Review and Validation of 2015 Southern California Edison Home Energy Reports Program Impacts (Final Report)

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1 EXECUTIVE SUMMARY

This report summarizes the results of DNV GL's review and evaluation of the Southern California Edison (SCE) Home Energy Reports (HER) program impacts for 2015. The evaluation includes calculated energy and demand savings estimates that are used to validate an earlier HER 2015 impact evaluation from Applied Energy Group (AEG).

1.1 Background

SCE's HER pilot program (Opower-1) started sending bi-monthly reports to 75,000 treatment households in December 2012 through 2013. The reports contain a mix of consumption information, energy usage comparison with similar neighbors and customized tips for saving energy. After one year of sending the reports, SCE discontinued Opower-1 and implemented the HER program to a new cohort (Opower-2).

SCE began sending HER reports to the Opower-2 cohort in March 2013. Opower-2 is the unused portion of the eligible population developed for Opower-1 and consists of 150,000 SCE customers that are randomly selected to the treatment and control groups.

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

1.2 Research questions and objectives

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

- What are the electric savings for Opower-2?
- Are there downstream/upstream rebate program savings that could be jointly claimed by both the HER program and other SCE rebate programs?
- What are the peak demand savings attributable to the program?
- Are the results produced by AEG on behalf of SCE consistent with the results produced by this independent evaluation?
- Do savings persist for Opower-1?

1.3 Study approach

To answer the research questions, DNV GL reviewed and validated AEG's early impact evaluation for SCE's 2015 HER program. DNV GL reviewed upstream joint savings calculation and replicated AEG's analysis to produce fully independent estimates. DNV GL compared its independent estimates for the different components of HER program savings with AEG's results. The different components were:

- *Overall unadjusted energy and demand savings*. These savings measure the impact of the HER program on average household energy consumption and demand. We estimated the unadjusted energy savings using a fixed effects regression model that compared 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 HER-induced savings derived from the increased uptake of SCE rebate programs. This estimate is produced for two kinds of programs:
  - *Downstream* joint savings occur due to increased participation by the HER treatment group versus the control group in SCE's tracked energy efficiency programs.
  - *Upstream* joint savings occur due to increased purchases of SCE-supported upstream lighting program CFL and LED bulbs by the HER 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.

This ex-post validation did not only review the approach used by AEG but also replicated the analysis. This approach allows DNV GL to provide the CPUC with recommendations from a more robust validation of the estimated savings that occurred within the program.

1.4 Key findings

DNV GL reviewed and validated AEG's calculation of the different savings components for Opower-2. Overall, AEG's and DNV GL's unadjusted electric and demand savings estimates are comparable (Table 1). DNV GL recommends using AEG's unadjusted energy and demand savings estimates for the 2015 SCE HER program.

Table 1. Comparison of AEG's and DNV GL's unadjusted kWh and kW savings per household

Unit of savings	AEG	DNV GL	% DNV / AEG
kWh	78	81	104%
kW	0.01	0.01	108%

For joint savings analysis, DNV GL recommends using AEG's downstream joint savings along with DNV GL's estimates for upstream programs. DNV GL's upstream joint savings provide a better representation of joint savings because the calculation included updated information based on recent lighting studies. This information was not available when AEG finished their evaluation and their calculations are different and based on less appropriate inputs. As a result, we recommend using DNV GL's estimates of upstream joint savings.

Table 2 provides the recommended estimates of unadjusted and adjusted savings at the household level as a fraction of the control group's average consumption in 2015. Overall, the HER program produced 1% electric savings and 0.5% demand savings.

Table 2. Average kWh savings per household as a percent of consumption

Savings	Baseline Consumption	Per Household Savings (Unadjusted)	Per Household Savings (Adjusted)	% Savings	
				Unadjusted	Adjusted
kWh	7,706	78	70	1.0%	0.9%
kW	2.5	0.01	0.01	0.5%	0.4%

Figure 1 presents the total kWh and kW unadjusted and adjusted savings at the program-level. Overall, the HER program achieved 4.8 GWh adjusted program savings and 0.7 MW adjusted demand savings. AEG's downstream and DNV GL's upstream joint savings estimates were subtracted from the total unadjusted savings to produce the final adjusted savings; this adjustment was performed to address the potential for "double-counting" savings already claimed by other SCE programs. The double-counted savings are small and accounted for 10% of the total unadjusted electric savings and 7% of the peak demand savings.

Figure 1. Program-level kWh and kW savings estimates for 2015

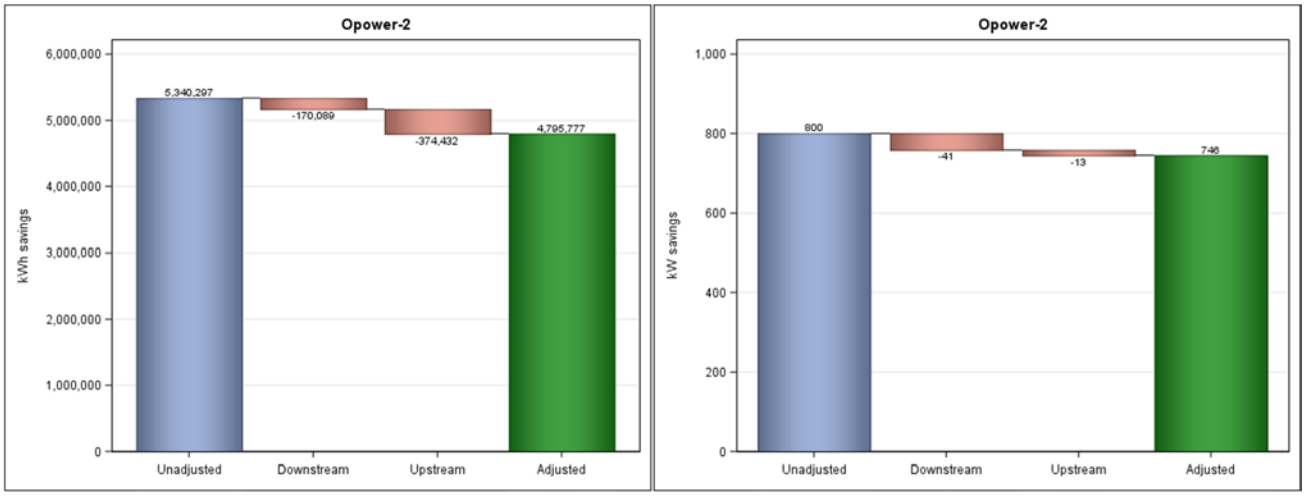
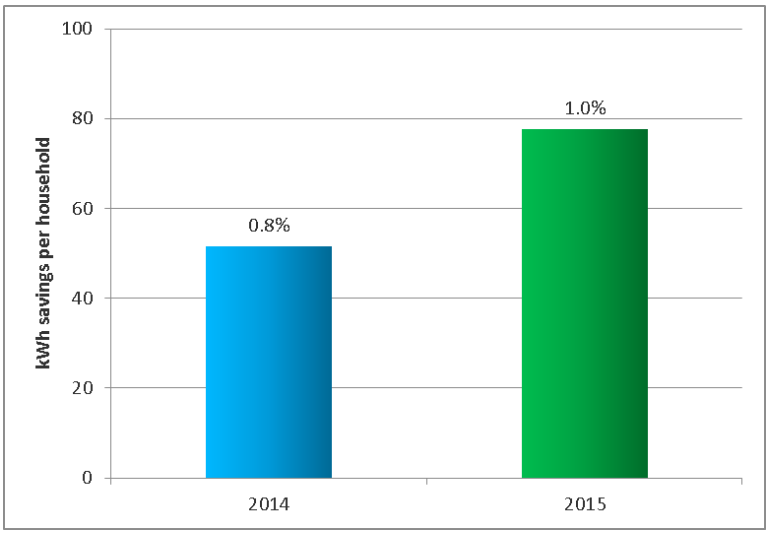


Figure 2 presents a comparison of the percent kWh savings in 2014 and 2015 for Opower-2. Percent savings increased from 0.8% to 1% from 2014 to 2015. The 2014 savings were not for a full year and represent the first 9 months of the Opower-2 program while 2015 represents a full year savings. Overall, Opower-2 produced electric savings that are consistent with the 1% to 3% savings reported for the HER program.

Figure 2. Opower-2 percent kWh savings in 2014 and 2015



2 INTRODUCTION

The California Public Utilities Commission (CPUC) engaged DNV GL to review and validate Southern California Edison's (SCE's) impact evaluation of the Home Energy Reports (HER) program for calendar year 2015. This report provides the findings of DNV GL's review and validation of SCE HER program savings estimates produced by Applied Energy Group (AEG).

This is DNV GL's fourth year as the independent evaluator of the HER program for CPUC. As such, DNV GL has access to a full set of SCE billing data and program tracking data, which allowed DNV GL to produce fully independent savings estimates to compare with AEG's.

2.1 HER program description

SCE's HER pilot program (Opower-1) started sending bi-monthly reports to 75,000 treatment households in December 2012 through 2013. The reports contain a mix of consumption information, energy usage comparison with similar neighbors and customized tips for saving energy. After one year of sending the reports, SCE discontinued Opower-1 and implemented the HER program to a new cohort (Opower-2).

In March 2014, SCE offer the HER program to Opower-2, that is composed of the unused portion of the eligible population developed for Opower-1. Opower-2 comprised 150,000 SCE customers that are randomly selected to the treatment and control groups.

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

Similar to Opower-1, there was an issue with mismatched addresses when implementing Opower-2. The mismatched addresses in SCE's billing system caused 5% of the treatment households to never receive the reports. According to SCE, the issue was inherent to their billing data system and was not program-related.

Both DNV GL and AEG included customers with mismatched addresses in the analysis to protect the experimental design of the HER program. Inclusion of these customers avoids any potential bias in estimation of program impact. The mismatched address issue can negatively affect program savings since customers with the address issue in the treatment group were never treated or received the comparative reports. In effect, the address issue is expected to decrease per household savings making the comparison of savings between Opower-1 and Opower-2 less straightforward due to the different percentage of the address issue in each of the wave.

2.2 Evaluation objectives and approach

The primary objective of this evaluation was to provide independent verification of electricity and demand savings attributable to the HER program. Specific research questions were:

- What are the electric savings for Opower2?
- Are there downstream/upstream rebate program savings that could be jointly claimed by both the HER program and other SCE rebate programs?

- What are the peak demand savings attributable to the program?
- Are the results produced by AEG on behalf of SCE consistent with the results produced by the independent evaluation?
- Do savings persist for Opower-1?

To answer these research questions, DNV GL reviewed and validated AEG's early impact evaluation for SCE's 2015 HER program. DNV GL replicated AEG's analysis using our own models to produce fully independent estimates and compared these estimates with AEG's results. The different components of program savings are:

- *Overall unadjusted energy and demand savings*. These savings measure the impact of the HER program on average household energy consumption and demand. 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 the 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 HER-induced savings derived from the increased uptake of SCE rebate programs. This estimate is produced for two kinds of programs:
  - *Downstream* joint savings occur due to increased rebate program participation by the HER treatment group versus the control group.
  - *Upstream* joint savings occur due to the increased purchases of SCE-supported upstream lighting program CFL and LED bulbs by the HER 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.

This ex-post validation goes well beyond simply vetting the approach used by AEG. By replicating the analysis, DNV GL is able to provide the CPUC with recommendations from a more robust validation of estimated savings occurring within the program. The results of these savings calculations are presented in Section 4

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. 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
λ_t = Monthly effects
μ_i = Account level fixed effect
ε_{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.

Households that moved out 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 opted 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 (SEE Action) Evaluation, Measurement, and Verification (EM&V) of Residential Behavior-Based Energy Efficiency Programs: Issues and Recommendations.[1]

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

3.2 Demand savings

Reductions in demand at peak times that result 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)[2]. 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 1st and September 30th.

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:

$$HW = \max_{1 \le k \le K} (\text{Score}_k)$$

$$\text{Score}_k = \max_{1 \le d \le 3} (temp_{d,k}) + \frac{1}{d} \sum_{d=1}^{3} (daily\_mean_{d,k}) + \frac{1}{d} \sum_{d=1}^{3} (afternoon\_avg_{d,k})$$

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.

DNV GL collected 15-minute and 60-minute interval data during the hours of 2 p.m.–5 p.m. of the most common heat wave in the pre- and post-periods for both treatment and control households. DNV GL then applied a difference-in-differences method to calculate demand savings due to the HUR program.

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

$$\overline{kW}\ savings = \left(\overline{post\_kW_C} - \overline{post\_kW_T}\right) - \left(\overline{pre\_kW_C} - \overline{pre\_kW_T}\right)$$

[2] *http://www.cpuc.ca.gov/NR/rdonlyres/4F93F9C2-434E-4B06-8D80-B2CB7E0A4198/0/DEER2013UpdateDocumentation_792013.pdf*

where:

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

$\overline{pre\_kW_C}$ = Average hourly load of the control group during the peak period in the pre-period

$\overline{pre\_kW_T}$ = Average hourly load of the treatment group during the peak period in the pre-period

$\overline{post\_kW_C}$ = Average hourly load of the control group during the peak period in the post-period being evaluated or 2015

$\overline{post\_kW_T}$ = Average hourly load of the treatment group during the peak period in the post-period being evaluated or 2015

3.3 Downstream rebate joint savings

One possible effect of the HER program is to increase rebate activity in other SCE 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. Any increase in treatment group rebate program savings represents savings caused by the HER program in conjunction with the rebate programs. While these joint savings are an added benefit of the HER 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 HER 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 SCE 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 program are adjusted using joint savings to avoid double counting of savings.

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

- Used accepted deemed savings values (those being used to claim the savings for the rebate program)
- Determine accumulated savings beginning from the installation date moving forward in time
- Assigned daily savings on a load-shape-weighted basis (more savings when we expect the measure to be used more)
- Maintained 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 upon the installation of that measure. We determined the daily share of annual savings using hourly 2011 DEER load shapes[3] for SCE. [4] These load shapes indicate when a measure is used during the

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

year and, by proxy, when efficiency savings would occur.[5] DNV GL's recommended method for estimating joint savings analysis is consistent with the approach recommended in the SEE Action report.

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 and included 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 SCE 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. SCE upstream savings still represent a source of savings that the 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 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 incorporated TRC's estimates for 2015 rebated sales fraction for CFL and LEDs. The online survey included households participating in Opower-2 and collected information on their purchase and installation of CFLs and LEDs for the past year. Table 3 presents the key inputs used in 2015 SCE HER joint savings calculation for the upstream lighting program.

Table 3. Input Assumptions used in 2015 upstream joint savings calculation

Assumptions	Input values	Source
Excess lamps due to HER		
2014 CFL	0.68	2012 PG&E in-home survey multiplied (0.95) by TRC estimate for fraction of CFL bulbs sold in SCE territory (72%)
2014 LED	0.27	2012 PG&E in-home survey multiplied (0.95) by TRC estimate for fraction of LED bulbs sold in SCE territory (28%)
2015 CFL	-0.18	2015 IOU Residential Behavioral Programs: Online Survey Results (DNV GL, 2017)
2015 LED	0.15	2015 IOU Residential Behavioral Programs: Online Survey Results (DNV GL, 2017)
Rebated sales fraction		

[4] *http://deeresources.com/DEER2011/download/DEER2011-UpdatedImpactProfiles-v2.zip*
[5] *This is more accurate and equitable than subtracting out the first year savings values that are used in DEER, because most measures are not in place from the first day to the last day of the year.*

2014 CFL	40%	2014 HER lighting overlap study (TRC, 2016)[6]
2014 LED	20%	2014 HER lighting overlap study (TRC, 2016)
2015 CFL	53%	2015 HER lighting overlap study (TRC, 2017)[7]
2015 LED	23%	2015 HER lighting overlap study (TRC, 2017)
Annual savings per bulb		
2014 CFL	45.2	2014 HER lighting overlap study (TRC, 2016)
2014 LED	19.9	2014 HER lighting overlap study (TRC, 2016)
Net to gross		
CFL	0.45	2013-14 ULP Evaluation (DNV GL, 2016)
LED	0.31	2013-14 ULP Evaluation (DNV GL, 2016)
Installation rate		
CFL	97%	2013-14 ULP Evaluation (DNV GL, 2016)
LED	99%	2013-14 ULP Evaluation (DNV GL, 2016)

The joint savings calculation used results from recent lighting studies in CA. Compared to the 2014 evaluation, we used updated estimates for SCE net-to-gross and installation rates based on the 2013-2014 ULP Evaluation. Also, we used SCE estimate for rebated sales fraction in 2015 based on a recent TRC lighting study.

The estimates for the excess lamps due to HER were based on participants' recall of the number of bulbs purchased and installed in 2016. DNV GL used these estimates as a proxy for the 2015 bulb uplift because we believe that the 2016 estimate from the online survey better represent the SCE Opower-2 program overall than the efficient bulb uplift due to the HER program based studies in another jurisdiction.

For annual savings per bulb in 2015, we used the 2014 savings per bulb as proxy because the 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:

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 in Table 3, DNV GL used peak watts impact to measure watt reductions per installed bulb at the

[6] TRC memo on Proposed Changes to ULP HER Lighting Savings Overlap for 2014.

[7] TRC memo on Rebated Sales Fraction for 2015 HER Lighting Savings Overlap (Draft)

time of peak. DNV GL also used AEG's number of treatment households that are active as of September 8, 2015 and without the address issue 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 2.7 watts for CFL and 1.6 watts for LEDs. These values were used to measure watts reductions at the peak from CFL and LED installation.

Table 4. SCE CFL peak diversity factor

Factor	CFL	LED	Source
Installation Rate	97%	99%	2013-2014 ULP Evaluation (DNV GL, 2016)
Delta Watts	46.25	27.5	2013-2014 ULP Evaluation (DNV GL, 2016)
Peak CF	0.07	0.06	2013-2014 ULP Evaluation (DNV GL, 2016)
Peak Watts Impact	**2.67**	**1.63**	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 0.07 indicating that only about 7% 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:

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

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

4 RESULTS

DNV GL reviewed AEG's methods stated in its evaluation report[8] and produced a set of comparison results for validating the reduction in consumption, joint savings, and peak demand analysis using DNV GL methods and data SCE provided to the CPUC. This chapter presents DNV GL's assessment of the four main components that resulted in final program savings and demand savings estimates for the 2015 SCE HER program.

4.1 Overall kWh savings estimate

DNV GL estimated consumption reductions for the HER program with the objective to verify whether AEG's results were consistent with independently produced results, and not necessarily to produce identical results. Table 5 presents a comparison of DNV GL's and AEG's calculation of the total unadjusted electric savings for HER program year 2015.

Table 5. Total unadjusted kWh savings at the program-level

Unit	AEG	DNV GL	% DNV / AEG
kWh	5,340,297	5,571,985	104%

Consistent with previous evaluation, both estimates used AEG's treatment counts for expanding household-level savings to program-level savings, making this a comparison of the underlying regression model results. Overall, the two savings estimates are comparable with DNV GL calculating 4% more savings.

DNV GL recommends AEG's program savings estimates for the 2015 HER program. The difference in savings estimates was small and not statistically significant at the 90% confidence level despite slight differences in the approach used. The differences between DNV GL and AEG's approaches are provided below:

- Consumption data used in the pre-period. AEG used only 10 months of billing data in the pre-period (March 2013 to December 2013) while DNV GL used 12 months of data the in pre-period (January 2013 to December 2013). The difference in consumption data used in the pre-period is not expected to have a substantial effect on the savings estimates because of the experimental design of the program.
- Model specification. AEG's approach included testing different program- and non-program-related variables for statistical significance and included only statistically significant coefficients in the final model. Consistent with AEG's approach in 2013, AEG included cooling degree days and their interaction with an overall post-program indicator. AEG's approach separates the effect of weather on consumption (the CDD term) and the effect of weather during the pre- and post-periods (CDD*post). The inclusion of these terms should improve the overall model performance, but will not, on average, affect the savings estimate as CDD is not interacted with the post*treatment variable that captures savings. DNV GL used a standard approach that does not include weather variables to estimate program savings as delineated in SEE Action to compare with AEG's results.[9]

[8] *SCE's Home Energy Report Program Savings Assessment: Ex-post Evaluation Results for Opower-2, Program Year 2015. Applied Energy Group. 2016*

[9] *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.*

4.2 Demand savings estimate

4.2.1 Heat waves by climate zone

DNV GL identified the 2015 heat waves using the weather data provided by SCE that used hourly temperatures from weather stations across the SCE service territory from 2013-2015. Consistent with last year's findings, DNV GL found that all climate zones but one fell on the same three-day heatwave in 2015. The three-day heatwave fell on September 8-10, 2015, the same heatwave AEG identified. Table 6 shows the three-day heatwaves based on DEER definition for the pre- and post-period of the Opower-2 participants.

Table 6. Peak period based on DEER definition for Opower-2

Period	DEER Heatwave
Pre	9/4/2013 - 9/6/2013
Post	9/8/2015 - 9/10/2015

4.2.2 Peak demand reductions

DNV GL and AEG used a difference-in-differences method to estimate peak demand reductions due to the HER program. We calculated demand reductions per household across each hour of the most common three-day heat wave in the pre- and post-period. The demand savings per household were then multiplied by AEG's number of treatment households (n=67,903) in order to provide an aggregate demand savings for Opower-2 to compare with AEG's demand savings estimate.

Table 7 provides a comparison of the total peak demand savings estimates based on the most common heatwave. Overall, AEG's and DNV GL's peak demand savings estimates are slightly different due to the different data cleaning procedures applied to screen sites for the analysis. The different procedures only resulted to a 0.001 kW per household difference that is not statistically significant. DNV GL recommends using the final peak demand savings reported by AEG.

Table 7. Aggregate unadjusted kW savings

Heat Wave Start	Heat Wave End	AEG Peak Reduction (kW)	DNV GL Peak Reduction (kW)	%DNV/AEG
8-Sep-15	**10-Sep-15**	800	876	108%

4.3 Joint savings: downstream programs

DNV GL reviewed AEG's codes and data used in estimating joint savings from downstream programs. The program tracking datasets used by AEG are comparable to the datasets used by DNV GL in joint savings calculation. AEG's approach in joint savings calculation also included measure installation from the 2014 and 2015 program years. Table 8 compares DNV GL's and AEG's kWh and kW joint savings for Opower-2.

Table 8. Total kWh and kW rebate savings from downstream programs

Unit	Joint savings - Downstream		% DNV / AEG
	AEG	DNV GL	
kWh	170,089	169,490	100%
kW	40.6	40.4	99%

Overall, DNV GL's and AEG's kWh and kW estimates for joint savings are comparable despite slight differences in the approach used for prorating kWh savings. DNV GL applied DEER load shapes according to the measure's load profile when prorating savings while AEG used a flat load shape for all measures. DNV GL recommends using AEG's kW and kWh estimates for joint savings due to rebate participation in downstream programs.

4.4 Joint savings: upstream programs

AEG's kWh joint savings from upstream programs followed the approach recommended in the 2014 HER evaluation. AEG included CFL and LED bulbs that were installed in 2014 and 2015 upstream programs. Table 9 shows AEG's calculation of kWh joint savings with the upstream lighting program.

Table 9. AEG's calculation for kWh joint savings from upstream programs

Inputs	CFL 2014	CFL 2015	LED 2014	LED 2015
Excess bulbs	0.95	0.54	0.95	0.54
Fraction of excess bulbs by type	0.72	0.72	0.28	0.28
Fraction of year program was running	0.75	1	0.75	1
Installation rate	0.97	0.97	0.97	0.97
No. of HER customers	65,281	65,281	65,281	65,281
Proration of full year savings to program year savings	1	0.5	1	0.5
Proportion of lamps that are rebated	0.4	0.4	0.2	0.2
Proportion of lamp attributed to ULP	0.69	0.69	0.69	0.69
Per bulb savings per year	45.2	45.2	19.9	19.9
kWh savings attributable to HER and ULP by type	404,299	152,499	34,902	13,165
Total CFL and LED kWh savings	604,864			

In 2016, DNV GL conducted an online survey to update assumptions used for the excess bulbs installed due to the Opower-2 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 program administrator (PA), behavioral program and experimental waves. For SCE Opower-2, survey results showed a very small uplift for LEDs and a negative uplift for CFL that are not statistically significant; versus what was used in the prior evaluations. Table 10 shows the kWh joint savings estimates using the 2015 bulb uplift estimate for Opower-2.

Table 10. kWh joint savings using 2015 HER bulb uplift estimate from DNV GL's online survey

Inputs	CFL 2014	CFL 2015	LED 2014	LED 2015
Excess bulbs	0.95	-0.18	0.95	0.15
Fraction of excess bulbs by type	0.72	n/a	0.28	n/a
Fraction of year program was running	0.75	1	0.75	1
Installation rate	0.97	n/a	0.97	n/a
No. of HER customers*	65,281	68,849	65,281	68,849
Proration of full year savings to program year savings	1	0.5	1	0.5
Proportion of lamps that are rebated	0.4	0.53	0.2	0.23
Proportion of lamp attributed to ULP	0.45	0.45	0.31	0.31
Per bulb savings per year	45.2	45.2	19.9	19.9
kWh savings attributable to HER and ULP by type	404,299	(72,910)	34,902	8,141
Total CFL and LED kWh savings	374,432			

As mentioned earlier, there was an issue with the addresses in SCE's billing system that caused 5% of the treatment households to never receive the reports. In accordance with the previous recommendation, treatment customers with mismatched addresses were removed from the joint savings calculation for bulbs installed in 2014. This is because the assumption used for the 2014 bulb uplift was based on a PG&E study that did not have the same address issue.

For calculating the incremental joint savings from bulbs installed in 2015, DNV GL used the average number of active households in the treatment group including those with mismatched addresses in the billing system. This is because the estimated number of excess bulbs in 2015 is based on a direct comparison of the treatment and control customers, including customers with the address issue.

Compared to 2014 calculation, the input assumptions for the fraction of excess bulb type and installation rates were not used when calculating for the kWh upstream joint saving for 2015 bulbs. The 2015 excess bulbs estimates are already based on the number of CFL and LED bulbs purchased and installed. DNV GL recommends using the upstream joint savings estimates in Table 10 since these results better represent the 2015 bulb uplift and the joint savings of the Opower-2 program.

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. AEG used the kWh savings per bulb and the coincidence diversity factor of 0.0449 watts at peak per kWh while DNV GL used calculated peak watts impact for CFL and LED bulbs using results from DNV GL's 2013-2014 Upstream Lighting study.

Consistent with kWh upstream joint savings calculation, DNV GL used survey results to update the 2015 bulb uplift due to HER in calculating kW joint savings. DNV GL used AEG's treatment count (without the address issue) to calculate aggregate peak demand joint savings for bulbs installed in 2014. For bulbs installed in 2015, DNV GL included customers with the address issue when calculating the total upstream joint savings. The number of treatment households used is the number of treatment accounts that were active on September 8, 2015, the first day of the heat wave. Table 11 shows DNV GL and AEG's aggregate and per household upstream kW joint savings estimates.

Consistent with kWh upstream joint savings recommendation, DNV GL recommends using DNV GL's estimate for kW upstream joint savings because DNV GL's savings estimate used a more accurate efficient bulb uplift to estimate joint savings for 2015.

Table 11. 2014 HER kW joint savings from upstream programs

Opower-2	kW Joint Savings per Household	Aggregate kW joint savings
AEG	0.0005	29.6
DNV GL	0.0002	13.4

4.5 Per household savings and total program savings

Table 12 summarizes the recommended kWh savings per household for Opower-2. Overall, the 2015 SCE HER program produced 77.7 kWh savings per household or 1% electric baseline consumption.

Table 12. Recommended per household kWh savings for the 2015 HER program

Unit	Baseline Consumption	Per Household Savings (Unadjusted)	Joint Savings - Downstream	Joint Savings - Upstream	Per Household Savings (Adjusted)	% Savings	
						Unadjusted	Adjusted
kWh	7,706	77.7	2.5	5.4	69.8	1.0%	0.9%

Note: DNV GL divided total kWh joint savings estimate from upstream by the average monthly treatment counts from January 2015 to December 2015 to get a per household joint savings estimate that is representative of all the households in the treatment group. For example, 374,432 kWh / 68,849 = 5.4 kWh per household.

Figure 3 summarizes the recommended total kWh and kW savings for Opower-2. The aggregate program savings are based on AEG's impact evaluation for the 2015 SCE HER program. The kWh and kW downstream joint savings estimates are also based on AEG's findings while the kWh and kW upstream joint savings are based on DNV GL's results. Overall, the 2015 SCE HER program produced 4,795,777 kWh adjusted savings and 746 kW adjusted savings.

Figure 3. Recommended kWh and kW savings for the 2015 HER program

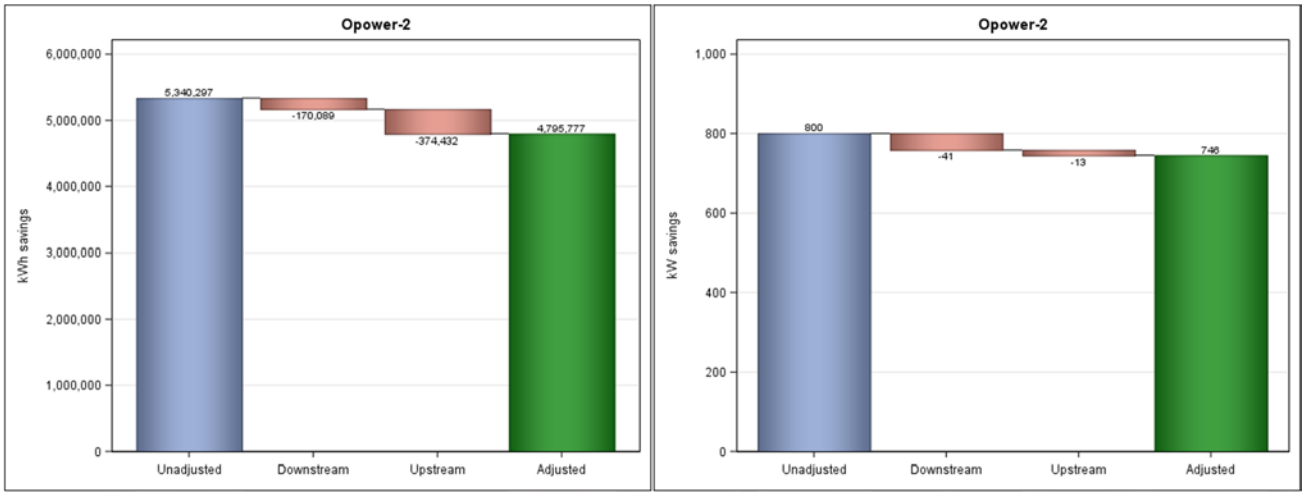
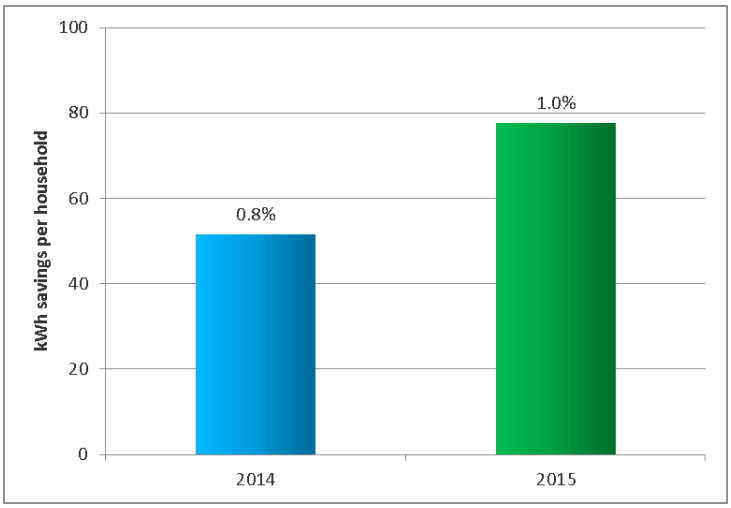


Figure 4 presents a historical electric savings for Opower-2. Opower-2 electric savings increased from 0.8% to 1.0% from 2014 to 2015. The 2014 savings were not for a full year and represent the first 9 months of the Opower-2 program while 2015 represents a full year of savings. Overall, Opower-2 produced electric savings that are consistent with the 1% to 3% savings typically reported for the HER program in other jurisdictions.

Figure 4. Opower-2 kWh savings in 2014 and 2015



Compared to Opower-1, Opower-2 savings are slightly lower. The Opower-1 sample targeted a high proportion of high usage customers versus the general population for Opower-2. The lower per household savings from Opower-2 can be attributed to the relatively fewer high users in the Opower-2 sample.

Appendix C provides additional analysis on the persistence of savings based on the pilot group (Opower-1). The Opower-1 treatment households only received the reports from December 2012 through December 2013. DNV GL estimated HER savings from the OPower-1 treatment group after two years of not getting the reports.

Appendix D presents the historical electric and gas savings per household for the HER program across CA PAs.

5 CONCLUSIONS

Overall, DNV GL evaluators found no major concerns with the results or methodology that AEG used for estimating kWh and kW savings. There were minor differences between DNV GL's and AEG's methods but the differences in overall program savings and demand savings are minimal. For joint savings adjustments, DNV GL recommends AEG's downstream joint savings estimates and DNV GL's upstream joint savings estimates. The final adjusted electric and demand savings are 4,795,777 kWh and 746 kW for the 2015 SCE HER program (Table 13).

Table 13. Recommended kWh and kW savings for the 2015 HER program

Type of Savings	Total Savings
Electric (kWh)	
Unadjusted	5,340,297
Joint Savings Downstream	170,089
Joint Savings Upstream	374,432
Adjusted	4,795,777
Peak Demand Savings (kW)	
Unadjusted	800
Joint Savings Downstream	41
Joint Savings Upstream	14
Adjusted	746

APPENDIX A. OPOWER POPULATION COUNTS

Population counts are used to expand estimated per-household savings to the program level. The population counts are a key component of the final savings estimates because of the size of the program but the process is complicated by ongoing attrition in both the treatment and control groups.

DNV GL population counts approximately recreate the counts reported by AEG. Exact counts depend on details such as how a move-out date is assigned and data quality criteria to be included in the regression. As a result, DNV GL did not attempt to recreate the exact average population AEG used to produce the savings estimates. In addition, DNV GL used SCE billing data to establish a move-out date. Overall, DNV GL treatment counts are comparable with AEG's counts. Table 1 presents the comparison of the number of customers in the treatment and control groups.

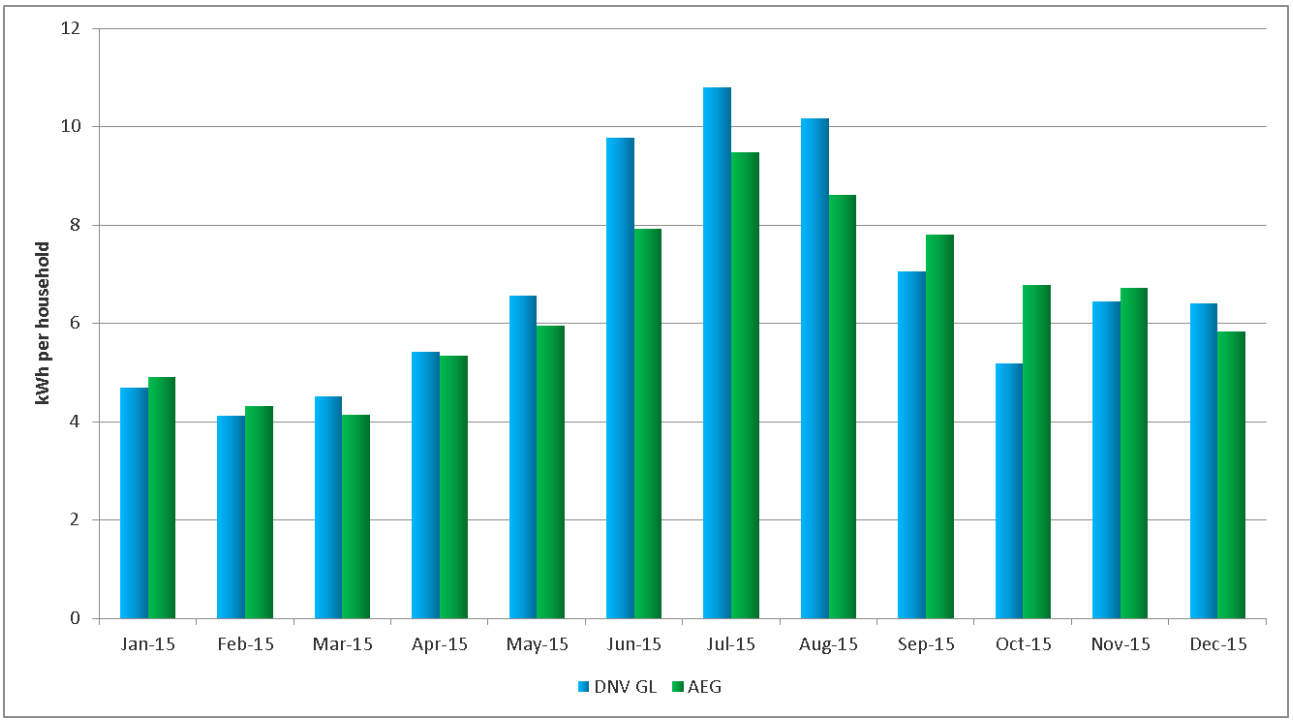
Table 1. Number of active customers in the control and treatment groups

Month	Control			Treatment		
	AEG	DNV GL	% DNV / AEG	AEG	DNV GL	% DNV / AEG
Jan-15	70,555	70,508	100%	70,537	70,491	100%
Feb-15	70,304	70,250	100%	70,296	70,246	100%
Mar-15	70,069	69,995	100%	70,047	69,954	100%
Apr-15	69,719	69,678	100%	69,701	69,637	100%
May-15	69,403	69,370	100%	69,400	69,351	100%
Jun-15	69,066	69,016	100%	69,069	68,993	100%
Jul-15	68,719	68,666	100%	68,705	68,627	100%
Aug-15	68,378	68,305	100%	68,356	68,278	100%
Sep-15	68,022	67,959	100%	67,963	67,905	100%
Oct-15	67,697	67,638	100%	67,657	67,579	100%
Nov-15	67,418	67,336	100%	67,357	67,275	100%
Dec-15	67,139	67,081	100%	67,101	67,039	100%

APPENDIX B. MONTHLY PROGRAM SAVINGS ESTIMATES

Figure 1 displays the monthly estimates of savings reported by AEG and reproduced by DNV GL. In general, AEG's and DNV GL's monthly savings estimates are comparable across the months. The results are not exactly identical because DNV GL used independent methods and data for calculating program savings estimates. Key differences between AEG's and DNV GL's analyses are summarized in Section 4.

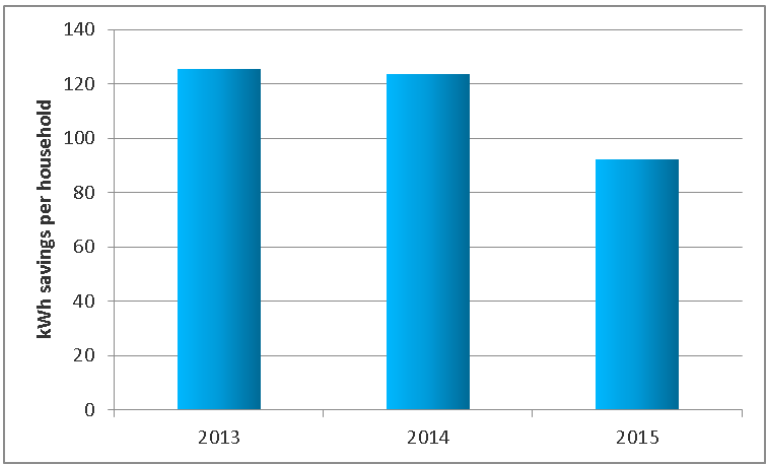
Figure 1. Monthly kWh savings per household



APPENDIX C. Persistence of Opower-1 Savings

This section examined the persistence of savings after discontinuation of treatment for Opower-1. Households in the treatment group received the comparative reports from December 2012 through December 2013 and no reports in 2014 and 2015. Figure 1 shows the annual unadjusted electric savings per household from 2013 to 2015. This analysis is based on households that are active in program year 2015. Overall, Opower-1 continued to produce savings that are statistically significant. In 2015, the second year of not receiving the reports, Opower-1 produced savings that are three-fourths of the first year savings.

Figure 1. Annual kWh savings per household for Opower-1, 2013 to 2015



APPENDIX D. 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
2011-12						
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%
2013						
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%
2014						
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[a]	138,588	1.19	0.0%	1.19
RES_3_1_2015_PGE_HER	**PGE**	**Total**	**116,439**	**138,588**	**1.19**	**0.0%**	**1.19**
RES_3_1_2015_PGE_HER		***Statewide***	***116,439***	***138,588***	***1.19***	***0.0%***	***1.19***
RES_3_2_2015_SCE_HER	SCE	Home Energy Reports	4,565	4,796	1.05	0.0%	1.05
RES_3_2_2015_SCE_HER	**SCE**	**Total**	**4,565**	**4,796**	**1.05**	**0.0%**	**1.05**
RES_3_2_2015_SCE_HER		***Statewide***	***4,565***	***4,796***	***1.05***	***0.0%***	***1.05***
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			
RES_3_3_2015_SDGE_HER	**SDGE**	**Total**	**0**	**11,189**			
RES_3_3_2015_SDGE_HER		***Statewide***	***0***	***11,189***			
RES_3_4_2015_MCE_HUR	MCE	Home Utility Reports	0	0			
RES_3_4_2015_MCE_HUR	**MCE**	**Total**	**0**	**0**			
RES_3_4_2015_MCE_HUR		***Statewide***	***0***	***0***			

[a] The ExAnte savings represent savings claimed by PG&E.

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[a]	138,588	1.19	0.0%	1.00	1.00	1.00	1.00
RES_3_1_2015_PGE_HER	**PGE**	**Total**	**116,439**	**138,588**	**1.19**	**0.0%**	**1.00**	**1.00**	**1.00**	**1.00**
RES_3_1_2015_PGE_HER		***Statewide***	***116,439***	***138,588***	***1.19***	***0.0%***	***1.00***	***1.00***	***1.00***	***1.00***
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**	**Total**	**4,565**	**4,796**	**1.05**	**0.0%**	**1.00**	**1.00**	**1.00**	**1.00**
RES_3_2_2015_SCE_HER		***Statewide***	***4,565***	***4,796***	***1.05***	***0.0%***	***1.00***	***1.00***	***1.00***	***1.00***
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**	**Total**	**0**	**11,189**				**1.00**		**1.00**
RES_3_3_2015_SDGE_HER		***Statewide***	***0***	***11,189***				***1.00***		***1.00***
RES_3_4_2015_MCE_HUR	MCE	Home Utility Reports	0	0						
RES_3_4_2015_MCE_HUR	**MCE**	**Total**	**0**	**0**						
RES_3_4_2015_MCE_HUR		***Statewide***	***0***	***0***						

[a]*The ExAnte savings represent savings claimed by PG&E.*

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[a]	27.3	1.36	0.0%	1.36
RES_3_1_2015_PGE_HER	**PGE**	**Total**	**20.0**	**27.3**	**1.36**	**0.0%**	**1.36**
RES_3_1_2015_PGE_HER		***Statewide***	***20.0***	***27.3***	***1.36***	***0.0%***	***1.36***
RES_3_2_2015_SCE_HER	SCE	Home Energy Reports	0.7	0.7	1.02	0.0%	1.02
RES_3_2_2015_SCE_HER	**SCE**	**Total**	**0.7**	**0.7**	**1.02**	**0.0%**	**1.02**
RES_3_2_2015_SCE_HER		***Statewide***	***0.7***	***0.7***	***1.02***	***0.0%***	***1.02***
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			
RES_3_3_2015_SDGE_HER	**SDGE**	**Total**	**0.0**	**1.4**			
RES_3_3_2015_SDGE_HER		***Statewide***	***0.0***	***1.4***			
RES_3_4_2015_MCE_HUR	MCE	Home Utility Reports	0.0	0.0			
RES_3_4_2015_MCE_HUR	**MCE**	**Total**	**0.0**	**0.0**			
RES_3_4_2015_MCE_HUR		***Statewide***	***0.0***	***0.0***			

[a]*The ExAnte savings represent savings claimed by PG&E.*

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[a]	27.3	1.36	0.0%	1.00	1.00	1.00	1.00
RES_3_1_2015_PGE_HER	**PGE**	**Total**	**20.0**	**27.3**	**1.36**	**0.0%**	**1.00**	**1.00**	**1.00**	**1.00**
RES_3_1_2015_PGE_HER		***Statewide***	***20.0***	***27.3***	***1.36***	***0.0%***	***1.00***	***1.00***	***1.00***	***1.00***
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**	**Total**	**0.7**	**0.7**	**1.02**	**0.0%**	**1.00**	**1.00**	**1.00**	**1.00**
RES_3_2_2015_SCE_HER		***Statewide***	***0.7***	***0.7***	***1.02***	***0.0%***	***1.00***	***1.00***	***1.00***	***1.00***
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**	**Total**	**0.0**	**1.4**				**1.00**		**1.00**
RES_3_3_2015_SDGE_HER		***Statewide***	***0.0***	***1.4***				***1.00***		***1.00***
RES_3_4_2015_MCE_HUR	MCE	Home Utility Reports	0.0	0.0						
RES_3_4_2015_MCE_HUR	**MCE**	**Total**	**0.0**	**0.0**						
RES_3_4_2015_MCE_HUR		***Statewide***	***0.0***	***0.0***						

[a]The ExAnte savings represent savings claimed by PG&E.

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[a]	4,691	1.13	0.0%	1.13
RES_3_1_2015_PGE_HER	**PGE**	**Total**	**4,148**	**4,691**	**1.13**	**0.0%**	**1.13**
RES_3_1_2015_PGE_HER		***Statewide***	***4,148***	***4,691***	***1.13***	***0.0%***	***1.13***
RES_3_2_2015_SCE_HER	SCE	Home Energy Reports	0	0			
RES_3_2_2015_SCE_HER	**SCE**	**Total**	**0**	**0**			
RES_3_2_2015_SCE_HER		***Statewide***	***0***	***0***			
RES_3_3_2015_SDGE_HER	SDGE	Home Energy Reports	0	130			
RES_3_3_2015_SDGE_HER	SDGE	Manage Act Save	0	271			
RES_3_3_2015_SDGE_HER	**SDGE**	**Total**	**0**	**401**			
RES_3_3_2015_SDGE_HER		***Statewide***	***0***	***401***			
RES_3_4_2015_MCE_HUR	MCE	Home Utility Reports	0	0			
RES_3_4_2015_MCE_HUR	**MCE**	**Total**	**0**	**0**			
RES_3_4_2015_MCE_HUR		***Statewide***	***0***	***0***			

[a]The ExAnte savings represent savings claimed by PG&E.

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[a]	4,691	1.13	0.0%	1.00	1.00	1.00	1.00
RES_3_1_2015_PGE_HER	**PGE**	**Total**	**4,148**	**4,691**	**1.13**	**0.0%**	**1.00**	**1.00**	**1.00**	**1.00**
RES_3_1_2015_PGE_HER		***Statewide***	***4,148***	***4,691***	***1.13***	***0.0%***	***1.00***	***1.00***	***1.00***	***1.00***
RES_3_2_2015_SCE_HER	SCE	Home Energy Reports	0	0						
RES_3_2_2015_SCE_HER	**SCE**	**Total**	**0**	**0**						
RES_3_2_2015_SCE_HER		***Statewide***	***0***	***0***						
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**	**Total**	**0**	**401**				**1.00**		**1.00**
RES_3_3_2015_SDGE_HER		***Statewide***	***0***	***401***				***1.00***		***1.00***
RES_3_4_2015_MCE_HUR	MCE	Home Utility Reports	0	0						
RES_3_4_2015_MCE_HUR	**MCE**	**Total**	**0**	**0**						
RES_3_4_2015_MCE_HUR		***Statewide***	***0***	***0***						

[a]*The ExAnte savings represent savings claimed by PG&E.*

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[a]	138,588	1.19	0.0%	1.19
RES_3_1_2015_PGE_HER	**PGE**	**Total**	**116,439**	**138,588**	**1.19**	**0.0%**	**1.19**
RES_3_1_2015_PGE_HER		***Statewide***	***116,439***	***138,588***	***1.19***	***0.0%***	***1.19***
RES_3_2_2015_SCE_HER	SCE	Home Energy Reports	4,565	4,796	1.05	0.0%	1.05
RES_3_2_2015_SCE_HER	**SCE**	**Total**	**4,565**	**4,796**	**1.05**	**0.0%**	**1.05**
RES_3_2_2015_SCE_HER		***Statewide***	***4,565***	***4,796***	***1.05***	***0.0%***	***1.05***
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			
RES_3_3_2015_SDGE_HER	**SDGE**	**Total**	**0**	**11,189**			
RES_3_3_2015_SDGE_HER		***Statewide***	***0***	***11,189***			
RES_3_4_2015_MCE_HUR	MCE	Home Utility Reports	0	0			
RES_3_4_2015_MCE_HUR	**MCE**	**Total**	**0**	**0**			
RES_3_4_2015_MCE_HUR		***Statewide***	***0***	***0***			

[a]The ExAnte savings represent savings claimed by PG&E.

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[a]	138,588	1.19	0.0%	1.00	1.00	1.00	1.00
RES_3_1_2015_PGE_HER	**PGE**	**Total**	**116,439**	**138,588**	**1.19**	**0.0%**	**1.00**	**1.00**	**1.00**	**1.00**
RES_3_1_2015_PGE_HER		***Statewide***	***116,439***	***138,588***	***1.19***	***0.0%***	***1.00***	***1.00***	***1.00***	***1.00***
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**	**Total**	**4,565**	**4,796**	**1.05**	**0.0%**	**1.00**	**1.00**	**1.00**	**1.00**
RES_3_2_2015_SCE_HER		***Statewide***	***4,565***	***4,796***	***1.05***	***0.0%***	***1.00***	***1.00***	***1.00***	***1.00***
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**	**Total**	**0**	**11,189**				**1.00**		**1.00**
RES_3_3_2015_SDGE_HER		***Statewide***	***0***	***11,189***				***1.00***		***1.00***
RES_3_4_2015_MCE_HUR	MCE	Home Utility Reports	0	0						
RES_3_4_2015_MCE_HUR	**MCE**	**Total**	**0**	**0**						
RES_3_4_2015_MCE_HUR		***Statewide***	***0***	***0***						

[a]*The ExAnte savings represent savings claimed by PG&E.*

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[a]	27.3	1.36	0.0%	1.36
RES_3_1_2015_PGE_HER	**PGE**	**Total**	**20.0**	**27.3**	**1.36**	**0.0%**	**1.36**
RES_3_1_2015_PGE_HER		***Statewide***	***20.0***	***27.3***	***1.36***	***0.0%***	***1.36***
RES_3_2_2015_SCE_HER	SCE	Home Energy Reports	0.7	0.7	1.02	0.0%	1.02
RES_3_2_2015_SCE_HER	**SCE**	**Total**	**0.7**	**0.7**	**1.02**	**0.0%**	**1.02**
RES_3_2_2015_SCE_HER		***Statewide***	***0.7***	***0.7***	***1.02***	***0.0%***	***1.02***
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			
RES_3_3_2015_SDGE_HER	**SDGE**	**Total**	**0.0**	**1.4**			
RES_3_3_2015_SDGE_HER		***Statewide***	***0.0***	***1.4***			
RES_3_4_2015_MCE_HUR	MCE	Home Utility Reports	0.0	0.0			
RES_3_4_2015_MCE_HUR	**MCE**	**Total**	**0.0**	**0.0**			
RES_3_4_2015_MCE_HUR		***Statewide***	***0.0***	***0.0***			

[a]*The ExAnte savings represent savings claimed by PG&E.*

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[a]	27.3	1.36	0.0%	1.00	1.00	1.00	1.00
RES_3_1_2015_PGE_HER	**PGE**	**Total**	**20.0**	**27.3**	**1.36**	**0.0%**	**1.00**	**1.00**	**1.00**	**1.00**
RES_3_1_2015_PGE_HER		***Statewide***	***20.0***	***27.3***	***1.36***	***0.0%***	***1.00***	***1.00***	***1.00***	***1.00***
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**	**Total**	**0.7**	**0.7**	**1.02**	**0.0%**	**1.00**	**1.00**	**1.00**	**1.00**
RES_3_2_2015_SCE_HER		***Statewide***	***0.7***	***0.7***	***1.02***	***0.0%***	***1.00***	***1.00***	***1.00***	***1.00***
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**	**Total**	**0.0**	**1.4**				**1.00**		**1.00**
RES_3_3_2015_SDGE_HER		***Statewide***	***0.0***	***1.4***				***1.00***		***1.00***
RES_3_4_2015_MCE_HUR	MCE	Home Utility Reports	0.0	0.0						
RES_3_4_2015_MCE_HUR	**MCE**	**Total**	**0.0**	**0.0**						
RES_3_4_2015_MCE_HUR		***Statewide***	***0.0***	***0.0***						

[a]*The ExAnte savings represent savings claimed by PG&E.*

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[a]	4,691	1.13	0.0%	1.13
RES_3_1_2015_PGE_HER	**PGE**	**Total**	**4,148**	**4,691**	**1.13**	**0.0%**	**1.13**
RES_3_1_2015_PGE_HER		***Statewide***	***4,148***	***4,691***	***1.13***	***0.0%***	***1.13***
RES_3_2_2015_SCE_HER	SCE	Home Energy Reports	0	0			
RES_3_2_2015_SCE_HER	**SCE**	**Total**	**0**	**0**			
RES_3_2_2015_SCE_HER		***Statewide***	***0***	***0***			
RES_3_3_2015_SDGE_HER	SDGE	Home Energy Reports	0	130			
RES_3_3_2015_SDGE_HER	SDGE	Manage Act Save	0	271			
RES_3_3_2015_SDGE_HER	**SDGE**	**Total**	**0**	**401**			
RES_3_3_2015_SDGE_HER		***Statewide***	***0***	***401***			
RES_3_4_2015_MCE_HUR	MCE	Home Utility Reports	0	0			
RES_3_4_2015_MCE_HUR	**MCE**	**Total**	**0**	**0**			
RES_3_4_2015_MCE_HUR		***Statewide***	***0***	***0***			

[a]The ExAnte savings represent savings claimed by PG&E.

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[a]	4,691	1.13	0.0%	1.00	1.00	1.00	1.00
RES_3_1_2015_PGE_HER	**PGE**	**Total**	**4,148**	**4,691**	**1.13**	**0.0%**	**1.00**	**1.00**	**1.00**	**1.00**
RES_3_1_2015_PGE_HER		***Statewide***	***4,148***	***4,691***	***1.13***	***0.0%***	***1.00***	***1.00***	***1.00***	***1.00***
RES_3_2_2015_SCE_HER	SCE	Home Energy Reports	0	0						
RES_3_2_2015_SCE_HER	**SCE**	**Total**	**0**	**0**						
RES_3_2_2015_SCE_HER		***Statewide***	***0***	***0***						
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**	**Total**	**0**	**401**				**1.00**		**1.00**
RES_3_3_2015_SDGE_HER		***Statewide***	***0***	***401***				***1.00***		***1.00***
RES_3_4_2015_MCE_HUR	MCE	Home Utility Reports	0	0						
RES_3_4_2015_MCE_HUR	**MCE**	**Total**	**0**	**0**						
RES_3_4_2015_MCE_HUR		***Statewide***	***0***	***0***						

[a]*The ExAnte savings represent savings claimed by PG&E.*

Appendix AB. Standardized Per Unit Savings

Not reported.

Appendix AC. Recommendations

Appendix AC: Recommendations

Study ID	Study Type	Study Title	Study Manager			
Res 3.2	Impact Evaluation	Review and Validation of 2015 Southern California Edison Home Energy Reports Program Impacts	CPUC			
Recommendation	**Program or Database**	**Summary of Findings**	**Additional Supporting Information**	**Best Practice / Recommendations**	**Recommendation Recipient**	**Affected Workpaper or DEER**
1	HER	The efficient bulb uplift used in the upstream joint savings calculation is based on the 2012 PG&E In-home Inventory.	N/A	We recommend using CFL and LED bulb uplift estimates from a recent online survey conducted by DNV GL for the SCE HER program.	SCE	N/A
2	HER	The assumptions used for rebated sales fraction and net to gross are based on earlier lighting studies.	N/A	We recommend updating the rebated sales fraction and net-to-gross assumptions with the most recent values from the 2014-2015 lighting studies.	SCE	N/A

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.