	0.7	16,381	10.8
13-Jun	0.2	-0.02	0.3	16,261	4.2
13-Jul	0.2	-0.03	0.3	16,105	4.0
13-Aug	0.2	-0.03	0.2	15,945	3.2
13-Sep	0.0	-0.03	0.0	15,806	-0.3
13-Oct	0.2	-0.03	0.2	15,704	3.5
13-Nov	0.6	-0.03	0.6	15,599	10.1
13-Dec	1.9	-0.03	2.0	15,505	30.5

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

Aggregate savings are reported in Table 15. Adjusted savings represents the HER program savings net of any savings claimed by any other SDG&E energy efficiency programs.

Table 15. Program-Level Savings Estimates

Evaluation Period	Source	Electric (MWh)	Gas (,000 Therms)
January 2013 - December 2013	Unadjusted Savings	4,539.84	184.4
	Tracked, Downstream Joint Savings	114.0	-1.0
	Untracked, Upstream Lighting Joint Savings	232.6	-3.9
	Adjusted Savings	4,193.27	189.33

Table 16 presents the unadjusted and adjusted savings as a fraction of control group, post-period consumption.[11] 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.

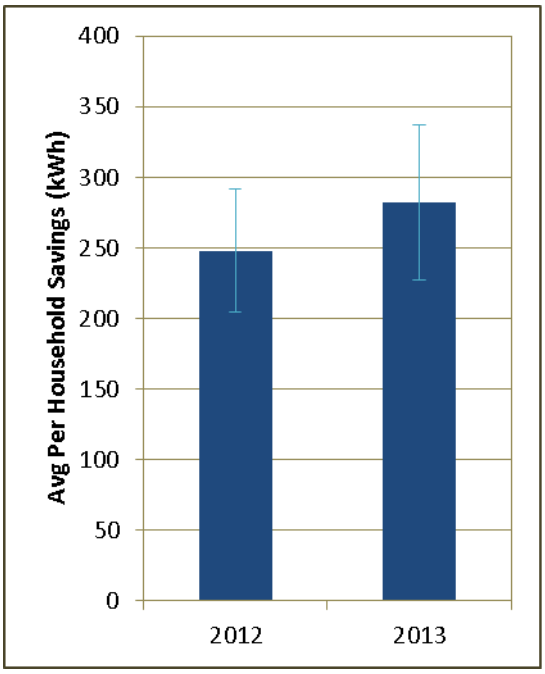
[11] Per customer savings are calculated by dividing the total aggregate savings by the average number of customers during that time period.

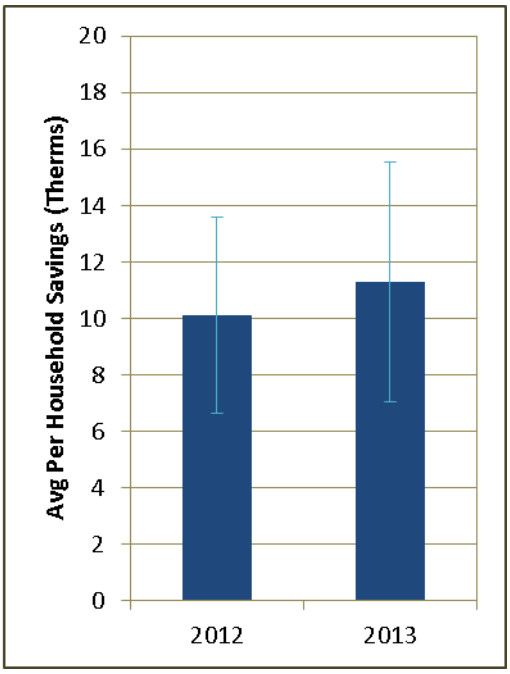
Table 16. Savings per Household as a Percent of Consumption

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
January 2013 - December 2013	Electric	281.9	260.4	10,023	2.81%	2.60%
	Gas	11.3	11.6	580	1.95%	2.00%

6 APPENDIX

6.1 SDG&E HER Program Savings 2012-2013





6.2 MAS Contamination in HER design

We include this section to present results from different methods that DNV GL explored to estimate HER program savings for 2013.

Under a randomized experiment, contamination happens when customers in the control group are exposed to the same or similar intervention that the treatment group received. For SDG&E HER program, a subset of the control group received a similar intervention thru SDG&E's Manage Act Save (MAS) program. MAS program is an energy conservation behavior program that allows homeowners to earn points for saving energy and use the points to redeem rewards. The program provides information on homeowner's historical consumption and also compares homeowner's energy use with other similar homes.

Instead of having a steady baseline that would mirror what the treatment group would have done in the absence of the HER program, the exposure of the control group to other behavioral based program may cause the customers to change the way they use energy.

DNV GL explored different approaches in estimating program savings in 2013:

Method 1. All Sites. This is a Fixed Effects estimation using the full HER population. This takes full advantage of the RCT ignoring the contamination issue. This is the model DNV GL used to estimate savings in 2013.

Method 2. MAS sites removed. This is a Fixed Effects estimation without the 7,823 sites in the HERcontrol group that were enrolled in MAS program (MAS-HER sites). This leads to a removal of 39% of the initial HER control group.

Method 3. MAS reads removed. Fixed effects estimation using full HER population but excludes billing reads of MAS-HER sites after the MAS program's launch date. This leads to excluding energy consumption for the last 6 months in 2013 of the 39% of the initial HER control group.

Method 4. MAS and selected treatment sites removed. This is a Fixed Effects estimation without MAS-HER sites and selected customers in the treatment group. A bin of customers from the treatment group was created using a similar range of annual consumption observed for MAS-HER sites. Annual consumption was based on the period Oct 2011 to Sep 2012 which is the same period used in one of the MAS sampling criteria. From the created bin, 7,823 treatment sites were randomly selected and removed from the analysis.

For Method 4, DNV GL validated the sites selected in the treatment group to balance the removal of the sites in the control group.

Table 17 shows that the difference in consumption between MAS-HER sites and selected treatment group is not statistically significant.

Table 17. Test of mean differences in consumption between MAS-HER sites and selected HER treatment sites

Group	Count of Treatment Group Participants	Average Annual Use (Oct2011-Sep2012)	Difference	tvalue
Opower control sites in MAS	7,823	11,487.3	-6.92^{ns}	-0.08
Matched treatment sites	7,823	11,494.3		

Table 18 provides the monthly kWh savings estimates from various approaches used by DNV GL Figure 11 provides a graphical illustration of monthly savings estimates in 2012 and 2013 as reported in Table 18.

Error! Reference source not found. provides the monthly Therm savings estimates from arious approaches used by DNV GL while **Error! Reference source not found.** provides a graphical illustration of savings estimates in 2012 and 2013 as reported in Table 19.

Table 18. Monthly kWh Savings per Household from Different Estimation Approaches

Month	Unadjusted Savings per Household (kWh)			
	Method 1	Method 2	Method 3	Method 4
Jan-13	23.9	9.7	23.9	17.2
Feb-13	16.9	14.4	16.7	10.7
Mar-13	18.3	17.3	18.3	10.5
Apr-13	18.1	19.0	18.1	9.1
May-13	21.6	29.5	21.5	23.3
Jun-13	20.3	22.5	20.3	17.8
Jul-13	28.8	27.0	22.5	33.6
Aug-13	28.0	31.9	27.4	34.1
Sep-13	38.2	31.2	26.2	52.3
Oct-13	24.4	28.5	24.0	26.5
Nov-13	21.9	27.3	23.1	20.0
Dec-13	21.5	26.8	22.3	28.6
2013 Savings	282	285	264	284

Figure 11. Comparison of 2012 and 2013 Monthly kWh Savings Estimates

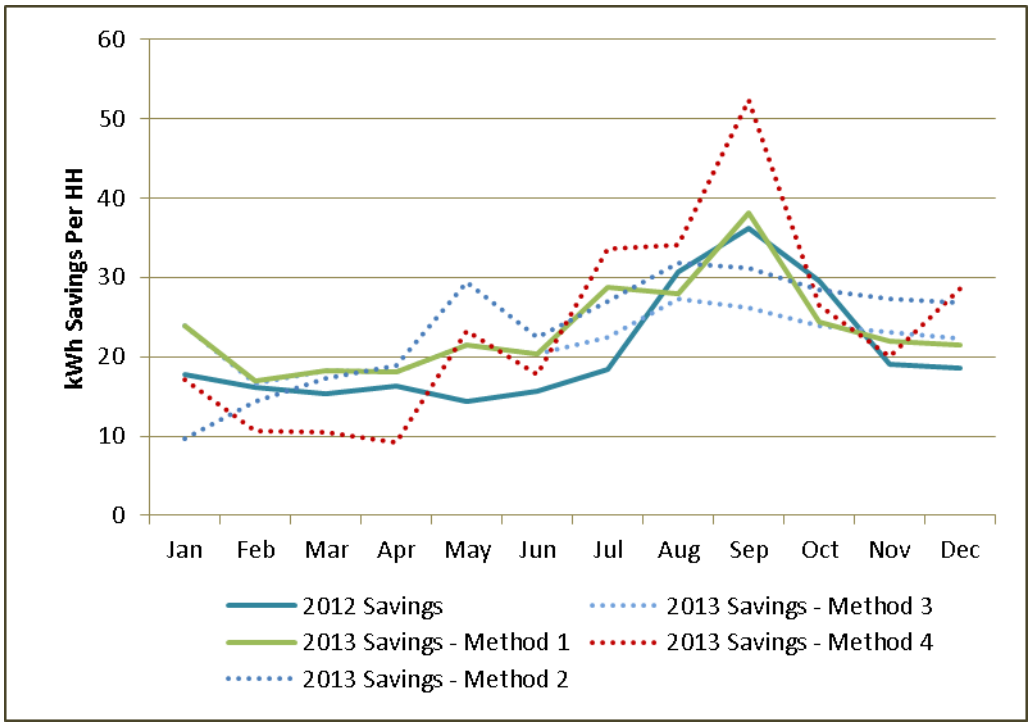
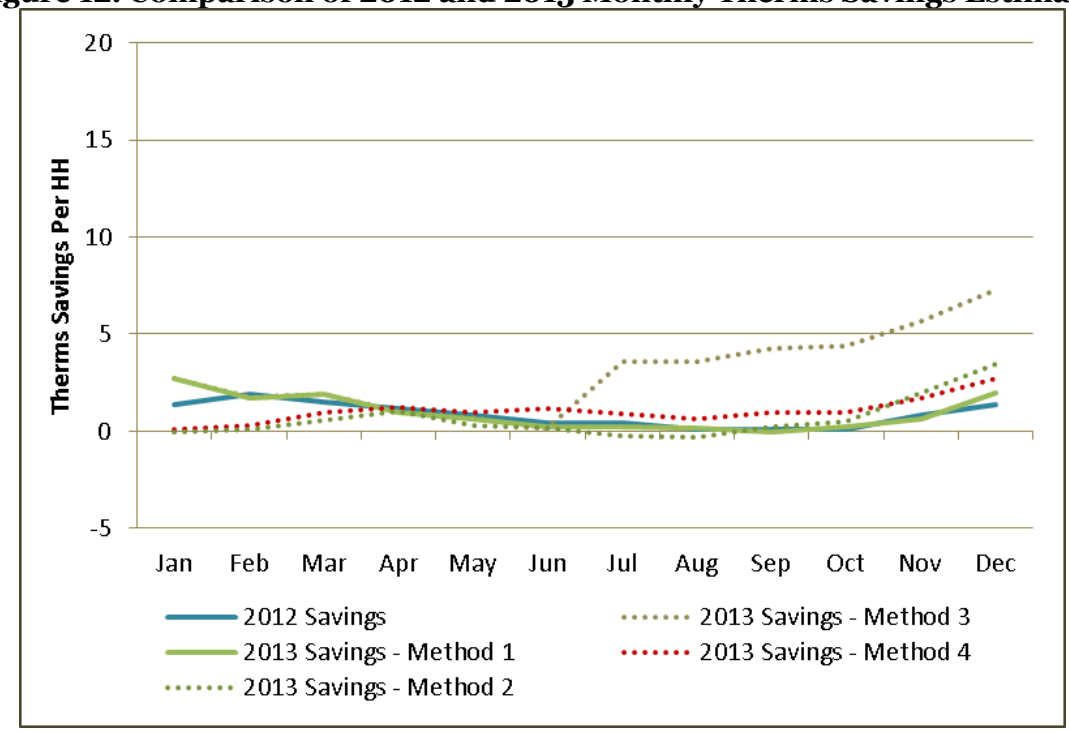


Table 19. Monthly Therms Savings per Household from Different Estimation Approaches

Month	Unadjusted Savings per Household (Therms)			
	Method 1	Method 2	Method 3	Method 4
Jan-13	2.7	0.0	2.7	0.1
Feb-13	1.7	0.1	1.8	0.3
Mar-13	1.9	0.5	1.9	1.0
Apr-13	1.0	1.0	1.0	1.2
May-13	0.6	0.3	0.7	1.0
Jun-13	0.2	0.2	0.2	1.2
Jul-13	0.2	-0.2	3.6	0.9
Aug-13	0.2	-0.3	3.6	0.7
Sep-13	0.0	0.2	4.2	1.0
Oct-13	0.2	0.5	4.4	1.0
Nov-13	0.6	2.0	5.7	1.7
Dec-13	1.9	3.4	7.3	2.7
2013 Savings	**11**	**8**	**37**	**13**

Figure 12. Comparison of 2012 and 2013 Monthly Therms Savings Estimates



As shown in Figure 11, 2013 monthly kWh savings estimates using Method 1 are higher than savings reported in 2012 evaluation for the first 6 months. The incremental increase in savings between the first 7 months of 2012 and 2013 averaged to about 5 kWh per month. However, in the last 5 months, the difference between 2012 savings and 2013 savings-Method1 more or less diminished indicating that the incremental increase in saving is almost zero. These findings are consistent with our expectations of lower measured consumption reduction for HER due to MAS contamination. However, it is also important to note that climate in 2013 is relatively milder than 2013.

For gas, there is no obvious increase in monthly savings from 2012 to 2013 using Method 1 that can be attributed to MAS contamination. For most months, gas savings estimates are similar between 2012 and 2013 program years except savings in January and December.

Methods 2, 3 and 4 actively remove sites or bill reads in an attempt to estimate savings that would correct for MAS contamination. Method 3 generated the lowest annual electric savings while Methods 1, 2 and 4 produced electric savings that are similar in magnitude. On the other hand, annual gas savings using Method 3 are more than three times the magnitude of gas savings generated using Method 1. This implies that estimating savings by simply excluding contaminated reads can produce results that are not robust.

Method 3 is similar to Method 1 in the first 6 months, by design. The other two methods remove substantial numbers of households altogether. These results for Methods 2 and 4 are quite different from Method 1 indicating that these changes in overall population have non-trivial impacts on the monthly savings.

Because of the inconsistencies in monthly savings from the other methods, DNV GL's impact evaluation of HER program is based on the full sample or Method 1. . We recognize that the HER program savings estimates may not reflect the true program savings because of the enrollment of some control sites in MAS program. The MAS program enrolled a maximum of 37% of the control group and savings reported after MAS launch date are potentially lower than the true program savings because of lower baseline consumption.