Review and Validation of 2014 Southern California Edison Home Energy Reports Program Impacts (Final Report)

California Public Utilities Commission

Date: 04/01/2016

CALMAC Study ID: CPU0125.01

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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 2014. The evaluation includes calculated energy and demand savings estimates that are used to validate an earlier HER 2014 impact evaluation from Applied Energy Group (AEG).

1.1 Background

The HER pilot program (Opower-1) started sending bi-monthly reports 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. In March 2014, SCE implemented the HER program to a new cohort (Opower-2) that is composed of the unused portion of the eligible population developed for Opower-1. A total of 150,000 SCE customers were randomly selected to the treatment and control groups.

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

1.2 Research questions and objectives

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

1.3 Study approach

To answer these research questions, DNV GL reviewed and validated; 1) AEG's early impact evaluation for SCE's 2014 HER program; and 2) TRC's upstream lighting study[1] that quantifies the portion of program savings that are produced in conjunction with the upstream lighting program. DNV GL reviewed TRC's 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 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

[1] TRC. *Lighting Savings Overlap in 2014 IOU Residential Behavioral Programs*.TRC memo dated June 30, 2015. Revised TRC memo, *Proposed Changes to Draft ULP HER Lighting Savings Overlap for 2014*, dated October 22, 2015.

consumption difference to that of the control group. We estimated the unadjusted demand savings as the difference in peak load between the treatment group and control group during the hottest heatwave in 2014. 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 normally produced for two areas:
  - *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 the increase in purchases of CFL and LED bulbs by the HER treatment group versus the control group through the SCE-supported upstream lighting program.[2]
- *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, the evaluators are able to provide the CPUC with recommendations from a more robust validation of the estimated savings that are occurring within the program.

[2] TRC, on behalf of the IOUs, produced the electric joint savings estimates and heating and cooling interactive effects associated with energy saving lighting measures from upstream programs.

2 KEY FINDINGS

Table 1 shows the estimated savings for the 2014 HER program. Since DNV GL's estimates are on par with AEG's savings estimates, DNV GL recommends using AEG's unadjusted and adjusted estimates for 2014 HER energy and demand savings. Overall, the HER program achieved 3.5 GWh adjusted program savings and 0.8 MW adjusted demand savings. These adjusted savings excludes savings that are potentially double counted by other SCE programs.

Table 1. Program-level kWh and kW savings estimates for 2014

Opower-2	Electric		% Difference = (Unadjusted – Adjusted) / Unadjusted
	Unadjusted	Adjusted	
kWh	3,711,449	3,496,345	6%
kW	859	828	4%

AEG's downstream and 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 accounted for 6% of the total unadjusted electric savings and 4% of the peak demand savings.

Table 2 provides estimates of unadjusted and adjusted savings at the household level as a fraction of the control group's average consumption in 2014. Based on AEG's results, the electric savings at the household level are less than one percent of the baseline consumption in 2014.[3]

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

Opower-2	Baseline Consumption	Per Household Savings (Unadjusted)	Per Household Savings (Adjusted)	% Savings	
				Unadjusted	Adjusted
kWh	6,131	52	48	0.8%	0.8%

Opower-2 per household unadjusted savings are less than half of the estimated per household savings for Opower-1 (123 kWh savings per household) in 2013. The program savings from Opower-1 and Opower-2 are based on different year and the treatment period for Opower-2 started in March 2014 and unlike Opower-1, the per household electric savings estimate does not represent savings for a full year. Another possible reason for lower per household savings from Opower-2 is that, based on AEG's report, there were fewer high users available when the sample for Opower-2 was selected because the Opower-1 sample has already targeted a high proportion of high usage customers.

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

3 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 2014. 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 third year as the independent evaluator of the HER program. As such, DNV GL has access to a full set of SCE's billing data and program tracking data, which allowed DNV GL to produce fully independent savings estimates to compare with AEG's. DNV GL also received SCEs peak demand data from advanced metering infrastructure (AMI), which allowed DNV GL to validate AEG's demand savings estimates for 2014. This ex post validation goes well beyond simply vetting the approach used by AEG. By replicating the analysis, DNV GL can provide a more robust validation of the estimated savings that are occurring within the program.

3.1 HER program description

The HER pilot program (Opower-1) started sending bi-monthly reports 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. In March 2014, SCE implemented a new HER program cohort (Opower-2) that is composed of the unused portion of the eligible population developed for Opower-1. Table 3 provides the count of control and treatment customers in Opower-2. The Opower-2 sample is composed of 150,000 households that were randomly allocated between the treatment and control groups.

Table 3. Number of customers in Opower-2

HER sample	No. of accounts in control group	No. of accounts in treatment group
Full sample	75,000	75,000
No. of sites with mismatched addresses	N/A	3,813
No. of sites without mismatched addresses	75,000	71,187

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

Similar to Opower-1, there was an issue with mismatched addresses when the program was implemented. The mismatched addresses in SCE's billing system caused participants to never receive the reports. According to SCE, the issue was inherent to their billing data system and was not program-related. AEG's report found this issue in both the treatment and control groups. However, DNV GL's findings indicate that the address issue was only present in the treatment group for Opower-2 and affected approximately 5% of the total number of treatment customers. These findings are unexpected because, in theory, the address issue is expected to equally affect both treatment and control groups given the RCT design of the program.

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 because 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.

3.2 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 included the following:

- 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?

To answer these research questions, DNV GL reviewed and validated; 1) AEG's early impact evaluation for SCE's 2014 HER program; and 2) TRC's upstream lighting study[4] that quantifies the portion of program savings that are produced in conjunction with the upstream lighting program. DNV GL reviewed TRC's 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 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. We estimated the unadjusted demand savings as the difference in peak load between the treatment group and control group during the hottest heatwave in 2014. 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 normally produced for two areas:
  - *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 the increase in purchases of CFL and LED bulbs by the HER treatment group versus the control group through the SCE-supported upstream lighting program.[5]

[4] TRC. *Lighting Savings Overlap in 2014 IOU Residential Behavioral Programs*.TRC memo dated June 30, 2015. Revised TRC memo, *Proposed Changes to Draft ULP HER Lighting Savings Overlap for 2014*, dated October 22, 2015.

[5] TRC, on behalf of the IOUs, produced the electric joint savings estimates and heating and cooling interactive effects associated with energy saving lighting measures from upstream programs.

- *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, the evaluators are able to provide the CPUC with recommendations from a more robust validation of the estimated savings that are occurring within the program. The results of these savings calculations are presented in Section 5

4 METHODOLOGY

4.1 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 also 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 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 (SEE Action) Evaluation, Measurement, and Verification (EM&V) of Residential Behavior-Based Energy Efficiency Programs: Issues and Recommendations.[6]

[6] 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

Reductions in demand at peak times that result from HER program participation can be measured through a variety of approaches given the gold standard has not yet been defined. DNV GL used the peak period definition provided by the Database for Energy Efficiency Resources (DEER)[7]. This definition takes into account the average temperature, average afternoon temperature (12 p.m. – 6p.m.), and maximum temperature over the course of 3-day heatwave candidates. Each candidate 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 tested for statistical differences in demand between HER treatment and control groups using 15-minute and 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 15-17, 2014). In a randomized experiment such as HER program, the simplest approach is to calculate the difference in average hourly load between treatment and control households during peak periods. This is referred to as a "post-only" framework as it employs only data that are observed after the launch date of the program and does not make use of any pre-program period data.

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

The general equation for the post-only approach is given below:

$$\overline{kW}\ savings = \overline{post\_kW_C} - \overline{post\_kW_T}$$

Where:

$\overline{kW}\ savings$ = 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 or 2014

$\overline{post\_kW_T}$ = Average hourly load of the treatment group during the peak period in the post period being evaluated or 2014

When there is evidence that a pre-existing difference exists between average treatment and control load, a post-only approach without any control for pre-period usage may result in biased estimates of demand reductions. DNV GL's approach involves testing for statistical difference in peak load consumption during the pre-period and then calculating demand savings using the post-only approach if peak load consumption during the pre-period is balanced. Otherwise, a difference-in-differences approach is a more appropriate method for controlling the differences in demand from pre- to post-period.

4.3 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. As a result, 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 IOU 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 applied 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)
- Started accumulating 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[8] for SCE. [9] These load shapes indicate when a measure is used during the year and, by proxy, when efficiency savings would occur.[10] 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.

4.4 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 does increase savings in upstream programs.

The alternative to the downstream census-level approach is to do a comparison of treatment and control group uptake of the upstream program measures on a sample basis. This approach also takes advantage of the RCT experimental design, that provides the structure to produce an un-biased estimate of upstream savings. PG&E conducted in-home surveys in 2013 to assess uptake of upstream measures (specifically, CFLs and flat-screen TVs) due to HER. The surveys included samples of treatment and control customers from PG&E HER program. Because of the expected similarity between upstream savings between SCE and PG&E and the prohibitive cost of performing a similar survey, results from PG&E study were used as the basis for SCE estimate of upstream joint savings in previous evaluations.

For the 2014 evaluation, the IOUs engaged TRC to revise and update the assumptions used in the joint savings methodology in order to consider the changing structure of the IOUs' upstream lighting programs (ULP) and reflect more recent available data on IOU lighting programs. [11] DNV GL reviewed TRC's lighting study and worked with the IOUs and their consultants (TRC, Nexant, and AEG) to develop a more appropriate method to distribute the savings adjustment stream over the timeline of the HER program using

[8] *DEER load shapes are in an 8760 hourly format. DNV GL aggregated the hourly shares to daily shares in order to estimate daily savings.*
[9] *http://deeresources.com/DEER2011/download/DEER2011-UpdatedImpactProfiles-v2.zip*
[10] *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.*
[11] TRC. *Lighting Savings Overlap in 2014 IOU Residential Behavioral Programs*.TRC memo dated June 30, 2015.

existing input data from the PG&E Home Inventory report, inputs from the TRC study and other available data from Puget Sound Energy's (PSE) Home Energy Report telephone survey.[12]

The improved approach assumed an increasing efficient bulb uptake but at a decreasing rate. The assumption for the number of excess efficient lamps due to HER was based on the results of PG&E's in-home inventory study in 2013 and the available data from PSE HER phone surveys.

presents the updated assumptions used in SCE 2014 HER joint savings calculation for upstream programs.

Table 4. Input Assumptions used in TRC calculation for 2014 upstream joint savings

Assumptions	Input values	Source
Excess lamps due to HER		
Year 1	0.95	2012 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	2014 PSE HER phone survey (DNV GL)
Rebated sales fraction		
2014 CFL	40%	Program tracking data (DEER 2013-14)
2014 LED	20%	Program tracking data (DEER 2013-14)
Annual savings per bulb		
2014 CFL	45.2	Program tracking data (DEER 2013-14)
2014 LED	19.9	Program tracking data (DEER 2013-14)
Fraction of CFL lamps in 2014	0.72	TRC estimate of total CFL and LED sold in territory
Fraction of LED lamps in 2014	0.28	TRC estimate of total CFL and LED sold in territory
Net to gross	0.69	2010-12 ULP Evaluation (DNV GL, 2014)
Installation rate	97%	2010-12 ULP Evaluation (DNV GL, 2014)

Source: TRC memo on Proposed Changes to ULP HER Lighting Savings Overlap for 2014.

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. Lastly, the new approach also assumed that all additional bulbs installed prior to 2014 were all CFLs while some of the additional bulbs in 2014 include LEDs.

The general equations used in calculating electric joint savings from ULP are presented below:

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

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

The TRC study did not provide an estimate of peak demand joint savings. DNV GL calculated peak demand joint savings using input assumptions used by TRC in Table 4 and findings from DNV GL's 2010-2012 Upstream Lighting study. 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. In a similar

[12] The improved methodology for joint savings calculation and upstream joint savings estimates for the 2014 HER is summarized in TRC's revised memo, *Proposed Changes to Draft ULP HER Lighting Savings Overlap for 2014*, dated October 22, 2015.

fashion, estimated HOU combined with delta watts and an installation rate provides measures of kWh reduction. Taking peak watt impacts as a proportion of kWh reductions provides an appropriate peak diversity factor estimate for the SCE service territory.

Table 5 provides DNV GL's calculation of peak watts impact for CFLs. DNV GL calculated a peak watts impact of 2.7 watts for CFL. This value was used to measure watts reductions at the peak from CFL and LED installation.

Table 5. SCE CFL peak diversity factor

Factor	Inputs	Source
Installation Rate	0.970	WO28 (2010-2012)
Delta Watts	41.825	WO28 (2010-2012)
Peak CF	0.066	WO28 (2010-2012)
Peak Watts Impact	**2.667**	Calculated as installation rate x delta watts x Peak CF
Hours-of-use (HOU)	1.825	WO28 (2010-2012)
kWh Impact	27.025	Calculated as installation rate x delta watts x (HOU * 365)/1,000
Watts per kWh	**0.099**	Calculated as peak watts impact/kWh impact

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

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

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

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 4, DNV GL used peak watts impact to measure watt reductions per installed bulb at the time of peak. DNV GL also used AEG's number of treatment households that are active as of September 15, 2014 and without the address issue to calculate aggregate kW joint savings.

5 RESULTS

DNV GL reviewed AEG's methods stated in its evaluation report[13] and in SAS program codes submitted by AEG. DNV GL 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 2014 SCE HER program.

5.1 Overall kWh savings estimate

DNV GL independently 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 6 presents a comparison of DNV GL's and AEG's calculation of the aggregate electric savings for HER program year 2014.

Table 6. Aggregate kWh savings

HER Opower2	AEG	DNV GL	% DNV / AEG
kWh	3,711,449	3,521,259	95%

Consistent with last year's 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, DNV GL's and AEG's savings estimates are comparable with DNV GL calculating 5% less savings. DNV GL recommends AEG's program savings estimates for the 2014 HER program.

DNV GL assessed discrepancies in savings estimates and found some differences in DNV GL's and AEG's approaches:

- Billing month assignment. DNV GL and AEG's billing month assignments are different. DNV GL used the month of the end date of the billing cycle as the billing month while AEG used the midpoint of the start and end of the billing cycle. 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 or subsequent month. Going forward, DNV GL will use the midpoint for assigning billing months when validating SCE HER results in order to minimize the sources of discrepancies in results.
- 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.[14]

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[13] *SCE's Home Energy Report Program Savings Assessment: Ex-post Evaluation results, Program Year 2014. Applied Energy Group. 2015,*

[14] *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.*

- 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.

Among the differences highlighted above, the difference in billing month assignments explained most of the discrepancies between DNV GL and AEG's savings estimates. DNV GL conducted additional analysis using the midpoint to create billing months and estimated savings using an independent model. DNV GL found a 2% difference between DNV GL's and AEG's savings estimates with DNV GL estimating slightly higher than AEG.

APPENDIX A provides a comparison of DNV GL's and AEG's number of customers in the control and treatment groups and APPENDIX B provides graphical illustration of DNV GL's and AEG's monthly electric savings estimates. The monthly savings per household from the additional analysis using the midpoint are shown in APPENDIX B.

5.2 Demand savings estimate

DNV GL reviewed the approaches and findings of AEG's analysis of peak demand savings. The process of estimating peak demand savings attributable to the HER program is still a relatively recent addition to the impact evaluation. Quantifying the demand reductions from the HER program is only possible with the availability of premise-level hourly and sub-hourly metering across households in the program population. The hourly demand data is the minimum required level of frequency in order to derive estimates of demand reductions occurring during peak system periods.

5.2.1 Heat waves by climate zone

DNV GL verified AEG's 2014 heat waves using the weather data provided by SCE that used hourly temperatures from weather stations across the SCE service territory from December 1, 2012 to February 1, 2015. The heat waves were identified using two separate statistical packages (R and SAS) and two independent analytical platforms.

DNV GL identified September 15-17, 2014, as the 2014 DEER-defined three-day heatwave for the climate zones included in Opower-2. This three-day heatwave is the same heat wave that AEG identified. Consistent with AEG's findings, DNV GL found that all climate zones but one fell on this three-day heatwave. The peak demand savings calculation was based on load consumption during this peak period.

Going forward, DNV GL proposes employing a separate definition of peak period that takes into account those hours when the system itself is actually peaking. This is the point in which true peak demand occurs, and where estimates of demand reduction are most relevant. DNV GL will work with SCE and AEG to identify separate definition of peak period that can be used to compare with the current DEER definition of peak for the HER program.

5.2.2 Peak demand reductions

DNV GL calculated per household demand reductions across each hour of the most common three-day heat wave. The household-level estimate of kW reduction was calculated as the difference between the demand of the control group and the treatment group during the post period. The post-only approach is sufficient for the analysis because pre-period assessment of peak load showed differences that are not statistically significant. DNV GL's per household demand savings were then multiplied by AEG's number of treatment households (n=71,559) in order to provide an aggregate demand savings for Opower-2 that can be compared with AEG's 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 0.0008 kW per household difference that are not statistically significant. DNV GL recommends using the final peak demand savings reported by AEG.

Table 7. Overall kW savings comparison

Heat Wave Start	Heat Wave End	AEG Peak Reduction (kW)	DNV GL Peak Reduction (kW)	% DNV / AEG
15-Sep-14	17-Sep-14	859	919	107%

5.3 Joint savings: downstream programs

DNV GL reviewed AEG's codes and data used in estimating joint savings from downstream programs. AEG continued to apply the recommended approach of prorating savings for each customer who received a rebate. The program tracking datasets used by AEG are comparable to the datasets used by DNV GL in joint savings calculation.

Table 8 compares DNV GL's and AEG's kWh and kW joint savings for Opower-2. Overall, DNV GL's and AEG's kW estimates for joint savings are comparable while kWh joint savings estimates are slightly different with DNV GL estimating 10% lower than AEG.

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

HER Wave	Joint savings - Downstream		% DNV / AEG
	AEG	DNV GL	
kWh	42,544	38,399	90%
kW	19	19	103%

The key differences between DNV GL's and AEG's approaches in joint savings calculation are summarized below:

- Prorating kWh savings. DNV GL applied DEER loadshapes according to the measure's load profile when prorating savings while AEG used a flat loadshape for all measures. DNV GL's approach takes the deemed annual savings values and assigns daily savings on a load-shape-weighted basis. DNV GL's approach is more realistic and more accurate when calculating joint savings from experimental waves that have not yet been around for a full year such as Opower-2.
- Aggregating kWh joint savings. Consistent with billing analysis approach, DNV GL calculated per household kWh joint savings at the monthly level and then multiplied these savings by AEG's treatment counts for each of the months. These monthly joint savings are summed up to calculate the total joint savings from downstream rebate programs. DNV GL's approach is analogous to the method used in calculating total program savings. This approach allowed DNV GL to capture only partial joint savings from households that moved out prior the end of the evaluation period. AEG calculated joint savings by subtracting the total prorated rebate savings from all measures installed

by the treatment group from the total prorated rebate savings of the control group. AEG excluded rebate savings after customers move out but AEG's approach makes unnecessary assumptions such as a) the number of households in the treatment group is equal to the number of households in the control group, and b) attrition is linear through the year.

The discrepancy in kWh joint savings estimates are mostly due to the different assumptions used when prorating savings. Despite differences in the methods of prorating savings, AEG's method of distributing rebate savings will provide joint savings estimates that are consistent with DNV GL's estimates when calculated year to year. DNV GL recommends using AEG's kW and kWh estimates for joint savings due to rebate participation in downstream programs.

5.4 Joint savings: upstream programs

AEG's kWh joint savings from upstream programs followed the approach recommended in the TRC lighting study. DNV GL recommends AEG's kWh upstream joint savings estimate of 172,560 kWh. Table 9 shows AEG's calculation kWh joint savings calculation is shown below:

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

Inputs	CFL	LED
Excess bulbs	0.95	0.95
Fraction of excess bulbs by type	0.72	0.28
Fraction of year program was running	0.75	0.75
Installation rate	0.97	0.97
No. of HER customers	68,396	68,396
Proration of full year savings to program year savings	0.375	0.375
Proportion of lamps that are rebated	0.4	0.2
Proportion of lamp attributed to ULP	0.69	0.69
Per bulb savings per year	45.2	19.9
kWh savings attributable to HER and ULP by type	158,847	13,713
Total CFL and LED kWh saving		172,560

Table 10 provides the calculation of peak watts impact for CFLs. DNV GL and AEG calculated peak demand joint savings for upstream programs in a similar fashion to calculating electric 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 2.7 watts as the peak watts impact based on the 2010-2012 CA Upstream Lighting study for SCE. DNV GL also used the same number of treatment households used by AEG to calculate aggregate peak demand joint savings from upstream programs. The number of treatment households used by AEG is the number of treatment accounts (without the address issue) that were s active on Sept 15, 2014, the first date of the heat wave. Table 10 shows the aggregate and per household upstream kW joint savings estimates. Overall, joint savings from upstream programs at the peak period are comparable and approximately 2% of the total HER demand savings. DNV GL recommends using AEG's kW joint savings estimates for upstream.

Table 10. 2014 HER kW joint savings from upstream programs

Opower-2	kW Joint Savings per Household	No. of Treated Households	Aggregate kW joint savings
AEG	0.0002	68,396	13
DNV GL	0.0002	68,396	12

5.5 Per household savings and total program savings

Table 11 summarizes the recommended kWh savings per household for Opower-2. These savings values are all based on AEG's impact evaluation for the 2014 SCE HER program. Overall, the 2014 SCE HER program produced 0.8% electric savings.

Table 11. Recommended per household kWh savings for the 2014 HER program

Opower-2	Baseline Consumption	Per Household Savings (Unadjusted)	Joint Savings - Downstream	Joint Savings - Upstream	Per Household Savings (Adjusted)	% Savings	
						Unadjusted	Adjusted
kWh	6,131	51.5	0.6	2.4	48.5	0.8%	0.8%

The total upstream joint savings for Opower-2 were based on the number of treatment households that did not have the address issue while the unadjusted per household savings reflect the average savings of all treatment households including those that had the address issue. DNV GL divided AEG's total kWh joint savings estimate by the average monthly treatment counts from April 2014 to December 2014 to get a per household joint savings estimate that is representative of all the households in the treatment group. For example, 172,560 kWh / 72,130 = 2.4 kWh per household.

Opower-2 per household unadjusted savings are less than half of the estimated per household savings for OPower-1 in 2013. The treatment period for Opower-2 started in March 2014 and unlike Opower-1, the per household electric savings estimate does not represent savings for a full year. Another reason for lower per household savings from Opower-2 is that, based on AEG's report, there were fewer high users available when the sample for Opower-2 was selected because the Opower-1 sample has already targeted a high proportion of high usage customers.

Table 12 summarizes the recommended total kWh and kW savings per household for Opower-2. These savings are aggregate program savings based on AEG's impact evaluation for the 2014 SCE HER program. Overall, the 2014 SCE HER program produced 3,498,345 kWh adjusted savings and 828 kW adjusted savings.

Table 12. Recommended total kWh and kW savings for the 2014 HER program

Opower-2	Total Savings			
	Unadjusted	Joint Savings - Downstream	Joint Savings - Upstream	Adjusted
kWh savings	3,711,449	42,544	172,560	3,496,345
kW savings	859	19	13	828

APPENDIX C shows DNV GL's additional analysis of HER per household savings based on California Alternate Rates for Energy (CARE) and non-CARE and APPENDIX D presents the historical electric and gas saving per household for the HER program across IOUs.

6 CONCLUSIONS

Overall, DNV GL evaluators found no major concerns or Referens with the results or methodology that AEG used for estimating kWh and kW savings and application of TRC's method for estimating kWh and kW joint savings from upstream programs. There were minor differences between DNV GL's and AEG's methods but the differences in overall program savings and demand savings are not statistically significant. DNV GL recommends accepting AEG's energy savings and demand savings for the 2014 HER program (Table 13).

Table 13. Recommended kWh and kW savings for the 2014 HER program

Type of Savings	Total Savings
Electric (kWh)	
Unadjusted	3,711,449
Joint Savings Downstream	42,544
Joint Savings Upstream	172,560
Adjusted	3,496,345
Peak Demand Savings (kW)	
Unadjusted	859
Joint Savings Downstream	19
Joint Savings Upstream	13
Adjusted	828

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, evaluators 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

	Control			Treatment		
Month	AEG	DNV GL	% DNV / AEG	AEG	DNV GL	% DNV / AEG
Apr-14	73,551	73,577	100%	73,472	73,502	100%
May-14	73,265	73,301	100%	73,169	73,195	100%
Jun-14	72,915	72,913	100%	72,847	72,847	100%
Jul-14	72,489	72,523	100%	72,427	72,471	100%
Aug-14	72,118	72,160	100%	72,087	72,110	100%
Sep-14	71,795	71,792	100%	71,784	71,782	100%
Oct-14	71,384	71,408	100%	71,415	71,431	100%
Nov-14	71,076	71,065	100%	71,138	71,127	100%
Dec-14	70,794	70,812	100%	70,833	70,853	100%

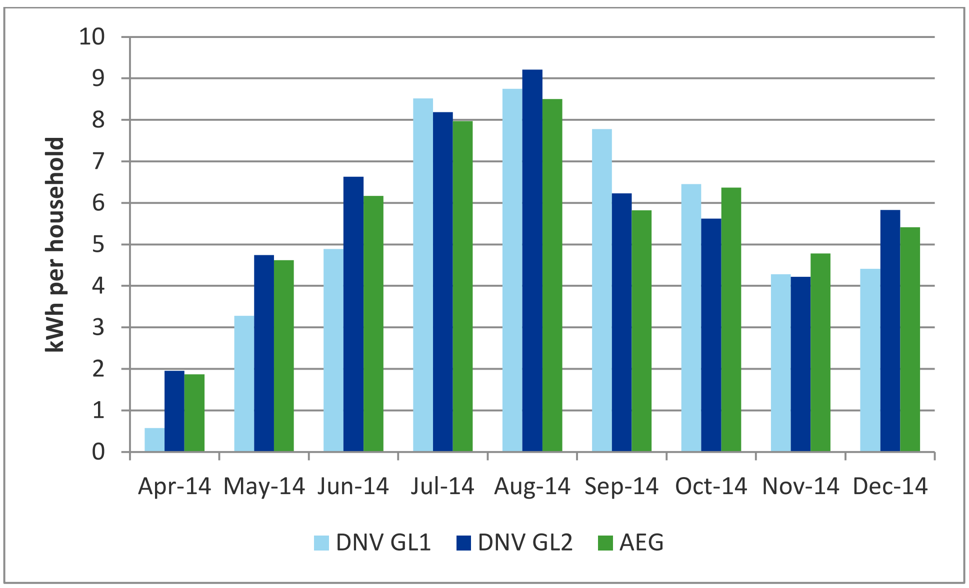
APPENDIX B. MONTHLY PROGRAM SAVINGS ESTIMATES

Figure 1 displays the monthly estimates of savings reported by AEG and reproduced by DNV GL. The plot includes DNV GL's estimates of electric savings using two different definitions of billing month:

- DNV GL1 – uses the month of the billing end date as billing month
- DNV GL2 – uses the month of the midpoint of the billing cycle as billing month

In general, the monthly savings estimates are comparable across the two sets of estimates with DNV GL's estimates using the midpoint of the billing cycle closest to AEG's estimates. 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. CARE VS. NON-CARE ANALYSIS

The Energy Division asked DNV GL to compare savings between California Alternate Rates for Energy (CARE) and non-CARE customers. Because customers were marked as CARE or non-CARE at a monthly level, we created three different thresholds to assign customers to the CARE or non-CARE categories.

The three thresholds were:

- Customers with a CARE rate for at least 1 billing month in 2014
- Customers with a CARE rate for at least 6 billing months in 2014
- Customers with a CARE rate for at least 10 billing months in 2014

Table 1 shows how the CARE and non-CARE customers are distributed using the three thresholds. CARE customers comprise more than 20% of the Opower-2 population. Overall, the proportion of treatment and control is balanced within the income groups (i.e. CARE and non-CARE).

Table 1. Count and percent of CARE and Non-CARE customers

HER sample	# of households		% of households	
	Control	Treatment	Control	Treatment
Customers with CARE rate for at least 1 billing month in 2014				
CARE	18,302	18,296	25%	25%
Non-CARE	56,087	56,030	75%	75%
Total	74,389	74,326	100%	100%
Customers with CARE rate for at least 6 billing month in 2014				
CARE	17,789	17,740	24%	24%
Non-CARE	56,600	56,586	76%	76%
Total	74,389	74,326	100%	100%
Customers with CARE rate for at least 10 billing month in 2014				
CARE	15,521	15,395	21%	21%
Non-CARE	58,868	58,931	79%	79%
Total	74,389	74,326	100%	100%

Figure 1 compares annual electric savings per household between CARE and non-CARE customers along with 90% confidence intervals. Based on the results both CARE and non-CARE groups generated statistically significant electric savings with non-CARE savings consistently higher than CARE savings but statistically not significant.

Figure 1. Annual kWh savings per household for CARE and non-CARE groups

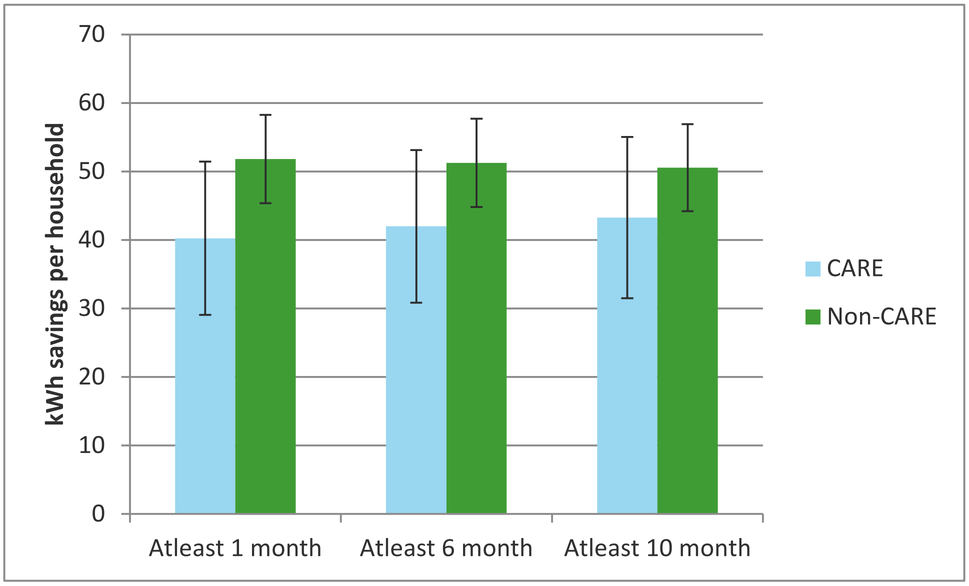
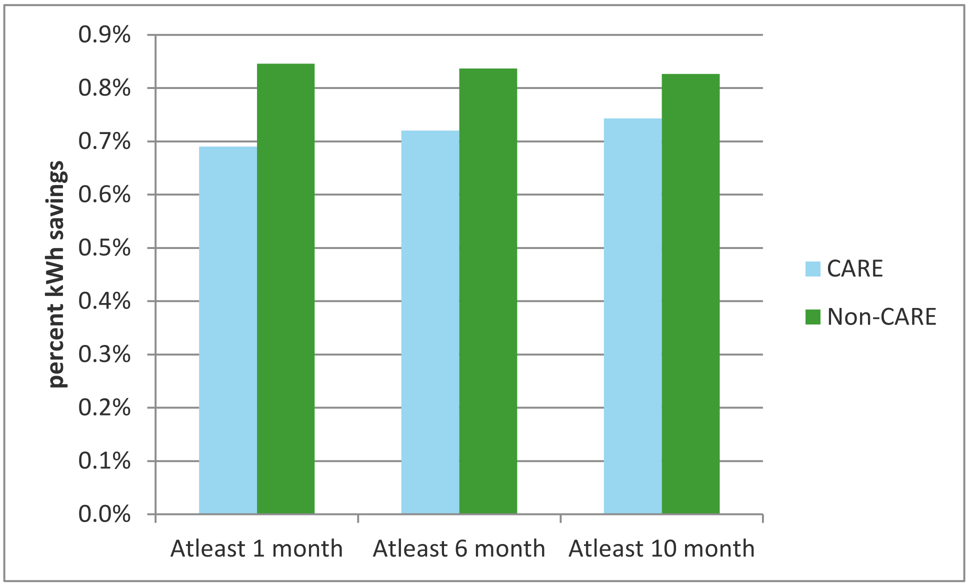


Figure 2 presents a graphical illustration of electric savings as a percent of baseline consumption for CARE and non-CARE groups. Non-CARE customers save a little more than 0.8% of baseline consumption while CARE customers save an average of 0.7% .

Figure 2. Percent kWh savings for CARE and non-CARE groups



APPENDIX D. HER SAVINGS BY IOU (2011-2014)

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

Year / IOU	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	PG&E	Home Energy Reports					
RES 3.1	**PG&E**	**Total**					
RES 3.1		***Statewide***					
RES 3.2	SCE	Home Energy Reports					
RES 3.2	**SCE**	**Total**					
RES 3.2		***Statewide***					
RES 3.3	SDG&E	Home Energy Reports					
RES 3.3	**SDG&E**	**Total**					
RES 3.3		***Statewide***					
RES 3.4	MCE	Home Utility Reports					
RES 3.4	**MCE**	**Total**					
RES 3.4		***Statewide***					

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	PG&E	Home Energy Reports		107,704						
RES 3.1	**PG&E**	**Total**		**107,704**						
RES 3.1		***Statewide***		***107,704***						
RES 3.2	SCE	Home Energy Reports		3,496						
RES 3.2	**SCE**	**Total**		**3,496**						
RES 3.2		***Statewide***		***3,496***						
RES 3.3	SDG&E	Home Energy Reports		3,575						
RES 3.3	**SDG&E**	**Total**		**3,575**						
RES 3.3		***Statewide***		***3,575***						
RES 3.4	MCE	Home Utility Reports		0						
RES 3.4	**MCE**	**Total**		**0**						
RES 3.4		***Statewide***		***0***						

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	PG&E	Home Energy Reports					
RES 3.1	**PG&E**	**Total**					
RES 3.1		***Statewide***					
RES 3.2	SCE	Home Energy Reports					
RES 3.2	**SCE**	**Total**					
RES 3.2		***Statewide***					
RES 3.3	SDG&E	Home Energy Reports					
RES 3.3	**SDG&E**	**Total**					
RES 3.3		***Statewide***					
RES 3.4	MCE	Home Utility Reports					
RES 3.4	**MCE**	**Total**					
RES 3.4		***Statewide***					

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	PG&E	Home Energy Reports		19.5						
RES 3.1	**PG&E**	**Total**		**19.5**						
RES 3.1		***Statewide***		***19.5***						
RES 3.2	SCE	Home Energy Reports		0.8						
RES 3.2	**SCE**	**Total**		**0.8**						
RES 3.2		***Statewide***		***0.8***						
RES 3.3	SDG&E	Home Energy Reports								
RES 3.3	**SDG&E**	**Total**								
RES 3.3		***Statewide***								
RES 3.4	MCE	Home Utility Reports								
RES 3.4	**MCE**	**Total**								
RES 3.4		***Statewide***								

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	PG&E	Home Energy Reports					
RES 3.1	**PG&E**	**Total**					
RES 3.1		***Statewide***					
RES 3.2	SCE	Home Energy Reports					
RES 3.2	**SCE**	**Total**					
RES 3.2		***Statewide***					
RES 3.3	SDG&E	Home Energy Reports					
RES 3.3	**SDG&E**	**Total**					
RES 3.3		***Statewide***					
RES 3.4	MCE	Home Utility Reports					
RES 3.4	**MCE**	**Total**					
RES 3.4		***Statewide***					

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	PG&E	Home Energy Reports		3,017						
RES 3.1	**PG&E**	**Total**		**3,017**						
RES 3.1		***Statewide***		***3,017***						
RES 3.2	SCE	Home Energy Reports								
RES 3.2	**SCE**	**Total**								
RES 3.2		***Statewide***								
RES 3.3	SDG&E	Home Energy Reports		124						
RES 3.3	**SDG&E**	**Total**		**124**						
RES 3.3		***Statewide***		***124***						
RES 3.4	MCE	Home Utility Reports								
RES 3.4	**MCE**	**Total**								
RES 3.4		***Statewide***								

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	PG&E	Home Energy Reports					
RES 3.1	**PG&E**	**Total**					
RES 3.1		***Statewide***					
RES 3.2	SCE	Home Energy Reports					
RES 3.2	**SCE**	**Total**					
RES 3.2		***Statewide***					
RES 3.3	SDG&E	Home Energy Reports					
RES 3.3	**SDG&E**	**Total**					
RES 3.3		***Statewide***					
RES 3.4	MCE	Home Utility Reports					
RES 3.4	**MCE**	**Total**					
RES 3.4		***Statewide***					

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	PG&E	Home Energy Reports		107,704						
RES 3.1	**PG&E**	**Total**		**107,704**						
RES 3.1		***Statewide***		***107,704***						
RES 3.2	SCE	Home Energy Reports		3,496						
RES 3.2	**SCE**	**Total**		**3,496**						
RES 3.2		***Statewide***		***3,496***						
RES 3.3	SDG&E	Home Energy Reports		3,575						
RES 3.3	**SDG&E**	**Total**		**3,575**						
RES 3.3		***Statewide***		***3,575***						
RES 3.4	MCE	Home Utility Reports		0						
RES 3.4	**MCE**	**Total**		**0**						
RES 3.4		***Statewide***		***0***						

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	PG&E	Home Energy Reports					
RES 3.1	**PG&E**	**Total**					
RES 3.1		***Statewide***					
RES 3.2	SCE	Home Energy Reports					
RES 3.2	**SCE**	**Total**					
RES 3.2		***Statewide***					
RES 3.3	SDG&E	Home Energy Reports					
RES 3.3	**SDG&E**	**Total**					
RES 3.3		***Statewide***					
RES 3.4	MCE	Home Utility Reports					
RES 3.4	**MCE**	**Total**					
RES 3.4		***Statewide***					

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	PG&E	Home Energy Reports		19.5						
RES 3.1	**PG&E**	**Total**		**19.5**						
RES 3.1		***Statewide***		***19.5***						
RES 3.2	SCE	Home Energy Reports		0.8						
RES 3.2	**SCE**	**Total**		**0.8**						
RES 3.2		***Statewide***		***0.8***						
RES 3.3	SDG&E	Home Energy Reports								
RES 3.3	**SDG&E**	**Total**								
RES 3.3		***Statewide***								
RES 3.4	MCE	Home Utility Reports								
RES 3.4	**MCE**	**Total**								
RES 3.4		***Statewide***								

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	PG&E	Home Energy Reports					
RES 3.1	**PG&E**	**Total**					
RES 3.1		***Statewide***					
RES 3.2	SCE	Home Energy Reports					
RES 3.2	**SCE**	**Total**					
RES 3.2		***Statewide***					
RES 3.3	SDG&E	Home Energy Reports					
RES 3.3	**SDG&E**	**Total**					
RES 3.3		***Statewide***					
RES 3.4	MCE	Home Utility Reports					
RES 3.4	**MCE**	**Total**					
RES 3.4		***Statewide***					

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	PG&E	Home Energy Reports		3,017						
RES 3.1	**PG&E**	**Total**		**3,017**						
RES 3.1		***Statewide***		***3,017***						
RES 3.2	SCE	Home Energy Reports								
RES 3.2	**SCE**	**Total**								
RES 3.2		***Statewide***								
RES 3.3	SDG&E	Home Energy Reports		124						
RES 3.3	**SDG&E**	**Total**		**124**						
RES 3.3		***Statewide***		***124***						
RES 3.4	MCE	Home Utility Reports								
RES 3.4	**MCE**	**Total**								
RES 3.4		***Statewide***								

Appendix AB. Standardized Per Unit Savings

Per Unit (Quantity) Gross Energy Savings (kWh)

Report Name	PA	Standard Report Group	Pass Through	% ER Ex-Ante	% ER Ex-Post	Average EUL (yr)	Ex-Post Lifecycle	Ex-Post First Year	Ex-Post Annualized
RES 3.1	PG&E	Home Energy Reports	0		0.0%	1.0			
RES 3.2	SCE	Home Energy Reports	0		0.0%	1.0			
RES 3.3	SDG&E	Home Energy Reports	0		0.0%	1.0			
RES 3.4	MCE	Home Utility Reports	0		0.0%	1.0			

Per Unit (Quantity) Gross Energy Savings (Therms)

Report Name	PA	Standard Report Group	Pass Through	% ER Ex-Ante	% ER Ex-Post	Average EUL (yr)	Ex-Post Lifecycle	Ex-Post First Year	Ex-Post Annualized
RES 3.1	PG&E	Home Energy Reports	0		0.0%	1.0			
RES 3.2	SCE	Home Energy Reports	0		0.0%	1.0			
RES 3.3	SDG&E	Home Energy Reports	0		0.0%	1.0			
RES 3.4	MCE	Home Utility Reports	0		0.0%	1.0			

Per Unit (Quantity) Net Energy Savings (kWh)

Report Name	PA	Standard Report Group	Pass Through	% ER Ex-Ante	% ER Ex-Post	Average EUL (yr)	Ex-Post Lifecycle	Ex-Post First Year	Ex-Post Annualized
RES 3.1	PG&E	Home Energy Reports	0		0.0%	1.0	77.1	77.1	77.1
RES 3.2	SCE	Home Energy Reports	0		0.0%	1.0	48.0	48.0	48.0
RES 3.3	SDG&E	Home Energy Reports	0		0.0%	1.0	239.6	239.6	239.6
RES 3.4	MCE	Home Utility Reports	0		0.0%	1.0	0.0	0.0	0.0

Per Unit (Quantity) Net Energy Savings (Therms)

Report Name	PA	Standard Report Group	Pass Through	% ER Ex-Ante	% ER Ex-Post	Average EUL (yr)	Ex-Post Lifecycle	Ex-Post First Year	Ex-Post Annualized
RES 3.1	PG&E	Home Energy Reports	0		0.0%	1.0	2.2	2.2	2.2
RES 3.2	SCE	Home Energy Reports	0		0.0%	1.0			
RES 3.3	SDG&E	Home Energy Reports	0		0.0%	1.0	8.2	8.2	8.2
RES 3.4	MCE	Home Utility Reports	0		0.0%	1.0			

Appendix AC. Recommendations

Study ID	Study Type	Study Title	Study Manager
Res 3	Impact Evaluation	Validation and Impact Evaluation of IOU's 2014 Home Energy Reports Program	CPUC

ommendat	Program or Database	Summary of Findings	Additional Supporting Information	Best Practice / Recommendations	Recommendation Recipient	Affected Workpaper or DEER
1	HER	DNV GL and the IOUs are using different assumptions on the distribution of savings from measures installed under IOU rebate programs.	N/A	DNV GL is working with the IOUs and their consultants to standardize the approach used in joint savings analysis.	DNV GL, PG&E, SCE and SDG&E	N/A
2	HER	DNV GL and the IOUs are using different approaches in calculating joint savings at the peak.	N/A	DNV GL proposes leveraging CA statewide lighting report to estimate peak savings from efficient bulbs. DNV GL is working with the IOUs and their consultants to standardize the approach.	DNV GL, PG&E, SCE and SDG&E	N/A
3	HER	DNV GL's inability to replicate the climate zone heat waves identified in PG&E HER early impact study while seeming to leverage data from the same underlying sources and approaches, presents evidence that peak periods using the DEER definition is sensitive to small changes.	N/A	DNV GL proposes to employ a separate definition of peak period for comparison with the current peak definition. DNV GL is working with the IOUs and their consultants to standardize this process.	DNV GL, PG&E, SCE and SDG&E	N/A
4	HER	The IOUs are using slightly different approaches in peak demand savings that can produce substantially different results.	N/A	Estimate or continue to estimate demand savings at the wave-level instead of calculating demand savings at the climate zone-level. DNV GL is working with the IOUs and their consultants to standardize the approach used in calculating peak demand savings.	DNV GL, PG&E, SCE and SDG&E	N/A

5	HER	Discrepancies between DNV GL program saving estimates and saving estimates reported in the IOU's early impact evaluation reports are mostly due to differences in billing month assignments.	N/A	Standardize the billing month assignment. Use or continue to use the mid-point when assigning billing months to standardize the approach and minimize the sources of discrepancies in the results.	DNV GL, PG&E, SCE and SDG&E	N/A
6	HER	Rebate savings from program participation of inactive customers were counted in joint savings calculation for PG&E HER early impact study.	N/A	DNV GL recommends calculating joint savings based on rebate participation of customers that are still active in 2014.	PG&E	N/A
7	HER	Combining households from all Gamma waves (or Wave One) can produce results that are substantially different.	N/A	DNV GL recommends splitting out Gamma and Wave One sub-waves in the PG&E HER rebate analysis so that the treatment group is compared to the corresponding control group and for consistency with the approach used in energy savings calculation	PG&E	N/A
8	HER	Early impact evaluation of PG&E HER reported standard errors for the aggregated savings that were based on a regression model at the wave-level where an overall post-treatment indicator was specified	N/A	The standard errors of the annual savings should be calculated using the combined monthly parameter standard errors weighted by the monthly counts.	PG&E	N/A

Appendix BA. Public Comments on 2014 SCE HER Evaluation

No.	From	Section	Comments	Response
1	SCE/ AEG	(p 4) Address mismatch in the control group	Table 3 shows the number of control accounts with mismatched addresses is 0. The paragraph that follows the table says that there are no mismatched addresses in the control group, and raises concern about the validity of the RCT. SCE would like to clarify that the control group mismatches simply were not checked, but the mismatched address issue in fact affected the control group in the same manner. However, the exact number wasn't calculated by the program (or relevant) since those customers were never contacted and there was no need to know who they were. Another reason was that all the treatment and control mismatched customers were included in the analysis, so it was not necessary to identify the mismatched control customers for evaluation purposes either. The mismatched treatment customers were identified solely for removal of ULP savings. Therefore, it would be more appropriate for the table to say N/A, with a footnote as to why this number was not calculated.	Replaced the number of control accounts with N/A instead of 0. DNV GL would like to note that based on AEG's Opower-2 Sampling Documentation Memo (dated December 4, 2013), the SCE team removed the accounts with mismatched addresses from the available sampling population for Opower-2. This exclusion means that the address issue was initially checked for all households in the sampling population and that in theory we should not observe households with mismatched addresses in Opower-2 treatment and control groups.
2	SCE/ AEG	(p7) Regression model specification	The regression model specification should be reviewed. The beta in the first equation should have a subscript of t, which it does lower down. Also, the indicator variable lambda should have a coefficient. It is not used in the analysis, but it should be there. A more serious concern is that this does not actually replicate the Difference in Differences equations. AEG did some work to replicate it, and you need to add a treatment/control indicator to get the same results as a DID. That doesn't make this equation wrong or inappropriate to use, but it should not be characterized as doing a DID. Can DNV clarify what specification they used, and either change the equation, or not call it a DID?	Added subscript to beta and clarified that lambda is the time effects and the coefficient itself just like the μ_i is the coefficient of the individual fixed effects. The difference-in-differences model is a version of a fixed effects model and in fact the difference-in-differences model is mathematically equivalent to a fixed effects model with two time periods (i.e. pre and post period). The equivalent fixed effects version of the difference-in-differences model does not require a treatment indicator in the equation because the treatment indicator will be cancelled out in the regression and will be absorbed by the individual intercepts.

				The methodology states that DNV GL used a fixed effects regression model. While we agree that the model used in the evaluation is not the basic difference-in-differences model, the fixed effects estimation method still applied the difference-in-differences framework in the calculation by correcting for any pre-existing differences in consumption between the treatment and control during the pre-period. Clarified in the text.
3	SCE/ AEG	(p9) Sec 4.2 – Post-only approach	SCE was surprised that DNV used a post-only approach for kW impacts after explicitly criticizing this approach when AEG used it in last year's Opower-1 report. SCE's understanding was that DNV advocated for the full DID going forward, which is what was used in the 2014 study by AEG. In their very last line of this section DNV states, "Otherwise, a difference-in-differences approach is a more appropriate method for controlling the differences in demand from pre- to post-period." SCE agrees with this sentiment and would advocate for a statewide agreement to use the full DID going forward. It is never worse than post-only, and can be better, so why not use it?	In the 2013 evaluation, we critiqued AEG's application of post-only approach in peak demand analysis without testing for balance first in peak load consumption during the pre-period. Consistent with the 2013 evaluation, we recommended checking for balance in the pre-period before applying the post-only approach. Otherwise, a difference-in-differences is a more appropriate method. The two options were provided because of the potential concern of having wildly different peak demand heatwave for the pre and the post periods. Also, PG&E HER program is 9x larger than SCE's and applying a difference-in-differences when post-only approach is just as good can be very resource intensive. After some discussions with the IOUs and their consultants during the 2014 evaluation phase, it was agreed on that the difference-in-differences will be used in peak demand analysis going forward.
4	SCE/ AEG		(p 13-14) Sec 5.1 – Model specification. DNV's statement that they used "the standard approach" in the SEE Action report is somewhat misleading and should be changed to "a standard approach." In its	Addressed in the text

			Appendix C: Overview of Acceptable Model Specifications, SEE Action offers a number of specification options, without any suggestion that one is better than the other. While DNV seems to have opted for specification 1.3, AEG used specification 1.4. Econometrics best practices always supports using incorporation of available and relevant data (in this case weather) in any way that adds explanatory power and does not bias the estimators. SCE believes that the approach AEG used is also a "standard approach" per SEE Action.	
5	SCE/ AEG	(p 14) Sec 5.1 – Erroneous reference to gas savings	The final paragraph says, "…AEG's monthly electric and gas savings…" this is a minor but clear misstatement.	Addressed in the text
6	SCE/ AEG	(p 14) Sec 5.2.1 – Heatwave calculation	This section makes a recommendation to change the heatwave calculation. SCE, while open to a change in methods, thinks this may not be the appropriate place to make this recommendation. Until very recently, DNV gave no indication they were not in full support of the DEER definition approach. In the final paragraph, it would also be fair to reword the final statement "At a minimum, a separate definition of peak period serves as a benchmark for comparison with the approach undertaken by AEG," to instead acknowledge that the AEG approach was fully compliant with CPUC mandate and previously approved by DNV-GL.	The recommendation proposes a separate definition to compare with the current peak definition and not necessarily to change the heat wave calculation. This recommendation was based on findings/observations from DNV GL's verification of PG&E HER early impact study where the application and replication of the DEER definition could become more challenging. We provide this recommendation to SCE evaluation with the objective of a standardized evaluation approach across all the IOUs in future HER evaluations.
7	SCE/ AEG	(p 16) "Aggregating kWh joint savings" bullet:	DNV doesn't represent the AEG work completely accurately. They mention the need to account for move-outs. AEG did this by excluding the savings from after moving out of any move-outs in downstream program savings. DNV accounted for it through calculating per-participant and per-control group averages, and then scaling them up monthly. Their approach would be necessary if the treatment and control groups were different	Addressed in the text. While we agree that the number of households in the treatment and control group were more or less similar, calculating per household averages would capture the slight differences in sizes and allows for the calculation of standard errors that will inform the statistical significance of savings being calculated.

			sizes, but they are not here. The two were slightly different sizes, but the difference was miniscule, and trivial. AEG's approach also does not assume linear attrition, but it may when combined with the regression model estimate of savings.	
8	SCE/ AEG	(p 17) Sec 5.4 – Number of customers in treatment group for purposes of kW analysis	The last paragraph (which focuses strictly on kW) says, "The number of treatment households used by AEG is the average number of customers in the treatment group from April to December 2014 without the inactive accounts and without mismatched accounts." While this IS true for the kWh calculation, it is NOT true for the kW calculation. For kW, AEG used the number of treatment accounts (minus mismatches) that were active on Sept 15, 2014, the first date of the heat wave.	Addressed in the text.
9	SCE/ AEG	(Appendix A)	Can DNV explain how they obtained the number of T and C customers shown in Table 1? AEG compared this to their own numbers, but wasn't able to determine why they are different. It's not a steady or always increasing amount (some months AEG shows higher numbers, other months DNV shows higher numbers). AEG examined their code and there are potentially a couple issues, but nothing that would cause that size discrepancy. The three issues AEG found were: 1. AEG did not remove ending bills for accounts. That would have only affected 27 bills through the entirety of the analysis, though, as SCE filtered out most of them (Last end date on bill < inactive date). 2. The filter for removing bills if the customer opts out has the end date of the bill > the opt-out date, which is fine. If going with a more restrictive >= (the customer opted out on their meter read date), AEG finds only another 13 bills. 3. DNV's report says that AEG used the midpoint of the bill, which isn't the case. AEG set the month/year to whichever month had the most number of days in it	DNV GL used the last billing month of the customer to identify move outs. We defined billing month as the month of the end date of the billing cycle. For each customer, we identified the last billing month available in 2014. The number of active participants in April 2014 is the total number of participants with last billing month from April 2014 to Dec 2014. For each succeeding months, the no. of active participants are calculated as the number of active participants in the previous month minus the no. of participants that moved out in the previous month. For example, the number of active participants in May 2014 is calculated as the no. of active participants in April 2014 minus the no. of participants whose last billing month is in April 2014.

			(e.g., a 05/10 to 06/08 bill is May's bill). This should mostly be equivalent to using the midpoint except, perhaps, in exceptional cases, it shouldn't could cause any major discrepancies. Without comparing to DNV's code directly, it is not possible to tell at this detailed level what the differences are. AEG and SCE would be interested in learning how DNV approached this.	
10	SCE/ AEG	(Appendix B)	Can DNV check the labeling on Figure 1? We can only estimate the numbers in the graphs, but the AEG numbers in the graph appear not to match the actual AEG numbers. For instance, August is over 9, but the AEG estimate is 8.5. Looking closely, it appears that the graph may be mislabeled– the green bar, labeled DNV GL-2, looks to match the AEG numbers. Table ES-1 of the AEG report clearly shows the average monthly per household savings (excerpted here): Month Average Per-Participant Savings (kWh) April 1.87 May 4.62 June 6.17 July 7.97 August 8.50 September 5.82 October 6.37 November 4.78 December 5.41	Fixed the labels
11	SCE/ AEG	(Appendix D) Figure 2	Please check this figure and the describing text. Either the legend is wrong or the text is wrong – CARE customers are stated to have higher savings in the text, but the figure shows lower savings for this group.	Addressed in the text

Appendix BB. Public Comments from Opower

No.	From	Section	Comments	Response
1	Opower		Opower would like to comment on the recommended approach to use the bill period mid-point to assign usage to months. We do not have an objection to this approach to assigning usage to months, but we request that the evaluator(s) specify the method used to define the pre/post treatment border in the billing data. The motivation for this request is our observation that accurate measurement of savings requires that no post treatment usage be defined as pre-treatment in the data. Specifically, how did the evaluators ensure that no post-treatment usage data was defined in the data as pretreatment usage? For example, if a bill period included the treatment start date, but the bill period mid-point was prior to the start date, how was this bill defined in the data used for the savings regression?	For this evaluation, DNV GL used the end date of the billing cycle as the billing month. Billing months that fall onto the same month of the program start date will be the first month in the post period. This ensures that no post treatment periods are assigned in the pre-period. When using the mid-point, we agree that careful assignment of pre and post period should be ensured to accurately estimate savings. This approach will require identifying the billing cycle that includes the program start date as the start of the treatment period.
2	Opower	Joint Savings - Upstream	DNV-GL, AEG, Nexant and the utilities have been tasked with ensuring that savings identified from HER programs are not attributed to and claimed by other portfolio programs. While a straightforward process to identify and back out savings from the increased uptake of downstream measures of HER recipients has been made possible by the experimental design, it is difficult to ascertain the savings that could be attributable to upstream measures. Broadly, it is far more challenging to identify the specific actions being taken by customers that lead to savings. The composition of savings for individual households varies as much as each household's usage profile	While we understand Opower's concern on the application of the same bulb uptake assumption across all program waves, the joint savings analysis from upstream programs were based on studies that were currently available at the time of the evaluation. DNV GL, the IOUs and the IOU consultants are working together to update the assumptions for future HER evaluations. Opower, the implementer of the program being evaluated, is welcome to provide any comments on the approach and assumptions used during public forums (i.e. EM&V quarterly meetings)

			does. In most cases, the question of what comprises HER savings is academic, and insights based on data from various deployments can be inferred. However, in the case of measuring joint upstream savings, these questions lead to a direct impact on the assesment of the HER program, both in terms of absolute savings and on costeffectiveness. At a high level, the assumption underlying this analysis that customers receiving HERs adopt upstream efficient lighting technology at a higher rate than those in the control group deserves additional discussion and scrutiny. From a strictly theoretical standpoint, it makes sense that when customers are more aware of their energy usage, they take actions to reduce it and one of the least-cost actions a residential customer can take is purchasing efficient lighting. Proving this hypothesis is a challenging, costly, and imprecise exercise. In 2012, Freeman, Sullivan, & Company (FSC) conducted a socket-level survey on behalf of PG&E, involving more than 1,000 home visits to count the number of CFLs customers in both the treatment and control group had installed. The survey found that, on average, HER recipients installed approximately 0.95 more CFLs than households in the control group; however, FSC notes that this difference was not statistically significant. Despite the statistical uncertainty around this 0.95 figure, it was applied on a statewide level without addressing the high probability that any number of variables may impact customers' response to HERs with respect to their lighting purchases. Variations in usage patterns and the regional	

			availability of different lighting technologies with varying levels of subsidies are all likely to have an impact on lighting purchases for HER recipients. In addition, the FSC survey focused on a subset of PG&E customers that was intentionally weighted toward relatively high users who have a higher relative propensity to take more significant savings actions in response to HERs. To assume that households with lower usage experiencing different variables will respond exactly the same is a logical leap that is unsupported by any data that Opower is aware of. To the contrary, the specific characteristics of the FSC survey group indicate that this segment was not representative of the broader PG&E customer base, let alone any other utility's customer base. The new methodology included in the joint upstream savings methodology employed in the 2014 HER evaluations relies on phone and web surveys conducted by DNV-GL on behalf of Puget Sound Energy over the course of their long-running HER deployment. Similar to the socket-level survey conducted by FSC, the difference in reported adoption levels between treatment and control customers at Puget Sound Energy was not statistically significant. Opower goes to great lengths to ensure that any savings claimed by a utility from our programs are measured with statistical significance. In fact, it is highly unlikely that the CPUC would accept savings claims from behavioral programs that were not statistically significant. To use figures that do not meet this standard as underlying assumptions for	

			removing savings from the HER program is inconsistent with the statistical rigor required of behavioral efficiency programs in California. Another concern regarding the new methodology is its extrapolation across lighting technologies. The methodology takes as its starting point an assumption that customers in the treatment group are purchasing 0.95, 0.4, 0.15, and 0.08 excess efficient bulbs compared with the control group in years 1-4 of an HER program. These numbers were arrived at through surveys conducted at a time when basic CFL bulbs comprised the vast majority of efficient lighting available. The new methodology assumes this number of excess efficient bulbs regardless of the changing lighting technologies in the marketplace. It is unclear assumed that customers will adopt high-efficiency advanced CFLs and LEDs, which are significantly more expensive than basic CFLs were, at the same historical rates. As alluded to above, Opower is also concerned about the approach of applying one assumed number of excess bulbs to households in every wave, regardless of the clear differences amongst different deployments. In Opower's 400+ program years of experience implementing HER programs, we have found that every individual wave across different utilities in different geographies varies with regard to energy savings percentage and other key outcomes. It is therefore not appropriate to apply a single number (e.g. 1.58) of efficient bulbs to each individual wave without acknowledging substantive differences both in customer	

			composition and geographies, climate zones and other variables. Aside from our concerns about the validity of the figures arrived at in these studies Opower is concerned that Energy Division and DNV-GL have landed on the belief that ⅓ or more of HER savings are due to lighting purchases (TRC Oct. 22 Memo; Page 3) despite the peer-reviewed evidence that a significant percentage of HER savings are very likely not associated with lighting. LBNL has analyzed a great deal of AMI data from HER recipients and published its findings in, “Insights from Smart Meters: Identifying specific actions, behaviors, and characteristics that drive savings in behavior-based programs.” LBNL’s analysis found that HER savings characteristics include a substantial increase during hotter days and higher savings for households with high likelihood of having central A/C. This observed HER savings curve does not correlate with a standard indoor lighting profile. Therefore, not only is the evidence of substantial lighting uptake by HER recipients statistically suspect, but the more rigorous analysis of HER savings appears to directly conflict with the concept that such a significant percentage of savings is from lighting. Opower understands that DNV-GL and Energy Division are working against very tight timelines to finalize these 2014 evaluations, and the savings removed due to ULP joint savings is under 10% of total first year savings. However, we are concerned that if this methodology is continued into subsequent years, this percentage will rise substantially to levels that don’t pass the smell test.	

			Opower therefore urges Energy Division and DNV-GL to take a thoughtful, deliberative, and transparent approach to determining how to address the question of jointly attributable savings from upstream measures going forward. To date, the process for determining these policies has only involved the IOUs, Energy Division, and evaluators. This excludes implementers like Opower that have both a very significant interest in these discussions, but also a wealth of experience, data, and knowledge about the characteristics of HER programs in the real world. We urgently request that there be a more open and transparent process around this topic going forward, as this issue is anything but technical minutiae to Opower. What happens in California does not stay in California. Rather, other states and utilities oftentimes look to our state as the thought leader on issues like this and will readily adopt the exact same policies without consideration of the local context or the level of debate that has occurred in California.	
3	Opower		The approach to accounting for jointly-attributable savings taken in the evaluations of PG&E, SCE, and SDG&E's HER programs raises broader policy questions regarding both downstream and upstream HER programs. While the current practice of savings attribution is a practical one given the ex ante vs. ex post approach to accounting for savings from deemed and behavioral programs respectively, it is at odds with the objectives placed on behavioral programs in California. HER programs have been deployed for more than seven years to produce verifiable savings via behavior change. Given their	This is not within the scope of DNV GL's impact evaluation. The approach that DNV GL and the IOUs (and their consultants) use in measuring savings credited to the HER program is based on the decision/policy provided under D. 10-04-029 (http://docs.cpuc.ca.gov/PUBLISHED/FINAL_DECISION/116710.htm) that states that savings credited to behavioral programs should not represent double counted savings.

			success, these programs could continue on with the narrow focus of behavioral change. But, behavioral programs are able to deliver various co-benefits beyond behavioral energy efficiency and there has been a significant push in California and peer states for HER programs to do more than just change behaviors in the short-term. Such outcomes include, but are not limited to, promoting participation in other demand side-management programs via targeted messaging to the right customer segment at the right time; maximizing the value of program marketing budgets; and increasing energy literacy. Based on evidence to date, HERs have been successful in delivering on these objectives, to the delight of regulators, clients, and the team at Opower. However, the current approach to accounting for jointly attributable savings decreases the perceived cost-effectiveness of HER programs and provides a disincentive to achieve these objectives. While these co-benefits do not overshadow the primary output of the HER program, behavioral savings, we should be sure that policy is designed to promote the success of programs that have multiple co-benefits across categories, not penalize them for their efficiency. After years of study, we know for that those who receive HERs use less energy than those who do not. We have also observed that those who receive HERs are more likely to participate in rebated energy efficient programs. Because of the experimental design, we know that this increased participation occurs directly because of the HER program. Yet, the attribution for savings negatively impacts the very program	

			that resulted in this increase. In order to accurately characterize the effect downstream and upstream lighting programs, while simultaneously allowing HERs to continue meeting the energy and policy objectives set for them, it may be time to reevaluate the attribution approach employed.	

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.