

# Impact Evaluation of 2015 San Diego Gas & Electric Home Energy Reports and Manage-Act-Save Programs (Final Report)

California Public Utilities Commission

**Date:** 05/05/2017

CALMAC Study ID: CPU0157.01





## LEGAL NOTICE

This report was prepared as an account of work sponsored by the California Public Utilities Commission. It does not necessarily represent the views of the Commission or any of its employees except to the extent, if any, that it has formally been approved by the Commission at a public meeting. For information regarding any such action, communicate directly with the Commission at 505 Van Ness Avenue, San Francisco, California 94102. Neither the Commission nor the State of California, nor any officer, employee, or any of its contractors or subcontractors makes any warranty, express or implied, or assumes any legal liability whatsoever for the contents of this document.

## Table of contents

1	EXECUTIVE SUMMARY .....	1
1.1	Background	1
1.2	Research questions and objectives	1
1.3	Study approach	2
1.4	Key findings	2
2	INTRODUCTION.....	8
2.1	Program description	8
2.2	Experimental Design	9
2.3	Evaluation objectives and approach	9
3	METHODOLOGY .....	11
3.1	Energy savings	11
3.2	Demand savings	12
3.3	Downstream rebate joint savings	13
3.4	Upstream joint savings	14
3.5	Data management	17
4	RESULTS .....	21
4.1	Home Energy Reports	21
4.1.1	Overall program savings estimates	21
4.1.2	Demand savings estimates	22
4.1.3	Joint savings: downstream programs	25
4.1.4	Joint savings: upstream programs	29
4.1.5	Per household savings and total program savings	33
4.2	Manage-Act-Save	36
4.2.1	Overall program savings estimates	36
4.2.2	Demand savings estimates	37
4.2.3	Joint savings: downstream programs	38
4.2.4	Joint savings: upstream programs	42
4.2.5	Per household savings and total program savings	46
4.3	Comparison of HER and MAS-2 Savings	49
5	CONCLUSIONS .....	51
APPENDIX A.	RANDOMIZATION TEST.....	52
APPENDIX B.	HER PROGRAM MONTHLY SAVINGS.....	56
APPENDIX C.	MAS-2 PROGRAM MONTHLY SAVINGS .....	59
APPENDIX D.	OPOWER-2 EMAIL AND PAPER RECIPIENTS BY INCOME GROUP .....	62
APPENDIX E.	MAS-2 MYACCOUNT PAPER AND EMAIL RECIPIENTS.....	63
APPENDIX F.	HER SAVINGS BY PA (2011-2014) .....	1

APPENDIX AA. STANDARDIZED HIGH LEVEL SAVINGS.....	AA-1
APPENDIX AB. STANDARDIZED PER UNIT SAVINGS .....	AB-1
APPENDIX AC. RECOMMENDATIONS .....	AC-1

## List of tables

Table 1. Average savings per household as a percent of consumption.....	3
Table 2. No. of households in the treatment and control groups, HER and MAS programs .....	9
Table 3. Input assumptions used in SDG&E calculation for 2015 upstream joint savings .....	15
Table 4. CFL and LED peak diversity factor.....	16
Table 5. Summary of billing data issues .....	18
Table 6. Data Disposition .....	19
Table 7. Active electric accounts for Opower-1 and Opower-2.....	19
Table 8. Active electric accounts for MAS -2 – MyAccount and Non-MyAccount .....	20
Table 9. Average monthly and total kWh and therm savings for Opower-1 .....	21
Table 10. Average monthly and total kWh and therm savings for Opower-2 .....	22
Table 11. Peak heatwaves identified for the pre- and post-periods. ....	24
Table 12. Overall pre period and post period kW comparison.....	24
Table 13. Overall HER kW savings.....	24
Table 14. Joint kWh and therms savings for Opower-1 .....	28
Table 15. Joint kWh and therms savings for Opower-2.....	29
Table 16. Joint kW savings for HER .....	29
Table 17. Upstream kWh joint savings inputs for CFL and LED for Opower-1 .....	30
Table 18. Upstream kWh joint savings inputs for CFL and LED for Opower-2 .....	30
Table 19. Monthly upstream kWh savings from lighting programs for Opower-1.....	31
Table 20. Monthly upstream kWh savings from lighting programs for Opower-2.....	32
Table 21. Monthly upstream interactive effects for Opower-1 .....	33
Table 22. Peak kW upstream joint savings at the time of peak.....	33
Table 23. Savings per household as a percent of kWh and therms consumption.....	34
Table 24. Average monthly and total kWh savings, MAS-2 MyAccount .....	36
Table 25. Average monthly and total kWh savings , MAS-2 Non-MyAccount .....	37
Table 26. Peak heatwaves identified for the pre and post-periods .....	37
Table 27. Pre and Post period kW comparison .....	38
Table 28. MAS kW savings per household .....	38
Table 29. Monthly kWh and therms joint savings MAS-2 MyAccount .....	41
Table 30. Monthly kWh and therms joint savings MAS-2 Non-MyAccount .....	42
Table 31. Joint kW Savings for HER.....	42
Table 32. Upstream kWh joint savings inputs for CFL and LED - MAS-2 MyAccount .....	43
Table 33. Upstream kWh joint savings inputs for CFL and LED - MAS 2 Non-MyAccount .....	43
Table 34. Monthly upstream kWh savings from lighting programs - MAS 2 MyAccount .....	44
Table 35. Monthly upstream kWh savings from lighting programs - MAS 2 Non My Account.....	44
Table 36. Monthly upstream interactive effects - MAS 2 MyAccount .....	45
Table 37. Monthly upstream interactive effects for Non-MyAccount .....	46
Table 38. Peak kW Upstream Joint Savings .....	46
Table 39. Savings per household as a percent of kWh and therms consumption.....	47
Table 40. Recommended total adjusted kWh, therms, and kW savings for 2015 HER and MAS programs ...	51



## List of figures

Figure 1. Recommended kWh, kW and therms savings for Opower-1 and Opower-2 in 2015 .....	4
Figure 2. Recommended kWh, kW and therms savings for MAS MyAccount and Non-MyAccount in 2014-2015 .....	5
Figure 2. Unadjusted kWh savings per household from 2012 - 2015.....	6
Figure 3. Unadjusted therms savings per household from 2012 - 2015 .....	7
Figure 4. Average monthly kWh joint savings per household for Opower-1 .....	25
Figure 5. Average monthly kWh joint savings per household for Opower-2 .....	26
Figure 6. Average monthly therms joint savings per household for Opower-1 .....	26
Figure 7. Average monthly therms joint savings per household for Opower-2 .....	27
Figure 9. Recommended kWh, kW and therms savings for Opower-1 and Opower-2 in 2015 .....	35
Figure 10. Average monthly kWh joint savings per household for MyAccount.....	39
Figure 11. Average monthly kWh joint savings per household for Non-MyAccount .....	39
Figure 12. Average monthly therms joint savings per household for MyAccount .....	40
Figure 13. Average monthly therms joint savings per household for Non-MyAccount .....	40
Figure 14. Recommended kWh, kW and therms savings for MAS MyAccount and Non-MyAccount in 2014-2015 .....	48

# 1 EXECUTIVE SUMMARY

This report provides the results of DNV GL's impact evaluation of San Diego Gas & Electric's (SDG&E) Home Energy Reports (HER) and Manage-Act-Save (MAS) programs for 2015. The evaluation includes calculated energy and demand savings estimates that can be used to support SDG&E savings claims for behavioral programs in 2015.

## 1.1 Background

SDG&E began sending residential energy usage reports to HER pilot program (Opower-1) participants in July 2011. The reports contain a mix of consumption information, comparison with similar neighbors and customized tips for saving energy. In November 2014, SDG&E offered the HER program to a new cohort (Opower-2) with 95,000 treatment households. The Opower-1 targeted customers with high energy usage while Opower-2 targeted customers in the coastal and inland climate zones in SDG&E service territory. Opower-2 is also composed of low income and non-low income groups receiving either paper or email reports.

In addition to the HER program, SDG&E implemented another behavioral program known as the MAS program. Similar to the HER program, the MAS program offered customers comparative reports via mail or email and personalized tips on how to save energy. The paper and email reports are aimed at encouraging participants to activate their accounts on the online MAS platform and earn points for their energy savings actions. Points are earned by completing the suggested tips and enrolling in other SDG&E demand-side management programs. Customers can redeem points for products or experience awards.

The MAS pilot program (MAS-1) started in July 2013 and discontinued in December 2013 due to sample contamination. SDG&E implemented a new wave of the MAS program (MAS-2) to customers enrolled in the SDG&E online billing and energy information system called MyAccount and to those not enrolled in this system (Non-MyAccount). The MyAccount participants received either e-mail or paper reports while the Non-MyAccount customers received paper reports only. The MAS-2 program started in October 2014 and was discontinued in December 2015. Similar to Opower-2, MAS-2 included homes in coastal and inland climate zones.

The HER and MAS programs were implemented by Opower and Simple Energy, respectively. Both programs used a randomized controlled trial (RCT) design that 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 1% to 3% of baseline consumption.

This study provides impact evaluation results for Opower-1, Opower-2 and MAS-2 for 2015 program year. The MAS-1 program has not been evaluated due to processing errors with the RCT sample.

## 1.2 Research questions and objectives

The primary objective of this evaluation is to provide independent verification of electricity and gas savings attributable to the HER and MAS programs. Specific research questions included the following:

- What are the energy savings for HER/MAS programs?

- Are there downstream/upstream rebate program savings that could be jointly claimed by either the HER or MAS program and SDG&E rebate programs?
- What are the peak demand savings attributable to the HER/MAS programs?
- Do customers who receive email reports generate more savings?

### 1.3 Study approach

To answer these research questions, DNV GL conducted an impact evaluation for the 2015 program year. This evaluation includes calculating the different components of the HER and MAS program savings. The different components are:

- *Overall unadjusted energy and demand savings.* These savings measure the impact of the specific program on average household energy consumption. We estimated the unadjusted energy savings using a fixed effects regression model that compares the treatment group's pre- and post-program consumption difference to that of the control group. For the unadjusted demand savings, we estimated savings as the difference in peak load between the treatment group and control group during the hottest heatwave in pre- and post-periods. These energy and demand savings reflect the overall program savings before applying any adjustment for joint savings achieved in conjunction with other rebate programs.
- *Joint savings.* Joint savings represent program induced savings derived from the increased uptake of SDG&E rebate programs. This estimate is normally produced for two areas:
  - *Downstream* joint savings occur due to increased participation by the HER/MAS treatment group versus the control group in SDG&E's tracked energy efficiency programs.
  - *Upstream* joint savings occur due to increased purchases of SDG&E-supported upstream lighting program CFL and LED bulbs by the HER/MAS treatment group versus the control group.
- *Final adjusted energy and demand savings.* These savings represent the final program savings after deducting both the downstream and upstream joint savings. This adjustment eliminates the potential to double count savings already accounted for in the rebated programs.

### 1.4 Key findings

Table 1 provides the estimates of unadjusted and adjusted kWh, kW and therms savings per household for the HER and MAS programs in 2015. Opower-1 produced the highest energy and demand savings amounting to roughly 2% savings while Opower-2 and MAS-2 programs produced relatively lower savings that ranged from 0.1% to 1.0%. Both HER and MAS programs produced electric and gas savings that are statistically significant at the 90% confidence level except for gas savings from Opower-2. At the program-level, total gas savings for the HER program are statistically significant despite the lack of savings from Opower-2. The differences in savings can be attributed to the different program designs and groups targeted by the the HER and MAS-2 programs.

For demand savings, the HER program produced demand savings that are statistically significant while the MAS program did not show evidence of peak load reduction. Overall, the joint savings shared between HER/MAS and other rebate programs are minimal.

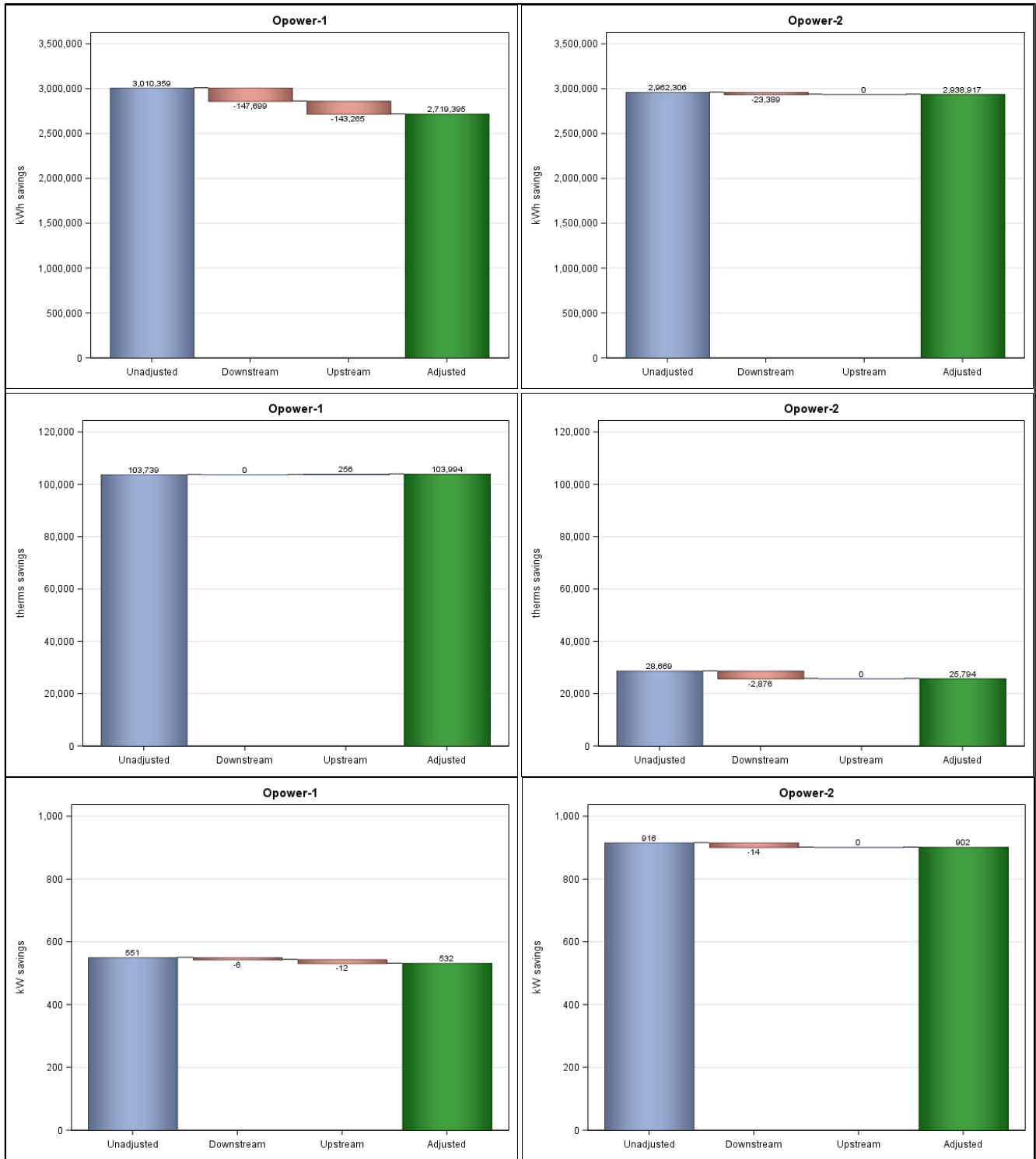
**Table 1. Average savings per household as a percent of consumption**

Program/ Wave	Evaluation Period	Fuel	Unadjusted Per Customer Savings	Adjusted Per Customer Savings	Unadjusted Savings as Percentage of Consumption	Adjusted Savings as Percentage of Consumption	Significant at 90% Confidence level
<b>Opower-1</b>	January 2015 - December 2015	kWh	232	210	2.4%	2.2%	Yes
		kW	0.04	0.04	1.7%	1.6%	Yes
		therms	8	8	1.8%	1.8%	Yes
<b>Opower-2</b>	December 2014 - December 2015	kWh	41	40	0.8%	0.7%	Yes
		kW	0.01	0.01	1.0%	1.0%	Yes
		therms	0	0	0.1%	0.1%	No
<b>MAS-2 MyAccount</b>	November 2014 - December 2015	kWh	24	23	0.4%	0.4%	Yes
		kW	0.01	0.00	0.4%	0.4%	No
		therms	1	1	0.5%	0.5%	Yes
<b>MAS-2 Non MyAccount</b>	November 2014 - December 2015	kWh	47	46	0.9%	0.8%	Yes
		kW	0.01	0.01	0.6%	0.6%	No
		therms	2	2	0.6%	0.6%	Yes

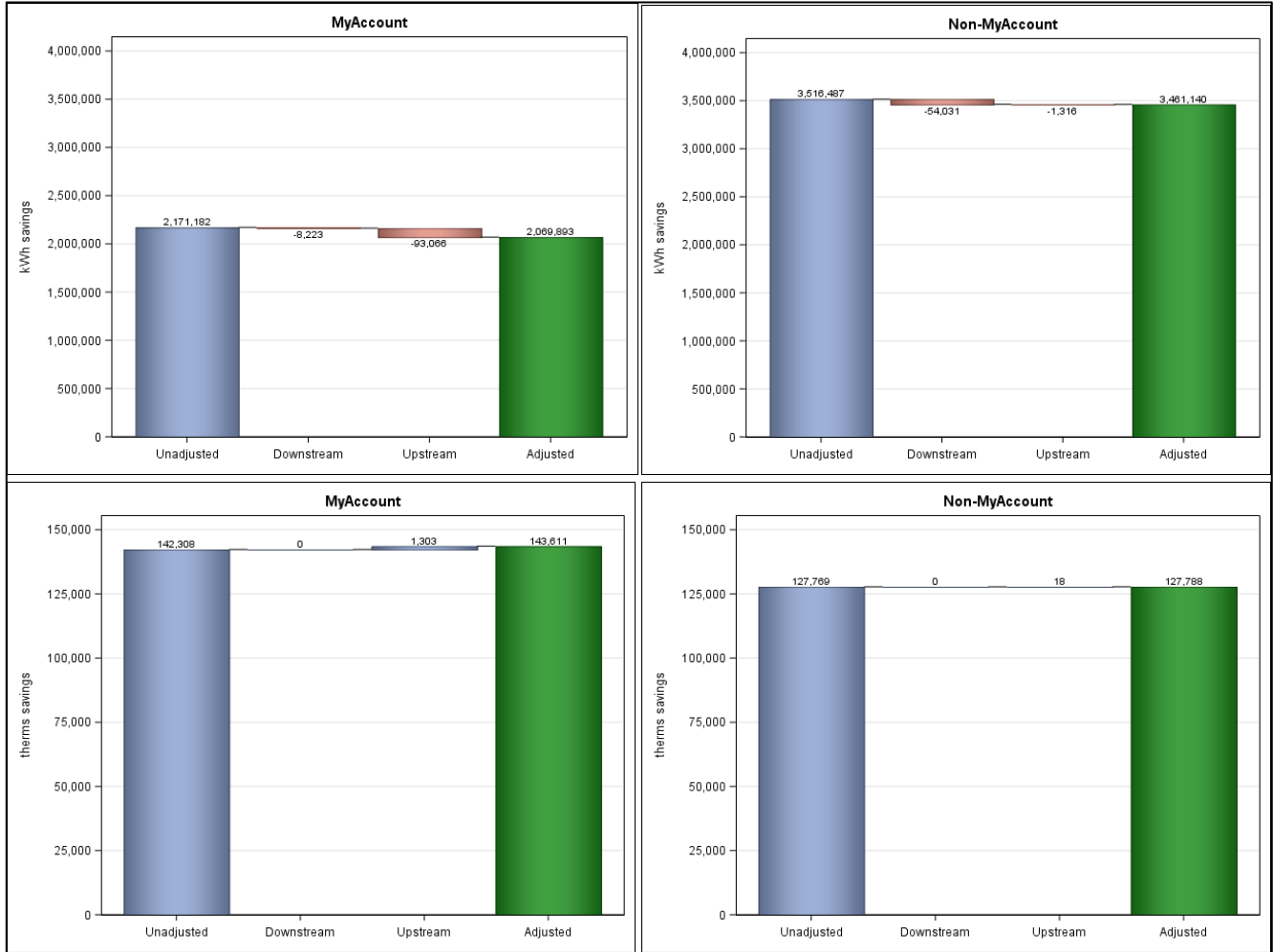
Figure 1 and Figure 2 present the program-level unadjusted and adjusted energy and demand savings for the 2015 HER and MAS program. These total program savings are calculated by multiplying the per household savings shown in Table 1 by the average number of households in the treatment group. The kWh, therms and kW per household savings from Opower-2 are lower than the per household savings from Opower-1. However, the total kW program savings for Opower-2 are much larger than Opower-1 due to the higher number of households in the treatment group in Opower-2.



Figure 1. Recommended kWh, kW and therms savings for Opower-1 and Opower-2 in 2015



**Figure 2. Recommended kWh, kW and therms savings for MAS MyAccount and Non-MyAccount in 2014-2015**



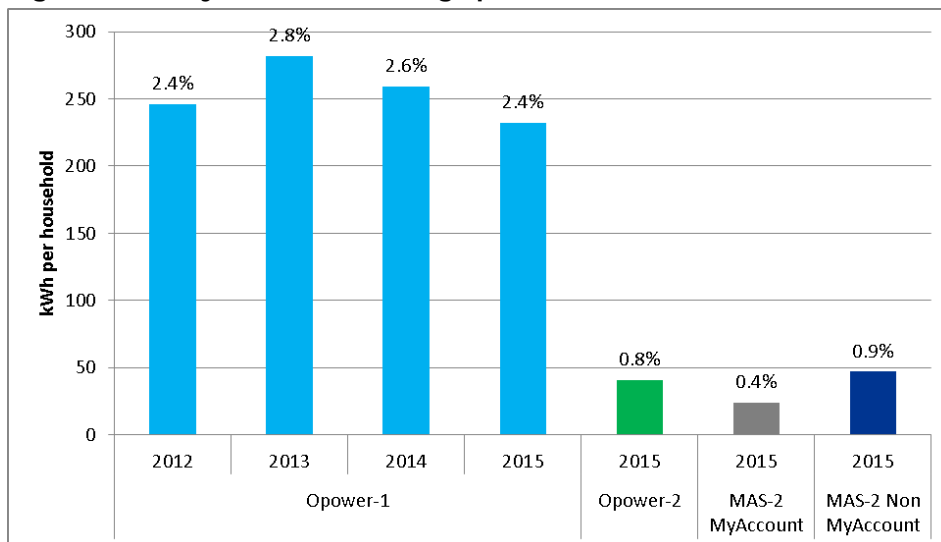
The final adjusted savings are calculated by subtracting the downstream and upstream joint savings from the unadjusted savings. This adjustment was performed to address the potential for “double-counting” savings already claimed by other SDG&E programs. Overall, the joint savings between HER/MAS and SDG&E rebate programs comprise a small percentage of the unadjusted savings.

For gas savings, the positive adjustments on the unadjusted savings for Opower-1 and MAS are due to the heating and cooling interactive effects associated with efficient bulb installations. Because we are deducting the upstream joint savings from the electric savings, it is important to remove the gas penalty associated with installing lower heat emissions lamps such as CFLs and LEDs. For Opower-2, no interactive heating and cooling effects are calculated because upstream joint savings are zero.

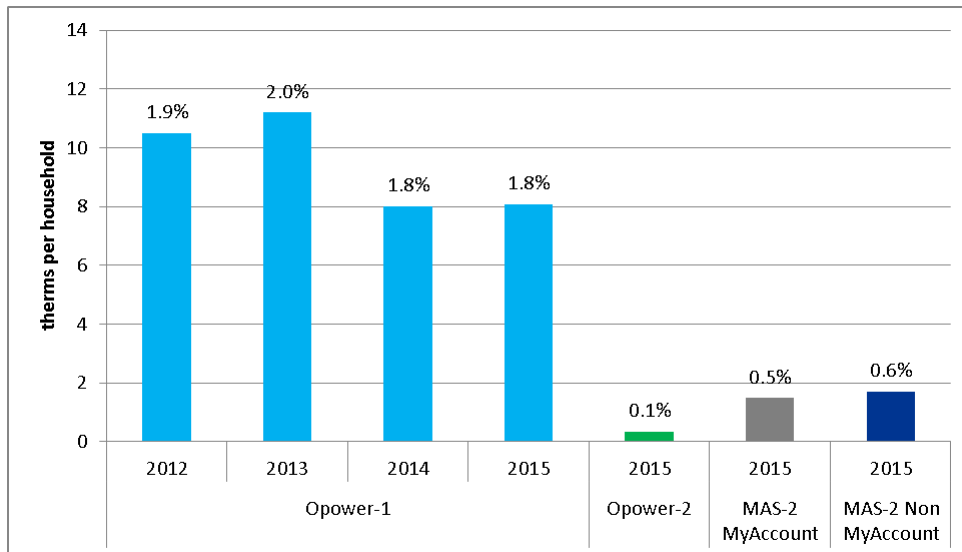
Overall, the HER program produced an aggregate adjusted savings of 5,658,311 kWh, 1,434 kW and 129,788 therms while the MAS-2 program produced 5,531,032 kWh and 271,398 therms savings. Demand savings from MAS program are very small and effectively zero. These adjusted savings are free of potentially double counted savings and SDG&E may use these results to support savings claims for the 2015 program cycle.

Figure 3 and Figure 4 present the historical electric and therms savings from 2012 to 2015 for the HER and MAS programs. Opower-1 continued to produce electric and gas savings that are statistically significant. In 2015, electric and gas savings are only 0.2 percentage point below the 2014 savings level. Opower-2 and MAS-2 started in late 2014 so there is no prior baseline of comparison. Compared to Opower-1, Opower-2 and MAS-2 produced relatively lower savings. Some of the differences between the savings results for Opower-1, Opower-2 program and MAS-2 program as discussed above are related to the variations within the program design, target group characteristics and maturity of the program.

**Figure 3. Unadjusted kWh savings per household from 2012 - 2015**



**Figure 4. Unadjusted therms savings per household from 2012 - 2015**



In this evaluation, DNV GL also compared electric and gas savings between paper report and email report recipients by income groups. For Opower-2, we found some indications that the paper recipients produced higher electric and gas savings than the email recipients regardless of income group. Similarly, the magnitude of savings produced by paper recipients is higher than the email recipients for MAS MyAccount.

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/MAS program effect on measures supported by energy efficiency program funds. The results show that there is limited evidence of increased uptake of rebate activities in 2015. For Opower-1, the joint savings captured are primarily carryover savings from rebate activities induced by the HER program last year. Overall, the estimated joint savings are a relatively small portion of the program savings. These findings suggest that behavioral changes could be the primary driver of savings.

---

---

## 2 INTRODUCTION

The California Public Utilities Commission (CPUC) engaged DNV GL to conduct an impact evaluation of the San Diego Gas & Electric's (SDG&E) Home Energy Reports (HER) and Manage Act Save (MAS) program for program year 2015. This impact evaluation uses program tracking data, monthly consumption data and hourly data provided to the CPUC by SDG&E to estimate energy and demand savings attributable to the HER and MAS programs. DNV GL evaluated three experimental waves 1) Pilot Phase of the HER program (Opower-1) that started in July 2011. 2) Expansion Phase of the HER Program (Opower -2) that started in November 2014 and 3) New population of the MAS program (MAS-2) that started in October 2014. The pilot phase of the MAS program has not been evaluated because the experiment was compromised due to processing error.

### 2.1 Program description

SDG&E began sending residential energy usage reports to Opower-1 participants in July 2011. The reports contain a mix of consumption information, comparison with similar neighbors and customized tips for saving energy. Opower-1 consisted of approximately 20,000 treatment households that initially received monthly reports for the first three months and then bi-monthly reports through December 2015. In November 2014, SDG&E offered the HER program to a new cohort (Opower-2) with 95,000 treatment households that are enrolled in the SDG&E online billing and energy information system (MyAccount).

The Opower-1 targeted customers with high energy usage while Opower-2 targeted customers in the coastal and inland climate zones in SDG&E service territory. Opower-2 is also composed of low income and non-low income groups receiving either paper or email reports.

In addition to the HER program, SDG&E implemented another behavioral program known as the MAS program. The HER and MAS programs were implemented by Opower and Simple Energy, respectively. Similar to the HER program, the MAS program offered customers comparative reports via mail or email and personalized tips on how to save energy and information regarding their energy usage. The paper and email reports are aimed at encouraging participants to activate their accounts on the MAS web platform and earn points for their energy savings actions. Points are earned by completing the suggested tips, saving energy and enrolling in other DSM programs offered by SDG&E. Customers can redeem points for products or experience awards.

The MAS pilot program (MAS-1) started in July 2013 and discontinued in December 2013 due to contamination concerns with the RCT<sup>1</sup>. SDG&E offered the MAS program to a new population that is composed of 115,000 treatment households enrolled in MyAccount and 85,000 treatment households that are not enrolled in the SDG&E online billing system (non-MyAccount). The MAS-2 MyAccount treatment households, were provided either customer paper reports or email reports while the non-MyAccount treatment households were provided paper reports. The MAS-2 program started in October 2014 and was discontinued in December 2015. Similar to Opower-2, MAS-2 included homes in coastal and inland climate zones.

---

<sup>1</sup> (need to explain how Simple Energy sent reports to portions of the control group)

## 2.2 Experimental Design

The HER and MAS programs used a randomized controlled trial (RCT) design that 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 unbiased 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 1% to 3% of consumption.

Opower-1 followed a simple random sampling method wherein an eligible population of customers with large energy consumption were randomly assigned to the treatment and control groups. For Opower-2 and MAS-2 programs, the population of eligible residential customers was stratified into inland and coastal areas based on climate zones and the level of energy consumption (high, medium and low). Customers were then separated into two groups based whether they are enrolled in the SDG&E online billing system (MyAccount) or not (Non-MyAccount). Customers in Opower-2 and MAS-2 MyAccount treatment and control groups were randomly selected from the MyAccount eligible sample while customers in MAS-2 Non-MyAccount were randomly selected from the pool of NonMyAccount customers. Treatment groups in Opower-2 and MAS-2 MyAccount receive either email or paper reports while treatment customers in MAS-2 MyAccount receive paper reports. Table 2 presents the initial no. of households in the treatment and control groups for the HER and MAS-2 programs.


**Table 2. No. of households in the treatment and control groups, HER and MAS programs**

Program	Sub-treatment group	No. of Households	
		Treatment	Control
<b>Opower-1</b>	All	19,977	19,909
<b>Opower-2</b>	All	95,002	26,302
	Non-Low Income Paper	14,996	7,925
	Non-Low Income Email	42,179	7,925
	Low Income Paper	10,000	3,538
	Low Income Paper Email	16,018	3,536
<b>MAS-2 Non-MyAccount</b>	Non-MyAccount Paper	85,003	45,002
<b>MAS-2 MyAccount</b>	All	115,004	27,501
	MyAccount Paper	15,003	27,501
	MyAccount Email	100,001	

## 2.3 Evaluation objectives and approach

The primary objective of this evaluation is to provide independent verification of electricity and gas savings attributable to the HER program. Specific research questions include the following:

- What are the energy savings for SDG&E HER/MAS pilot and expansion waves?
- Are there downstream/upstream rebate program savings that could be jointly claimed by both the HER/MAS program and SDG&E rebate programs?
- What are the peak demand savings attributable to the HER/MAS program?
- Do customers who receive email reports generate more savings?



To answer these research questions, DNV GL conducted an impact evaluation for the 2015 program year. This evaluation includes calculating the different components of program savings. The different components are:

- *Overall unadjusted energy and demand savings.* These savings measure the impact of the specific program on average household energy consumption. We estimated the unadjusted energy savings using a fixed effects regression model that compares the treatment group's pre- and post-program consumption difference to that of the control group. For the unadjusted demand savings, we estimated savings as the difference in peak load between the treatment group and control group during the hottest heatwave in pre- and post-periods. These energy and demand savings reflect the overall program savings before applying any adjustment for joint savings achieved in conjunction with other rebate programs.
- *Joint savings.* Joint savings represent program induced savings derived from the increased uptake of SDG&E rebate programs. This estimate is normally produced for two areas:
  - *Downstream* joint savings occur due to increased participation by the HER/MAS treatment group versus the control group in SDG&E's tracked energy efficiency programs.
  - *Upstream* joint savings occur due to increased purchases of SDG&E-supported upstream lighting program CFL and LED bulbs by the HER/MAS treatment group versus the control group.
- *Final adjusted energy and demand savings.* These savings represent the final program savings after deducting both the downstream and upstream joint savings. This adjustment eliminates the potential to double count savings already accounted for in the rebated programs.

DNV GL also participated in the establishment of the RCT design for the SDG&E HER and MAS Program. For Opower-1, 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. For Opower-2 and MAS-2, DNV GL provided oversight in the sampling design for randomly allocating households in the treatment and control groups.

## 3 METHODOLOGY

### 3.1 Energy savings

For this evaluation, we used a fixed-effects regression model that is the standard for evaluating behavioral programs like HER and MAS. The fixed effects model specification calculates program savings by comparing consumption of the treatment group to the control group before and after program implementation. The change that occurs in the treatment group is adjusted to reflect any change that occurred in the control group, in order to isolate changes attributable to the program.

The fixed-effects equation is:

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

Where:

$E_{it}$	=	Average daily energy consumption for account $i$ during month $t$
$P_{it}$	=	Binary variable: one for households in the treatment group in the post period month $t$ , zero otherwise
$\lambda_t$	=	Monthly effects
$\mu_i$	=	Account level fixed effects
$\varepsilon_{it}$	=	Regression residual

This model produces estimates of average monthly savings using the following equation:

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

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-program dummy variables pick up the average monthly effects of the treatment.

As opposed to previous SDG&E HER evaluations, the billing months are based on the mid-point date of the billing cycles. In prior evaluations, the billing months were based on the end dates of the billing cycles. DNV GL changed the billing month definition for consistency with other HER evaluations. The billing cycles in the consumption data do not always conform to a calendar month and savings represented in each billing month may also include some savings from the previous month.

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.<sup>2</sup>

### 3.2 Demand savings

Reductions in demand at peak times that resulted from HER program participation can be measured through a variety of approaches. The preferred approach in California is to examine peak demand differences in pre- and post-program periods that occur during a given peak period. We used the peak period definition provided by the Database for Energy Efficiency Resources (DEER)<sup>3</sup>. This definition takes into account the average temperature, average afternoon temperature (12 p.m. – 6p.m.), and maximum temperature over the course of three-day heatwave candidates. Each candidate heatwave is a combination of three consecutive non-holiday weekdays occurring between June 1<sup>st</sup> and September 30<sup>th</sup>.

Using this definition, the optimal heatwave (HW) for each climate zone is ultimately selected by choosing the single candidate three-day-period with the highest peak score ( $Score_k$ ) among all possible candidates.

The mathematical expression can be given by:

$$HW = \max_{1 \leq k \leq K} (Score_k)$$

$$Score_k = \max_{1 \leq d \leq 3} (temp_{d,k}) + \frac{1}{d} \sum_{d=1}^3 (daily\_mean_{d,k}) + \frac{1}{d} \sum_{d=1}^3 (afternoon\_avg_{d,k})$$

Where

- $HW$  = Zone-specific set of three consecutive non-holiday weekdays that's has the highest value of  $Score_k$  for heat wave candidate  $k$  across all possible candidates  $K$
- $Score_k$  = The summation of maximum temp, average daily, and afternoon average temperature
- $daily\_max_{d,k}$  = The maximum hourly temperature value across all hours on day  $d$ , for heat wave candidate  $k$ .
- $daily\_mean_{d,k}$  = The average hourly temperature across all hours on day  $d$ , for heat wave candidate  $k$ .
- $afternoon\_avg_{d,k}$  = The average hourly temperature between 12 and 6 PM on day  $d$ , for heat wave candidate  $k$ .

<sup>2</sup> 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>.

<sup>3</sup> [http://www.cpuc.ca.gov/NR/rdonlyres/4F93F9C2-434E-4B06-8D80-B2CB7E0A4198/0/DEER2013UpdateDocumentation\\_792013.pdf](http://www.cpuc.ca.gov/NR/rdonlyres/4F93F9C2-434E-4B06-8D80-B2CB7E0A4198/0/DEER2013UpdateDocumentation_792013.pdf)

DNV GL tested for statistical differences in demand between HER treatment and control groups using 60-minute AMI data, and consumption during the hours of 2 p.m.–5 p.m. of the most common heat wave (e.g., September 8-10, 2015). The peak demand reduction is calculated using the difference-in-differences approach. A difference-in-difference method is used when there may be pre-existing differences between the control and treatment group. This method controls for the differences in demand between the pre and post period.

The general equation for the difference-in-difference approach is given below:

$$\overline{kW} \text{ savings} = (\overline{post_{kW_C}} - \overline{post_{kW_T}}) - (\overline{pre_{kW_C}} - \overline{pre_{kW_T}})$$

Where:

$\overline{kW} \text{ savings}$  = Average demand reductions during the peak period

$\overline{post_{kW_C}}$  = Average hourly load of the control group during the peak period in the post period being evaluated for 2015

$\overline{post_{kW_T}}$  = Average hourly load of the treatment group during the peak period in the post period being evaluated for 2015

$\overline{pre_{kW_C}}$  = Average hourly load of the control group during the peak period in the pre period being evaluated


$\overline{pre_{kW_T}}$  = Average hourly load of the treatment group during the peak period in the pre period being evaluated

DNV GL also assessed demand savings using other definitions of the peak period. DNV GL calculated peak demand reduction using CA ISO peak, the program administrator (PA) distribution peak and the PA residential class peak. The results from DNV GL's additional analysis are presented within the Appendix.

### 3.3 Downstream rebate joint savings

One possible effect of the HER and MAS programs is to increase rebate activity in other SDG&E energy efficiency programs. The RCT experimental design facilitates the measurement of this effect. We compared the average savings from rebate measures installed by the treatment group with the savings from measures installed by the control group. An increase in treatment group rebate program savings represents savings caused by the specific program jointly with the rebate programs. While these joint savings are an added benefit of the HER/MAS behavioral program, it is essential that these joint savings are only reported once. The most common and simple approach is to remove all joint savings from the program savings rather than remove program-specific joint savings from all of the associated rebate programs. This has been the approach used historically to adjust the savings from the HER programs.

The savings estimates from the fixed effects regressions include all differences between the treatment and control group in the post-report period. Joint savings are picked up by the regressions and included in the overall savings estimate. These joint savings are also included in SDG&E rebate program tracking databases



and are claimed as part of those programs' savings unless further actions were taken to remove them. Savings from the HER programs are adjusted using joint savings to avoid double counting of savings.

DNV GL used the following approach for rolling up individual rebated savings and calculating joint savings overall:

- Use accepted deemed savings values (those being used to claim the savings for the rebate program)
- Determine accumulating savings beginning 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)
- 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 determined the daily share of annual savings using hourly 2011 California Database for Energy Efficiency Resources (DEER) load shapes<sup>4</sup> for SDG&E. <sup>5</sup> These load shapes indicate when a measure is used during the year and, by proxy, when efficiency savings would occur.<sup>6</sup>

Savings for each installed measure start to accrue at the time of installation (or removal for refrigerator recycling). We calculated 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. DNV GL's recommended method for estimating joint savings analysis is consistent with the approach recommended in the SEE Action report

DNV GL used a similar approach to calculate potentially double counted savings in HER demand savings estimates. DNV GL used deemed kW savings from measures installed during the treatment period but before the start of the peak period. The average deemed kW savings per household of the control group were subtracted from the average deemed kW savings per household of the treatment group to calculate joint savings between HER program and SDG&E downstream rebate programs during the peak period.

### 3.4 Upstream joint savings

Upstream joint savings are similar to downstream joint savings, except that upstream savings are not tracked at the customer level. SDG&E upstream savings still represent a source of savings that HER program could potentially double count. Unlike tracked programs, it is 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.

In the past HER evaluations, the joint savings analysis for upstream programs used the efficient bulb uplift from the 2012 PG&E In-home Inventory. For this evaluation, DNV GL conducted an online survey to update the efficient bulb uplift due to HER and MAS programs and incorporated TRC's estimates for 2015 rebated sales fraction for CFL and LEDs. The online survey included both treatment and control group households and collected information on their purchase and installation of CFLs and LEDs for the past year.

---

<sup>4</sup> DEER load shapes are in an 8760 hourly format. DNV GL aggregated the hourly shares to daily shares in order to estimate daily savings.

<sup>5</sup> <http://deeresources.com/DEER2011/download/DEER2011-UpdatedImpactProfiles-v2.zip>

<sup>6</sup> 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.

The primary objective of the online survey was to provide a more accurate efficient bulb uplift to estimate joint savings for 2015. The survey was conducted from late December 2016 through January 2017 and gathered information on the purchase and installation of CFLs and LEDs for the HER and MAS program treatment and control groups in the last 12 months. DNV GL calculated the efficient bulb uplift based on the online survey and applied a double-counting adjustment for upstream savings to the final 2015 savings. Table 3 presents the key inputs used in 2015 SDG&E HER joint savings for upstream lighting programs.

**Table 3. Input assumptions used in SDG&E calculation for 2015 upstream joint savings**

Assumptions	CFL	LED	Source
<b>Excess lamps due to HER</b>			
Year 1	0.95		2013 PG&E in-home survey
Year 2	0.4		Interpolated from PG&E ad PSE values (DNV GL)
Year 3	0.15		2013 PSE HER phone survey (DNV GL)
Year 4	0.08		2013 PSE HER phone survey (DNV GL)
2015 Opower 1	0.32	0.20	2015 IOU Residential Behavioral Programs: Online Survey Results (DNV GL, 2017)
2015 Opower 2	-0.07	-0.65	
2015 MAS MyAccount	0.06	0.64	
2015 MAS NonMyAccount	-0.04	0.03	
<b>Rebated sales fraction</b>			
2011	57%	Not available	2014 TRC HER lighting overlap study <sup>7</sup>
2012	68%	Not available	2014 TRC HER lighting overlap study
2013	40%	Not available	2014 TRC HER lighting overlap study
2014	18%	32%	2014 TRC HER lighting overlap study
2015	20%	31%	2015 TRC HER lighting overlap study <sup>8</sup>
<b>Annual savings per bulb</b>			
2011	23.3	Not available	2010-12 ULP Evaluation (DNV GL, 2014)
2012	22.6	Not available	2010-12 ULP Evaluation (DNV GL, 2014)
2013	17.9	21.8	2014 TRC HER lighting overlap study
2014	17.9	21.8	2014 TRC HER lighting overlap study
<b>Fraction of CFL/LED lamps in 2014</b>	0.6	0.4	2014 TRC HER lighting overlap study
<b>2010-2012 Net-to-gross</b>	0.61	NA	2010-12 ULP Evaluation (DNV GL, 2014)
<b>2013-2014 Net to gross</b>	0.30	0.32	2013-14 ULP Evaluation (DNV GL, 2016)
<b>Installation rate</b>	97%	99%	2013-14 ULP Evaluation (DNV GL, 2016)
<b>Assumed gas savings</b>	-0.014		Program tracking data (DEER 2013-14)

<sup>7</sup> TRC memo on Proposed Changes to ULP HER Lighting Savings Overlap for 2014.

<sup>8</sup> TRC memo on Rebated Sales Fraction for 2015 HER Lighting Savings Overlap (Draft)

The estimates for the excess lamps due to HER/MAS are mostly based on participants' recall of their 2016 bulb purchases due to the timing of the online survey. DNV GL used these estimates as a proxy for the 2015 bulb uplift since the 2016 estimates from the online survey better represent the HER and MAS efficient bulb uplift versus a study from 2012 and based on another jurisdiction.

The joint savings calculation also used SDG&E rebated sales fraction in 2015 based on a recent TRC lighting study and savings per bulb estimates for 2014. We used the annual savings per bulb estimate for 2014 as a proxy for 2015 since the final 2015 values have not yet been fully vetted at the time of this evaluation.

With regards to the timing of purchase of an efficient bulb, the approach assumed that the excess efficient lamps purchased due to HER were purchased evenly throughout the year. The general equations used in calculating electric joint savings from ULP are presented below:

$$\text{CFL(or LED)kWh joint savings per household} = \text{Excess CFLs(or LED)due to HER} \times \\ \text{Number of years CFLs(or LED)have been installed} \times \text{CFL(or LED)rebated sales fraction} \times \text{NTG} \times \\ \text{Installation rate} \times \text{Annual savings per CFL(or LED)}$$

$$\text{Total kWh joint savings from ULP} = \text{Number of households in the treatment group} \times (\text{CFL kWh joint savings per household} + \text{LED kWh joint savings per households})$$

For calculating upstream joint savings at the peak period, DNV GL followed the same method in calculating electric joint savings from upstream programs but instead of using the assumed CFL and LED kWh savings per bulb, DNV GL used peak watts impact to measure watt reductions per installed bulb at the time of peak. DNV GL also used the number of treatment households that are active as of September 2015 to calculate aggregate kW joint savings.

Table 4 provides DNV GL's calculation of peak watts impact for CFLs and LEDs. DNV GL calculated a peak watts impact of 1.9 watts for CFL and 2.0 watts for LEDs. These values were used to measure watts reductions at the peak from CFL and LED installation.

**Table 4. CFL and LED peak diversity factor**

Factor	CFL	LED	Source
<b>Installation Rate</b>	97%	99%	2013-2014 ULP Evaluation (DNV GL, 2016)
<b>Delta Watts</b>	48.40	34.50	2013-2014 ULP Evaluation (DNV GL, 2016)
<b>Peak CF</b>	0.04	0.06	2013-2014 ULP Evaluation (DNV GL, 2016)
<b>Peak Watts Impact</b>	1.88	2.05	Calculated as installation rate X delta watts X Peak CF

Delta watts are a measure of instantaneous demand reductions in watts that results from replacing an inefficient incandescent bulb with a CFL, LED or other bulb type. DNV GL's lighting study reports that the peak coincidence factor (CF) for CFLs is approximately 0.04 indicating that only about 4% of these bulbs are actually turned on at time of peak. These two factors combined with an estimated installation rate of 97% provide a measure of watt reductions per installed bulb at time of peak.

To calculate for peak demand joint savings, the equations below are used:

$$\text{CFL(or LED)kW joint savings per household} = \text{Excess CFLs(or LED)due to HER} \times \\ \text{Number of years CFLs(or LED)have been installed} \times \text{CFL(or LED)rebated sales fraction} \times \text{NTG} \times \\ \text{Peak watts impact CFL(or LED)/1000}$$

$$\text{Total kW joint savings from ULP} = \text{Number of households in the treatment group during peak} \times \\ (\text{CFL kW joint savings per household} + \text{LED kW joint savings per households})$$

California recognizes the potential for interactive effects across fuels when assigning savings. Interactive effects are explicitly accounted for in the downstream rebate program tracking database. For the untracked ULP, a similar estimate of interactive effects for gas is calculated using the ratio of kWh and therms savings per watt from DEER. The assumed gas savings per kWh savings from upstream lighting program are -0.014 therms per kWh based on TRC memo. The equation below is used to calculate the heating and cooling interactive effects associated with energy saving lighting measures:

$$\text{Therms savings due to interactive effects} = \text{Total kWh joint savings from ULP} \times (-0.014 \text{ therms per kWh})$$

The approach directly estimates gas effect from the estimated upstream electric joint savings. The interactive effect produce negative gas joint savings and therefore increases the overall adjusted gas savings. This adjustment is important because the replacement of inefficient lighting measures with more efficient lamps can increase heating load consumption due to lower heat emissions from CFLs and LEDs.

### 3.5 Data management

The impact evaluation relies on consumption data from the SDG&E monthly billing data system. Consumption data are closely tied to the billing function and are generally considered accurate. However, missed reads, estimated reads, and corrections do occur, and may undermine 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. In an RCT analysis, we would expect anomalies to appear in the same proportion in the treatment and control groups, and thus there is no need to remove such records. In this study, DNV GL examined potential issues in the consumption data (Table 5).

**Table 5. Summary of billing data issues**

Data disposition	Electric		Gas	
	Control	Treatment	Control	Treatment
<b>Opower-1</b>				
<b>Bad Read Dates</b>	0.00%	0.00%	0.00%	0.00%
<b>Zero Reads</b>	1.30%	1.34%	6.99%	7.47%
<b>Negative Reads</b>	0.00%	0.00%	0.00%	0.00%
<b>Missing Reads</b>	0.00%	0.00%	0.00%	0.00%
<b>Extreme Reads</b>	0.07%	0.06%	0.00%	0.00%
<b>No Issues</b>	98.63%	98.62%	93.01%	92.53%
<b>Opower-2</b>				
<b>Bad Read Dates</b>	0.00%	0.00%	0.00%	0.00%
<b>Zero Reads</b>	0.53%	0.65%	5.17%	5.34%
<b>Negative Reads</b>	0.00%	0.00%	0.00%	0.00%
<b>Missing Reads</b>	0.00%	0.00%	0.00%	0.00%
<b>Extreme Reads</b>	0.00%	0.00%	0.00%	0.00%
<b>No Issues</b>	99.47%	99.35%	94.83%	94.66%
<b>MAS-2</b>				
<b>Bad Read Dates</b>	0.00%	0.00%	0.00%	0.00%
<b>Zero Reads</b>	0.58%	0.61%	4.82%	5.07%
<b>Negative Reads</b>	0.00%	0.00%	0.00%	0.00%
<b>Missing Reads</b>	0.00%	0.00%	0.00%	0.00%
<b>Extreme Reads</b>	0.01%	0.01%	0.00%	0.00%
<b>No Issues</b>	99.42%	99.38%	95.18%	94.93%

DNV GL’s analysis found that potential data issues are small and proportionally balanced between the treatment and control groups. These findings indicate that data issues are infrequent and that the treatment/control difference inherent in the RCT structure controlled for the majority of the issues that existed.

For this evaluation, the two primary groups removed from the analysis were customers that moved out before 2015 and customers that switched to net metering. Customers who installed solar panels and switched to net metering posed a dilemma for this evaluation because of the way that net metering was addressed in the billing data. This created challenges for either including them in the analysis or fully understanding the extent of the issue. For example, if the solar households were included in the analysis it would be necessary to incorporate household-level energy production data.<sup>9</sup> Otherwise, potential differences in solar energy production could be conflated with program-related savings, biasing the results up or down.

<sup>9</sup> 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

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.

**Table 6. Data Disposition**

Sample	Opower-1		Opower-2		MAS-2	
	Treatment	Control	Treatment	Control	Treatment	Control
<b>Original sample</b>	20,196	20,195	95,002	26,302	200,007	72,503
<b>Move-out/Net metered</b>	6,438	6,459	10,504	2,994	15,308	4,707
<b>Active customers</b>	13,758	13,736	84,498	23,308	184,699	67,796

Table 7. show the number of households with respect to natural attrition due to change in occupancy for HER and MAS programs. The tables provide the number of active households after accounting for the move-outs per month. Customer attrition for Opower-1 ranged from 7% to 13% per year for program years 2013-2015. MAS-2 and Opower-2 started in late 2014 so we have no baseline for these programs. The number of active households in the treatment group was used to calculate total program savings.

**Table 7. Active electric accounts for Opower-1 and Opower-2**

Billing month	Opower-1		Opower-2	
	Treatment Group	Control Group	Treatment Group	Control Group
<b>Dec-14</b>			84,498	23,308
<b>Jan-15</b>	13,758	13,736	83,131	22,925
<b>Feb-15</b>	13,624	13,621	81,823	22,558
<b>Mar-15</b>	13,508	13,519	80,537	22,228
<b>Apr-15</b>	13,392	13,388	79,098	21,763
<b>May-15</b>	13,247	13,253	77,652	21,386
<b>Jun-15</b>	13,087	13,101	76,129	20,964
<b>Jul-15</b>	12,921	12,932	74,486	20,510
<b>Aug-15</b>	12,784	12,774	72,958	20,094
<b>Sep-15</b>	12,627	12,610	71,538	19,726
<b>Oct-15</b>	12,504	12,484	70,405	19,414
<b>Nov-15</b>	12,358	12,337	69,332	19,094
<b>Dec-15</b>	12,193	12,171	68,398	18,831

Note: The monthly counts provided exclude sites with net metering

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. 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 introduce bias.



**Table 8. Active electric accounts for MAS -2 – MyAccount and Non-MyAccount**

Billing month	My Account Paper		Non-MyAccount	
	Treatment Group	Control Group	Treatment Group	Control Group
Nov-14	103,989	24,921	80,710	42,875
Dec-14	102,212	24,516	79,968	42,460
Jan-15	100,527	24,094	79,217	42,072
Feb-15	98,911	23,722	78,537	41,748
Mar-15	97,311	23,361	77,829	41,366
Apr-15	95,573	22,942	77,050	40,951
May-15	93,825	22,535	76,226	40,527
Jun-15	91,985	22,084	75,386	40,104
Jul-15	89,998	21,632	74,533	39,660
Aug-15	88,120	21,183	73,772	39,228
Sep-15	86,409	20,756	73,027	38,797
Oct-15	85,136	20,431	72,322	38,432
Nov-15	83,817	20,121	71,627	38,057
Dec-15	82,671	19,858	71,029	37,738

Note: The monthly counts provided exclude sites with net metering

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

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 opted-out of the program 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.

Appendix A presents the randomization tests for HER and MAS programs. The results from the statistical tests suggest that there is pre-existing difference between consumption of the treatment and control groups for Opower-1 and Opower-2. However, the magnitude of the difference in consumption is minimal and the savings estimation approach used in this evaluation corrects for mean differences across the whole pre-report period.

## 4 RESULTS

This chapter presents the final reported savings estimates for the 2015 SDG&E HER and MAS programs. Section 4.1 and Section 4.2 present the impact evaluation results for the HER and MAS programs in 2015, respectively.

### 4.1 Home Energy Reports

#### 4.1.1 Overall program savings estimates

Table 9 provides monthly electric and gas savings along with the count of treatment group households for each month for Opower-1 and Opower-2. In combination, these numbers generate the total monthly estimated electric and gas savings for the HER Program. The total rows at the bottom of the tables provide the total annual savings along with confidence intervals at 90%.

**Table 9. Average monthly and total kWh and therm savings for Opower-1**

Billing Months	Count of Treatment Group Participants	Unadjusted Savings per Household (kWh)	Unadjusted Savings per Household (therms)	Program Unadjusted Savings (kWh)	Program Unadjusted Savings (therms)
Jan-15	13,758	15.20	1.18	209,185	16,265
Feb-15	13,624	16.14	1.06	219,931	14,469
Mar-15	13,508	18.59	0.32	251,056	4,314
Apr-15	13,392	13.09	0.33	175,339	4,452
May-15	13,247	13.20	0.31	174,873	4,089
Jun-15	13,087	19.98	0.26	261,474	3,442
Jul-15	12,921	24.75	0.10	319,834	1,231
Aug-15	12,784	30.10	0.18	384,806	2,262
Sep-15	12,627	30.05	0.13	379,451	1,611
Oct-15	12,504	25.73	0.41	321,781	5,102
Nov-15	12,358	14.38	1.12	177,648	13,851
Dec-15	12,193	11.07	2.68	134,979	32,650
<b>Total Program Savings</b>		232.29	8.07	3,010,359	103,739
<b>Lower Bound at 90% CI</b>		177.34	3.52	2,305,411	45,700
<b>Upper Bound at 90% CI</b>		285.79	12.44	3,715,306	161,778

**Table 10. Average monthly and total kWh and therm savings for Opower-2**

Billing Months	Count of Treatment Group Participants	Unadjusted Savings per Household (kWh)	Unadjusted Savings per Household (therms)	Program Unadjusted Savings (kWh)	Program Unadjusted Savings (therms)
Dec-14	84,498	-0.25	0.15	-21,536	12,913
Jan-15	83,131	1.60	0.30	132,632	24,557
Feb-15	81,823	0.16	0.09	13,274	7,310
Mar-15	80,537	1.33	0.08	106,969	6,662
Apr-15	79,098	1.25	-0.05	99,162	-4,014
May-15	77,652	1.52	-0.05	118,167	-3,619
Jun-15	76,129	2.83	-0.09	215,546	-6,727
Jul-15	74,486	5.16	-0.11	384,089	-8,262
Aug-15	72,958	7.45	-0.11	543,640	-7,667
Sep-15	71,538	7.32	-0.17	523,800	-11,994
Oct-15	70,405	6.33	-0.18	445,482	-13,019
Nov-15	69,332	2.50	0.08	173,636	5,286
Dec-15	68,398	3.33	0.40	227,446	27,243
<b>Total Program Savings</b>		40.52	0.34	2,962,306	28,669
<b>Lower Bound at 90% CI</b>		23.94	-0.67	1,823,129	-51,268
<b>Upper Bound at 90% CI</b>		53.86	1.43	4,101,482	108,606

Opower-1 generated 232 kWh and 8 therms per household savings in 2015. Compared to the per household savings estimates in 2014, electric savings decreased by 10% while gas savings remained similar. Opower-2 started in late November 2014 and produced 41 kWh savings per household from inception through December 2015 while overall gas savings are very small and not statistically significant at the 90% confidence level.

DNV GL assessed kWh and therms savings by the type of report (paper versus email reports) received and by income group for Opower-2. Appendix C summarizes the result from this additional analysis.

#### 4.1.2 Demand savings estimates

DNV GL determined the heat waves using the weather data provided by SDG&E across its service territory from January 1, 2010 to December 31, 2015. DNV GL identified the peak heatwaves using the DEER peak definition as discussed in the methodology section. Heatwaves are assessed for each of the climate zones and the heatwave from the climate zone that had the highest number of control and treatment households was selected.




Table 11 provides the final set of peak heat waves identified for the HER program. Based on the results, the most common three-day heat wave among Opower participants is September 8-10, 2015.

**Table 11. Peak heatwaves identified for the pre- and post-periods.**

Program/Wave	Period	DEER Heatwave
Opower-1	Pre	9/27/2010 - 9/29/2010
	Post	9/8/2015 - 9/10/2015
Opower-2	Pre	9/15/2014 - 9/17/2014
	Post	9/8/2015 - 9/10/2015

DNV GL used a difference in differences approach to calculate demand reductions for Opower-1 and Opower-2 during the identified peak. Table 12 provides a comparison of the pre-period and post-period kW per household and Table 13 provides the overall kW savings for Opower-1 and Opower-2. Based on the results, Opower-1 and Opower-2 showed evidence of peak load reduction amounting to 0.04 kW per household and 0.01 kW per household, respectively.

**Table 12. Overall pre period and post period kW comparison**

Program/Wave	Group	Average kW per household	
		Pre Period	Post Period
Opower-1	Treatment	2.17	2.45
	Control	2.23	2.56
Opower-2	Treatment	1.28	1.20
	Control	1.29	1.22

**Table 13. Overall HER kW savings**

HER program	kW Savings per Household	+/- at 90% CI
Opower-1	0.04	0.03
Opower-2	0.01	0.01

### 4.1.3 Joint savings: downstream programs

Downstream joint savings are identified by comparing savings of the treatment and control groups from downstream program installations. These savings from measure installations build up over time in the post-treatment period. If the HER program also motivates increased participation in other SDG&E programs, then the treatment group downstream savings will accrue faster than the control group. The difference in savings between the treatment and control groups represents the savings jointly attributable to both the HER program and other downstream programs.

Figure 5 through Figure 8 provide the monthly estimates of average joint electric and gas savings per customer in kWh and therms, respectively. These figures simply provide a graphical illustration of the difference in savings between the treatment and control groups along with the corresponding confidence intervals. Overall, we found very little evidence of increased uptake of downstream rebate program in the treatment group in 2015.

**Figure 5. Average monthly kWh joint savings per household for Opower-1**

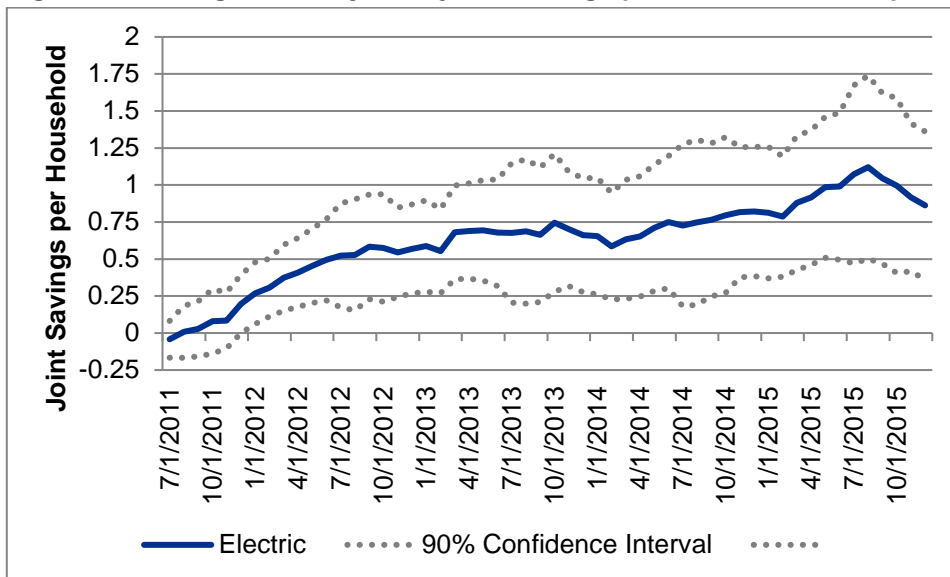


Figure 6. Average monthly kWh joint savings per household for Opower-2

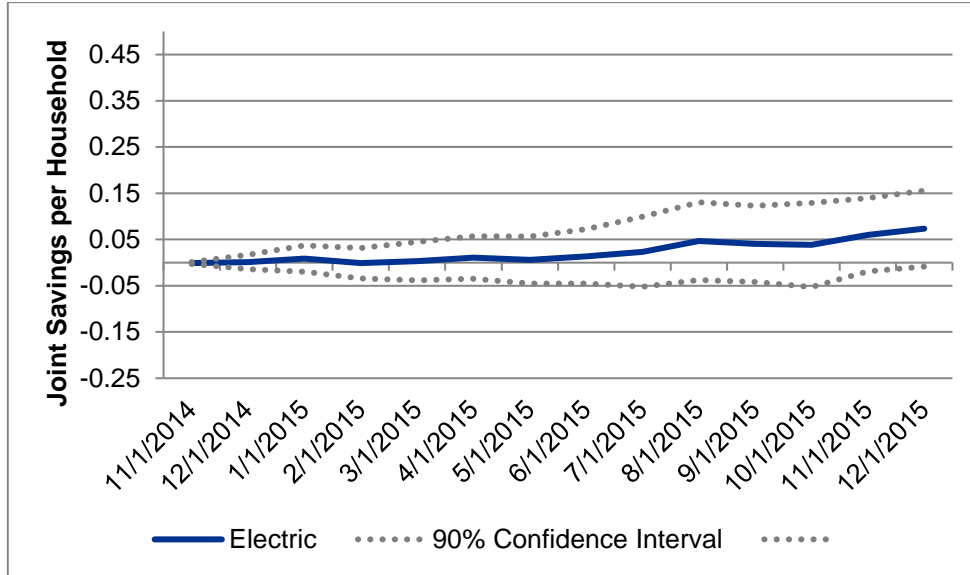
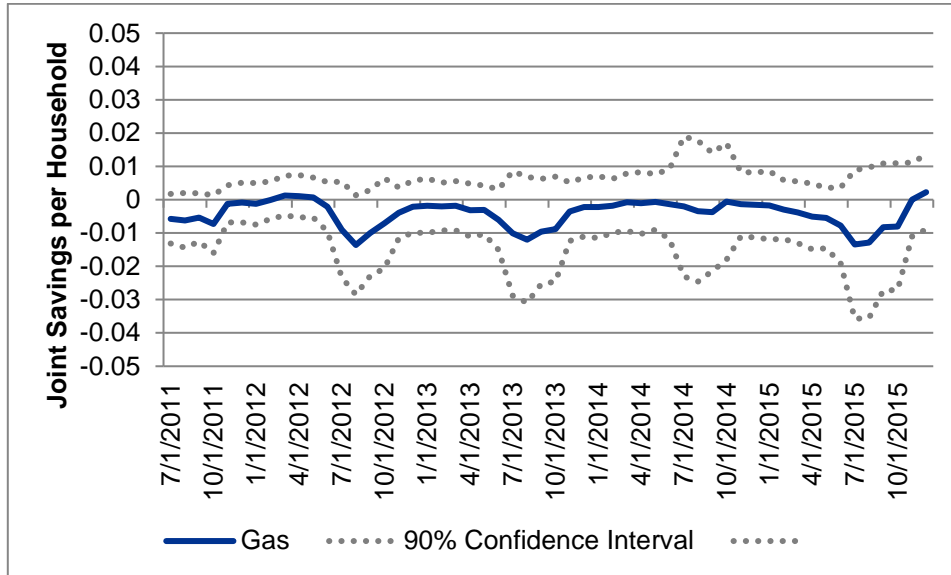
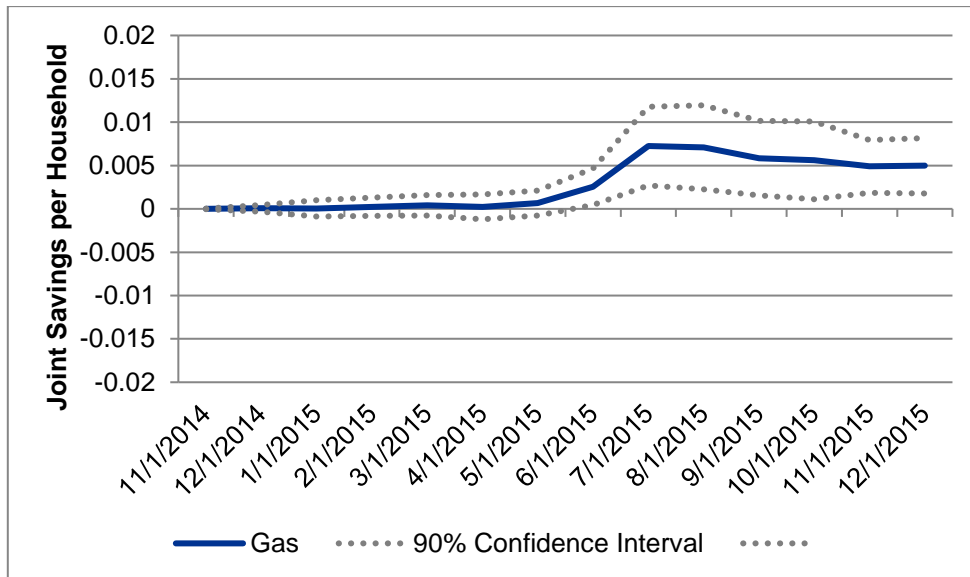


Figure 7. Average monthly therms joint savings per household for Opower-1



**Figure 8. Average monthly therms joint savings per household for Opower-2**



The addition of the confidence intervals illustrates that the joint savings for Opower-1 from rebate programs is statistically significant for electric measures but negative for gas measures. Opower-2 findings show that the joint savings for electric are not significantly different from zero, but the HER program caused an increased uptake of gas measures from other rebate programs.

Table 14 and Table 15 provide the joint savings for electric and gas along with the monthly count of treatment group customers in kWh and therms. The monthly joint savings are the combination of the average per customer savings and the customer counts.<sup>10</sup> The overall savings estimates are provided along with confidence intervals. Despite being non-statistically significant, we removed positive joint savings since they provide some evidence of possible double counting.

<sup>10</sup> 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 14. Joint kWh and therms savings for Opower-1**

Billing Months	Count of Treatment Group Participants	Joint Savings per Household - Tracked		Program Tracked Joint Savings (kWh)	Program Tracked Joint Savings (therms)
		/Downstream Programs (kWh)	/Downstream Programs (therms)		
Jan-15	13,758	0.81	0.00	11,185	-23
Feb-15	13,624	0.79	0.00	10,722	-40
Mar-15	13,508	0.88	0.00	11,868	-51
Apr-15	13,392	0.92	-0.01	12,269	-68
May-15	13,247	0.98	-0.01	13,044	-73
Jun-15	13,087	0.99	-0.01	12,961	-101
Jul-15	12,921	1.07	-0.01	13,849	-174
Aug-15	12,784	1.12	-0.01	14,324	-164
Sep-15	12,627	1.04	-0.01	13,195	-104
Oct-15	12,504	1.00	-0.01	12,462	-101
Nov-15	12,358	0.92	0.00	11,310	1
Dec-15	12,193	0.86	0.00	10,510	27
<b>2015 Program Savings</b>		11.38	-0.07	147,699	-872
<b>Lower Bound at 90% CI</b>		5.45	-0.22	70,857	-2,890
<b>Upper Bound at 90% CI</b>		17.31	0.09	225,050	1,146

**Table 15. Joint kWh and therms savings for Opower-2**

Billing Months	Count of Treatment Group Participants	Joint Savings per Household - Tracked		Program Tracked Joint Savings (kWh)	Program Tracked Joint Savings (therms)
		/Downstream Programs (kWh)	/Downstream Programs (therms)		
Dec-14	84,498	0.00	0.00	121	6
Jan-15	83,131	0.01	0.00	740	4
Feb-15	81,823	0.00	0.00	-76	19
Mar-15	80,537	0.00	0.00	245	33
Apr-15	79,098	0.01	0.00	884	18
May-15	77,652	0.01	0.00	451	51
Jun-15	76,129	0.01	0.00	1,043	194
Jul-15	74,486	0.02	0.01	1,758	540
Aug-15	72,958	0.05	0.01	3,402	518
Sep-15	71,538	0.04	0.01	2,916	418
Oct-15	70,405	0.04	0.01	2,703	395
Nov-15	69,332	0.06	0.00	4,172	340
Dec-15	68,398	0.07	0.00	5,030	340
<b>Total Program Savings</b>		0.33	0.04	23,389	2,876
<b>Lower Bound at 90% CI</b>		-0.35	0.01	-26,749	847
<b>Upper Bound at 90% CI</b>		1.00	0.07	76,313	5,226

Table 16 provides the per household and total joint kW savings for Opower-1 and Opower-2. The joint savings at the peak are positive but not statistically significant. Despite being non-statistically significant, we removed positive joint savings since they provide some evidence of possible double counting during the identified peak period.

**Table 16. Joint kW savings for HER**

Program/Wave	No. of treatment	Per household Joint Savings	Total Joint Savings
Opower-1	12,627	0.001	6
Opower-2	71,538	0.000	14

#### 4.1.4 Joint savings: upstream programs

In 2016, DNV GL conducted an online survey to update assumptions used for the excess bulbs installed due to the HER program. As discussed earlier, the objective of the online survey was to provide an estimate of the extra 2015 CFL and LED bulbs purchased and installed due to the HER program. The survey produced estimates of 2015 bulb uplift that are specific to each PA, program and experimental waves. For Opower-1, survey results showed a small uplift of 0.32 for CFL and 0.16 for LEDs while the results are negative for

Opower-2. The negative bulb uplift indicates that the control group purchased and installed more efficient bulbs than the treatment group. The CFL and LED bulb uplift estimates are not statistically significant.

Table 17 and Table 18 shows the kWh joint savings estimates using the 2015 bulb uplift estimate for Opower-1 and Opower-2. The total upstream joint savings per household for Opower-1 are 10.7 kWh per household for CFLs and 0.3 kWh per year for LEDs. On the other hand, the upstream joint savings per household for Opower-2 are negative due to the negative excess bulb. This means that the control group purchased and installed more bulbs than the treatment group. No adjustments due to upstream joint savings will be applied to Opower-2 program savings.

**Table 17. Upstream kWh joint savings inputs for CFL and LED for Opower-1**

Inputs	CFL					LED	
	2011	2012	2013	2014	2015	2014	2015
No. of excess bulb per year	0.95	0.40	0.15	0.05	0.32	0.03	0.16
No. of excess bulbs/month	0.08	0.03	0.01	0.00	0.03	0.00	0.02
No. of bulbs installed due to HER	0.48	0.68	0.28	0.07	0.32	0.04	0.20
Year bulbs have been installed in 2015	1.00	1.00	1.00	1.00	0.54	1.00	0.54
Deemed kWh savings per bulb	23.30	22.60	17.90	17.90	17.90	21.80	21.80
CFL rebated sales fraction	0.57	0.68	0.40	0.18	0.20	0.32	0.31
Net-to-gross	0.61	0.61	0.30	0.30	0.30	0.32	0.32
Installation rate	0.97	0.97	0.97	0.97	-	0.97	-
kWh joint savings	3.73	6.14	0.58	0.07	0.19	0.09	0.24
Total kWh joint savings per household	10.70					0.32	

**Table 18. Upstream kWh joint savings inputs for CFL and LED for Opower-2**

Inputs	2014	2015	2014	2015
No. of excess bulb per year	0.05	-0.07	0.03	-0.65
No. of excess bulbs/month	0.00	-0.01	0.00	-0.05
No. of bulbs installed due to HER	-0.01	-0.07	-0.05	-0.65
Year bulbs have been installed in 2015	17.90	17.90	21.80	21.80
Deemed kWh savings per bulb	1.00	17.90	21.80	21.80
CFL rebated sales fraction	0.18	0.20	0.32	0.31
Net-to-gross	0.30	0.30	0.32	0.32
Installation rate	0.97	-	0.97	-
kWh joint savings	-0.01	-0.04	-0.12	-0.76
Total kWh joint savings per household	-0.051		-0.88	

Joint savings values are calculated as the product of the number of bulbs installed due to HER, year lamps have been installed in 2015, deemed savings per bulb, CFL (or LED) rebated sales fraction, net-to-gross ratio and installation rate. For example, the portion of 2015 joint savings from CFLs installed in 2011 is calculated as 0.48 bulbs x 1 year x 23.3 kWh/bulb x 0.57 rebated CFLs x 0.61 CFL savings attributed to ULP x 0.97 installation rate or 3.7 kWh per household.

Compared to previous calculations, the input assumptions for the fraction of excess bulb type and installation rate were not used when calculating for the kWh upstream joint savings from 2015 bulbs. The 2015 excess bulbs estimates are already based on the number of CFL and LED bulbs purchased and installed.

Table 19 combines the monthly per bulb joint savings estimate with the monthly treatment group counts to generate an estimate of upstream joint savings for the duration of the program. Overall, the total program joint savings due to participation in upstream program are 143 MWh for Opower-1. As discussed earlier, no adjustments will be applied to Opower-2 HER savings because joint savings are negative

**Table 19. Monthly upstream kWh savings from lighting programs for Opower-1**

Month	CFL Joint Savings per Household	LED Joint Savings per Household	Count of Treatment Group Participants	Program Joint Savings (kWh)
Jan-15	0.88	0.01	13,758	12,235
Feb-15	0.88	0.01	13,624	12,189
Mar-15	0.88	0.02	13,508	12,159
Apr-15	0.89	0.02	13,392	12,127
May-15	0.89	0.02	13,247	12,067
Jun-15	0.89	0.03	13,087	11,992
Jul-15	0.89	0.03	12,921	11,910
Aug-15	0.90	0.03	12,784	11,853
Sep-15	0.90	0.03	12,627	11,776
Oct-15	0.90	0.04	12,504	11,729
Nov-15	0.90	0.04	12,358	11,659
Dec-15	0.91	0.04	12,193	11,569
<b>Total Program Savings</b>	10.70	0.32		143,265

**Table 20. Monthly upstream kWh savings from lighting programs for Opower-2**

Month	CFL Joint Savings per Household	LED Joint Savings per Household	Count of Treatment Group Participants	Program Joint Savings (kWh)
Dec-14	0.00	-0.01	84,498	-868
Jan-15	0.00	-0.02	83,131	-1,708
Feb-15	0.00	-0.03	81,823	-2,522
Mar-15	0.00	-0.04	80,537	-3,310
Apr-15	0.00	-0.05	79,098	-4,064
May-15	0.00	-0.06	77,652	-4,787
Jun-15	0.00	-0.07	76,129	-5,476
Jul-15	0.00	-0.08	74,486	-6,123
Aug-15	0.00	-0.09	72,958	-6,747
Sep-15	-0.01	-0.10	71,538	-7,351
Oct-15	-0.01	-0.11	70,405	-7,958
Nov-15	-0.01	-0.12	69,332	-8,549
Dec-15	-0.01	-0.13	68,398	-9,137
<b>Total Program Savings</b>	-0.051	-0.885		-66,023

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 the untracked, upstream program savings we need to establish a similar estimate of interactive effects for gas. In the context of ULP joint savings, interactive savings increase the HER program gas savings as measured in the billing analysis.

This method for calculating the interactive effects is discussed in the Methodology section. The approach directly estimates the gas effect from the estimated untracked, upstream electric joint savings that are removed as potential double counting from HER program unadjusted electric savings. The approach also assumes that SDG&E HER program treatment group members, all of which are dual-fuel households, have gas heat. Table 21 provides the stream of ULP interactive effects for Opower-1. The total program joint savings adjustment in gas savings is -256 therms. This adjustment will have a positive effect on Opower-1 gas savings. For Opower-2, DNV GL did not estimate the interactive effects for Opower-2 because there is no evidence of joint savings with the upstream programs.

**Table 21. Monthly upstream interactive effects for Opower-1**

Month	Joint Savings per Customer - Untracked/Upstream Programs (therms)	Count of Treatment Group Participants	Program Joint Savings (therms)
Jan-15	(0.00)	13,758	-19
Feb-15	(0.00)	13,624	-20
Mar-15	(0.00)	13,508	-20
Apr-15	(0.00)	13,392	-21
May-15	(0.00)	13,247	-21
Jun-15	(0.00)	13,087	-21
Jul-15	(0.00)	12,921	-22
Aug-15	(0.00)	12,784	-22
Sep-15	(0.00)	12,627	-22
Oct-15	(0.00)	12,504	-22
Nov-15	(0.00)	12,358	-23
Dec-15	(0.00)	12,193	-23
<b>2015 Savings</b>	-0.02		-256

The joint upstream kW savings are calculated in a similar fashion to calculating kWh joint savings from upstream programs but slightly differed in the value used for savings per bulb. DNV GL calculated peak watts impact for CFL and LED bulbs using results from DNV GL’s 2013-2014 Upstream Lighting study.

Consistent with kWh joint savings, DNV GL used the survey results to update the 2015 bulb uplift due to HER in calculating kW joint savings. Table 22 shows the aggregate and per household upstream kW joint savings estimates at the time of peak. The number of treatment households used is the number of treatment accounts that are active on September 2015.

**Table 22. Peak kW upstream joint savings at the time of peak**

Program/Wave	Active Accounts during Peak Period (September 8 - 10 2015)	Upstream Joint Savings per Household	Program Joint Savings (kW)
<b>Opower-1</b>	12,627	0.001	12
<b>Opower-2</b>	71,538	-0.000	-8

#### 4.1.5 Per household savings and total program savings

This section combines the results in the prior three sub-sections to provide the final savings estimates for the program. Program savings for Opower-1 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 23 presents

the unadjusted and adjusted savings as a fraction of control group, post-period consumption.<sup>11</sup> 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.

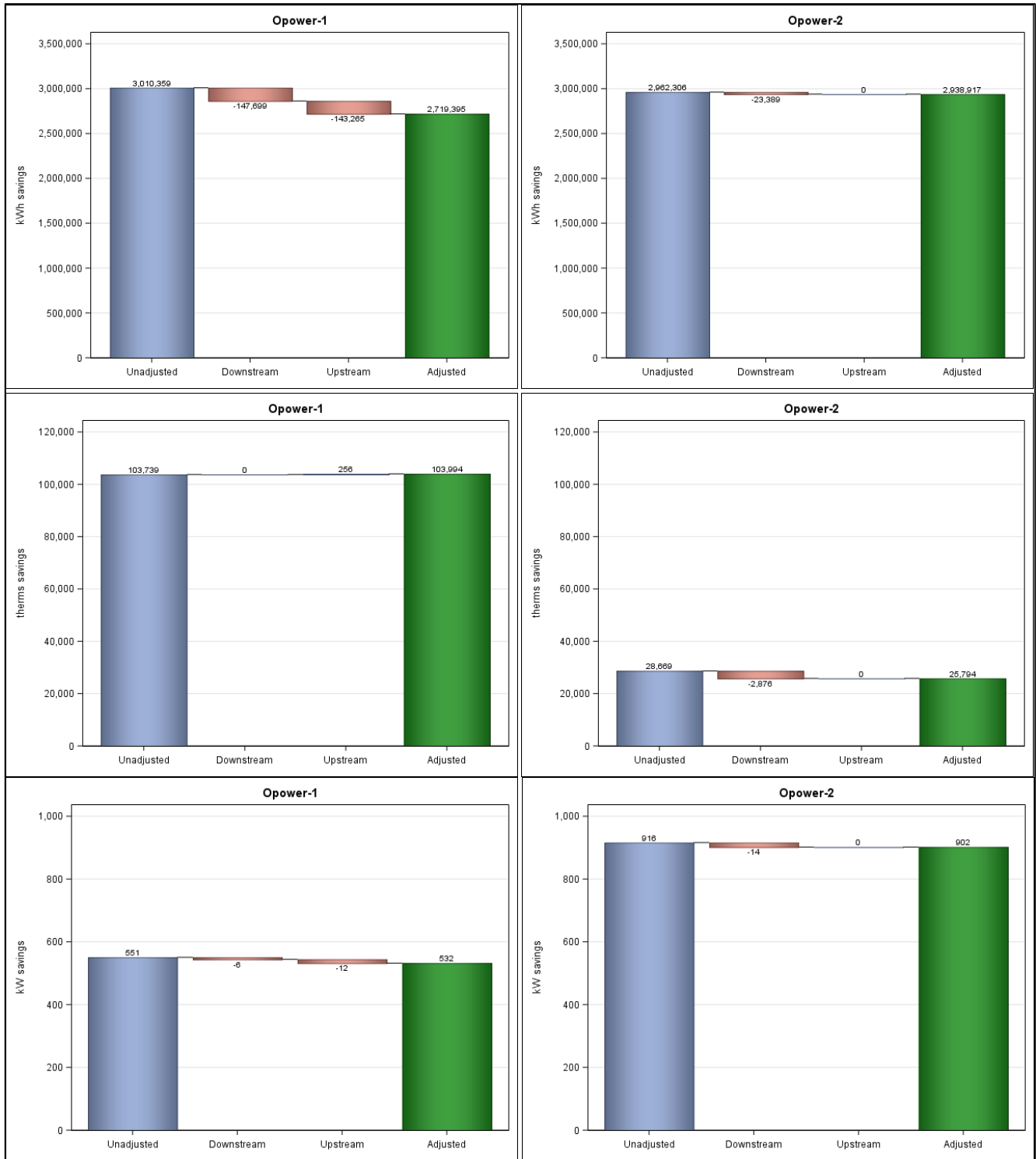
**Table 23. Savings per household as a percent of kWh and therms consumption**

Wave	Evaluation Period	Fuel	Unadjusted Savings	Adjusted Savings	Unadjusted Savings as Percentage of Consumption	Adjusted Savings as Percentage of Consumption
<b>Opower-1</b>	January 2015 - December 2015	kWh	232	210	2.4%	2.2%
		kW	0.04	0.04	1.7%	1.6%
		therms	8	8	1.8%	1.8%
<b>Opower-2</b>	December 2015 - December 2015	kWh	41	40	0.8%	0.7%
		kW	0.01	0.01	1.0%	1.0%
		therms	0	0	0.1%	0.1%

Figure 11 presents the electric, demand and gas savings at the program level along with the two forms of joint savings that we removed from the unadjusted savings. The downstream, tracked gas savings and demand savings for Opower-1 and the untracked upstream savings for Opower-2 are included here as a true zero to be consistent with aggregate results. The adjusted savings represents the HER program savings net of any savings claimed by other SDG&E energy efficiency programs.

<sup>11</sup> Per customer savings are calculated by dividing the total aggregate savings by the average number of customers during that time period.

Figure 9. Recommended kWh, kW and therms savings for Opower-1 and Opower-2 in 2015





## 4.2 Manage-Act-Save

This section presents the impact evaluation results for the MAS-2 MyAccount and Non-MyAccount program in 2014-2015 program cycle.

### 4.2.1 Overall program savings estimates

Table 24 and Table 25 provide monthly electric and gas savings along with the count of treatment group households for each month. In combination, these numbers generate the total monthly estimated electric and gas savings for the MAS Program. The total rows at the bottom of the tables provide the total annual savings along with confidence intervals at 90%. Based on the results, the MAS-2 program produced electric and gas savings that are statistically significant. MyAccount produced electric and gas savings that are lower by 50% and 13%, respectively than the savings from Non-MyAccount group.

**Table 24. Average monthly and total kWh savings, MAS-2 MyAccount**

Billing Months	Count of Treatment Group Participants	Unadjusted Savings per Household (kWh)	Unadjusted Savings per Household (therms)	Program Unadjusted Savings (kWh)	Program Unadjusted Savings (therms)
Nov-14	103,989	1.21	0.10	125,318	10,310
Dec-14	102,212	0.29	0.38	29,880	38,850
Jan-15	100,527	1.02	0.30	102,948	29,763
Feb-15	98,911	1.25	0.22	123,953	21,887
Mar-15	97,311	1.63	0.11	158,738	10,849
Apr-15	95,573	1.98	0.01	189,242	1,342
May-15	93,825	1.84	0.10	172,439	9,305
Jun-15	91,985	1.29	-0.05	118,424	-4,244
Jul-15	89,998	2.13	-0.07	191,504	-6,695
Aug-15	88,120	2.04	-0.06	179,496	-5,359
Sep-15	86,409	1.82	-0.07	156,878	-6,050
Oct-15	85,136	3.73	0.01	317,184	778
Nov-15	83,817	2.18	0.16	182,435	13,597
Dec-15	82,671	1.48	0.34	122,744	27,975
<b>Total Program Savings</b>		23.88	1.48	2,171,182	142,308
<b>Lower Bound at 90% CI</b>		8.79	0.48	816,321	44,362
<b>Upper Bound at 90% CI</b>		37.96	2.59	3,526,043	240,254

**Table 25. Average monthly and total kWh savings , MAS-2 Non-MyAccount**

Billing Months	Count of Treatment Group Participants	Unadjusted Savings per Household (kWh)	Unadjusted Savings per Household (therms)	Program Unadjusted Savings (kWh)	Program Unadjusted Savings (therms)
Nov-14	80,710	1.30	0.06	105,119	5,070
Dec-14	79,968	2.74	0.24	219,309	19,165
Jan-15	79,217	3.49	0.32	276,681	25,108
Feb-15	78,537	2.00	0.09	156,754	7,178
Mar-15	77,829	2.17	0.01	169,131	412
Apr-15	77,050	1.55	0.10	119,348	7,542
May-15	76,226	1.93	0.13	146,834	9,951
Jun-15	75,386	2.89	0.00	217,521	-348
Jul-15	74,533	3.54	-0.07	263,514	-5,430
Aug-15	73,772	5.24	-0.05	386,731	-3,506
Sep-15	73,027	5.05	-0.07	368,851	-5,018
Oct-15	72,322	5.06	-0.04	366,181	-2,988
Nov-15	71,627	4.27	0.33	306,116	23,723
Dec-15	71,029	5.83	0.66	414,396	46,910
<b>Total Program Savings</b>		47.07	1.70	3,516,487	127,769
<b>Lower Bound at 90% CI</b>		34.96	0.72	2,650,188	54,580
<b>Upper Bound at 90% CI</b>		57.82	2.65	4,382,785	200,959

DNV GL assessed savings by the type of report (paper versus email reports) received among MyAccount participants. We summarize the results of this additional analysis in Appendix D.

#### 4.2.2 Demand savings estimates

Table 26 provides the set of peak heat waves identified for the MAS program. The most common three-day heat wave among MAS-2 participants is September 8-10, 2015. This peak period is the same three-day heatwave identified for the HER program.

**Table 26. Peak heatwaves identified for the pre and post-periods**

Program/Wave	Period	DEER Heatwave
<b>MAS-2 MyAccount</b>	Pre	9/15/2014 - 9/17/2014
	Post	9/8/2015 - 9/10/2015
<b>MAS-2 Non-MyAccount</b>	Pre	9/15/2014 - 9/17/2014
	Post	9/8/2015 - 9/10/2015

DNV GL used a difference in differences approach for calculating the peak demand reductions for each of the programs within each of the heatwaves. Table 27 presents a comparison of the average pre- and post-period kW per household while Table 28 shows the peak demand savings per household for MAS-2 MyAccount and Non-MyAccount. Overall, the demand savings for both MyAccount and Non-MyAccount are not statistically significant at the identified peak.

**Table 27. Pre and Post period kW comparison**

Program/Wave	Group	Average kW per household	
		Pre Period	Post Period
MAS 2 MyAccount	Treatment	1.28	1.21
	Control	1.28	1.22
MAS 2 Non-MyAccount	Treatment	1.30	1.22
	Control	1.31	1.24

**Table 28. MAS kW savings per household**

MAS-2 program	kW Savings per Household	+/- at 90% CI
MyAccount	0.005	0.006
Non-MyAccount	0.007	0.008

### 4.2.3 Joint savings: downstream programs

Figure 10 through Figure 13 show the monthly estimates of average joint electric and gas savings per household for MyAccount and Non-MyAccount. These figures provide a graphical illustration of the difference in savings between the treatment and control groups along with the corresponding confidence intervals.

Overall, we found very limited increase in the uptake of downstream programs for both MyAccount and Non-MyAccount. The electric and gas joint savings are relatively flat and not statistically different from zero except for electric joint savings for Non-MyAccount.

Figure 10. Average monthly kWh joint savings per household for MyAccount

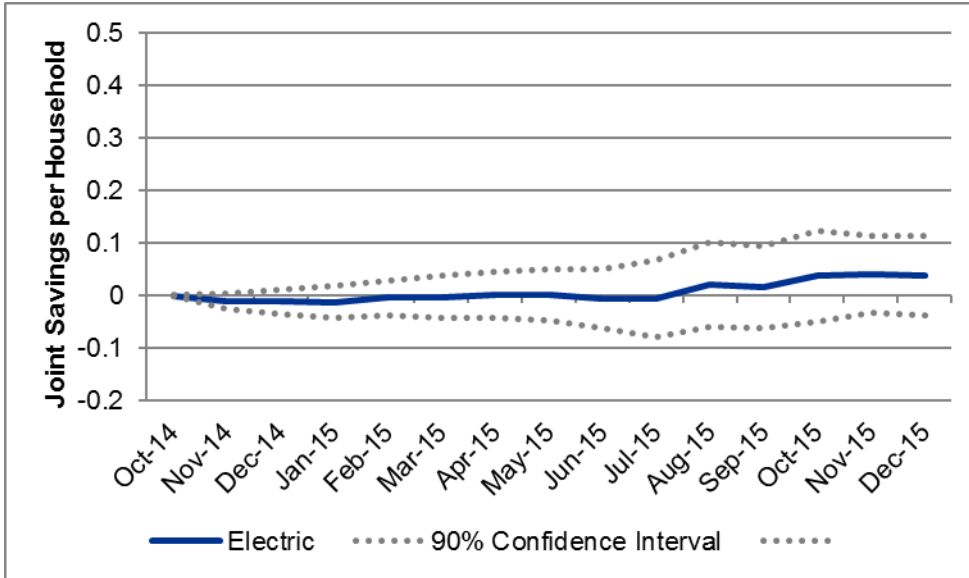


Figure 11. Average monthly kWh joint savings per household for Non-MyAccount

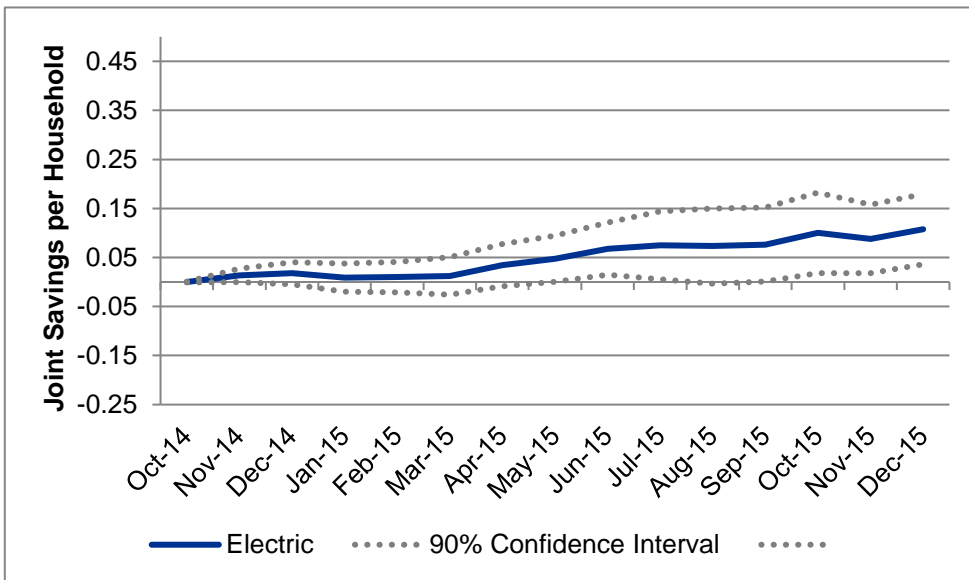


Figure 12. Average monthly therms joint savings per household for MyAccount

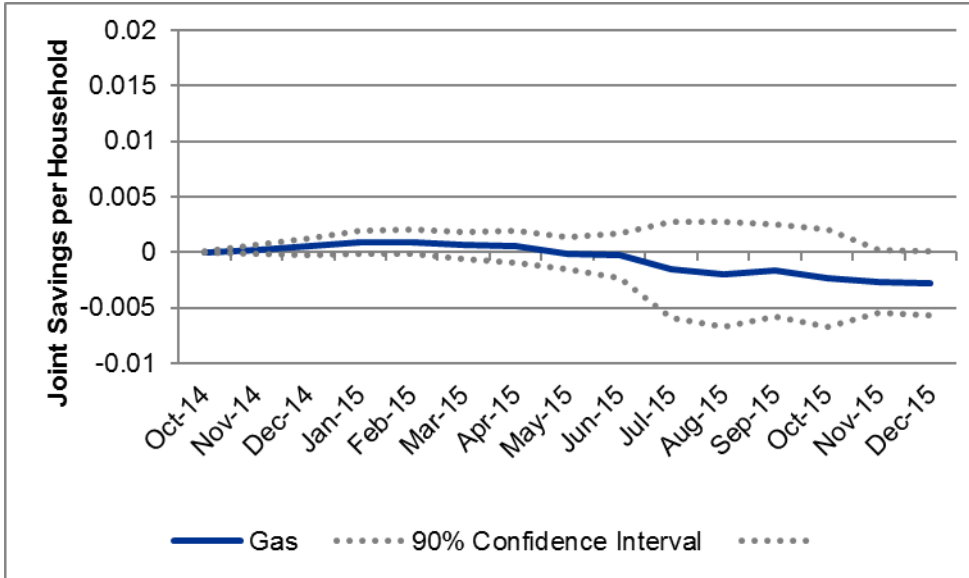


Figure 13. Average monthly therms joint savings per household for Non-MyAccount

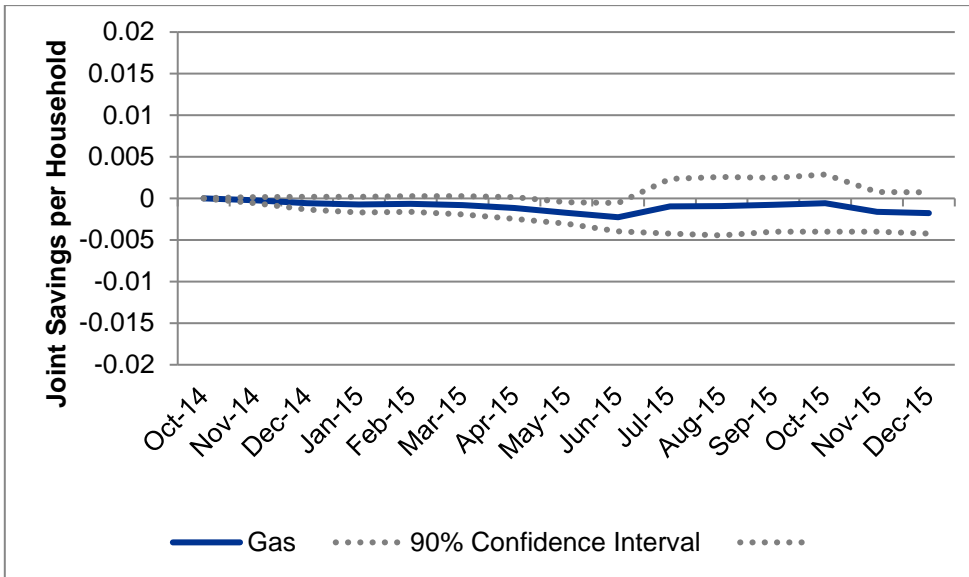


Table 29 and Table 30 provide the joint savings for electric and gas along with the monthly count of treatment group customers in kWh and therms. The monthly joint savings are the combination of the average per customer savings and the customer counts.<sup>12</sup> The overall savings estimates are provided along with confidence intervals. Despite being non-statistically significant, positive joint savings are removed as they provided some evidence of possible double counting. For MAS-2, MyAccount and Non-MyAccount electric downstream joint savings are positive and gas joint savings are negative. As a result, only electric savings will be adjusted with joint savings from downstream programs.

**Table 29. Monthly kWh and therms joint savings MAS-2 MyAccount**

Billing Months	Count of Treatment Group Participants	Joint Savings per Household - Tracked		Program Tracked Joint Savings (kWh)	Program Tracked Joint Savings (therms)
		/Downstream Programs (kWh)	/Downstream Programs (therms)		
Nov-14	103,989	-0.01	0.00	-1,086	-22
Dec-14	102,212	-0.01	0.00	-1,144	-58
Jan-15	100,527	-0.01	0.00	-1,213	-75
Feb-15	98,911	0.00	0.00	-442	-65
Mar-15	97,311	0.00	0.00	-302	-80
Apr-15	95,573	0.00	0.00	118	-112
May-15	93,825	0.00	0.00	200	-163
Jun-15	91,985	-0.01	0.00	-540	-208
Jul-15	89,998	-0.01	0.00	-588	-85
Aug-15	88,120	0.02	0.00	1,858	-82
Sep-15	86,409	0.02	0.00	1,468	-66
Oct-15	85,136	0.04	0.00	3,168	-48
Nov-15	83,817	0.04	0.00	3,488	-136
Dec-15	82,671	0.04	0.00	3,238	-145
<b>Total Program Savings</b>		0.11	-0.01	8,223	-1,344
<b>Lower Bound at 90% CI</b>		-0.56	-0.04	-51,580	-3,498
<b>Upper Bound at 90% CI</b>		0.77	0.02	71,197	1,737

<sup>12</sup> 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 30. Monthly kWh and therms joint savings MAS-2 Non-MyAccount**

Billing Months	Count of Treatment Group Participants	Joint Savings per Household - Tracked		Program Tracked Joint Savings (kWh)	Program Tracked Joint Savings (therms)
		/Downstream Programs (kWh)	/Downstream Programs (therms)		
Nov-14	80,710	0.01	0.00	1,092	-17
Dec-14	79,968	0.02	0.00	1,417	-45
Jan-15	79,217	0.01	0.00	708	-59
Feb-15	78,537	0.01	0.00	790	-51
Mar-15	77,829	0.01	0.00	966	-64
Apr-15	77,050	0.03	0.00	2,636	-90
May-15	76,226	0.05	0.00	3,597	-133
Jun-15	75,386	0.07	0.00	5,113	-171
Jul-15	74,533	0.07	0.00	5,567	-71
Aug-15	73,772	0.07	0.00	5,398	-68
Sep-15	73,027	0.08	0.00	5,575	-55
Oct-15	72,322	0.10	0.00	7,247	-40
Nov-15	71,627	0.09	0.00	6,285	-116
Dec-15	71,029	0.11	0.00	7,640	-124
<b>Total Program Savings</b>		0.73	-0.01	54,031	-1,106
<b>Lower Bound at 90% CI</b>		0.10	-0.04	7,435	-2,868
<b>Upper Bound at 90% CI</b>		1.37	0.01	103,480	634

Table 31 provides the per household and total joint kW savings for MyAccount and Non-MyAccount. The joint savings at the peak from MAS-2 are very small and not statistically significant. This indicates that there very limited savings that are potentially double counted at the identified peak period.

**Table 31. Joint kW Savings for HER**

Program/Wave	No. of treatment	Per household Joint Savings	Total Joint Savings
MAS-2 MyAccount	86,409	0.0021	181
MAS-2 Non-MyAccount	73,027	0.00009	8

#### 4.2.4 Joint savings: upstream programs

The online survey results on bulb uplift showed that the excess efficient bulbs purchased and installed due to MAS-2 are mostly LEDs. The bulb uplift estimates from the survey are not statistically significant at 90 percent confidence interval.

Table 32 and Table 33 the kWh joint savings estimates using the 2015 bulb uplift estimate for MAS-2. The total upstream joint savings per household for MAS-2 are very small ranging from 0 to 1.0 kWh savings per household. This suggests the program has limited impact on the purchase of CFL and LED bulbs.

**Table 32. Upstream kWh joint savings inputs for CFL and LED - MAS-2 MyAccount**

Inputs	CFL		LED	
	2014	2015	2014	2015
No. of excess bulb per year	0.00	0.06	0.00	0.64
No. of excess bulbs/month	0.00	0.00	0.00	0.05
No. of bulbs installed due to HER	0.01	0.06	0.11	0.64
Year bulbs have been installed in 2014	1.00	0.50	1.00	0.50
Deemed kWh savings per bulb	17.90	17.90	21.80	21.80
CFL rebated sales fraction	0.18	0.20	0.32	0.31
Net-to-gross	0.30	0.30	0.32	0.32
Installation rate	-	-	-	-
kWh joint savings	0.01	0.03	0.24	0.68
<b>Total joint savings per household</b>	0.05		1.00	

**Table 33. Upstream kWh joint savings inputs for CFL and LED - MAS 2 Non-MyAccount**

Inputs	CFL		LED	
	2014	2015	2014	2015
No. of excess bulb per year	0.00	-0.04	0.00	0.03
No. of excess bulbs/month	0.00	0.00	0.00	0.00
No. of bulbs installed due to HER	-0.01	-0.04	0.01	0.03
Year bulbs have been installed in 2014	1.00	0.50	1.00	0.50
Deemed kWh savings per bulb	17.90	17.90	21.80	21.80
CFL rebated sales fraction	0.18	0.20	0.32	0.31
Net-to-gross	0.30	0.30	0.32	0.32
Installation rate	-	-	-	-
kWh joint savings	-0.01	-0.02	0.01	0.04
<b>Total joint savings per household</b>	-0.030		0.05	

Table 34 and Table 35 combine the monthly per bulb upstream joint savings estimate with the monthly treatment group counts to generate an estimate of upstream joint savings for the duration of the program. Overall, the total program joint savings due to participation in upstream program are 93 MWh for MyAccount and 1 MWh for Non-MyAccount, These upstream savings will be deducted from the overall MAS-2 savings to avoid any potential of double counting savings with ULP.



**Table 34. Monthly upstream kWh savings from lighting programs - MAS 2 MyAccount**

Month	CFL Joint Savings per Household	LED Joint Savings per Household	Count of Treatment Group Participants	Program Joint Savings (kWh)
Nov-14	0.00	0.01	103,989	1,033
Dec-14	0.00	0.02	102,212	2,031
Jan-15	0.00	0.03	100,527	2,996
Feb-15	0.00	0.04	98,911	3,930
Mar-15	0.00	0.05	97,311	4,833
Apr-15	0.00	0.06	95,573	5,696
May-15	0.00	0.07	93,825	6,524
Jun-15	0.00	0.08	91,985	7,310
Jul-15	0.00	0.09	89,998	8,046
Aug-15	0.00	0.10	88,120	8,754
Sep-15	0.00	0.10	86,409	9,442
Oct-15	0.01	0.11	85,136	10,149
Nov-15	0.01	0.12	83,817	10,824
Dec-15	0.01	0.13	82,671	11,497
<b>Total</b>	<b>0.05</b>	<b>1.00</b>		<b>93,066</b>

**Table 35. Monthly upstream kWh savings from lighting programs - MAS 2 Non My Account**

Month	CFL Joint Savings per Household	LED Joint Savings per Household	Count of Treatment Group Participants	Program Joint Savings (kWh)
Nov-14	0.00	0.00	80,710	14
Dec-14	0.00	0.00	79,968	27
Jan-15	0.00	0.00	79,217	40
Feb-15	0.00	0.00	78,537	53
Mar-15	0.00	0.00	77,829	66
Apr-15	0.00	0.00	77,050	78
May-15	0.00	0.00	76,226	90
Jun-15	0.00	0.00	75,386	102
Jul-15	0.00	0.00	74,533	113
Aug-15	0.00	0.00	73,772	125
Sep-15	0.00	0.01	73,027	136
Oct-15	0.00	0.01	72,322	147
Nov-15	0.00	0.01	71,627	157
Dec-15	0.00	0.01	71,029	168
<b>Total</b>	<b>-0.03</b>	<b>0.05</b>		<b>1,316</b>

Table 36 and Table 37 provide the stream of ULP interactive effects for MyAccount and Non-MyAccount. The total program joint savings adjustment in gas savings is -1,303 therms for MyAccount and -18 therms for Non-MyAccount. These interactive effects will adjust program gas savings upwards.

**Table 36. Monthly upstream interactive effects - MAS 2 MyAccount**

Month	Joint Savings per Customer - Untracked/Upstream Programs (therms)	Count of Treatment Group Participants	Program Joint Savings (therms)
Nov-14	-0.00	103,989	-14
Dec-14	-0.00	102,212	-28
Jan-15	-0.00	100,527	-42
Feb-15	-0.00	98,911	-55
Mar-15	-0.00	97,311	-68
Apr-15	-0.00	95,573	-80
May-15	-0.00	93,825	-91
Jun-15	-0.00	91,985	-102
Jul-15	-0.00	89,998	-113
Aug-15	-0.00	88,120	-123
Sep-15	-0.00	86,409	-132
Oct-15	-0.00	85,136	-142
Nov-15	-0.00	83,817	-152
Dec-15	-0.00	82,671	-161
<b>Total</b>	-0.01		-1,303

**Table 37. Monthly upstream interactive effects for Non-MyAccount**

Month	Joint Savings per Customer - Untracked/Upstream Programs (therms)	Count of Treatment Group Participants	Program Joint Savings (therms)
Nov-14	-0.00	80,710	-0.2
Dec-14	-0.00	79,968	-0.4
Jan-15	-0.00	79,217	-0.6
Feb-15	-0.00	78,537	-0.7
Mar-15	-0.00	77,829	-0.9
Apr-15	-0.00	77,050	-1.1
May-15	-0.00	76,226	-1.3
Jun-15	-0.00	75,386	-1.4
Jul-15	-0.00	74,533	-1.6
Aug-15	-0.00	73,772	-1.7
Sep-15	-0.00	73,027	-1.9
Oct-15	-0.00	72,322	-2.1
Nov-15	-0.00	71,627	-2.2
Dec-15	-0.00	71,029	-2.4
<b>2015 Savings</b>	-0.00		-18

The joint upstream kW savings were calculated in a similar fashion to calculating kWh joint savings from upstream programs but slightly differed in the value used for savings per bulb. DNV GL calculated peak watts impact for CFL and LED bulbs using results from DNV GL’s 2013-2014 Upstream Lighting study.

Consistent with kWh joint savings, DNV GL used the survey results to update the 2015 bulb uplift due to MAS-2 in calculating kW joint savings. Table 22 shows the aggregate and per household upstream kW joint savings estimates at the time of peak. The number of treatment households used is the number of treatment accounts that are active on September 2015.

**Table 38. Peak kW Upstream Joint Savings**

Program/Wave	Active Accounts during Peak Period (Sept 8 - 10 2015)	Upstream Joint Savings per Household	Program Joint Savings (kW)
MAS-2 MyAccount	86,409	0.000118	10.17
MAS-2 Non-MyAccount	73,027	0.000002	0.11

#### 4.2.5 Per household savings and total program savings

This section combines the results in the prior three sub-sections to provide the final savings estimates for the MAS-2 program. Table 39 presents the unadjusted and adjusted savings as a fraction of control group,

post-period consumption.<sup>13</sup> Percentage savings are widely used to describe behavioral program savings across utilities. As reported in other venues, these percentages may be adjusted or unadjusted savings. The MAS-2 unadjusted savings ranged from 0.4% to 0.9% and are relatively lower compared to savings from the HER program.

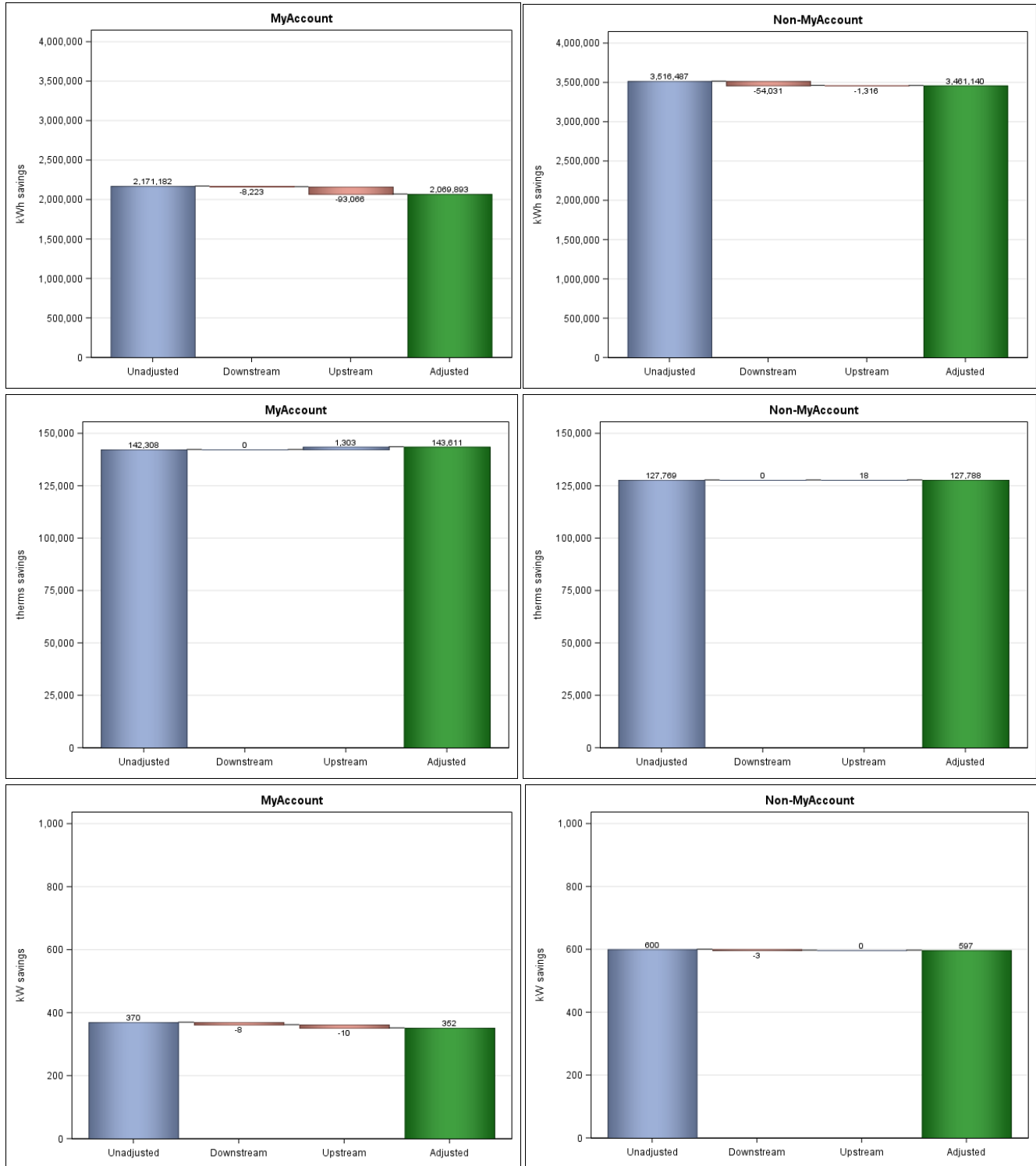
**Table 39. Savings per household as a percent of kWh and therms consumption**

Program/Wave	Evaluation Period	Fuel	Unadjusted Per Customer Savings	Adjusted Per Customer Savings	Average Per Customer Consumption (Demand)	Unadjusted Savings as Percentage of Consumption	Adjusted Savings as Percentage of Consumption
MAS-2 MyAccount	November 2014 - December 2015	Electric (kWh)	24	23	5,654	0.4%	0.4%
		Demand (kW)	0.01	0.00	1.22	0.4%	0.4%
		Gas (therms)	1	1	280	0.5%	0.5%
MAS-2 Non-MyAccount	November 2014 - December 2015	Electric (kWh)	47	46	5,526	0.9%	0.8%
		Demand (kW)	0.01	0.01	1.20	0.6%	0.6%
		Gas (therms)	2	2	293	0.6%	0.6%

The overall program adjusted savings are calculated using the monthly count of active treatment group participants and the monthly adjusted savings. Figure 14 presents the program-level savings as well and the downstream and upstream joint savings deductions. For MyAccount and Non-MyAccount, the downstream, tracked gas savings are included as a true zero to be consistent with aggregate results. The adjusted electric and gas savings represent the MAS-2 program savings net of any savings claimed by any other SDG&E energy efficiency programs. Demand savings are not statistically significant and are effectively zero.

<sup>13</sup> Per customer savings are calculated by dividing the total aggregate savings by the average number of customers during that time period.

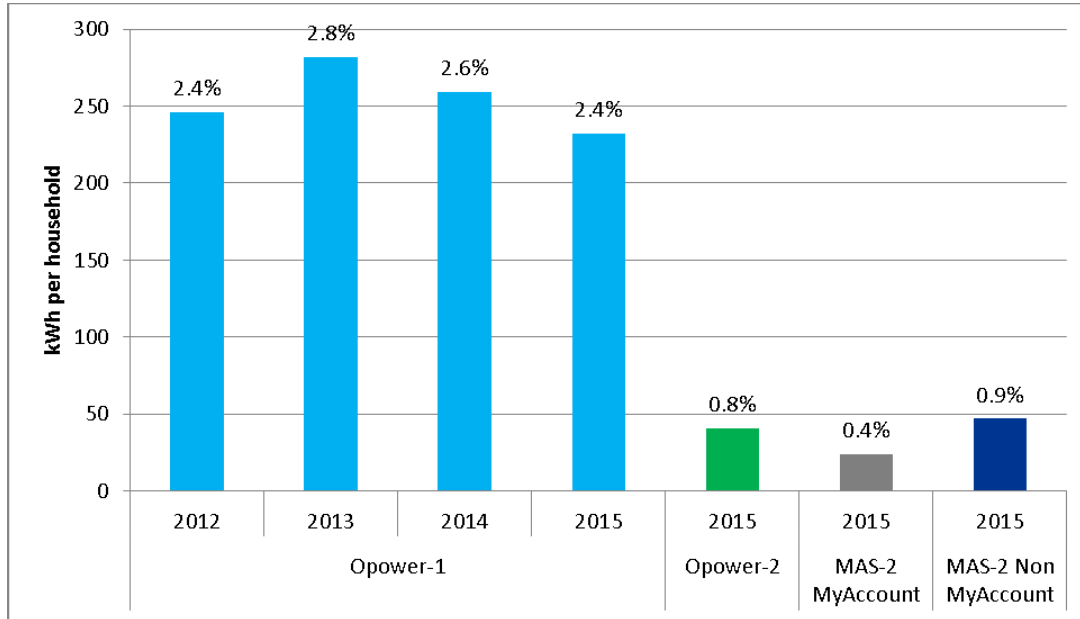
**Figure 14. Recommended kWh, kW and therms savings for MAS MyAccount and Non-MyAccount in 2014-2015**



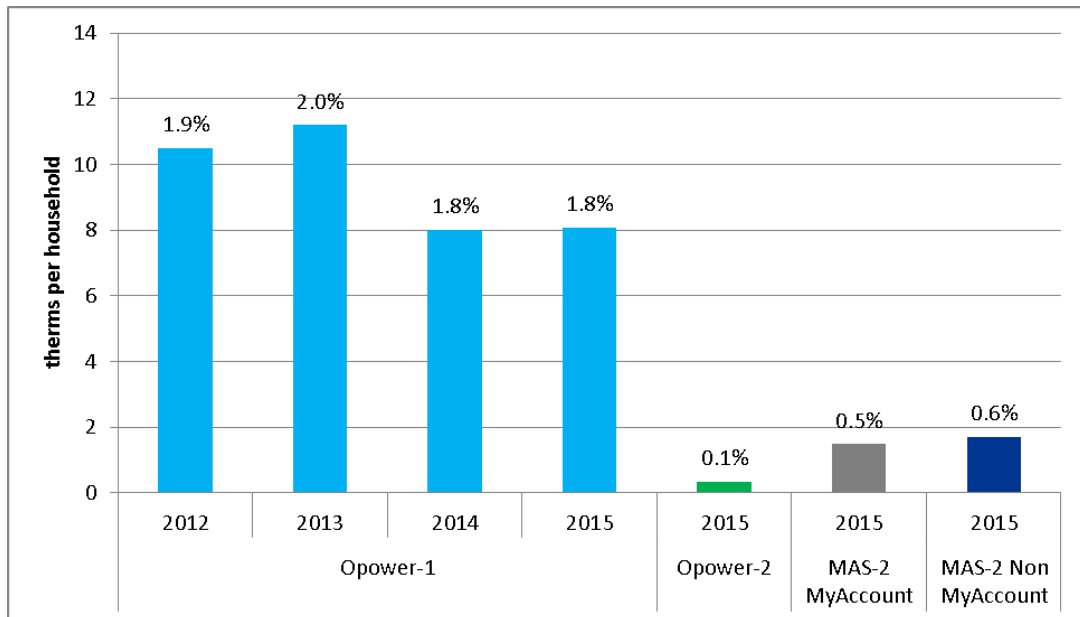
### 4.3 Comparison of HER and MAS-2 Savings


This evaluation shows that electric and gas savings vary across the treatment groups in HER and MAS-2 programs. Figure 15 and Figure 16 provide a comparison of savings across the different HER and MAS-2 experiments. Results show that targeting plays an important role in the effectiveness of behavioral programs. The comparative reports produce the highest impact among large users targeted under Opower-1. This finding is consistent with the results from HER evaluations in other jurisdiction.

**Figure 15. Unadjusted kWh savings per household from 2012 - 2015**



**Figure 16. Unadjusted therms savings per household from 2012 - 2015**





Both Opower-2 and MAS-2 MyAccount targeted customers located in coastal and inland areas who are also enrolled in SDG&E billing online system. The slight difference in savings between the HER and MAS programs can be attributed to the difference in messaging and design of the HER and MAS programs.

Within the MAS-2 program, the Non-MyAccount treatment customers receive paper reports only while MyAccount treatment customers receive either email or paper reports. The Non MyAccount savings are slightly higher than the savings produced by the treatment customers in MyAccount. This indicates that email reports is not as effective as paper reports in reducing consumption. However, sending email reports may still be a cost-effective channel since it is likely to cost less than sending paper reports.

Appendix D and Appendix E provide a comparison of savings between email and paper recipients in Opower-2 and MAS-2 MyAccount. The results also show that paper recipients tend to produce more savings than customers receiving email reports.

Overall, this study shows that targeting customers with high energy consumption produced the highest savings. This finding indicates the importance of targeting in determining the expected level of savings and cost-effectiveness of the program. If SDG&E is looking to expand their program to a general population or different target group, results from these experiments should be used with caution as they may have the tendency to overestimate or underestimate program benefits.

## 5 CONCLUSIONS

The HER program continued to produce electric and gas savings that are statistically significant at the 90% confidence interval in 2015. Gas savings are statistically significant at the program level despite limited gas savings from Opower-2. The HER program also showed evidence of demand savings during the identified peak period.

For the MAS program, this evaluation finds electric and gas savings for both MyAccount and Non-MyAccount groups, with Non-MyAccount producing more electric savings. Contrary to HER findings, the MAS program did not show any evidence of load reduction during the identified peak.

DNV GL's recommendation for total adjusted energy and demand savings for 2015 SDG&E HER and MAS program are summarized in Table 40. Overall, the HER program produced an aggregate adjusted savings of 5,658,311 kWh, 1,434 kW and 129,788 therms in 2015 while the MAS-2 program produced 5,531,032 kWh and 271,398 therms savings. These adjusted savings are free of potentially double counted savings and SDG&E may use these results to support savings claims for the 2015 program cycle.

**Table 40. Recommended total adjusted kWh, therms, and kW savings for 2015 HER and MAS programs**

Program/ Wave	Evaluation Period	Source	Electric (kWh)	Demand (kW)	Gas (therms)
Opower-1	January 2015 - December 2015	Unadjusted Savings	3,010,359	551	103,739
		Downstream Joint Savings	147,699	6	0
		Upstream Joint Savings	143,265	12	-256
		Adjusted Savings	2,719,395	532	103,994
Opower-2	December 2014 - December 2015	Unadjusted Savings	2,962,306	916	28,669
		Downstream Joint Savings	23,389	14	2,876
		Upstream Joint Savings	0	0	0
		Adjusted Savings	2,938,917	902	25,794
MAS-2 MyAccount	November 2014 - December 2015	Unadjusted Savings	2,171,182	0	142,308
		Downstream Joint Savings	8,223	0	0
		Upstream Joint Savings	93,066	0	-1,303
		Adjusted Savings	2,069,893	0	143,611
MAS-2 Non MyAccount	November 2014 - December 2015	Unadjusted Savings	3,516,487	0	127,769
		Downstream Joint Savings	54,031	0	0
		Upstream Joint Savings	1,316	0	-18
		Adjusted Savings	3,461,140	0	127,788
<b>Total Adjusted savings from HER program</b>			5,658,311	1,434	129,788
<b>Total Adjusted savings from MAS program</b>			5,531,032	0	271,398
<b>Total Adjusted savings from HER and MAS programs</b>			11,189,344	1,434	375,393



## APPENDIX A. RANDOMIZATION TEST

DNV GL applied statistical t-tests to the final sample to test the randomness of the treatment and control group allocations for HER and MAS programs. Table 1 through Table 4 provide electric and gas consumption for each month in the pre-program period between the treatment and the control group. For Opower-1 and Opower-2, The test showed that the difference in pre-period electric consumption is statistically different from zero for both Opower-1 and Opower-2. For gas, the test also showed statistically significant differences between treatment and control for Opower-2.

The results from the statistical tests suggest that there is pre-existing difference between consumption of the treatment and control groups. The magnitude of the difference is very small and the savings estimation approach used in this evaluation corrects for mean differences across the whole pre-report period. On an annual basis, the model used in savings estimation produce unbiased savings. For MAS waves, the pre-period electric and gas consumption between the treatment and control groups are comparable.

**Table 1. Test of differences in pre-period consumption between treatment and control groups for Opower-1**

Fuel	Month	Treatment			Control			Control-Treatment	
		Count	Mean	Std Error	Count	Mean	Std Error	Difference	Pr >  t
Electric Consumption (kWh)	1-Jul-10	13,756	27.37	0.12	13,735	27.81	0.13	0.44	0.01*
	1-Aug-10	13,757	28.84	0.13	13,735	29.39	0.14	0.55	0.00*
	1-Sep-10	13,756	28.24	0.13	13,735	28.83	0.13	0.59	0.00*
	1-Oct-10	13,747	27.15	0.12	13,735	27.63	0.12	0.47	0.01*
	1-Nov-10	13,361	28.26	0.13	13,359	28.61	0.13	0.35	0.05*
	1-Dec-10	13,757	31.46	0.13	13,735	31.82	0.14	0.35	0.07*
	1-Jan-11	13,758	28.46	0.12	13,735	28.78	0.12	0.32	0.06*
	1-Feb-11	13,091	27.43	0.12	13,088	27.79	0.12	0.35	0.04*
	1-Mar-11	13,758	26.04	0.11	13,736	26.40	0.12	0.36	0.02*
	1-Apr-11	13,478	25.15	0.11	13,463	25.57	0.12	0.43	0.01*
	1-May-11	13,758	24.80	0.11	13,736	25.14	0.11	0.35	0.03*
1-Jun-11	13,758	26.01	0.12	13,736	26.47	0.13	0.46	0.01*	
Gas Consumption (therms)	1-Jul-10	13,708	0.94	0.01	13,672	0.94	0.01	0.00	0.71
	1-Aug-10	13,709	0.89	0.01	13,672	0.89	0.01	0.00	0.93
	1-Sep-10	13,709	0.91	0.01	13,673	0.90	0.01	0.00	0.70
	1-Oct-10	13,709	1.06	0.01	13,673	1.06	0.01	0.00	0.72
	1-Nov-10	13,312	2.06	0.01	13,299	2.09	0.01	0.03	0.10
	1-Dec-10	13,709	2.85	0.01	13,673	2.89	0.01	0.03	0.08
	1-Jan-11	13,709	2.67	0.01	13,673	2.69	0.01	0.01	0.47
	1-Feb-11	13,044	2.69	0.01	13,030	2.72	0.01	0.03	0.10
	1-Mar-11	13,709	2.06	0.01	13,674	2.07	0.01	0.02	0.23

	1-Apr-11	13,441	1.43	0.01	13,404	1.44	0.01	0.01	0.37
	1-May-11	13,709	1.20	0.01	13,673	1.21	0.01	0.01	0.53
	1-Jun-11	13,709	1.02	0.01	13,674	1.03	0.01	0.01	0.40

\* Indicates statistically significant at the 90% confidence interval.

**Table 2. Test of differences in pre-period consumption between treatment and control groups for Opower-2**

Fuel	Month	Treatment			Control			Control-Treatment	
		Count	Mean	Std Err	Count	Mean	Std Err	Difference	Pr >  t
Electric	1-Nov-13	81,622	12.38	0.03	22,538	12.55	0.07	0.17	0.01*
	1-Dec-13	85,992	14.00	0.03	23,705	14.16	0.06	0.16	0.02*
	1-Jan-14	85,991	12.73	0.03	23,705	12.88	0.05	0.15	0.01*
	1-Feb-14	78,349	12.15	0.03	21,566	12.35	0.05	0.20	0.00*
	1-Mar-14	85,991	11.50	0.03	23,705	11.66	0.05	0.17	0.00*
	1-Apr-14	85,991	11.57	0.03	23,705	11.73	0.05	0.16	0.00*
	1-May-14	85,991	12.71	0.03	23,705	12.91	0.05	0.20	0.00*
	1-Jun-14	85,991	12.74	0.03	23,705	12.92	0.06	0.18	0.00*
	1-Jul-14	85,991	15.01	0.04	23,705	15.21	0.07	0.19	0.01*
	1-Aug-14	85,990	16.14	0.04	23,705	16.36	0.07	0.22	0.01*
	1-Sep-14	81,666	16.98	0.04	22,545	17.23	0.08	0.25	0.00*
	1-Oct-14	85,977	13.00	0.03	23,702	13.17	0.05	0.18	0.00*
Gas	1-Nov-13	57,155	0.76	0.00	15,816	0.78	0.00	0.01	0.02*
	1-Dec-13	59,050	1.17	0.00	16,355	1.19	0.01	0.01	0.06*
	1-Jan-14	59,035	1.00	0.00	16,352	1.01	0.01	0.01	0.03*
	1-Feb-14	54,796	0.89	0.00	15,123	0.90	0.00	0.01	0.01*
	1-Mar-14	59,037	0.71	0.00	16,353	0.72	0.00	0.01	0.01*
	1-Apr-14	59,045	0.61	0.00	16,356	0.62	0.00	0.01	0.02*
	1-May-14	59,048	0.50	0.00	16,356	0.50	0.00	0.01	0.01*
	1-Jun-14	59,049	0.46	0.00	16,355	0.46	0.00	0.01	0.01*
	1-Jul-14	59,027	0.42	0.00	16,347	0.42	0.00	0.01	0.02*
	1-Aug-14	58,967	0.39	0.00	16,326	0.40	0.00	0.00	0.04*
	1-Sep-14	56,974	0.37	0.00	15,770	0.38	0.00	0.01	0.00*
	1-Oct-14	58,710	0.43	0.00	16,263	0.43	0.00	0.01	0.03*

\* Indicates statistically significant at the 90% confidence interval.

**Table 3. Test of differences in pre-period consumption between treatment and control groups for MAS 2 MyAccount**

Fuel	Month	Treatment			Control			Control-Treatment	
		Count	Mean	Std Err	Count	Mean	Std Err	Difference	Pr >  t
Electric	1-Oct-13	105,861	11.74	0.02	25,352	11.69	0.05	-0.05	0.36
	1-Nov-13	100,601	12.40	0.04	24,097	12.37	0.07	-0.04	0.69
	1-Dec-13	105,968	14.00	0.03	25,372	13.94	0.06	-0.06	0.40
	1-Jan-14	105,968	12.74	0.03	25,372	12.70	0.05	-0.04	0.56
	1-Feb-14	96,407	12.18	0.03	23,132	12.12	0.05	-0.06	0.33
	1-Mar-14	105,969	11.52	0.03	25,372	11.48	0.05	-0.04	0.48
	1-Apr-14	105,969	11.60	0.03	25,372	11.56	0.05	-0.04	0.47
	1-May-14	105,969	12.74	0.03	25,372	12.68	0.05	-0.06	0.35
	1-Jun-14	105,969	12.75	0.03	25,372	12.70	0.05	-0.05	0.41
	1-Jul-14	105,967	15.02	0.03	25,372	14.96	0.06	-0.06	0.39
	1-Aug-14	105,965	16.16	0.04	25,372	16.10	0.07	-0.05	0.50
	1-Sep-14	100,655	16.98	0.04	24,099	16.96	0.07	-0.02	0.80
Gas	1-Oct-13	72,942	0.53	0.00	17,398	0.53	0.00	0.00	0.43
	1-Nov-13	70,615	0.76	0.00	16,865	0.77	0.00	0.00	0.89
	1-Dec-13	72,972	1.17	0.00	17,402	1.17	0.01	0.00	0.55
	1-Jan-14	72,962	1.00	0.00	17,400	1.00	0.01	0.00	0.88
	1-Feb-14	67,626	0.88	0.00	16,164	0.89	0.00	0.00	0.81
	1-Mar-14	72,962	0.71	0.00	17,401	0.71	0.00	0.00	0.99
	1-Apr-14	72,965	0.61	0.00	17,404	0.61	0.00	0.00	0.87
	1-May-14	72,968	0.50	0.00	17,407	0.49	0.00	-0.01	0.10
	1-Jun-14	72,969	0.46	0.00	17,403	0.45	0.00	0.00	0.14
	1-Jul-14	72,949	0.42	0.00	17,400	0.41	0.00	0.00	0.57
	1-Aug-14	72,871	0.39	0.00	17,385	0.39	0.00	0.00	0.21
	1-Sep-14	70,425	0.37	0.00	16,816	0.37	0.00	0.00	0.18

\* Indicates statistically significant at the 90% confidence interval.

**Table 4. Test of differences in consumption between treatment and control groups, for MAS-2 Non MyAccount**

Fuel	Month	Treatment			Control			Control-Treatment	
		Count	Mean	Std Err	Count	Mean	Std Err	Difference	Pr >  t
Electric	1-Oct-13	81,365	11.60	0.03	43,175	11.62	0.04	0.02	0.64
	1-Nov-13	77,848	12.36	0.03	41,340	12.40	0.05	0.05	0.44
	1-Dec-13	81,506	13.93	0.03	43,244	13.97	0.05	0.03	0.58
	1-Jan-14	81,506	12.68	0.03	43,244	12.71	0.05	0.04	0.46
	1-Feb-14	73,708	12.12	0.03	39,216	12.15	0.05	0.04	0.50
	1-Mar-14	81,506	11.44	0.03	43,244	11.46	0.04	0.01	0.79
	1-Apr-14	81,506	11.46	0.03	43,244	11.47	0.04	0.01	0.80
	1-May-14	81,506	12.40	0.03	43,244	12.40	0.05	0.00	0.93
	1-Jun-14	81,505	12.44	0.03	43,244	12.43	0.05	-0.01	0.85
	1-Jul-14	81,505	14.49	0.04	43,244	14.48	0.06	-0.01	0.92
	1-Aug-14	81,502	15.49	0.04	43,244	15.50	0.06	0.01	0.90
	1-Sep-14	77,925	16.19	0.04	41,366	16.24	0.06	0.05	0.52
Gas	1-Oct-13	55,733	0.54	0.00	29,691	0.54	0.00	0.00	0.46
	1-Nov-13	54,057	0.82	0.00	28,803	0.83	0.00	0.00	0.55
	1-Dec-13	55,761	1.28	0.00	29,706	1.28	0.01	0.00	0.89
	1-Jan-14	55,739	1.09	0.00	29,690	1.09	0.00	0.00	0.77
	1-Feb-14	51,159	0.95	0.00	27,318	0.96	0.00	0.00	0.43
	1-Mar-14	55,743	0.75	0.00	29,693	0.75	0.00	0.00	0.89
	1-Apr-14	55,749	0.63	0.00	29,696	0.63	0.00	0.00	0.87
	1-May-14	55,752	0.50	0.00	29,697	0.49	0.00	0.00	0.20
	1-Jun-14	55,753	0.45	0.00	29,701	0.45	0.00	0.00	0.30
	1-Jul-14	55,726	0.41	0.00	29,686	0.41	0.00	0.00	0.20
	1-Aug-14	55,639	0.38	0.00	29,627	0.38	0.00	0.00	0.11
1-Sep-14	53,750	0.36	0.00	28,633	0.36	0.00	0.00	0.14	

\*Indicates statistically significant at the 90% confidence interval.

## APPENDIX B. HER PROGRAM MONTHLY SAVINGS

Figure 1 through Figure 4 provide graphic illustrations of monthly electric and gas savings for 2015. The average monthly electric and gas savings follow a strong seasonal pattern. Monthly electric savings are all statistically significant and are highest during the summer months for both Opower-1 and Opower-2. For gas, Opower-1 produced savings during the winter months while Opower-2 produced very limited savings across all months in 2015. Overall, the levels of electric and gas savings from Opower-2 are relatively lower than Opower-1 savings.

Figure 1. Average monthly kWh savings per household for Opower-1

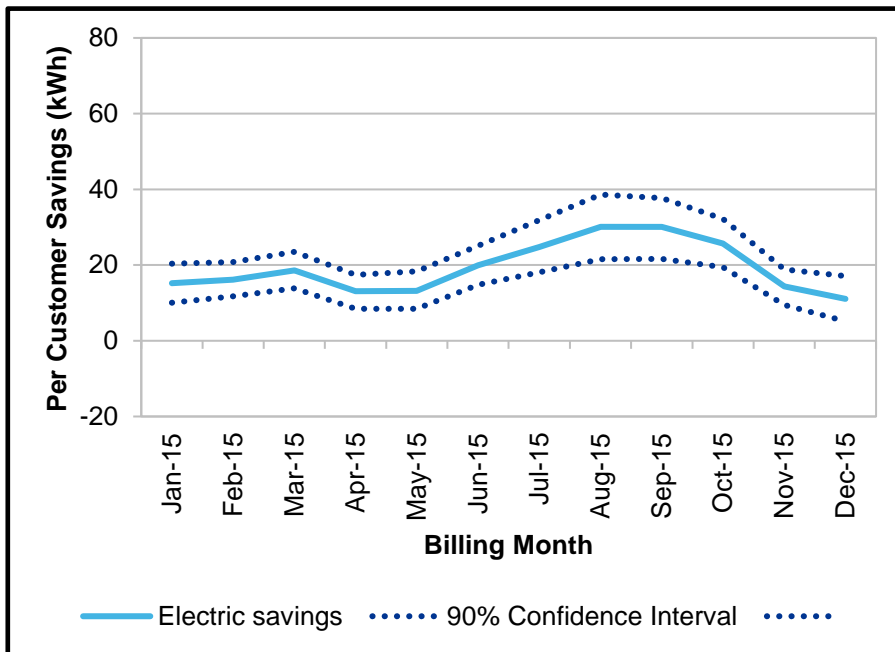


Figure 2. Average monthly kWh savings per household for Opower-2

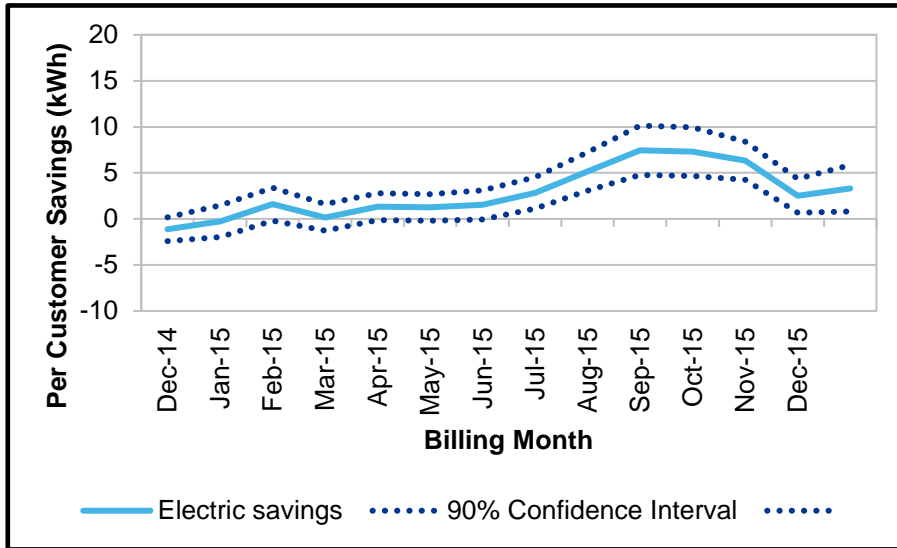


Figure 3. Average monthly therm savings per household for Opower-1

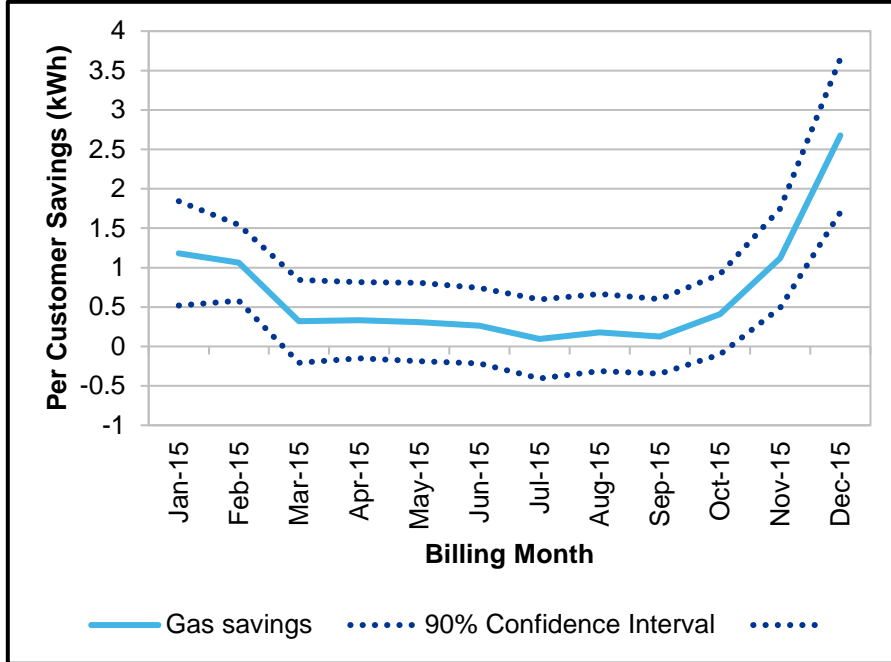
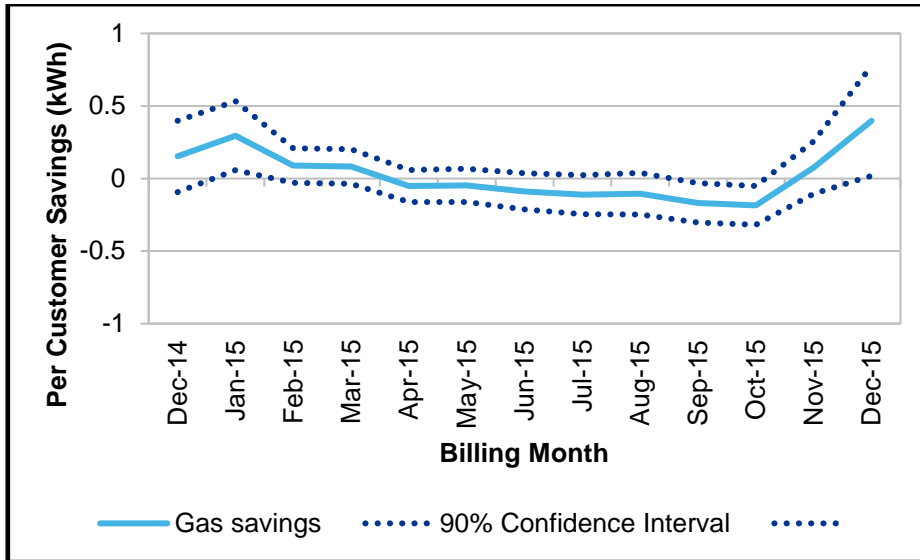


Figure 4. Average monthly therm savings per household for Opower-2



The reported program savings estimate for 2015 could be potentially lower than the true savings for Opower-1 because of the MAS-1 program contamination in the control group. However, we expect the effect (if any) to be marginal because the MAS-1 program was already discontinued in 2013 and only 38% of the initial control group were affected.

## APPENDIX C. MAS-2 PROGRAM MONTHLY SAVINGS

Figure 1 through Figure 4 provide the monthly electric and gas savings from November 2014 through December 2015 for MAS-2 MyAccount and Non-MyAccount program. Similar to HER, the monthly electric and gas savings follow a seasonal pattern except for the monthly electric savings estimates for MyAccount that is relatively flatter. Overall, electric and gas savings for MAS-2 are positive and statistically significant at the 90% confidence level.

**Figure 1. Average monthly kWh savings per household for MyAccount**

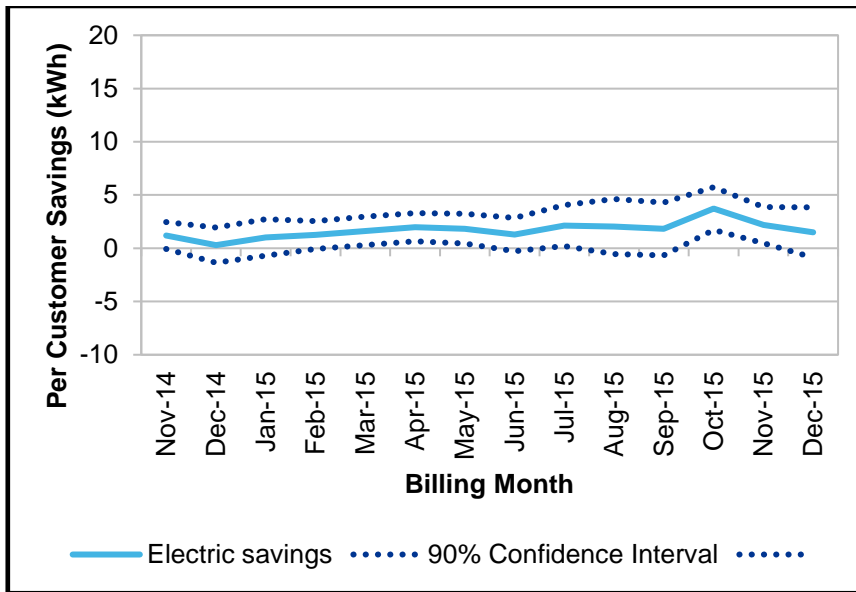




Figure 2. Average monthly kWh savings per household for Non-MyAccount

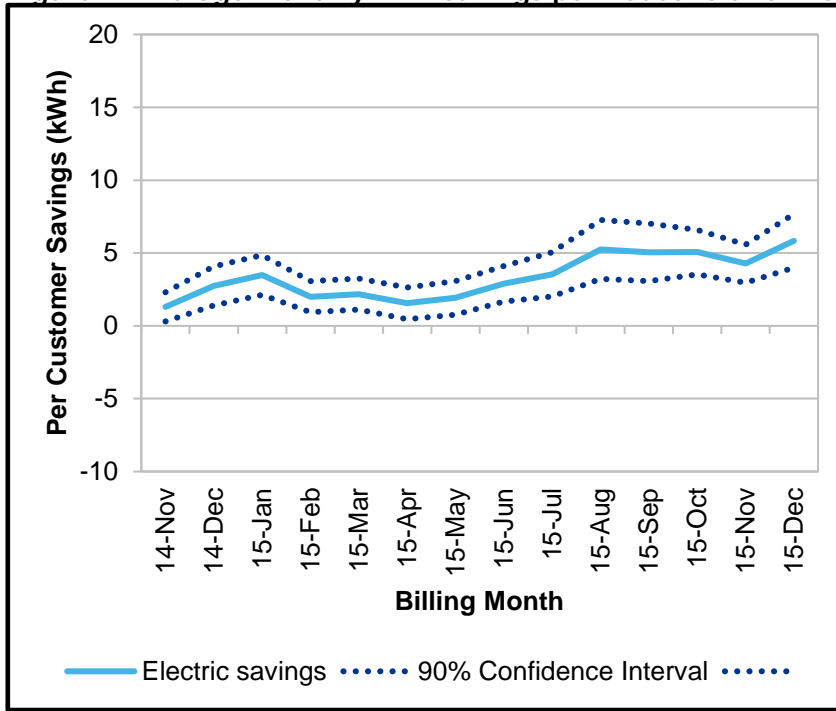


Figure 3. Average monthly therms savings per household for MyAccount

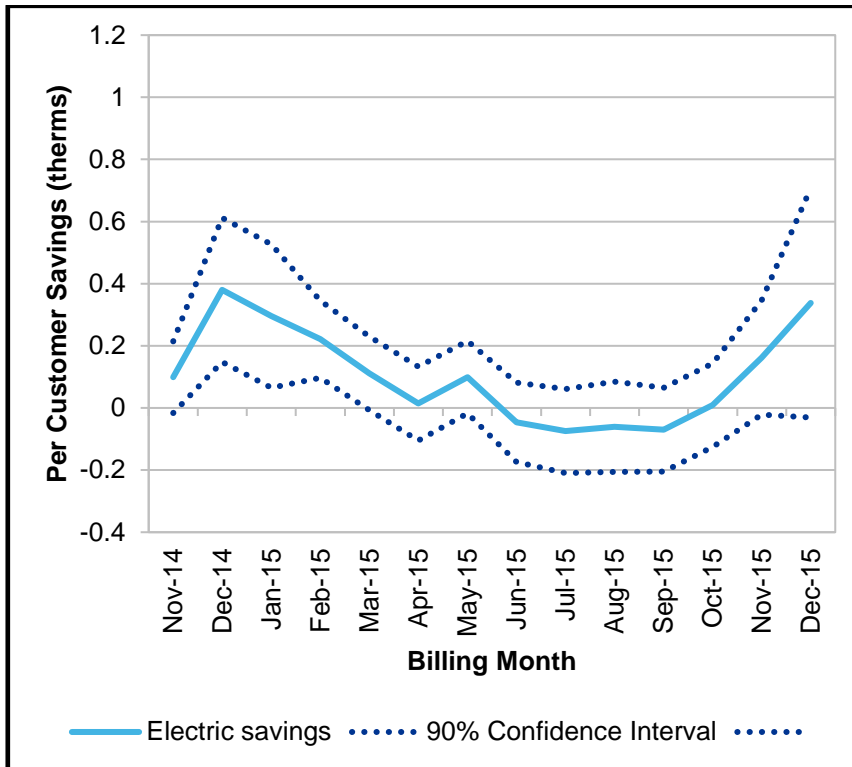
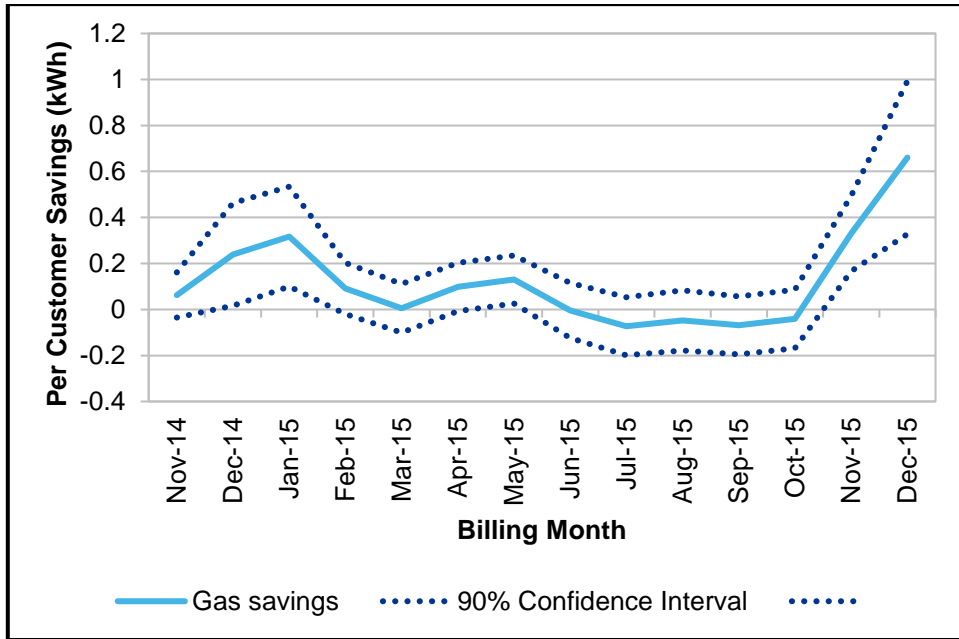


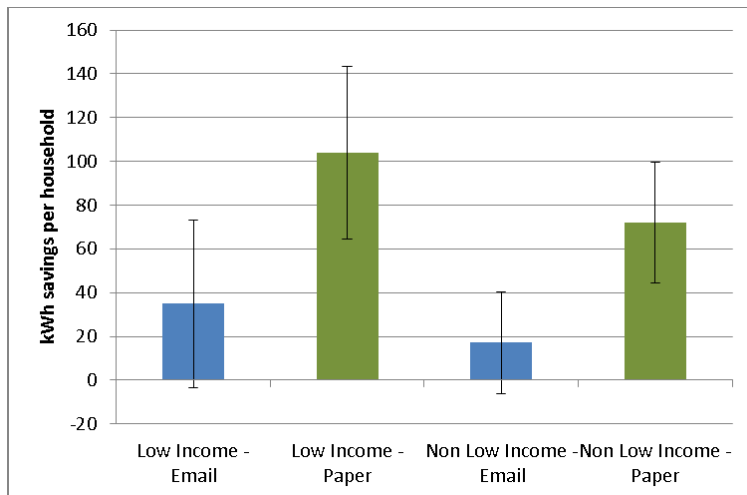
Figure 4. Average monthly therms savings per household for NonMyAccount



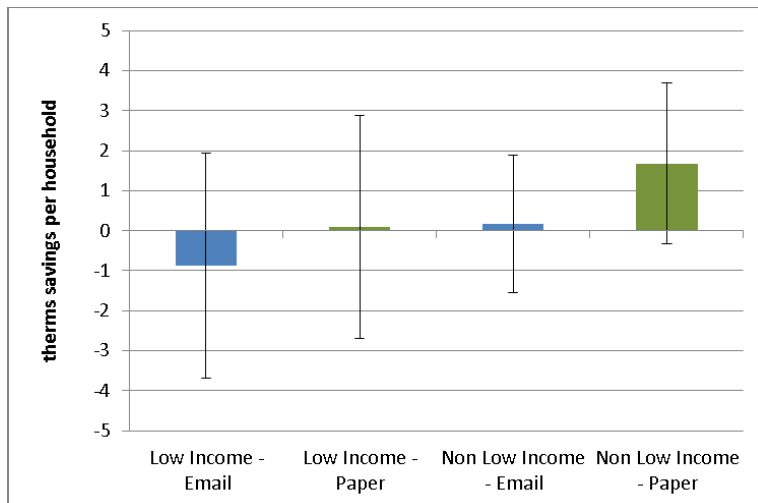
## APPENDIX D. OPOWER-2 EMAIL AND PAPER RECIPIENTS BY INCOME GROUP

Opower-2 is composed of low income and non-low income groups receiving either paper or email reports. Figure 1 and Figure 2 presents a comparison of electric and gas savings from the different treatment groups. Overall, we found that the paper recipients produced higher electric savings than the email recipients regardless of income group. The electric savings from email recipients in both income groups are positive but not statistically significant at the 90% confidence level. Among paper recipients, the low income group produced higher electric savings than the non-low income but the difference is not statistically significant at the 90% confidence level. For gas, we found no evidence of savings in any of the treatment groups for Opower-2. These findings suggest that the paper reports are more effective than the email reports.

**Figure 1. Unadjusted kWh savings for paper and email recipients by income group, Opower-2**



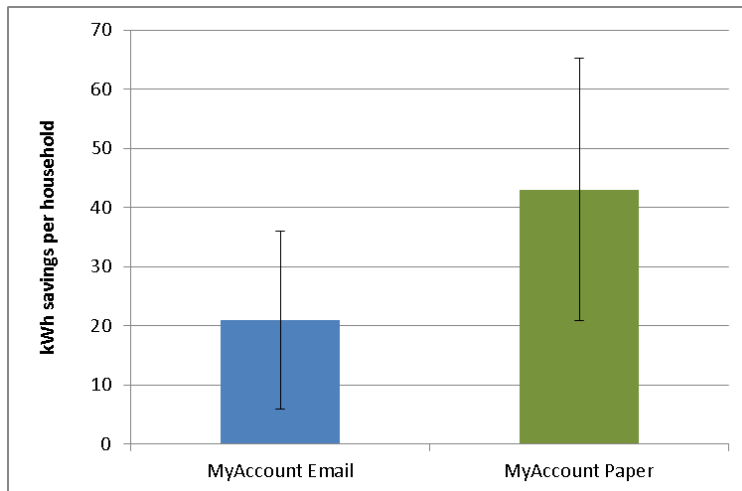
**Figure 2. Unadjusted therms savings for paper and email recipients by income group, Opower-2**



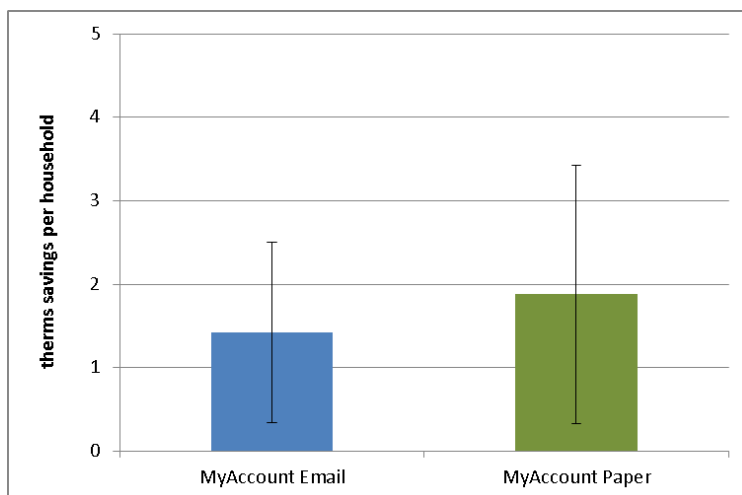
## APPENDIX E. MAS-2 MYACCOUNT PAPER AND EMAIL RECIPIENTS

The treatment group under MAS-2 MyAccount received either paper or email reports. Figure 1 and Figure 2 present a comparison of electric and gas savings from paper and email recipients. Consistent with Opower-2 results, the magnitude of savings produced by paper recipients is higher than the email recipients. However, the difference in savings between the email and paper recipients are not statistically significant at the 90% confidence level.

**Figure 1. Unadjusted kWh savings for paper and email recipients, MAS-2 MyAccount**



**Figure 2. Unadjusted therms savings for paper and email recipients, MAS-2 MyAccount**



## APPENDIX F. HER SAVINGS BY PA (2011-2014)

Table 1. Historical HER kWh and therms savings per household across PAs from 2011 to 2014

Year/PA	Wave	No. of Treatment Months	Unadjusted kWh Savings per Household	Percent kWh Savings	Unadjusted therms Savings per Household	Percent therms Savings
<b>2011-12</b>						
PG&E	Beta	17	234	1.5%	10	0.9%
	Gamma Dual Standard	14	90	1.1%	3	0.6%
	Gamma Dual Reduced	14	74	0.9%	4	0.6%
	Gamma Electric only	14	111	1.4%	NA	NA
	Wave One Dual	11	77	1.1%	1	0.4%
	Wave One Electric only	11	85	1.1%	NA	NA
SDG&E	Pilot	18	310	2.0%	12	1.5%
<b>2013</b>						
PG&E	Beta	12	221	2.1%	8	1.0%
	Gamma Dual Standard	12	112	1.5%	2	0.5%
	Gamma Dual Reduced	12	101	1.4%	2	0.5%
	Gamma Electric only	12	118	1.7%	NA	NA
	Wave One Dual	12	112	1.5%	3	0.6%
	Wave One Electric only	12	128	1.6%	NA	NA
	Wave Two Area 7	11	52	0.9%	3	0.6%
	Wave Two Not Area 7	11	60	0.9%	3	0.7%
	Wave Three	6	27	0.8%	1	0.6%
SCE	Opower1	12	123	1.2%	NA	NA
SDG&E	Pilot	12	282	2.8%	11	2.0%
<b>2014</b>						
PG&E	Beta	12	222	2.2%	5	0.8%
	Gamma Dual Standard	12	121	1.7%	2	0.6%
	Gamma Dual Reduced	12	99	1.4%	2	0.6%
	Gamma Electric only	12	105	1.5%	NA	NA
	Wave One Dual	12	117	1.7%	3	0.7%
	Wave One Electric only	12	129	1.6%	NA	NA
	Wave Two Area 7	12	92	1.4%	3	0.8%
	Wave Two Not Area 7	12	86	1.5%	3	0.8%
	Wave Three	12	69	1.0%	3	0.8%
	Wave Four	10	37	0.7%	1	0.2%
	Wave Five	3	10	0.4%	1	0.6%
SCE	Opower2	9	52	0.8%	NA	NA
SDG&E	Pilot	12	259	2.6%	8	1.8%



## Appendix AA. Standardized High Level Savings

The tables in Appendix AA summarizing natural gas savings make use of the unit MTherms – 1,000 Therms – rather than MMTherms – 1,000,000 Therms – for formatting purposes.

### Gross Lifecycle Savings (MWh)

Report Name	PA	Standard Report Group	Ex-Ante Gross	Ex-Post Gross	GRR	% Ex-Ante Gross Pass Through	Eval GRR
RES_3_1_2015_PGE_HER	PGE	Home Energy Reports	116,439 <sup>a</sup>	138,588	1.19	0.0%	1.19
<b>RES_3_1_2015_PGE_HER</b>	<b>PGE</b>	<b>Total</b>	<b>116,439</b>	<b>138,588</b>	<b>1.19</b>	<b>0.0%</b>	<b>1.19</b>
<i>RES_3_1_2015_PGE_HER</i>		<i>Statewide</i>	<i>116,439</i>	<i>138,588</i>	<i>1.19</i>	<i>0.0%</i>	<i>1.19</i>
RES_3_2_2015_SCE_HER	SCE	Home Energy Reports	4,565	4,796	1.05	0.0%	1.05
<b>RES_3_2_2015_SCE_HER</b>	<b>SCE</b>	<b>Total</b>	<b>4,565</b>	<b>4,796</b>	<b>1.05</b>	<b>0.0%</b>	<b>1.05</b>
<i>RES_3_2_2015_SCE_HER</i>		<i>Statewide</i>	<i>4,565</i>	<i>4,796</i>	<i>1.05</i>	<i>0.0%</i>	<i>1.05</i>
RES_3_3_2015_SDGE_HER	SDGE	Home Energy Reports	0	5,658			
RES_3_3_2015_SDGE_HER	SDGE	Manage Act Save	0	5,531			
<b>RES_3_3_2015_SDGE_HER</b>	<b>SDGE</b>	<b>Total</b>	<b>0</b>	<b>11,189</b>			
<i>RES_3_3_2015_SDGE_HER</i>		<i>Statewide</i>	<i>0</i>	<i>11,189</i>			
RES_3_4_2015_MCE_HUR	MCE	Home Utility Reports	0	0			
<b>RES_3_4_2015_MCE_HUR</b>	<b>MCE</b>	<b>Total</b>	<b>0</b>	<b>0</b>			
<i>RES_3_4_2015_MCE_HUR</i>		<i>Statewide</i>	<i>0</i>	<i>0</i>			

<sup>a</sup>The ExAnte savings represent savings claimed by PG&E.  
DNV GL

## Net Lifecycle Savings (MWh)

Report Name	PA	Standard Report Group	Ex-Ante Net	Ex-Post Net	NRR	% Ex-Ante Net Pass Through	Ex-Ante NTG	Ex-Post NTG	Eval Ex-Ante NTG	Eval Ex-Post NTG
RES_3_1_2015_PGE_HER	PGE	Home Energy Reports	116,439 <sup>a</sup>	138,588	1.19	0.0%	1.00	1.00	1.00	1.00
RES_3_1_2015_PGE_HER	PGE	<b>Total</b>	<b>116,439</b>	<b>138,588</b>	<b>1.19</b>	<b>0.0%</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>
<i>RES_3_1_2015_PGE_HER</i>		<i>Statewide</i>	<i>116,439</i>	<i>138,588</i>	<i>1.19</i>	<i>0.0%</i>	<i>1.00</i>	<i>1.00</i>	<i>1.00</i>	<i>1.00</i>
RES_3_2_2015_SCE_HER	SCE	Home Energy Reports	4,565	4,796	1.05	0.0%	1.00	1.00	1.00	1.00
RES_3_2_2015_SCE_HER	SCE	<b>Total</b>	<b>4,565</b>	<b>4,796</b>	<b>1.05</b>	<b>0.0%</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>
<i>RES_3_2_2015_SCE_HER</i>		<i>Statewide</i>	<i>4,565</i>	<i>4,796</i>	<i>1.05</i>	<i>0.0%</i>	<i>1.00</i>	<i>1.00</i>	<i>1.00</i>	<i>1.00</i>
RES_3_3_2015_SDGE_HER	SDGE	Home Energy Reports	0	5,658				1.00		1.00
RES_3_3_2015_SDGE_HER	SDGE	Manage Act Save	0	5,531				1.00		1.00
RES_3_3_2015_SDGE_HER	SDGE	<b>Total</b>	<b>0</b>	<b>11,189</b>				<b>1.00</b>		<b>1.00</b>
<i>RES_3_3_2015_SDGE_HER</i>		<i>Statewide</i>	<i>0</i>	<i>11,189</i>				<i>1.00</i>		<i>1.00</i>
RES_3_4_2015_MCE_HUR	MCE	Home Utility Reports	0	0						
RES_3_4_2015_MCE_HUR	MCE	<b>Total</b>	<b>0</b>	<b>0</b>						
<i>RES_3_4_2015_MCE_HUR</i>		<i>Statewide</i>	<i>0</i>	<i>0</i>						

<sup>a</sup>The ExAnte savings represent savings claimed by PG&E.  
DNV GL



### Gross Lifecycle Savings (MW)

Report Name	PA	Standard Report Group	Ex-Ante Gross	Ex-Post Gross	GRR	% Ex-Ante Gross Pass Through	Eval GRR
RES_3_1_2015_PGE_HER	PGE	Home Energy Reports	20.0 <sup>a</sup>	27.3	1.36	0.0%	1.36
<b>RES_3_1_2015_PGE_HER</b>	<b>PGE</b>	<b>Total</b>	<b>20.0</b>	<b>27.3</b>	<b>1.36</b>	<b>0.0%</b>	<b>1.36</b>
<i>RES_3_1_2015_PGE_HER</i>		<i>Statewide</i>	<i>20.0</i>	<i>27.3</i>	<i>1.36</i>	<i>0.0%</i>	<i>1.36</i>
RES_3_2_2015_SCE_HER	SCE	Home Energy Reports	0.7	0.7	1.02	0.0%	1.02
<b>RES_3_2_2015_SCE_HER</b>	<b>SCE</b>	<b>Total</b>	<b>0.7</b>	<b>0.7</b>	<b>1.02</b>	<b>0.0%</b>	<b>1.02</b>
<i>RES_3_2_2015_SCE_HER</i>		<i>Statewide</i>	<i>0.7</i>	<i>0.7</i>	<i>1.02</i>	<i>0.0%</i>	<i>1.02</i>
RES_3_3_2015_SDGE_HER	SDGE	Home Energy Reports	0.0	1.4			
RES_3_3_2015_SDGE_HER	SDGE	Manage Act Save	0.0	0.0			
<b>RES_3_3_2015_SDGE_HER</b>	<b>SDGE</b>	<b>Total</b>	<b>0.0</b>	<b>1.4</b>			
<i>RES_3_3_2015_SDGE_HER</i>		<i>Statewide</i>	<i>0.0</i>	<i>1.4</i>			
RES_3_4_2015_MCE_HUR	MCE	Home Utility Reports	0.0	0.0			
<b>RES_3_4_2015_MCE_HUR</b>	<b>MCE</b>	<b>Total</b>	<b>0.0</b>	<b>0.0</b>			
<i>RES_3_4_2015_MCE_HUR</i>		<i>Statewide</i>	<i>0.0</i>	<i>0.0</i>			

<sup>a</sup>The ExAnte savings represent savings claimed by PG&E.  
DNV GL

## Net Lifecycle Savings (MW)

Report Name	PA	Standard Report Group	Ex-Ante Net	Ex-Post Net	NRR	% Ex-Ante Net Pass Through	Ex-Ante NTG	Ex-Post NTG	Eval Ex-Ante NTG	Eval Ex-Post NTG
RES_3_1_2015_PGE_HER	PGE	Home Energy Reports	20.0 <sup>a</sup>	27.3	1.36	0.0%	1.00	1.00	1.00	1.00
RES_3_1_2015_PGE_HER	PGE	<b>Total</b>	<b>20.0</b>	<b>27.3</b>	<b>1.36</b>	<b>0.0%</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>
<b>RES_3_1_2015_PGE_HER</b>		<b>Statewide</b>	<b>20.0</b>	<b>27.3</b>	<b>1.36</b>	<b>0.0%</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>
RES_3_2_2015_SCE_HER	SCE	Home Energy Reports	0.7	0.7	1.02	0.0%	1.00	1.00	1.00	1.00
RES_3_2_2015_SCE_HER	SCE	<b>Total</b>	<b>0.7</b>	<b>0.7</b>	<b>1.02</b>	<b>0.0%</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>
<b>RES_3_2_2015_SCE_HER</b>		<b>Statewide</b>	<b>0.7</b>	<b>0.7</b>	<b>1.02</b>	<b>0.0%</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>
RES_3_3_2015_SDGE_HER	SDGE	Home Energy Reports	0.0	1.4				1.00		1.00
RES_3_3_2015_SDGE_HER	SDGE	Manage Act Save	0.0	0.0						
RES_3_3_2015_SDGE_HER	SDGE	<b>Total</b>	<b>0.0</b>	<b>1.4</b>				<b>1.00</b>		<b>1.00</b>
<b>RES_3_3_2015_SDGE_HER</b>		<b>Statewide</b>	<b>0.0</b>	<b>1.4</b>				<b>1.00</b>		<b>1.00</b>
RES_3_4_2015_MCE_HUR	MCE	Home Utility Reports	0.0	0.0						
RES_3_4_2015_MCE_HUR	MCE	<b>Total</b>	<b>0.0</b>	<b>0.0</b>						
<b>RES_3_4_2015_MCE_HUR</b>		<b>Statewide</b>	<b>0.0</b>	<b>0.0</b>						

<sup>a</sup>The ExAnte savings represent savings claimed by PG&E.  
DNV GL

### Gross Lifecycle Savings (MTherms)

Report Name	PA	Standard Report Group	Ex-Ante Gross	Ex-Post Gross	GRR	% Ex-Ante Gross Pass Through	Eval GRR
RES_3_1_2015_PGE_HER	PGE	Home Energy Reports	4,148 <sup>a</sup>	4,691	1.13	0.0%	1.13
<b>RES_3_1_2015_PGE_HER</b>	<b>PGE</b>	<b>Total</b>	<b>4,148</b>	<b>4,691</b>	<b>1.13</b>	<b>0.0%</b>	<b>1.13</b>
<i>RES_3_1_2015_PGE_HER</i>		<i>Statewide</i>	<i>4,148</i>	<i>4,691</i>	<i>1.13</i>	<i>0.0%</i>	<i>1.13</i>
RES_3_2_2015_SCE_HER	SCE	Home Energy Reports	0	0			
<b>RES_3_2_2015_SCE_HER</b>	<b>SCE</b>	<b>Total</b>	<b>0</b>	<b>0</b>			
<i>RES_3_2_2015_SCE_HER</i>		<i>Statewide</i>	<i>0</i>	<i>0</i>			
RES_3_3_2015_SDGE_HER	SDGE	Home Energy Reports	0	130			
RES_3_3_2015_SDGE_HER	SDGE	Manage Act Save	0	271			
<b>RES_3_3_2015_SDGE_HER</b>	<b>SDGE</b>	<b>Total</b>	<b>0</b>	<b>401</b>			
<i>RES_3_3_2015_SDGE_HER</i>		<i>Statewide</i>	<i>0</i>	<i>401</i>			
RES_3_4_2015_MCE_HUR	MCE	Home Utility Reports	0	0			
<b>RES_3_4_2015_MCE_HUR</b>	<b>MCE</b>	<b>Total</b>	<b>0</b>	<b>0</b>			
<i>RES_3_4_2015_MCE_HUR</i>		<i>Statewide</i>	<i>0</i>	<i>0</i>			

<sup>a</sup>The ExAnte savings represent savings claimed by PG&E.  
DNV GL

### Net Lifecycle Savings (MTherms)

Report Name	PA	Standard Report Group	Ex-Ante Net	Ex-Post Net	NRR	% Ex-Ante Net Pass Through	Ex-Ante NTG	Ex-Post NTG	Eval Ex-Ante NTG	Eval Ex-Post NTG
RES_3_1_2015_PGE_HER	PGE	Home Energy Reports	4,148 <sup>a</sup>	4,691	1.13	0.0%	1.00	1.00	1.00	1.00
RES_3_1_2015_PGE_HER	PGE	<b>Total</b>	<b>4,148</b>	<b>4,691</b>	<b>1.13</b>	<b>0.0%</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>
<b>RES_3_1_2015_PGE_HER</b>		<b>Statewide</b>	<b>4,148</b>	<b>4,691</b>	<b>1.13</b>	<b>0.0%</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>
RES_3_2_2015_SCE_HER	SCE	Home Energy Reports	0	0						
RES_3_2_2015_SCE_HER	SCE	<b>Total</b>	<b>0</b>	<b>0</b>						
<b>RES_3_2_2015_SCE_HER</b>		<b>Statewide</b>	<b>0</b>	<b>0</b>						
RES_3_3_2015_SDGE_HER	SDGE	Home Energy Reports	0	130				1.00		1.00
RES_3_3_2015_SDGE_HER	SDGE	Manage Act Save	0	271				1.00		1.00
RES_3_3_2015_SDGE_HER	SDGE	<b>Total</b>	<b>0</b>	<b>401</b>				<b>1.00</b>		<b>1.00</b>
<b>RES_3_3_2015_SDGE_HER</b>		<b>Statewide</b>	<b>0</b>	<b>401</b>				<b>1.00</b>		<b>1.00</b>
RES_3_4_2015_MCE_HUR	MCE	Home Utility Reports	0	0						
RES_3_4_2015_MCE_HUR	MCE	<b>Total</b>	<b>0</b>	<b>0</b>						
<b>RES_3_4_2015_MCE_HUR</b>		<b>Statewide</b>	<b>0</b>	<b>0</b>						

<sup>a</sup>The ExAnte savings represent savings claimed by PG&E.  
DNV GL

### Gross First Year Savings (MWh)

Report Name	PA	Standard Report Group	Ex-Ante Gross	Ex-Post Gross	GRR	% Ex-Ante Gross Pass Through	Eval GRR
RES_3_1_2015_PGE_HER	PGE	Home Energy Reports	116,439 <sup>a</sup>	138,588	1.19	0.0%	1.19
<b>RES_3_1_2015_PGE_HER</b>	<b>PGE</b>	<b>Total</b>	<b>116,439</b>	<b>138,588</b>	<b>1.19</b>	<b>0.0%</b>	<b>1.19</b>
<i>RES_3_1_2015_PGE_HER</i>		<i>Statewide</i>	<i>116,439</i>	<i>138,588</i>	<i>1.19</i>	<i>0.0%</i>	<i>1.19</i>
RES_3_2_2015_SCE_HER	SCE	Home Energy Reports	4,565	4,796	1.05	0.0%	1.05
<b>RES_3_2_2015_SCE_HER</b>	<b>SCE</b>	<b>Total</b>	<b>4,565</b>	<b>4,796</b>	<b>1.05</b>	<b>0.0%</b>	<b>1.05</b>
<i>RES_3_2_2015_SCE_HER</i>		<i>Statewide</i>	<i>4,565</i>	<i>4,796</i>	<i>1.05</i>	<i>0.0%</i>	<i>1.05</i>
RES_3_3_2015_SDGE_HER	SDGE	Home Energy Reports	0	5,658			
RES_3_3_2015_SDGE_HER	SDGE	Manage Act Save	0	5,531			
<b>RES_3_3_2015_SDGE_HER</b>	<b>SDGE</b>	<b>Total</b>	<b>0</b>	<b>11,189</b>			
<i>RES_3_3_2015_SDGE_HER</i>		<i>Statewide</i>	<i>0</i>	<i>11,189</i>			
RES_3_4_2015_MCE_HUR	MCE	Home Utility Reports	0	0			
<b>RES_3_4_2015_MCE_HUR</b>	<b>MCE</b>	<b>Total</b>	<b>0</b>	<b>0</b>			
<i>RES_3_4_2015_MCE_HUR</i>		<i>Statewide</i>	<i>0</i>	<i>0</i>			

<sup>a</sup>The ExAnte savings represent savings claimed by PG&E.  
DNV GL

## Net First Year Savings (MWh)

Report Name	PA	Standard Report Group	Ex-Ante Net	Ex-Post Net	NRR	% Ex-Ante Net Pass Through	Ex-Ante NTG	Ex-Post NTG	Eval Ex-Ante NTG	Eval Ex-Post NTG
RES_3_1_2015_PGE_HER	PGE	Home Energy Reports	116,439 <sup>a</sup>	138,588	1.19	0.0%	1.00	1.00	1.00	1.00
RES_3_1_2015_PGE_HER	PGE	<b>Total</b>	<b>116,439</b>	<b>138,588</b>	<b>1.19</b>	<b>0.0%</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>
<b>RES_3_1_2015_PGE_HER</b>		<b>Statewide</b>	<b>116,439</b>	<b>138,588</b>	<b>1.19</b>	<b>0.0%</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>
RES_3_2_2015_SCE_HER	SCE	Home Energy Reports	4,565	4,796	1.05	0.0%	1.00	1.00	1.00	1.00
RES_3_2_2015_SCE_HER	SCE	<b>Total</b>	<b>4,565</b>	<b>4,796</b>	<b>1.05</b>	<b>0.0%</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>
<b>RES_3_2_2015_SCE_HER</b>		<b>Statewide</b>	<b>4,565</b>	<b>4,796</b>	<b>1.05</b>	<b>0.0%</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>
RES_3_3_2015_SDGE_HER	SDGE	Home Energy Reports	0	5,658				1.00		1.00
RES_3_3_2015_SDGE_HER	SDGE	Manage Act Save	0	5,531				1.00		1.00
RES_3_3_2015_SDGE_HER	SDGE	<b>Total</b>	<b>0</b>	<b>11,189</b>				<b>1.00</b>		<b>1.00</b>
<b>RES_3_3_2015_SDGE_HER</b>		<b>Statewide</b>	<b>0</b>	<b>11,189</b>				<b>1.00</b>		<b>1.00</b>
RES_3_4_2015_MCE_HUR	MCE	Home Utility Reports	0	0						
RES_3_4_2015_MCE_HUR	MCE	<b>Total</b>	<b>0</b>	<b>0</b>						
<b>RES_3_4_2015_MCE_HUR</b>		<b>Statewide</b>	<b>0</b>	<b>0</b>						

<sup>a</sup>The ExAnte savings represent savings claimed by PG&E.  
DNV GL

### Gross First Year Savings (MW)

Report Name	PA	Standard Report Group	Ex-Ante Gross	Ex-Post Gross	GRR	% Ex-Ante Gross Pass Through	Eval GRR
RES_3_1_2015_PGE_HER	PGE	Home Energy Reports	20.0 <sup>a</sup>	27.3	1.36	0.0%	1.36
<b>RES_3_1_2015_PGE_HER</b>	<b>PGE</b>	<b>Total</b>	<b>20.0</b>	<b>27.3</b>	<b>1.36</b>	<b>0.0%</b>	<b>1.36</b>
<b>RES_3_1_2015_PGE_HER</b>		<b>Statewide</b>	<b>20.0</b>	<b>27.3</b>	<b>1.36</b>	<b>0.0%</b>	<b>1.36</b>
RES_3_2_2015_SCE_HER	SCE	Home Energy Reports	0.7	0.7	1.02	0.0%	1.02
<b>RES_3_2_2015_SCE_HER</b>	<b>SCE</b>	<b>Total</b>	<b>0.7</b>	<b>0.7</b>	<b>1.02</b>	<b>0.0%</b>	<b>1.02</b>
<b>RES_3_2_2015_SCE_HER</b>		<b>Statewide</b>	<b>0.7</b>	<b>0.7</b>	<b>1.02</b>	<b>0.0%</b>	<b>1.02</b>
RES_3_3_2015_SDGE_HER	SDGE	Home Energy Reports	0.0	1.4			
RES_3_3_2015_SDGE_HER	SDGE	Manage Act Save	0.0	0.0			
<b>RES_3_3_2015_SDGE_HER</b>	<b>SDGE</b>	<b>Total</b>	<b>0.0</b>	<b>1.4</b>			
<b>RES_3_3_2015_SDGE_HER</b>		<b>Statewide</b>	<b>0.0</b>	<b>1.4</b>			
RES_3_4_2015_MCE_HUR	MCE	Home Utility Reports	0.0	0.0			
<b>RES_3_4_2015_MCE_HUR</b>	<b>MCE</b>	<b>Total</b>	<b>0.0</b>	<b>0.0</b>			
<b>RES_3_4_2015_MCE_HUR</b>		<b>Statewide</b>	<b>0.0</b>	<b>0.0</b>			

<sup>a</sup>The ExAnte savings represent savings claimed by PG&E.  
DNV GL

## Net First Year Savings (MW)

Report Name	PA	Standard Report Group	Ex-Ante Net	Ex-Post Net	NRR	% Ex-Ante Net Pass Through	Ex-Ante NTG	Ex-Post NTG	Eval Ex-Ante NTG	Eval Ex-Post NTG
RES_3_1_2015_PGE_HER	PGE	Home Energy Reports	20.0 <sup>a</sup>	27.3	1.36	0.0%	1.00	1.00	1.00	1.00
RES_3_1_2015_PGE_HER	PGE	<b>Total</b>	<b>20.0</b>	<b>27.3</b>	<b>1.36</b>	<b>0.0%</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>
<i>RES_3_1_2015_PGE_HER</i>		<i>Statewide</i>	<i>20.0</i>	<i>27.3</i>	<i>1.36</i>	<i>0.0%</i>	<i>1.00</i>	<i>1.00</i>	<i>1.00</i>	<i>1.00</i>
RES_3_2_2015_SCE_HER	SCE	Home Energy Reports	0.7	0.7	1.02	0.0%	1.00	1.00	1.00	1.00
RES_3_2_2015_SCE_HER	SCE	<b>Total</b>	<b>0.7</b>	<b>0.7</b>	<b>1.02</b>	<b>0.0%</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>
<i>RES_3_2_2015_SCE_HER</i>		<i>Statewide</i>	<i>0.7</i>	<i>0.7</i>	<i>1.02</i>	<i>0.0%</i>	<i>1.00</i>	<i>1.00</i>	<i>1.00</i>	<i>1.00</i>
RES_3_3_2015_SDGE_HER	SDGE	Home Energy Reports	0.0	1.4				1.00		1.00
RES_3_3_2015_SDGE_HER	SDGE	Manage Act Save	0.0	0.0						
RES_3_3_2015_SDGE_HER	SDGE	<b>Total</b>	<b>0.0</b>	<b>1.4</b>				<b>1.00</b>		<b>1.00</b>
<i>RES_3_3_2015_SDGE_HER</i>		<i>Statewide</i>	<i>0.0</i>	<i>1.4</i>				<i>1.00</i>		<i>1.00</i>
RES_3_4_2015_MCE_HUR	MCE	Home Utility Reports	0.0	0.0						
RES_3_4_2015_MCE_HUR	MCE	<b>Total</b>	<b>0.0</b>	<b>0.0</b>						
<i>RES_3_4_2015_MCE_HUR</i>		<i>Statewide</i>	<i>0.0</i>	<i>0.0</i>						

<sup>a</sup>The ExAnte savings represent savings claimed by PG&E.  
DNV GL



### Gross First Year Savings (MTherms)

Report Name	PA	Standard Report Group	Ex-Ante Gross	Ex-Post Gross	GRR	% Ex-Ante Gross Pass Through	Eval GRR
RES_3_1_2015_PGE_HER	PGE	Home Energy Reports	4,148 <sup>a</sup>	4,691	1.13	0.0%	1.13
<b>RES_3_1_2015_PGE_HER</b>	<b>PGE</b>	<b>Total</b>	<b>4,148</b>	<b>4,691</b>	<b>1.13</b>	<b>0.0%</b>	<b>1.13</b>
<i>RES_3_1_2015_PGE_HER</i>		<i>Statewide</i>	<i>4,148</i>	<i>4,691</i>	<i>1.13</i>	<i>0.0%</i>	<i>1.13</i>
RES_3_2_2015_SCE_HER	SCE	Home Energy Reports	0	0			
<b>RES_3_2_2015_SCE_HER</b>	<b>SCE</b>	<b>Total</b>	<b>0</b>	<b>0</b>			
<i>RES_3_2_2015_SCE_HER</i>		<i>Statewide</i>	<i>0</i>	<i>0</i>			
RES_3_3_2015_SDGE_HER	SDGE	Home Energy Reports	0	130			
RES_3_3_2015_SDGE_HER	SDGE	Manage Act Save	0	271			
<b>RES_3_3_2015_SDGE_HER</b>	<b>SDGE</b>	<b>Total</b>	<b>0</b>	<b>401</b>			
<i>RES_3_3_2015_SDGE_HER</i>		<i>Statewide</i>	<i>0</i>	<i>401</i>			
RES_3_4_2015_MCE_HUR	MCE	Home Utility Reports	0	0			
<b>RES_3_4_2015_MCE_HUR</b>	<b>MCE</b>	<b>Total</b>	<b>0</b>	<b>0</b>			
<i>RES_3_4_2015_MCE_HUR</i>		<i>Statewide</i>	<i>0</i>	<i>0</i>			

<sup>a</sup>The ExAnte savings represent savings claimed by PG&E.  
DNV GL

### Net First Year Savings (MTherms)

Report Name	PA	Standard Report Group	Ex-Ante Net	Ex-Post Net	NRR	% Ex-Ante Net Pass Through	Ex-Ante NTG	Ex-Post NTG	Eval Ex-Ante NTG	Eval Ex-Post NTG
RES_3_1_2015_PGE_HER	PGE	Home Energy Reports	4,148 <sup>a</sup>	4,691	1.13	0.0%	1.00	1.00	1.00	1.00
RES_3_1_2015_PGE_HER	PGE	<b>Total</b>	<b>4,148</b>	<b>4,691</b>	<b>1.13</b>	<b>0.0%</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>
<b>RES_3_1_2015_PGE_HER</b>		<b>Statewide</b>	<b>4,148</b>	<b>4,691</b>	<b>1.13</b>	<b>0.0%</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>
RES_3_2_2015_SCE_HER	SCE	Home Energy Reports	0	0						
RES_3_2_2015_SCE_HER	SCE	<b>Total</b>	<b>0</b>	<b>0</b>						
<b>RES_3_2_2015_SCE_HER</b>		<b>Statewide</b>	<b>0</b>	<b>0</b>						
RES_3_3_2015_SDGE_HER	SDGE	Home Energy Reports	0	130				1.00		1.00
RES_3_3_2015_SDGE_HER	SDGE	Manage Act Save	0	271				1.00		1.00
RES_3_3_2015_SDGE_HER	SDGE	<b>Total</b>	<b>0</b>	<b>401</b>				<b>1.00</b>		<b>1.00</b>
<b>RES_3_3_2015_SDGE_HER</b>		<b>Statewide</b>	<b>0</b>	<b>401</b>				<b>1.00</b>		<b>1.00</b>
RES_3_4_2015_MCE_HUR	MCE	Home Utility Reports	0	0						
RES_3_4_2015_MCE_HUR	MCE	<b>Total</b>	<b>0</b>	<b>0</b>						
<b>RES_3_4_2015_MCE_HUR</b>		<b>Statewide</b>	<b>0</b>	<b>0</b>						

<sup>a</sup>The ExAnte savings represent savings claimed by PG&E.  
DNV GL



## Appendix AB. Standardized Per Unit Savings

Not reported.



## Appendix AC. Recommendations

**Appendix AC: Recommendations**

Study ID	Study Type	Study Title	Study Manager			
Res 3.3	Impact Evaluation	Impact Evaluation of 2015 San Diego Gas & Electric Home Energy Reports and Manage-Act-Save Program	CPUC			
Recommendation	Program or Database	Summary of Findings	Additional Supporting Information	Best Practice / Recommendations	Recommendation Recipient	Affected Workpaper or DEER
1	HER	The experimental wave targeting large users produced the highest savings.	N/A	Expand the program particularly to high usage customers to achieve the greatest savings from the program	SDG&E	N/A
2	HER	Savings from paper reports tend to produce higher savings than email reports. The email reports may not be as effective as paper reports but it may still be a cost-effective channel since sending email reports is likely cheaper than sending paper reports.	N/A	Compare the cost effectiveness of paper and email reports. This requires tracking costs associated to paper and email reports separately.	SDG&E	N/A

**Appendix BA. Public Comments on 2015 SDGE HER Evaluation**

No.	From	Section	Comments	Response
1	SDG&E	Overarching	<p>Comments:</p> <p>We noticed that the study virtually did not cover the “characteristics” of the participants for each “Wave of Opower” or MAS. We believe this is a missed opportunity since all HER participants are highly targeted (i.e., high usage, hot climate zones, and other characteristics). Just drawing conclusion on if a participate “Wave” was producing positive energy savings is really not address the importance of screening and targeting to make the particular “Wave” cost effective. For example, for Opower implementation, it is important to target high usage customers. This also means that lower usage customers should be screened out of the RCT design.</p> <p>For the final report, SDG&amp;E is recommending the following:</p> <ol style="list-style-type: none"> <li>(1) Create a section to talk about the screening and targeting criteria for each HER mailing design (i.e., for both Opower and MAS),</li> <li>(2) Discuss in context if a particular screening and targeting strategy is working as designed.</li> <li>(3) Discuss the implication of HER mailing given the RCT design and targeting limitations.</li> </ol>	<p>We clarified this in the report. We added a description of the target groups/ experimental design for HER and MAS programs in Section 1, and Section 2, We also added a section (Section 4.3) discussing how the design/target groups may have contributed to the variations in savings.</p>
2	SDG&E	Overarching (continued)	<p>SDGE asks DNV-GL to discuss how they controlled for potential differences between strata in the RCT design? SDGE uses a stratified random sample for the RCT design, and treatment and control group assignments. If potential differences between strata are not controlled for, the results may be biased.</p>	<p>The model we used in estimating savings controls for potential differences between strata through the inclusion of the fixed effects. The inclusion of fixed effects allows us to measure the average treatment effect while controlling for customer heterogeneity that is constant over time. This includes controlling for differences in geography, size, baseline usage, and other unobserved characteristics that are time-invariant. SDG&amp;E used climate</p>

				zones and baseline usage in HER and MAS stratification. Differences in climate zones and baseline consumption between stratum are absorbed in the customer fixed effects.
3	SDG&E	P.2	Under key findings, it may be helpful to provide some context for Opower-1, Opower-2 and MAS since each of these HER/MAS Home Energy Reports are specifically targeted for certain participant characteristics. This also means that the participants for Opower-1 vs Opower-2 and MAS-2 are fundamentally different, thus readers should take extra caution to compare results across these three implementation efforts.	See response in #1
3	SDG&E	P.4	As illustrated by Figure-1, why is the Opower-2 generating so much more kW savings than Opower-1? This result is not supported by Table-1.	The results reported in Figure-1 are the total program savings i.e the per household savings multiplied by the number of households while Table 1 presents the per household savings. Opower-2 produced higher total program kW savings despite lower per household savings when compared to Opower-1 because of the higher number of treatment customers in Opower-2.
4	SDG&E	P.18	<p>The study removal of two net metering customers which is about 5% to 7% of the households. We understand the desire to not over- or under-estimate energy savings due to customers transition to net metering accounts. Removing these accounts, after the fact, risk the possibility of invalidating the integrity and balance of the RCT design, which is an important concern.</p> <p>An alternative to removing these accounts is to conduct additional analysis (similar to other joint saving analysis) for these accounts to isolate "behavior savings" as a result of receiving program treatment, using the same RCT construct.</p>	Including customers who installed solar and switched to net metering during the treatment period posed some challenges in the evaluation because of how net metering is addressed in the billing data. If net metered households are included in the analysis, it would be necessary to incorporate household-level energy production data to estimate savings. We can conduct the recommended additional analysis if production data from solar homes are provided. Otherwise, the potential

			<p>Missing customers. We know that customers with non-usage were dropped. What other SDG&amp;E accounts were excluded from the control group? SDG&amp;E has a higher internal reported number of accounts even with dropping the non-usage customer. Please let us know all customers dropped.</p>	<p>difference in solar energy production between the treatment and control groups would be conflated with program savings and could bias the results up or down.</p> <p>The number of customers that switched to net metering is more or less balanced between the treatment and control groups. The removal of customers that switched to net metering from the treatment and control groups is consistent with the approach we used in the HER program evaluations for the 2010-2012 and 2013-2014 program years for SDG&amp;E and other IOUs. The</p> <p>Customers that we dropped from the analysis includes those who moved out before 2015, and net metered customers. We included a table summarizing the sample disposition in the report (See Section 3.5 Table 6).</p>
--	--	--	--	--





## **ABOUT DNV GL**

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16,000 professionals are dedicated to helping our customers make the world safer, smarter and greener.