Review and Validation of 2014 Pacific Gas and Electric Home Energy Reports Program Impacts (Final Report)

California Public Utilities Commission

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1 EXECUTIVE SUMMARY

This report provides the results of DNV GL's review and evaluation of the Pacific Gas and Electric Company's (PG&E's) 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 Nexant, Inc.

1.1 Background

The HER pilot program (Beta wave) started sending reports in August 2011. The reports contain a mix of consumption information, comparison with similar neighbors and customized tips for saving energy. Since then, a new wave of households began receiving reports in each subsequent year. There are seven waves (Beta, Gamma, One, Two, Three, Four, and Five) with some waves split further down into smaller sub-waves (i.e., Wave Two Area 7 versus Wave Two Not Area 7). Table 1 shows the treatment counts of the different waves and sub-waves for PG&E HER. PG&E started each wave at different times, drew them from different populations, and applied slightly different treatments. Approximately 1.4 million PG&E customers were enrolled in the treatment groups in 2014.

Table 1. HER experimental waves and launch dates

Wave	Fuel type/Frequency of report/Area	Launch date	Treatment Customers**
Beta	Dual fuel	Aug-11	46,907
Gamma*	Dual fuel – standard frequency	Nov-11	54,859
	Dual fuel – reduced frequency		54,921
	Electric only		29,433
Wave One	Dual fuel	Feb-12	284,556
	Electric only		27,947
Wave Two	Non-Area 7	Feb-13	259,055
	Area 7		68,123
Wave Three	Dual fuel	Jul-13	191,891
Wave Four	Dual fuel	Mar-14	183,629
Wave Five	Dual fuel	Oct-14	195,443

* Customers in Gamma Wave – reduced frequency receive the comparative reports quarterly as opposed to receiving the reports every other month (standard frequency).
**The average number of treatment customers is based on PG&E 2014 GWh and Therm Savings Memo (prepared by Nexant, July 10, 2015).

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 energy and demand savings attributable to the HER program. Specific research questions included the following:

- What are the energy savings for each HER wave?
- Are there downstream/upstream rebate program savings that could be jointly claimed by both the HER program and other PG&E rebate programs?
- What are the peak demand savings attributable to the program?
- Are the results produced by Nexant on behalf of PG&E consistent with the results produced by the independent evaluation?

1.3 Study approach

To answer these research questions, DNV GL reviewed and validated; 1) Nexant's early impact evaluation for PG&E'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 Nexant's analysis to produce fully independent estimates. DNV GL compared its independent estimates for the different components of HER program savings with Nexant'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 PG&E 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 PG&E'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 PG&E-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 Nexant. 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.

[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.

[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.

1.4 Key findings

Table 2 shows DNV GL's recommended savings for the 2014 HER program. Since DNV GL's unadjusted electric and gas savings are on par with Nexant's unadjusted estimates, we recommend using Nexant's estimates for unadjusted electric and gas savings. Because there were some indications that Nexant's analysis may have included rebate savings from customers that are no longer active in 2014, we recommend using DNV GL's joint savings estimate from downstream programs.

To eliminate double counting, DNV GL recommends subtracting the DNV GL estimate for electric joint savings from downstream rebates and the TRC estimate for electric joint savings from upstream lighting programs from the Nexant unadjusted estimate. The result is the final savings estimate.

Table 2. Program-level kWh and therms savings estimates for 2014

Wave	Electric (kWh)		Gas (therms)	
	Unadjusted	Adjusted	Unadjusted	Adjusted
Beta	10,397,686	9,745,651	226,393	234,593
Gamma - Dual Standard	6,658,177	6,169,593	122,896	131,661
Gamma - Dual Reduced	5,446,000	4,888,713	118,645	127,400
Gamma - Electric only	3,085,802	2,752,975		-
Wave One - Dual	33,418,209	30,820,067	700,734	741,283
Wave One - Electric only	3,597,712	3,482,644		-
Wave Two - Non-Area 7	23,891,677	23,205,417	771,358	783,171
Wave Two - Area 7	5,871,707	5,369,905	206,865	209,972
Wave Three	13,185,136	12,693,711	533,885	540,083
Wave Four	6,733,656	6,710,209	123,420	124,815
Wave Five	1,888,811	1,864,892	123,894	124,265
Total	114,174,573	107,703,778	2,928,090	3,017,243

Overall, the PG&E HER program achieved program savings of 108 GWh and 2.9 million therms in 2014. The double-counted savings accounted for 5% of the decrease in electric savings while gas savings increased by 3% after accounting for heating and cooling interactive effects associated with energy saving lighting measures. This adjustment is important because the replacement of inefficient lighting measures with more efficient lamps can increase heating load consumption due to lower heat emissions from CFLs and LEDs.

California recognizes the potential for interactive effects across fuels when assigning savings. Interactive effects are explicitly accounted for in the downstream rebate program tracking database. For the untracked upstream lighting program, a similar estimate of interactive effects for gas is calculated using the ratio of kWh and therms savings per watt from DEER. The approach directly estimates gas effect from the estimated upstream electric joint savings. The interactive effect produce negative gas joint savings and therefore increases the overall adjusted gas savings.

Table 3 provides the recommended estimates of unadjusted and adjusted savings at the household level as a fraction of the control group's average consumption in 2014. The electric savings at the household level range from 1% to 2% of electric consumption except for Wave Four and Wave Five.[3] These two waves began in 2014 and do not represent savings for a full year.[4] The gas savings per household were all less than 1% of baseline gas consumption in 2014.

Table 3. Average kWh and therms savings per household as a percent of consumption

HER Wave	Baseline Consumption	Per Household Savings (Unadjusted)	Per Household Savings (Adjusted)	% Savings	
				Unadjusted	Adjusted
Electric (kWh)					
Beta	10,131	222	208	2.2%	2.1%
Gamma Reduced	7,172	121	111	1.7%	1.6%
Gamma Standard	7,172	99	91	1.4%	1.3%
Gamma Electric Only	6,819	105	94	1.5%	1.4%
Wave One	7,096	117	108	1.7%	1.5%
Wave One - Electric Only	8,055	129	125	1.6%	1.5%
Wave Two – Non Area 7	6,757	92	89	1.4%	1.3%
Wave Two – Area 7	5,894	86	83	1.5%	1.4%
Wave Three	6,714	69	66	1.0%	1.0%
Wave Four	5,053	37	37	0.7%	0.7%
Wave Five	2,352	10	10	0.4%	0.4%
Gas (therms)					
Beta	604	4.8	5.0	0.8%	0.8%
Gamma Reduced	353	2.2	2.4	0.6%	0.6%
Gamma Standard	353	2.2	2.3	0.6%	0.6%
Wave One	362	2.5	2.6	0.7%	0.7%
Wave Two – Non Area 7	371	3.0	3.0	0.8%	0.8%
Wave Two – Area 7	400	3.0	3.1	0.8%	0.8%
Wave Three	371	2.8	2.8	0.8%	0.8%
Wave Four	284	0.7	0.7	0.2%	0.2%
Wave Five	105	0.6	0.6	0.6%	0.6%

[3] Per customer savings are calculated by dividing the total aggregate savings by the average number of customers during that time period.
[4] Wave Four and Wave treatment periods started in March 2014 and October 2014, respectively.

Table 4 provides the recommended estimates for demand savings for the HER program. DNV GL's estimates are on par with Nexant's demand savings. The total adjusted peak reduction is based on Nexant's peak demand estimates and DNV GL's joint savings estimates for potentially double counted savings. Overall, the HER program achieved a total adjusted peak reduction of 19 MW in 2014.

Table 4. Overall peak demand (kW) savings

Wave	Electric (kW)			
	Unadjusted	Joint Savings Downstream	Joint Savings Upstream	Adjusted
Peak Demand Savings	20,961	951	476	19,534

2 INTRODUCTION

The California Public Utilities Commission (CPUC) engaged DNV GL to review and validate Pacific Gas & Electric's (PG&E'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 PG&E HER program savings estimates produced by Nexant.

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 PG&E's billing data and program tracking data, which allowed evaluators to produce fully independent savings estimates to compare with Nexant's. DNV GL also received PG&E's peak demand data from advanced metering infrastructure (AMI), which allowed evaluators to replicate Nexant's peak demand analysis and validate demand savings estimates for 2014. This ex-post validation goes well beyond simply vetting the approach used by Nexant. By replicating the analysis, the evaluators provide a more robust validation of the estimated savings that are occurring within the program.

2.1 HER program description

The HER pilot program (wave Beta) started sending reports in August 2011. The reports contain a mix of consumption information, comparison of energy usage with similar neighbors and customized tips for saving energy. Since then, PG&E has introduced seven waves: Beta Wave, Gamma Wave, Wave One, Wave Two, Wave Three, Wave Four, and Wave Five. PG&E started each wave at different times, drew them from different populations, and applied slightly different treatments. Waves Three through Five represent replacements for the attrition the program experiences each year. Table 5 provides the count of treatment customers in each wave.

Table 5. HER experimental waves and launch dates (Nexant's counts)

Wave	Fuel type/Frequency of report/Area	Launch date	Treatment Customers**
Beta	Dual fuel	Aug-11	46,907
Gamma*	Dual fuel – standard frequency	Nov-11	54,859
	Dual fuel – reduced frequency		54,921
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* Customers in Gamma Wave – reduced frequency receive the comparative reports quarterly as opposed to receiving the reports every other month (standard frequency).
**The average number of treatment customers is based on PG&E 2014 GWh and Therm Savings Memo (prepared by Nexant, July 10, 2015).

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.

Figure 1 and Figure 2 show the historical electric and gas savings as a percent of baseline consumption for all PG&E experimental waves. The wave-level differences in percent savings are due to the different target populations, target areas and timing and frequency of the reports.

Figure 1. Percent kWh savings from 2011-2014

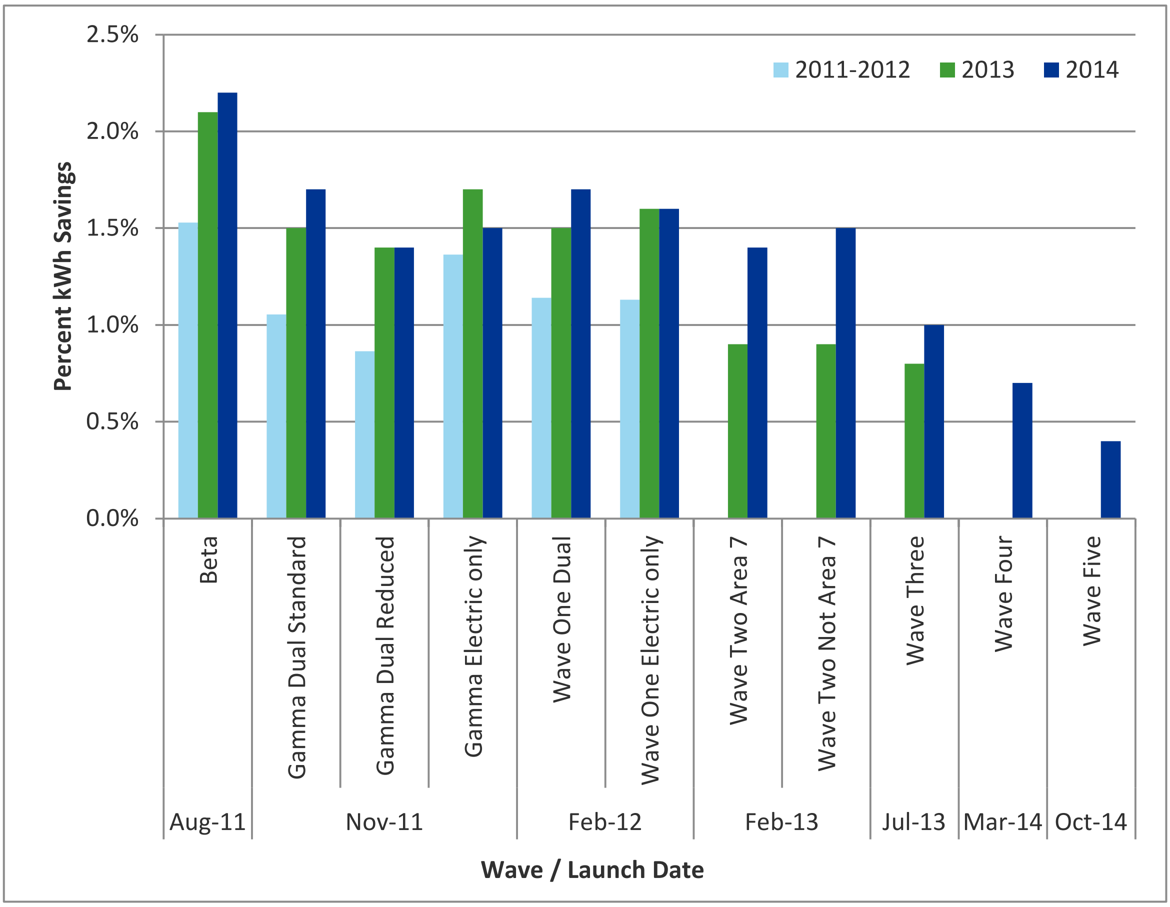
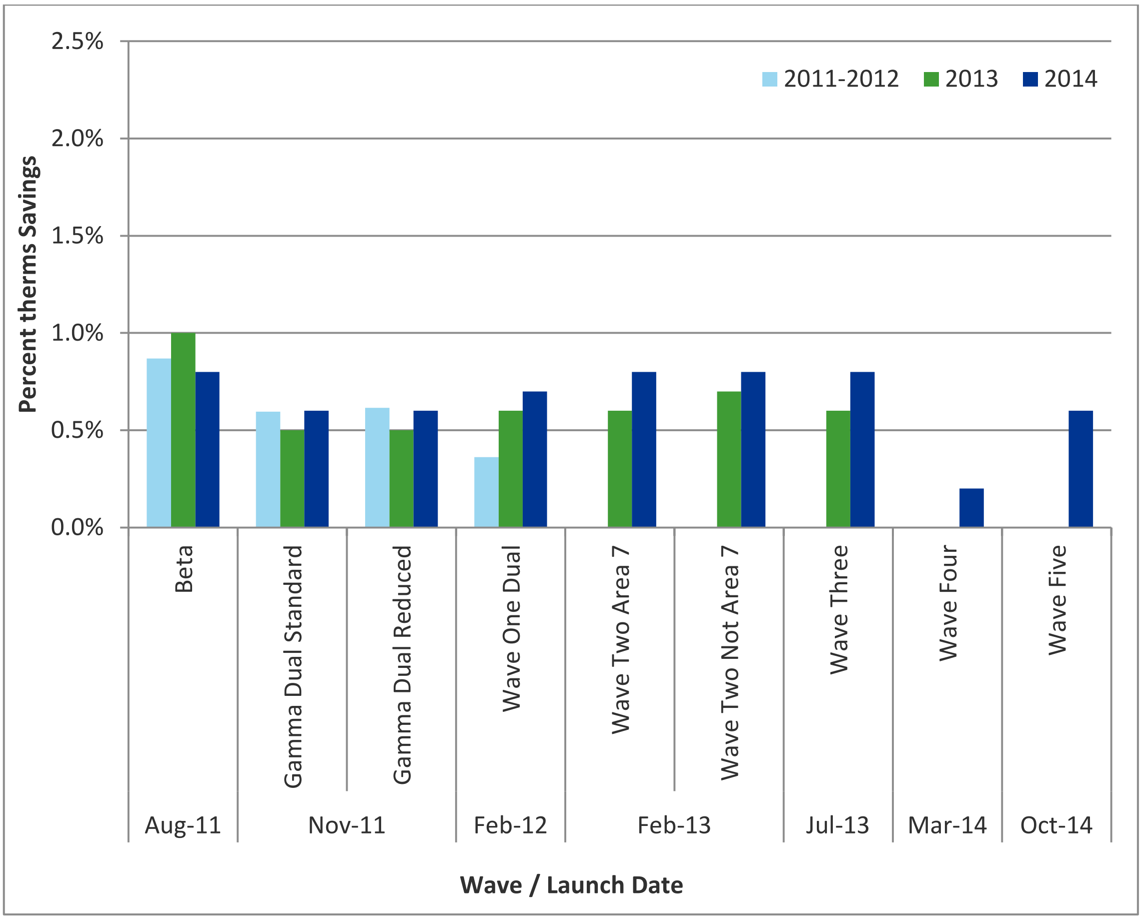


Figure 2. Percent therms savings from 2011-2014



For most of the experimental waves, the largest increase in electric savings was observed during the second year of receiving the reports. This increase amounted to approximately 0.5% point increase in percent electric savings. However, the incremental increase in electric savings started to decrease during the third year of the program. Gas savings are relatively flat compared to electric savings and are less than 1% for all experimental waves.

2.2 Evaluation objectives and approach

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

- What are the energy savings for each HER wave?
- Are there downstream/upstream rebate program savings that could be jointly claimed by both the HER program and other PG&E rebate programs?
- What are the peak demand savings attributable to the program?
- Are the results produced by Nexant on behalf of PG&E consistent with the results produced by the independent evaluation?

To answer these research questions, DNV GL reviewed and validated; 1) Nexant's early impact evaluation for PG&E's 2014 HER program; and 2) TRC's upstream lighting study[5] 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 Nexant's analysis to produce fully independent estimates. DNV GL compared its independent estimates for the different components of HER program savings with Nexant'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 PG&E 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 PG&E'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 PG&E-supported upstream lighting program (ULP).[6]
- *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.

The results of these savings calculations are presented in Section 4.

[5] 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.

[6] 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.

3 METHODOLOGY

This section describes how DNV GL estimated impacts of the 2014 HER program.

3.1 Energy savings

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

The fixed-effects equation is:

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

Where:

E_{it} = Average daily energy consumption for account i during month t

P_{it} = Binary variable: one for households in the treatment group in the post period month t, zero otherwise

λ_t = Monthly effects

μ_i = Account level fixed effect

ε_{it} = Regression residual

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

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

Where:

$\bar{S}_t$ = Average treatment related consumption reduction during month t

$\hat{\beta}_t$ = Estimated parameter measuring the treatment group difference in the post period month t

The model 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 (SEEAction) Evaluation, Measurement, and Verification (EM&V) of Residential Behavior-Based Energy Efficiency Programs: Issues and Recommendations.[7]

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

3.2 Demand savings

Reductions in demand at peak times that result from HER program participation can be measured through a variety of approaches given that the gold standard has not yet been defined. DNV GL used the peak period definition provided by the Database for Energy Efficiency Resources (DEER).[8] This definition takes into account the average temperature, average afternoon temperature (12 p.m.–6 p.m.), and maximum temperature over the course of three-day heatwave candidates. Each candidate is a combination of three consecutive non-holiday weekdays occurring between June 1 and September 30.

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., July 23-25, 2014). In a randomized experiment such as the 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.

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

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

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

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.

3.3 Downstream rebate joint savings

One possible effect of the HER program is to increase rebate activity in other PG&E energy efficiency programs. The RCT experimental design facilitates the measurement of this effect. DNV GL compared the average savings from rebate measures installed by the treatment group with the savings from measures installed by the control group. An increase in treatment group rebate program savings represents savings caused by the 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 PG&E rebate program tracking databases and are claimed as part of those programs' savings unless further actions were taken to remove them. Savings from the HER 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[9] for PG&E. These load shapes indicate when a measure is used during the year and, by proxy, when efficiency savings would occur.[10]

Savings for each installed measure start to accrue at the time of installation (or removal for refrigerator recycling). DNV GL 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 PG&E downstream rebate programs during the peak period.

3.4 Upstream joint savings

Upstream joint savings are similar to downstream joint savings, except that upstream savings are not tracked at the customer level. PG&E 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. The results from PG&E study were used as the basis for PG&E 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 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 while the assumption used in past PG&E HER evaluations assumed that the HER program encouraged a total of 1.5 CFL installation per household by the end of the second year of the program. The new assumption for the number of excess 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.

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

[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.

Table 6 presents the updated assumptions used in PG&E 2014 HER joint savings calculation for upstream programs.

Table 6. 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		
2011 CFL	50%	TRC estimate
2012 CFL	45%	TRC estimate
2013 CFL	16%	TRC estimate
2014 CFL	7%	Program tracking data (DEER 2013-14)
2014 LED	21%	Program tracking data (DEER 2013-14)
Annual savings per bulb		
2011 CFL	26.80	2010-12 ULP Evaluation (DNV GL, 2014)
2012 CFL	26.20	2010-12 ULP Evaluation (DNV GL, 2014)
2013 CFL	23.50	Program tracking data (DEER 2013-14)
2014 CFL	23.50	Program tracking data (DEER 2013-14)
2014 LED	24.80	Program tracking data (DEER 2013-14)
Fraction of CFL lamps in 2014	0.66	TRC estimate of total CFL and LED sold in territory
Fraction of LED lamps in 2014	0.34	TRC estimate of total CFL and LED sold in territory
Net-to-gross	0.63	2010-12 ULP Evaluation (DNV GL, 2014)
Installation rate	97%	2010-12 ULP Evaluation (DNV GL, 2014)
Assumed gas savings	-0.02	Program tracking data (DEER 2013-14)

Source: TRC memo on Proposed Changes to Draft 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:

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

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

California recognizes the potential for interactive effects across fuels when assigning savings. Interactive effects are explicitly accounted for in the downstream rebate program tracking database. For the untracked ULP, a similar estimate of interactive effects for gas is calculated using the ratio of kWh and therms savings per watt from DEER. The assumed gas savings per kWh savings from upstream lighting program are -0.019 therms per kWh based on TRC memo. The equation below is used to calculate the heating and cooling interactive effects associated with energy saving lighting measures:

$$\text{Therms savings due to interactive effects} = \text{Total kWh joint savings from ULP} \times (-0.019 \text{ therms per kWh})$$

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

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 6 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 0.05 indicating that only about 5% 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 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 PG&E service territory.

Table 7 provides the calculation of peak watts impact for CFLs. DNV GL calculated a peak watts impact of 2.3 watts for CFL. This value was used to measure watts reductions at the peak from CFL and LED installation.

Table 7. PG&E CFL peak diversity factor

Factor	Input Value	Source
Installation Rate	0.97	WO28 (2010-2012)
Delta Watts	47.10	WO28 (2010-2012)
Peak CF	0.05	WO28 (2010-2012)
Peak Watts Impact	**2.28**	Calculated as installation rate × delta watts × Peak CF
Hours-of-use (HOU)	1.594	WO28 (2010-2012)
kWh Impact	26.581	Calculated as installation rate × delta watts × (HOU*365)/1,000
Watts per kWh	**0.086**	Calculated as peak watts impact/kWh impact

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

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

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

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 6, DNV GL used peak watts impact to measure watt reductions per installed bulb at the time of peak. DNV GL also used the number of treatment households that are active in July 2014, the month of the peak period, to calculate aggregate kW joint savings.

4 RESULTS

DNV GL reviewed Nexant's methods as presented in its evaluation report[13] and in Stata program codes submitted by Nexant. 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 PG&E 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 PG&E HER program.

4.1 Overall kWh and therms savings estimates

DNV GL found Nexant's approach to estimating the reduction in consumption to be consistent with most of the best practices as delineated in State and Local Energy Efficiency Action Network's report (SEE Action, hereafter).[14] In particular, Nexant followed the recommended fixed-effects regression approach and used clustered standard errors to control for lack of independence among data points or correlations for each customer.

Also consistent with last year's evaluation, Nexant diverged from the SEEAction recommended approach in one major way; the SEE Action approach states that residential move-outs should be excluded when aggregating to program level consumption reductions, but Nexant allows both treatment and control group households to be included in the regression model until residents close their accounts. DNV GL supports Nexant's approach as it captures valid partial savings in households that moved out or went inactive prior to the end of the evaluation period.

DNV GL independently estimated wave-level consumption reductions for the HER program with the objective to verify whether Nexant's results were consistent with independently produced results, and not necessarily to produce identical results. DNV GL evaluators also cross-checked the monthly savings estimates provided by Nexant for 2014 with the monthly savings provided in 2013. This allowed a review of savings trends over time and evaluators to raise a flag for any unusual patterns in Nexant's reported monthly savings.

Table 8 presents a comparison of DNV GL's and Nexant's calculation of the aggregate electric and gas savings for HER program year 2014. Consistent with last year's evaluation, both estimates used Nexant's treatment counts for expanding household-level savings to program-level savings, making this a comparison of the underlying regression model results.[15]

[13] Nexant, Inc. *2014 Energy Efficiency Savings Estimates: Pacific Gas and Electric Home Energy Reports Program*, January 26, 2014. Nexant, Inc. *2014 Demand Savings Methodology and Estimate: Pacific Gas and Electric Home Energy Reports Program*, January 26, 2014.

[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.

[15] DNV GL used treatment counts as reported in Nexant's results file 'Energy – Savings FE Model.xlsx'.

Table 8. Aggregate kWh and therms savings

Wave	Electric (kWh)			Gas (therms)		
	Nexant	DNV GL	% DNV / Nexant	Nexant	DNV GL	% DNV / Nexant
Beta	10,397,686	10,362,007	100%	226,393	280,919	124%
Gamma - Dual Standard	6,658,177	7,093,167	107%	122,896	122,562	100%
Gamma - Dual Reduced	5,446,000	5,497,149	101%	118,645	121,721	103%
Gamma - Electric only	3,085,802	3,269,279	106%			
Wave One - Dual	33,418,209	33,399,370	100%	700,734	669,336	96%
Wave One - Electric only	3,597,712	3,723,960	104%			
Wave Two – Non-Area 7	23,891,677	22,704,428	95%	771,358	824,386	107%
Wave Two – Area 7	5,871,707	5,802,203	99%	206,865	260,329	126%
Wave Three	13,185,136	12,563,338	95%	533,885	493,828	92%
Wave Four	6,733,656	6,545,056	97%	123,420	130,576	106%
Wave Five	1,888,811	1,325,036	70%	123,894	27,260	22%
Total	**114,174,573**	**112,284,994**	**98%**	**2,928,090**	**2,930,916**	**100%**

Overall, DNV GL estimates are on par with Nexant's estimates for gas and electricity savings but the differences in savings among waves did vary. With the exception of Wave Five, the electric savings were at most 7% different while gas savings exhibited differences that ranged up to 26%. Wave Five generated the biggest discrepancies with DNV GL calculating significantly less savings. However, given these differences DNV GL and Nexant's total savings for electric and gas across all waves were still comparable with each other. DNV GL assessed the discrepancies and found that differences in data preparation are likely the primary cause of discrepancies in savings estimates. The differences are summarized below:

- Billing month assignment. As noted in previous evaluations, DNV GL's and Nexant's billing month assignments are different. DNV GL used the month of the end date of the billing cycle as the billing month while Nexant used the midpoint of the start and end dates 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 mid-point for assigning billing months when validating PG&E HER results in order to minimize the sources of discrepancies in results.
- Data cleaning. DNV GL reviewed Nexant's process in data preparation and found some inconsistencies with last year's approach. For the 2014 evaluation, Nexant used raw consumption in the analysis leaving in sites with negative values while DNV GL's approach consistently removed sites with negative values (typically due to net metering) and converted billing records of each billing interval to average consumption per day for each site. Using the average consumption in a billing cycle is particularly important to avoid over- or under-estimation of consumption in a billing cycle because the number of days in an interval could vary from month to month in the billing data. DNV GL recommends Nexant to revisit data cleaning procedures to ensure consistency with previous approach.
- Consumption data used in pre-period. DNV GL only considered consumption of HER customers that are active in 2014 in billing analysis. Limiting consumption to active population ensures that

consumption in the pre-period is being compared to post-consumption of the same HER customers. Nexant's approach included all customers with pre- or post-consumption data regardless of whether the customer is still active or not.

DNV GL also reviewed the impact evaluation results file, which indicated that the standard errors for the aggregated savings were based on an overall regression model at the wave-level where an overall post-treatment indicator was specified. This is consistent with Nexant's approach last year and is an unnecessary simplification that does not account for the different monthly counts in the aggregate estimates' standard errors. As previously recommended, the standard errors should be calculated using the combined monthly parameter standard errors weighted by the monthly counts if the annual savings estimates are calculated by combining monthly savings estimates and monthly treatment counts.[16]

The difference between DNV GL's and Nexant's overall savings for 2014 HER program is only 2% of the estimated savings for electric and 0.1% of the estimated savings for gas despite differences in methods summarized in this section. DNV GL recommends Nexant's electric and gas savings estimates for 2014 HER program.

Appendix A provides a comparison of DNV GL's and Nexant's average treatment counts and Appendix B provides graphical illustrations of DNV GL's and Nexant's monthly electric and gas savings estimates.

4.2 Demand savings estimates

DNV GL reviewed the approaches and findings of Nexant'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.

4.2.1 Heat waves by climate zone

DNV GL verified Nexant's 2014 heat waves using the weather data provided by PG&E that used hourly temperatures from weather stations across the PG&E service territory from January 1, 2010 to December 31, 2014. The heat waves were identified using two separate statistical packages (R and SAS) and two independent analytical platforms.

Table 9 provides a comparison of peak heat waves identified for each climate zone by DNV GL and Nexant. DNV GL was able to match the heat waves findings to Nexant's for five out of the nine climate zones. Despite some differences in heat waves, DNV GL found Nexant's logic, procedure, and application of DEER peak definition in identifying heat waves to be sound. Based on the results, the most common three-day heat wave among HER participants is July 23-25, 2014. This three-day heat wave is elected to represent all climate zones.

[16] Estimates of combined parameter standard error estimates are standard output in any statistical computing package.

Table 9. Peak heatwaves identified by climate zone

Climate Zone	Nexant Heat Waves		DNV GL Heat Waves		Matching
	Begin	End	Begin	End	
1	9/22/2014	9/24/2014	9/22/2014	9/24/2014	Yes
2	7/23/2014	7/25/2014	7/23/2014	7/25/2014	Yes
3	7/23/2014	7/25/2014	7/23/2014	7/25/2014	Yes
4	6/30/2014	7/2/2014	7/23/2014	7/25/2014	No
5	7/15/2014	7/17/2014	7/28/2014	7/30/2014	No
11	7/14/2014	7/16/2014	7/30/2014	8/1/2014	No
12	6/9/2014	6/11/2014	7/30/2014	8/1/2014	No
13	7/30/2014	8/1/2014	7/30/2014	8/1/2014	Yes
16	7/30/2014	8/1/2014	7/30/2014	8/1/2014	Yes

Similar to Nexant's approach, DNV GL also estimated weighted averages of weather station temperatures within PG&E's territory to identify the heat waves. DNV GL's approach only differed from Nexant in terms of the customer identifiers used to produce zonal weighted temperature. DNV GL identified households as the unique combination of account and premise identifiers while Nexant used only the Service Account ID. Using different identifiers produced different sets of population weights associated with weather stations within climate zones and produced different values for zonal weighted temperature. The inability to replicate the climate zone heat waves between analyses, 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.

Going forward, DNV GL proposes employing a separate definition of peak period that takes into account the 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 PG&E and Nexant to identify separate definition of peak period that can be used to compare with the current DEER definition of peak for the HER program.

4.2.2 Weighting

A crucial step in Nexant's approach involved weighting the control group usage based on the ratio of treatment and control households within each wave. This step corrects for the imbalance in the ratio of treatment-to-control across the experimental waves.

Table 10 provides wave-specific control weights from Nexant and DNV GL. For each experimental wave, the treatment to control ratio found by both DNV GL and Nexant were effectively identical. For Gamma and Wave One, DNV GL calculated the weights separately instead of combining the different sub-waves. Wave 5 of the program began after the summer of 2014 and therefore is excluded from this comparison and from the peak demand reduction analysis overall.

Table 10. Control-to-treatment ratio comparison

Wave	Within Wave Treatment-to-Control Ratio		% DNV / Nexant
	DNV GL	Nexant	
Beta	1.0	1.0	101%
Gamma – Standard	1.0	Not reported	-
Gamma – Reduced	1.0		
Gamma – Electric only	1.0		
Gamma (All)	1.7	1.7	98%
Wave One Dual	4.0	Not reported	-
Wave One – Electric only	3.9		
Wave One	4.0	4.0	100%
Wave Two Area 7	1.6	1.6	100%
Wave Two Not Area 7	6.3	6.4	99%
Wave Three	3. 0	3.0	100%
Wave Four	2.7	2.7	99%

4.2.3 Peak demand reductions

DNV GL replicated Nexant's approach in calculating peak demand reductions. DNV GL applied a similar weighting scheme described above and 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 for each climate zone and then multiplied by the number of treatment households provided by Nexant to estimate an aggregate demand savings across the program population.

Table 11 provides a comparison of the total peak demand savings estimates for the most common heat wave. Overall, DNV GL's and Nexant's peak demand savings estimates showed slight differences. The different weighting approach applied for Gamma and Wave One and different criteria used for inclusion of sites in the analysis are likely to account for the differences in demand savings. For the peak demand analysis, DNV GL only included sites that were also used in energy savings calculation for consistency purposes.

Table 11. Overall kW savings comparison

Heat Wave Start	Heat Wave End	Nexant Peak Reduction (kW)	DNV GL Peak Reduction (kW)	% DNV / Nexant
23-Jul-14	25-Jul-14	20,961	19,281	92%

Peak demand analysis is a relatively new concept in the context of HER program and there are a number of details that need to be explored. The IOUs are using slightly different approaches (i.e. calculating savings at the climate zone level vs wave-level) that can produce substantially different results. Despite slight differences in demand savings, DNV GL recommends using Nexant's peak demand reductions for the 2014 HER program.

Going forward, DNV GL recommends a more standardized approach for calculating peak demand savings. There is no reason not to use a wave-level approach consistent with the energy savings approach for peak demand savings. The wave-level approach is both simpler and as robust as any of the alternative approaches. In addition, DNV GL's pre-period assessment for the 2013 program cycle showed indications of statistically significant differences in peak load consumption between the treatment and control for some climate zones. This zonal pre-period differences in peak load become statistically not significant when treatment and corresponding control groups are compared at the wave-level. DNV GL recommends estimating peak demand savings at the wave-level that is consistent with the approach used in the energy savings calculation. Also consistent with previous recommendations, DNV GL recommends checking for statistical difference in peak load consumption during the pre-period for all new experimental waves at the minimum 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 Joint savings: downstream programs

DNV GL reviewed Nexant's codes and data used in estimating electric joint savings from downstream programs. In prior years' joint savings calculation, Nexant carried forward savings incurred by the HER population from other energy efficiency measures installed in 2011, 2012, 2013, and 2014. Following DNV GL's recommendation from 2013 evaluation, Nexant only carried forward savings from measures installed after the program start date of each experimental wave. Nexant continued to apply the recommended approach of prorating kWh savings for each customer who received a rebate.

The PG&E tracking data that Nexant used in their rebate analysis included a more complete program tracking data than the data used in 2013 evaluation. Unlike last year, the 2014 analysis included downstream program participation for the last quarter of 2012.

Table 12 compares DNV GL's and Nexant's rebate savings for each experimental wave. Overall, DNV GL's joint savings estimate from downstream programs is 22% lower than Nexant's total savings estimate.

Table 12. Total downstream rebate kWh savings by HER wave, electric customers

HER Wave	Control		Treatment		Difference	
	Nexant	DNV GL	Nexant	DNV GL	Nexant	DNV GL
Beta	3,072,993	2,573,716	3,295,003	2,794,206	222,010	220,490
Gamma-Standard	NA	1,620,645	NA	1,647,892	NA	27,247
Gamma-Reduced	NA	1,622,796	NA	1,719,267	NA	96,471
Gamma-Electric Only	NA	716,845	NA	802,434	NA	85,589
Gamma All	4,844,536	3,960,286	5,166,524	4,169,593	321,988	209,307
Wave One-Dual	NA	7,668,784	NA	8,132,755	NA	463,971
Wave One-Electric Only	NA	555,850	NA	461,315	NA	-94,535
Wave One All	8,986,295	8,224,634	9,452,426	8,594,070	466,131	369,437
Wave Two Area 7	656,061	624,566	753,536	689,094	97,475	64,528
Wave Two Not Area 7	4,178,347	3,939,027	4,587,470	4,277,333	409,123	338,307
Wave Three All	1,987,419	1,833,686	2,164,365	1,998,896	176,946	165,210
Wave Four	663,683	655,697	650,795	605,693	-12,888	-50,004
Wave Five	106,372	75,528	114,726	79,902	8,354	4,374
Total Difference in Rebated Savings (kWh)					**1,689,139**	**1,321,650**
Total Difference in Rebated Savings (GWh)					**1.7**	**1.3**

Note: DNV GL control group savings were scaled for comparison with the treatment.
NA means not available

The discrepancy in joint savings estimates for downstream programs are due to the different approaches used in the calculation. The key differences are summarized below:

- *Exclusion of savings from inactive HER customers*. Consistent with billing analysis approach, DNV GL only considered program participation of households that are still active in 2014 in joint savings calculation while Nexant's approach included program participation of all HER customers since program inception of each wave. Nexant's approach carried forward savings from measures installed by customers who are no longer receiving the report and active in 2014. Savings from rebate program participation of inactive customers should not be counted as joint savings because consumption reduction of customers after moving out are not included in the measured program savings.
- *Prorating savings*. DNV GL applied DEER load shapes according to the measure while Nexant used a flat load shape 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 Wave Four and Wave Five.
- *Data cleaning*. DNV GL examined potential outliers in the program tracking data. Some lighting measures in Gamma wave had very high savings values. DNV GL reviewed these records and excluded these observations since indications appear that these savings were from measures installed in common areas in multifamily homes.

- *Splitting out Gamma and Wave One sub-waves*. DNV GL separately analyzed the different Gamma (dual standard, dual reduced and electric only) and Wave One (dual, electric only) sub-waves. This approach allowed for a better comparison of treatment and control that is consistent with program savings calculation.

DNV GL recommends that Nexant revisit their joint savings calculation and apply the necessary adjustments for future HER program evaluation. DNV GL recommends applying 1.3 GWh as the total downstream rebate savings for 2014 HER program. Regarding adjustments in gas savings, joint savings from downstream measures were fairly small. Nexant omitted any adjustment in gas savings that might have been due to double-counting.

The issue of potential double counting also applies to demand impacts to the extent that HER programs successfully motivate increased uptake in other energy efficiency programs and those programs claim demand savings. DNV GL calculated joint savings that are attributed to downstream rebated measures by using deemed demand values contained in downstream rebate tracking data and only by using those measures installed prior to the first day of the most common heat wave (July 23, 2014)

Table 13 provides DNV GL's joint savings estimates for downstream programs during the peak period. Overall, the total joint savings at the peak are 1MW or approximately 5% of the total peak demand savings.

Table 13. kW joint savings from downstream rebate programs by wave

Wave	Per Household kW Savings			Average number of treated customers	Total kW joint savings
	Treatment	Control	Difference		
Beta	0.022	0.021	0.00	46,907	62
Gamma - Dual Standard	0.019	0.017	0.00	54,859	92
Gamma - Dual Reduced	0.017	0.017	-0.00	54,921	-4
Gamma - Electric only	0.021	0.012	0.01	29,433	256
Wave One - Dual	0.015	0.015	0.00	284,556	103
Wave One - Electric only	0.008	0.009	-0.00	28,287	-35
Wave Two - Non-Area 7	0.008	0.008	0.00	259,055	83
Wave Two - Area 7	0.003	0.003	0.00	68,123	28
Wave Three	0.007	0.004	0.00	191,891	441
Wave Four	0.002	0.002	-0.00	183,629	-76
Total				1,201,661	951

Nexant did not report their peak demand joint savings at the wave-level but reported a total 0.6 MW joint savings to account for potentially double counted savings from downstream programs. Due to the limited information available, DNV GL was unable to account for the discrepancy in peak demand joint savings. It is likely that the differences in approach used to calculate the kWh joint savings also explain the discrepancy in peak demand joint savings. For consistency, DNV GL recommends using DNV GL's estimate for peak demand joint savings from downstream programs.

4.4 Joint savings: upstream programs

Table 14 provides the upstream joint savings inputs for CFLs and LEDs. Based on TRC's calculation, 2014 electric joint savings from upstream programs are 5.1 GWh. The replacement of inefficient lighting measures with efficient lamps is associated with an increase in heating load due to lower heat emissions from CFLs and LEDs. These interactive effects translate to a gas penalty that would have been double counted by HER and the ULP. TRC estimated the interactive effect on natural gas to be -104,000 therms. This negative number is subtracted from the unadjusted gas savings to remove the gas penalty associated with the removal of electric joint savings from upstream programs.

DNV GL reviewed and re-calculated TRC's approach and estimated a lower total gas penalty amounting to -89,000 therms in 2014. DNV GL's estimate of total gas penalty is based on TRC's total electric joint savings from ULP and is lower than TRC's estimate because DNV GL excluded households from the Gamma-Electric only and Wave One Electric only. Participants from these two waves are either from single fuel homes or dual fuel homes who do not receive gas service from PG&E; as such, these homes should not be included with homes used to calculate the total gas penalty that is associated with the electric joint savings from ULP.

Table 14. 2014 HER joint savings from upstream programs

PG&E Treatment Wave	Month Treatment Began	Number of Households	Excess CFLs				Excess LEDs	Number of Years since 2014 Excess Lamps were Installed	Annual kWh Joint savings per household		Total kWh joint savings per household	TRC Total joint savings (GWh / year)	TRC Annual Gas savings (therms, 000)	DNV GL Annual Gas savings (therms, 000)
			2011	**2012**	**2013**	**2014**	**2014**		**CFL**	**LED**				
Beta	Aug-11	46,907	0.4	0.7	0.3	0.1	0.0	0.5	9.2	0.1	9.2	0.4	-7.4	-7.6
Gamma Dual Standard	Nov-11	54,859	0.2	0.9	0.4	0.1	0.0	0.5	8.4	0.1	8.4	0.5	-8.6	-9.5
Gamma Dual Reduced	Nov-11	54,921	0.2	0.9	0.4	0.1	0.0	0.5	8.4	0.1	8.4	0.5	-8.6	-9.5
Gamma Electric only	Nov-11	29,433	0.2	0.9	0.4	0.1	0.0	0.5	8.4	0.1	8.4	0.2	-4.6	0
Wave One Dual	Feb-12	284,556		0.9	0.4	0.1	0.1	0.5	7.4	0.1	7.5	2.1	-39.6	-39.9
Wave One Electric Only	Feb-12	27,947		0.9	0.4	0.1	0.1	0.5	7.4	0.1	7.5	0.2	-3.9	0
Wave Two Non-Area 7	Feb-13	259,055			0.9	0.3	0.2	0.5	2.2	0.2	2.4	0.6	-13.5	-11.4
Wave Two Area 7	Feb-13	68,123			0.9	0.3	0.2	0.5	2.2	0.2	2.4	0.2	-3.5	-3.8
Wave Three	Jul-13	191,891			0.5	0.4	0.2	0.5	1.4	0.4	1.7	0.3	-10.0	-5.7
Wave Four	May-14	183,629				0.4	0.2	0.3	0.1	0.2	0.4	0.1	-3.5	-1.9
Wave Five	Oct-14	195,443				0.2	0.1	0.1	0.0	0.0	0.1	0.0	-1.2	-0.2
Total		**1,396,764**										5.1	-104	-89

DNV GL recommends revisiting the adjustments used for gas savings due to interactive effects to confirm that the values as reported in the revised TRC memo are updated. DNV GL recommends TRC's estimates for electric joint savings as reported in Table 14 and DNV GL's adjustments for gas savings.

Nexant estimated that 4% of electric savings are double counted due to upstream programs. For joint kW savings estimates from upstream programs, Nexant used the same percent reduction to calculate peak demand joint savings from upstream programs. This approach amounted to 0.8 MW joint savings from upstream programs.

Table 15 shows DNV GL's aggregate and per household peak demand joint savings estimates from upstream programs. Overall, peak demand joint savings from upstream programs are approximately 2% of the total HER demand savings.

Table 15. 2014 HER kW joint savings from upstream programs

Wave	kW Joint Savings per Household	Number of Treatment Households Active as of July 2014 (DNV GL)	Average Number of Treatment Households (Nexant)	Aggregate kW joint savings using DNV GL's Count	Aggregate kW joint savings using Nexant's Count
Beta	0.0008	45,883	46,907	38	39
Gamma Dual Standard	0.0008	54,692	54,859	43	43
Gamma Dual Reduced	0.0008	54,825	54,921	43	43
Gamma Electric only	0.0008	29,476	29,433	23	23
Wave One Dual	0.0007	284,263	284,556	194	194
Wave One Electric Only	0.0007	27,631	27,947	19	19
Wave Two Non-Area 7	0.0002	259,701	259,055	61	61
Wave Two Area 7	0.0002	68,143	68,123	16	16
Wave Three	0.0002	192,107	191,891	32	32
Wave Four	0.0000	185,294	183,629	7	7
Total aggregate kW joint savings				476	478

DNV GL's estimate is approximately 40% less than Nexant's estimate for peak demand joint savings. Nexant applied several assumptions regarding peak reductions from installed CFLs while DNV GL leveraged inputs from the 2010-2012 ULP study for CA to estimate peak load reduction due to efficient bulbs. While Nexant's method produced a conservative estimate for peak demand joint savings, DNV GL's approach is the better approach since instead of assumptions; we used data from the published California statewide lighting report that can also be replicated for the other CA IOUs. DNV GL recommends using DNV GL's estimate of 476 kW adjustment in peak demand savings to account for potentially double counted savings from upstream programs.

4.5 Per-household savings and total program savings

Table 16 summarizes the recommended electric and gas savings per household while Table 17 summarizes the total program savings for each experimental wave and overall. Baseline consumption and unadjusted per household savings are based on Nexant's estimates while joint savings adjustments are based on DNV GL's downstream rebate analysis and TRC's joint savings calculation for upstream programs.

Table 16. 2014 Recommended per household kWh and therms savings for the 2014 HER program

HER Wave	Baseline Consumption	Per Household Savings (Unadjusted)	Per Household Savings (Adjusted)	% Savings	
				Unadjusted	Adjusted
Electric (kWh)					
Beta	10,131	222	208	2.2%	2.1%
Gamma Reduced	7,172	121	111	1.7%	1.6%
Gamma Standard	7,172	99	91	1.4%	1.3%
Gamma Electric only	6,819	105	94	1.5%	1.4%
Wave One	7,096	117	108	1.7%	1.5%
Wave One - Elec only	8,055	129	125	1.6%	1.5%
Wave Two - Non Area 7	6,757	92	89	1.4%	1.3%
Wave Two - Area 7	5,894	86	83	1.5%	1.4%
Wave Three	6,714	69	66	1.0%	1.0%
Wave Four	5,053	37	37	0.7%	0.7%
Wave Five	2,352	10	10	0.4%	0.4%
Gas (therms)					
Beta	604	4.8	5.0	0.8%	0.8%
Gamma Reduced	353	2.2	2.4	0.6%	0.6%
Gamma Standard	353	2.2	2.3	0.6%	0.6%
Wave One	362	2.5	2.6	0.7%	0.7%
Wave Two - Non Area 7	371	3.0	3.0	0.8%	0.8%
Wave Two - Area 7	400	3.0	3.1	0.8%	0.8%
Wave Three	371	2.8	2.8	0.8%	0.8%
Wave Four	284	0.7	0.7	0.2%	0.2%
Wave Five	105	0.6	0.6	0.6%	0.6%

Wave Four and Wave Five were launched in March 2014 and October 2014, respectively. Baseline consumption (control usage in 2014) and savings only represent partial months of 2014. Gas savings estimates (adjusted) take into account gas interactive effects from increased participation in ULP.

Table 17. Recommended kWh and therms savings for the 2014 HER program

Wave	Electric (kWh)				Gas (therms)		
	Unadjusted	Joint Savings - Downstream	Joint Savings - Upstream	Adjusted	Unadjusted	Joint Savings - Interactive effects	Adjusted
Beta	10,397,686	220,490	431,544	9,745,651	226,393	(8,199)	234,593
Gamma - Dual Standard	6,658,177	27,247	461,336	6,169,593	122,896	(8,765)	131,661
Gamma - Dual Reduced	5,446,000	96,471	460,816	4,888,713	118,645	(8,755)	127,400
Gamma - Electric only	3,085,802	85,589	247,237	2,752,975	-	-	-
Wave One - Dual	33,418,209	463,971	2,134,170	30,820,067	700,734	(40,549)	741,283
Wave One - Electric only	3,597,712	(94,535)	209,603	3,482,644	-	-	-
Wave Two - Non-Area 7	23,891,677	64,528	621,732	23,205,417	771,358	(11,813)	783,171
Wave Two - Area 7	5,871,707	338,307	163,495	5,369,905	206,865	(3,106)	209,972
Wave Three	13,185,136	165,210	326,215	12,693,711	533,885	(6,198)	540,083
Wave Four	6,733,656	(50,004)	73,452	6,710,209	123,420	(1,396)	124,815
Wave Five	1,888,811	4,374	19,545	1,864,892	123,894	(371)	124,265
Total	**114,174,573**	**1,321,650**	**5,149,144**	**107,703,778**	**2,928,090**	**-89,154**	**3,017,243**

Table 18 shows the recommended savings estimates from peak demand analysis. The unadjusted peak demand savings are based on Nexant's estimate while joint savings estimates are based on DNV GL's analysis.

Table 18. Recommended demand (kW) savings for 2014 HER program

Wave	Electric (kW)			
	Unadjusted	Joint Savings - Downstream	Joint Savings - Upstream	Adjusted
kW Savings	20,961	951	476	19,534

Appendix C shows DNV GL's additional analysis of HER per household savings by CARE and non-CARE and Appendix D presents the historical electric and gas saving per household for the HER program across IOUs.

5 CONCLUSIONS

Overall, DNV GL evaluators found no major concerns or errors with the results or methodology Nexant used for estimating kWh and kW savings and TRC's method for estimating electric joint savings from upstream programs other than what is noted above. DNV GL recommends accepting Nexant's energy savings and demand savings for the 2014 HER program. However, DNV GL recommends using DNV GL's estimates for electric joint savings from downstream programs, gas adjustments due to interactive effects with lighting programs and peak demand savings adjustments due to reasons noted in Section 4.

DNV GL's recommendation for total adjusted energy and demand savings for 2014 PG&E HER program are summarized in Table 19. PG&E may use these results to support savings claims for the 2014 HER Program.

Table 19. Recommended kWh, therms, and kW savings for 2014 HER program

Type of Savings	Total Aggregate Savings
Electric (kWh)	
Unadjusted	114,174,573
Joint Savings Downstream	1,321,650
Joint Savings Upstream	5,149,144
Adjusted	107,703,778
Gas (therms)	
Unadjusted	2,928,090
Joint Savings Downstream	0
Joint Savings Upstream	-89,154
Adjusted	3,017,243
Peak Demand Savings (kW)	
Unadjusted	20,961
Joint Savings Downstream	951
Joint Savings Upstream	476
Adjusted	19,534

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 Nexant. 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 Nexant used to produce the savings estimates. In addition, DNV GL used PG&E billing data to establish a move-out date. Overall, DNV GL treatment counts are comparable with Nexant's. Table 1 presents the comparison of the number of customers in the treatment group. These numbers are based on electric customers only.

Table 1. Number of customers in the HER treatment groups

Wave	Treatment		% DNV/Nexant
	Nexant	DNV GL	
Beta	46,907	45,969	98%
Gamma	139,213	139,445	100%
Wave One	312,504	312,888	100%
Wave Two - Not Area 7	259,055	260,455	101%
Wave Two - Area 7	68,123	68,344	100%
Wave Three	191,891	193,293	101%
Wave Four	183,629	183,924	100%
Wave Five	195,443	199,346	102%
Total	**1,396,765**	**1,403,663**	**100%**

APPENDIX B. MONTHLY PROGRAM SAVINGS ESTIMATES

Figure 1 to Figure 11 display the monthly estimates of electric savings reported by Nexant and reproduced by DNV GL. The plots include savings estimates of electric savings for all the following waves:

- Beta
- Gamma - Dual Standard
- Gamma - Dual Reduced
- Gamma - Electric Only
- Wave One - Dual
- Wave One – Electric Only
- Wave Two – Area 7
- Wave Two – Non-Area 7
- Wave Three
- Wave Four
- Wave Five

In general, the monthly savings estimates are comparable across the two sets of estimates. The results are not exactly identical because DNV GL used independent methods and data for calculating program savings estimates. Key differences between Nexant's and DNV GL's analyses are summarized in Section 4.

Figure 1. Average monthly kWh savings for Beta Wave

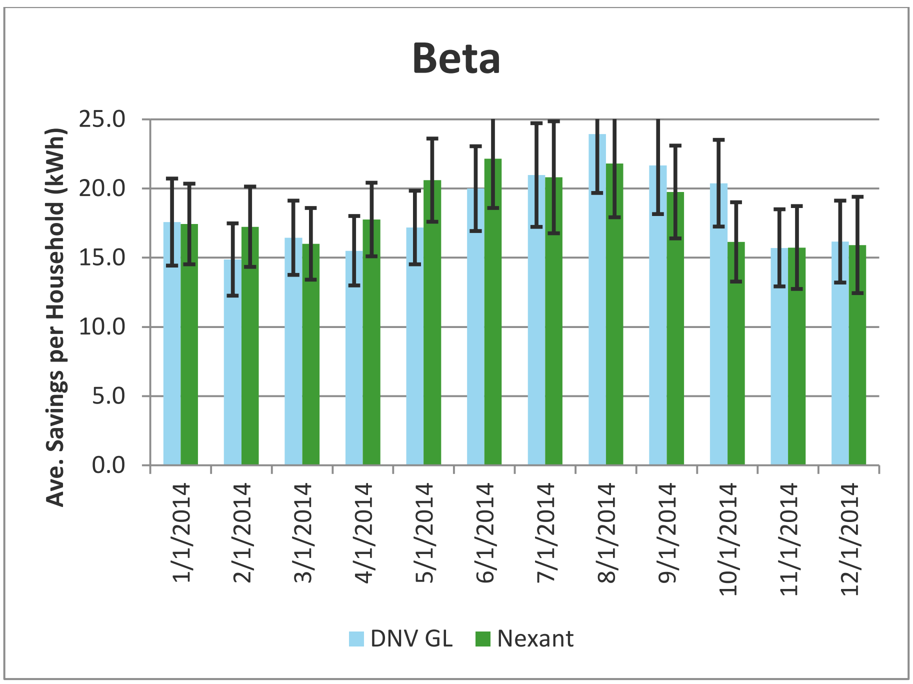


Figure 2. Average monthly kWh savings for Gamma Wave – Dual Standard

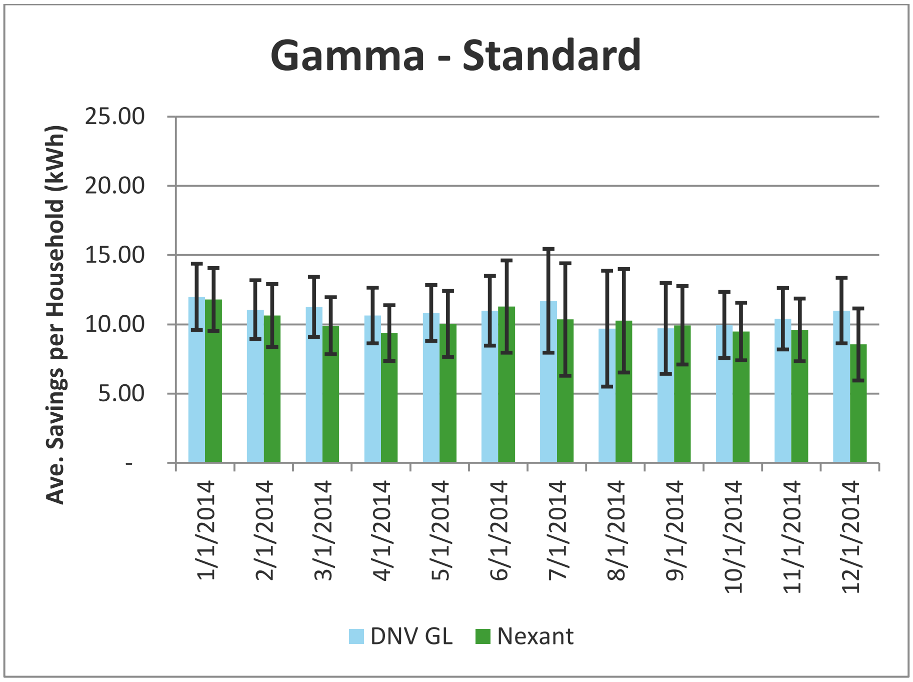


Figure 3. Average monthly kWh savings for Gamma Wave – Dual Reduced

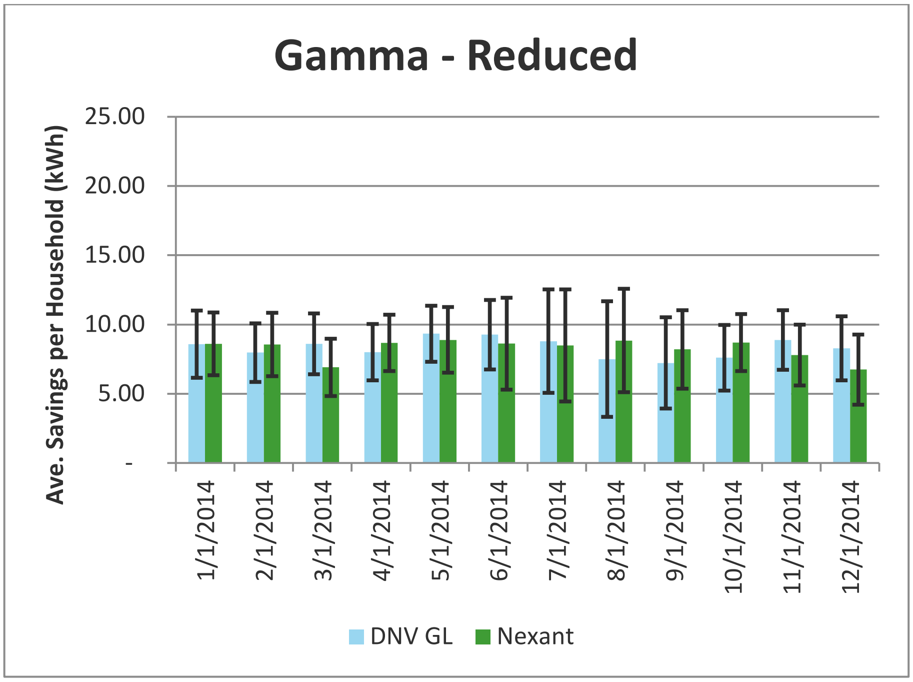


Figure 4. Average monthly kWh savings for Gamma Wave – Electric Only

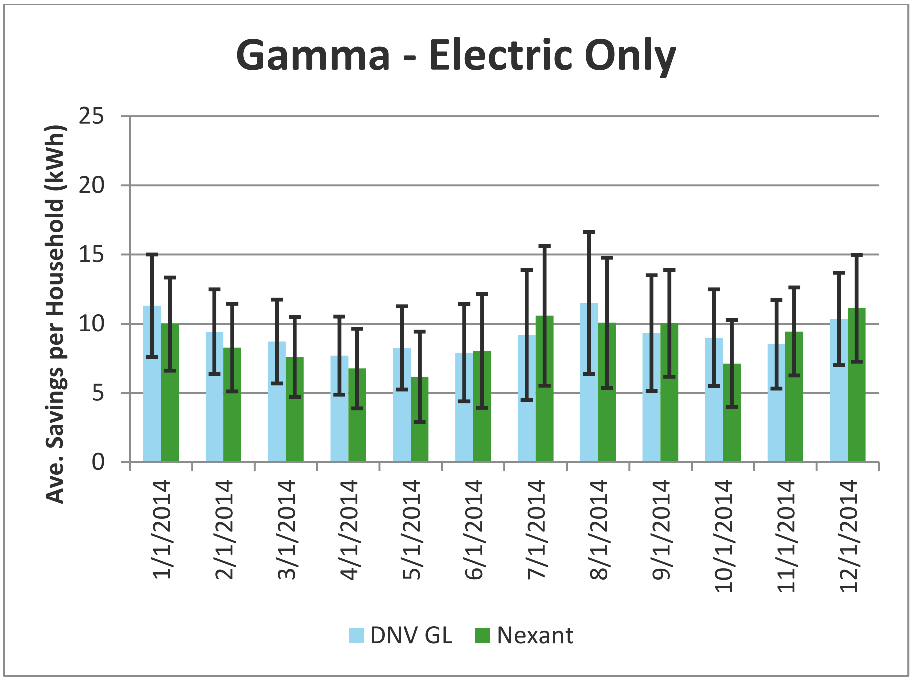


Figure 5. Average monthly kWh savings for Wave One – Dual

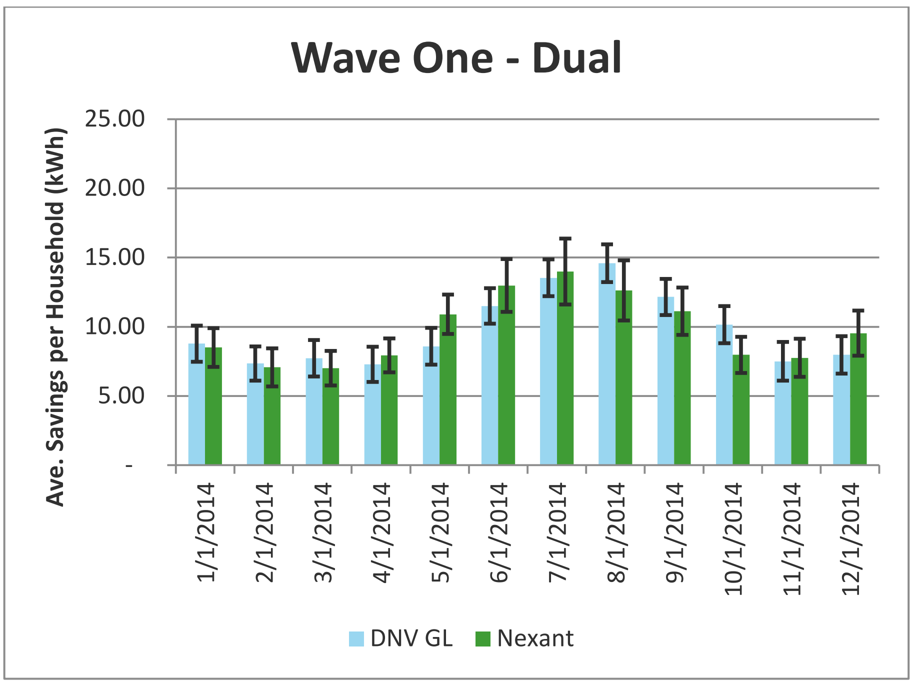


Figure 6. Average monthly kWh savings for Wave One – Electric Only

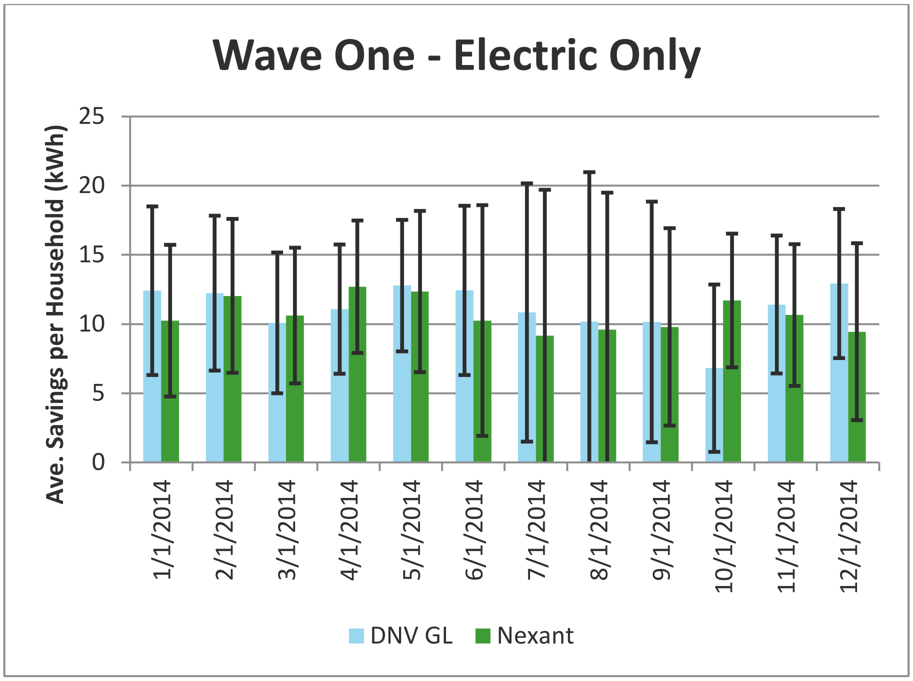


Figure 7. Average monthly kWh savings for Wave Two – Non Area 7

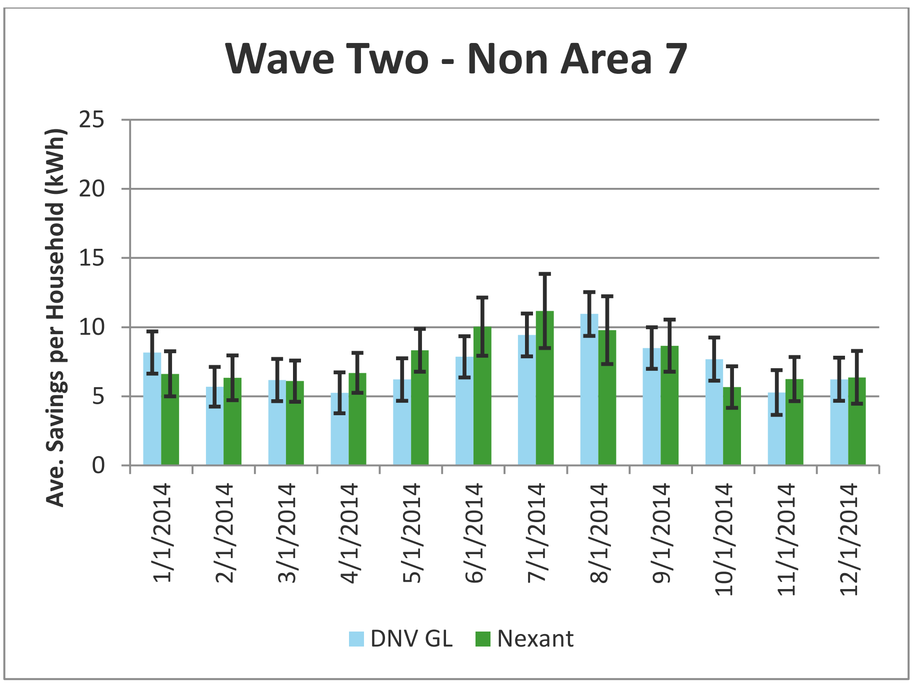


Figure 8. Average monthly kWh savings for Wave Two – Area 7

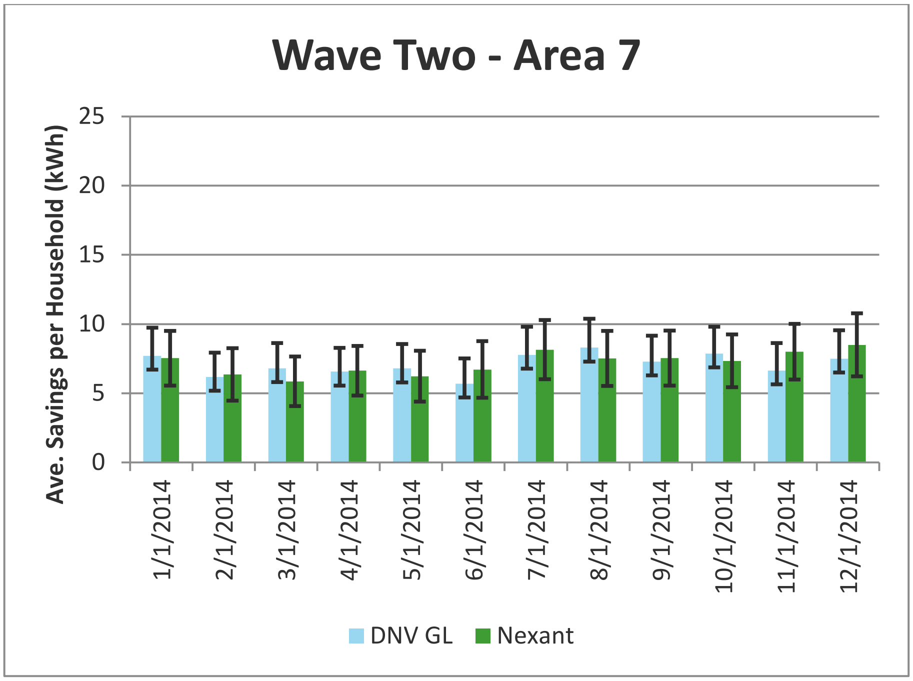


Figure 9. Average monthly kWh savings for Wave Three

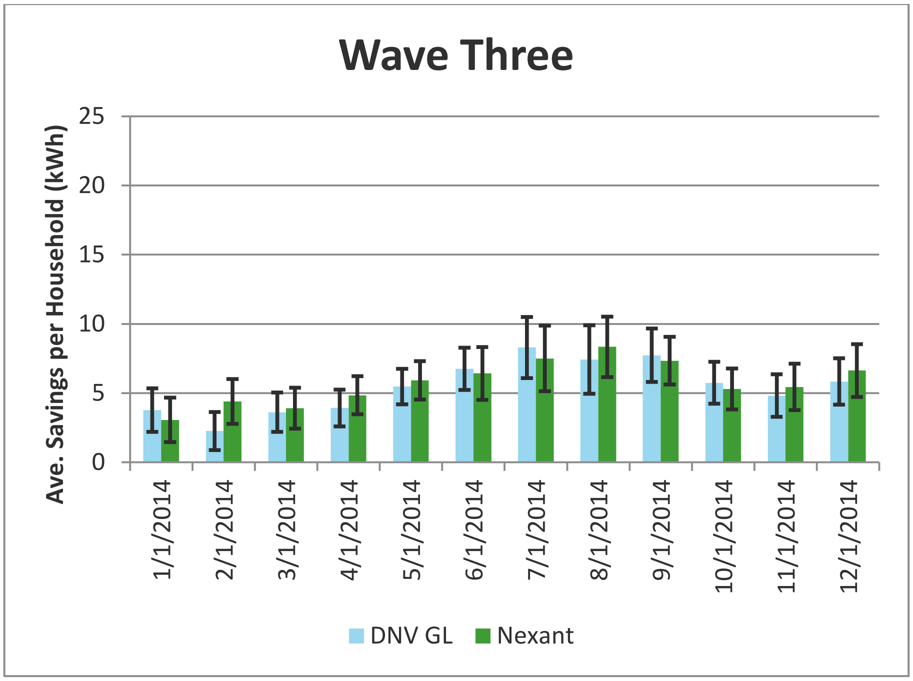


Figure 10. Average monthly kWh savings for Wave Four

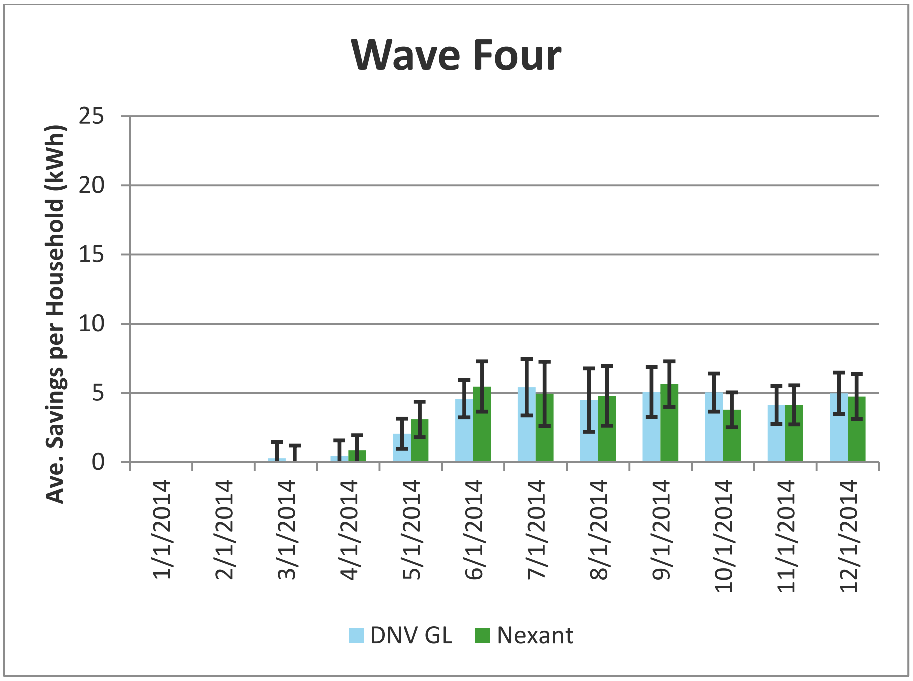


Figure 11. Average monthly kWh savings for Wave Five

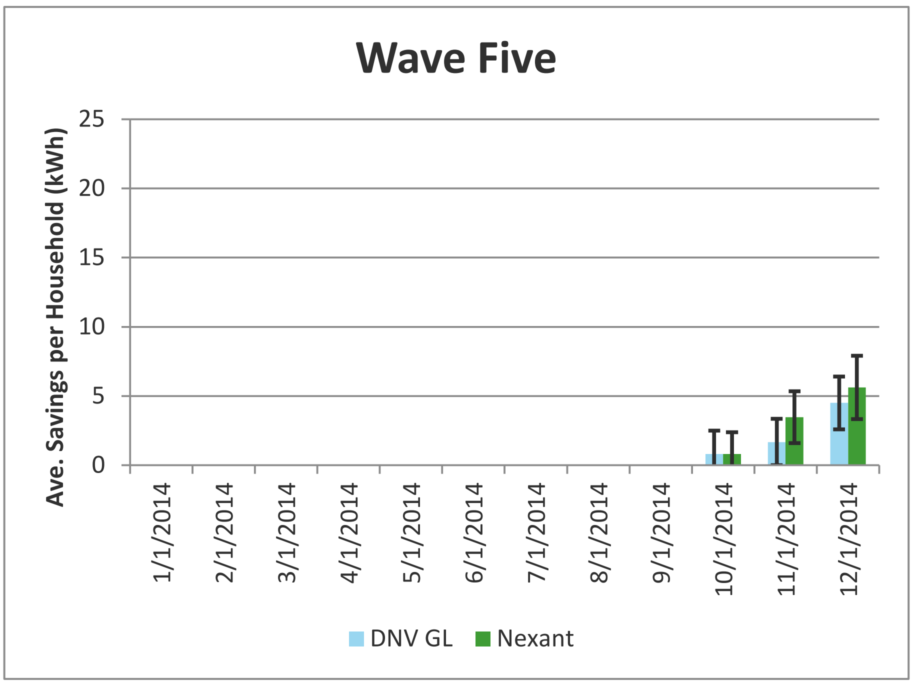


Figure 12 to Figure 20 compare the monthly estimates of gas savings reported by Nexant and reproduced by DNV GL. There is a noticeable difference between DNV GL and Nexant's monthly savings estimates. The gaps are most likely attributed to the difference in billing month assignment. DNV GL used the month of the end date of the billing cycle as the billing month while Nexant used the midpoint of the start and end of the billing cycle.

Figure 12. Average monthly therms savings for Beta Wave

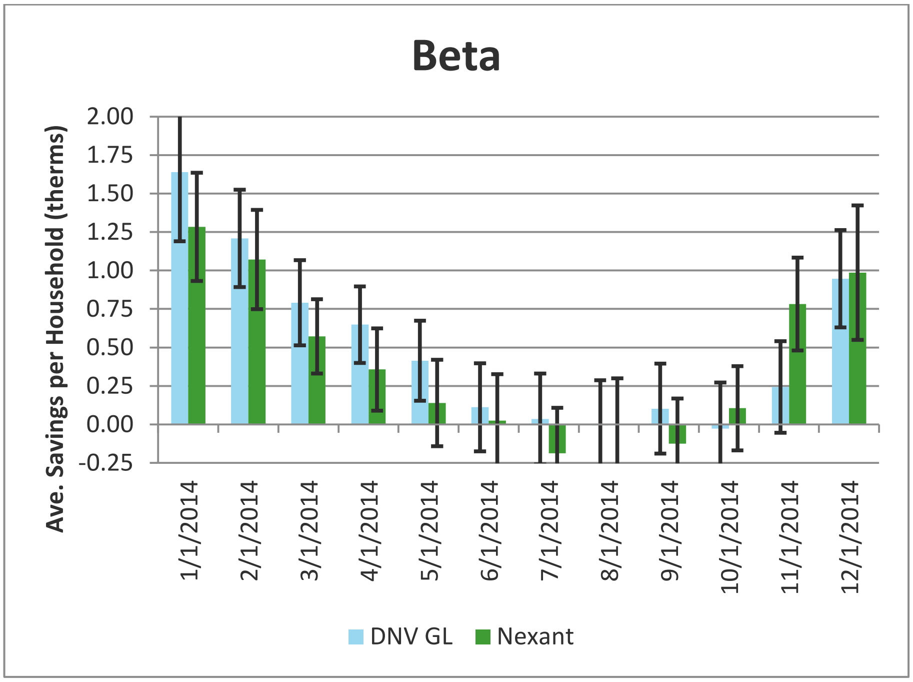


Figure 13. Average monthly therms savings for Gamma Wave – Dual Standard

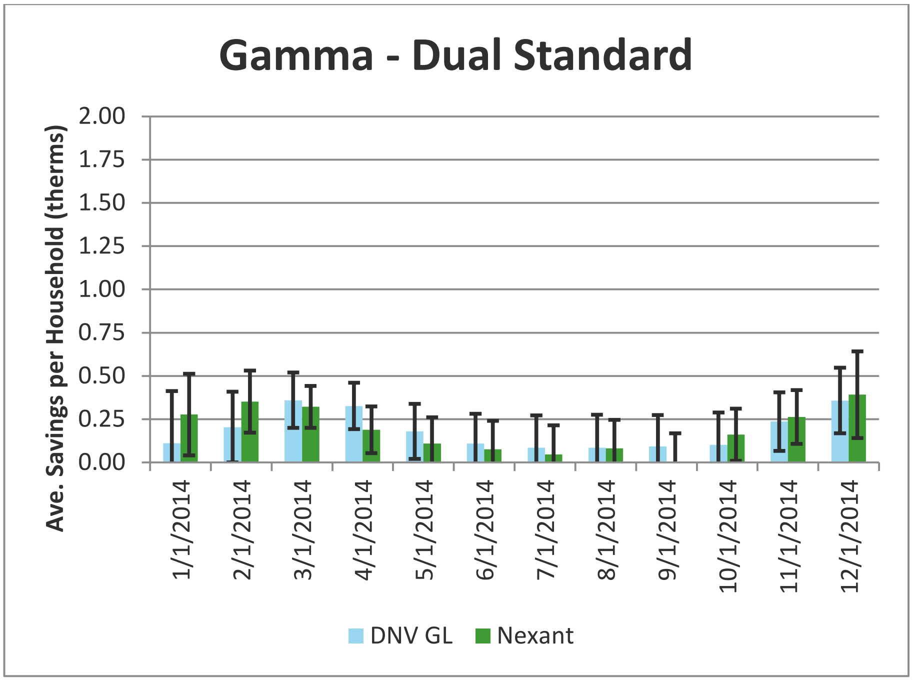


Figure 14. Average monthly therms savings for Gamma Wave – Dual Reduced

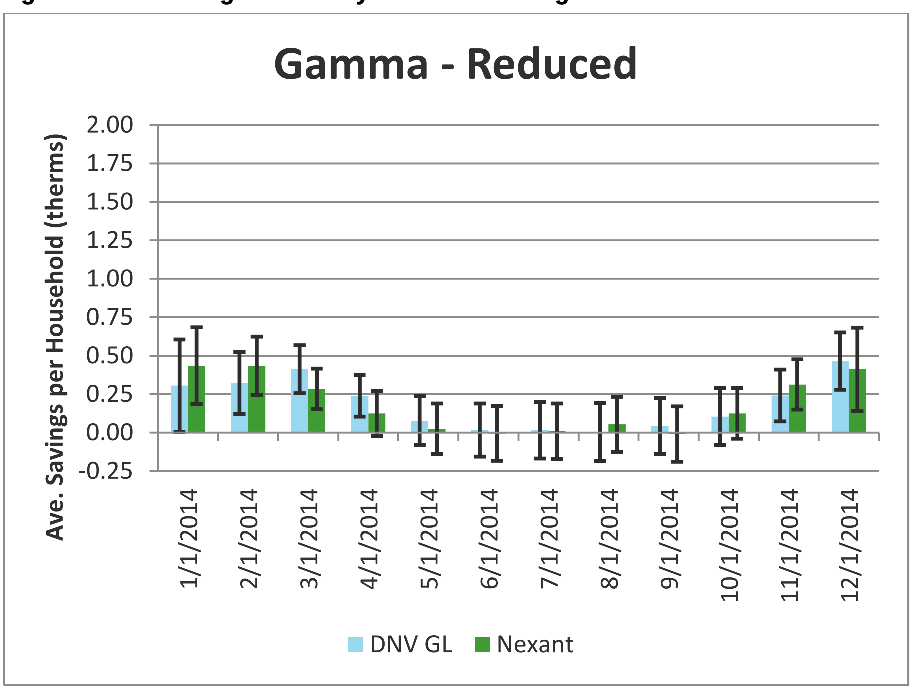


Figure 15. Average monthly therms savings for Wave One – Dual

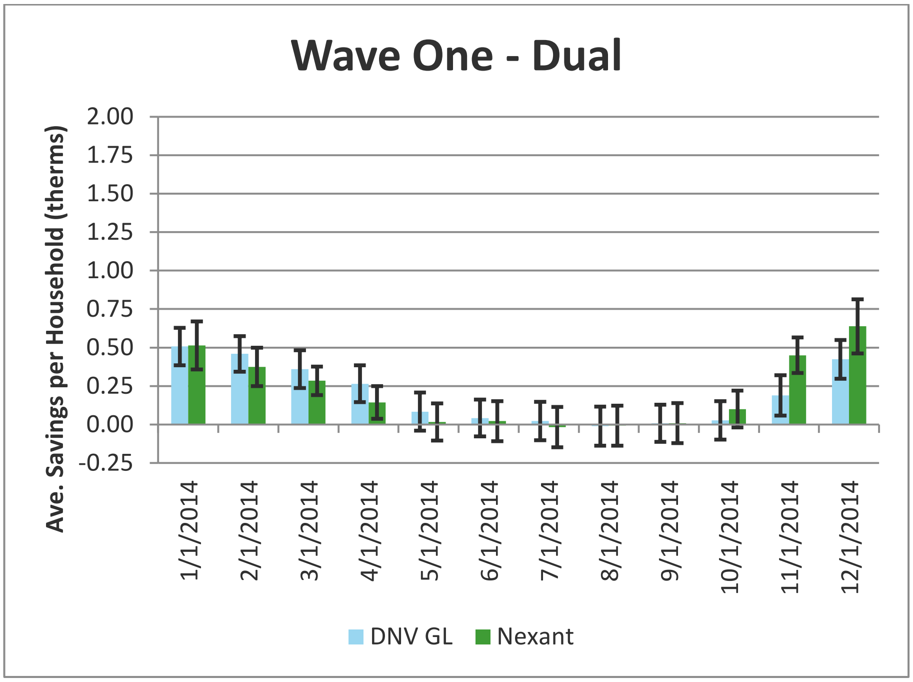


Figure 16. Average monthly therms savings for Wave Two – Non Area 7

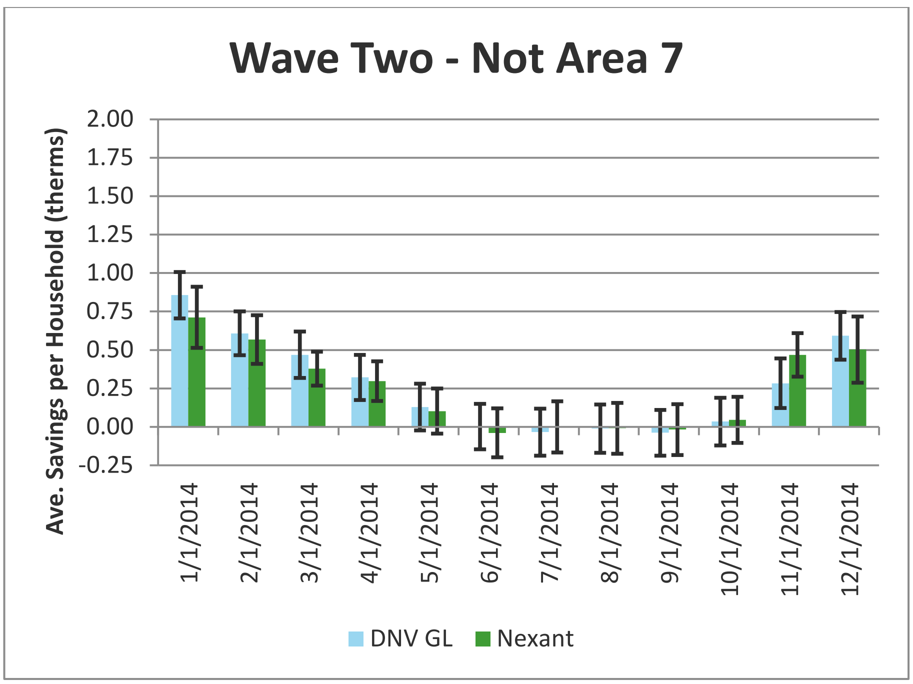


Figure 17. Average monthly therms savings for Wave Two – Area 7

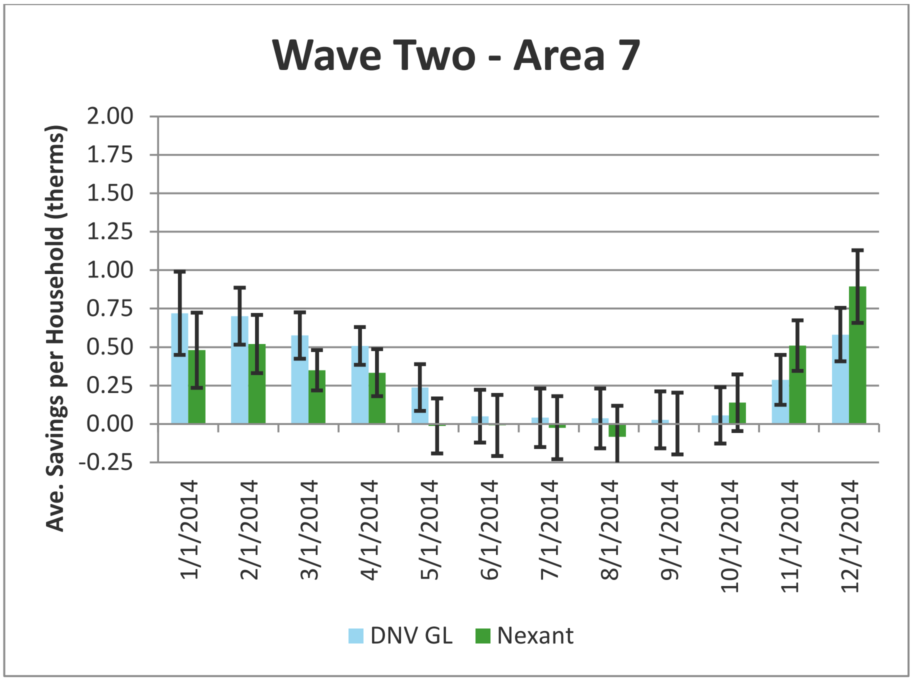


Figure 18. Average monthly therms savings for Wave Three

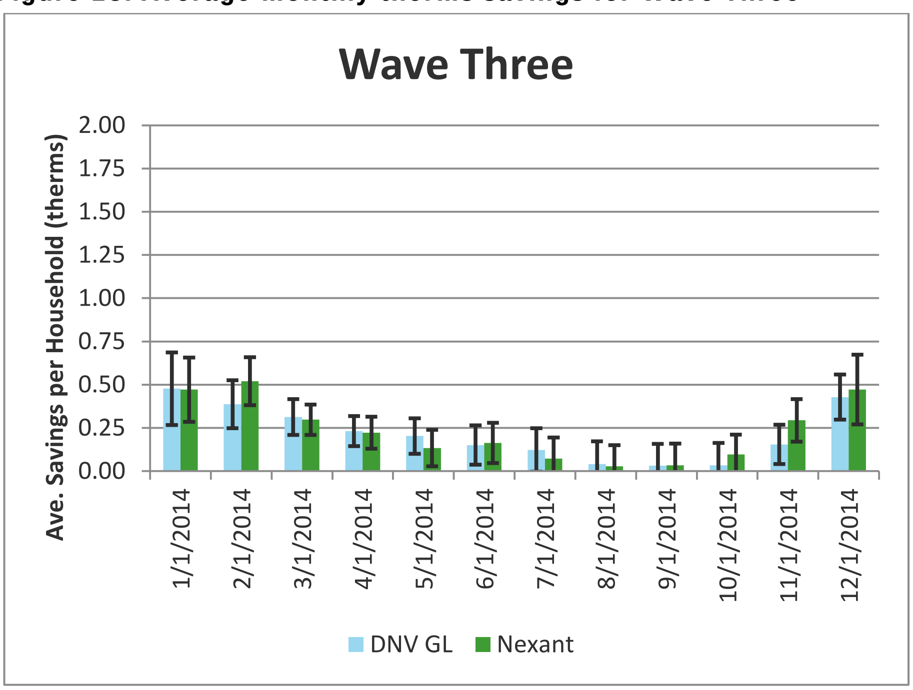


Figure 19. Average monthly therms savings for Wave Four

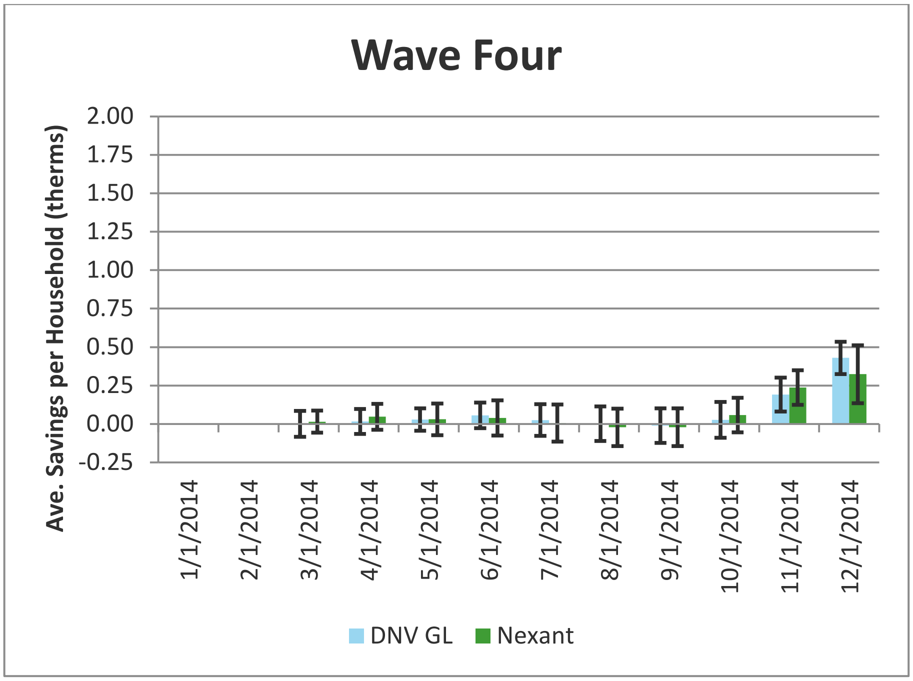
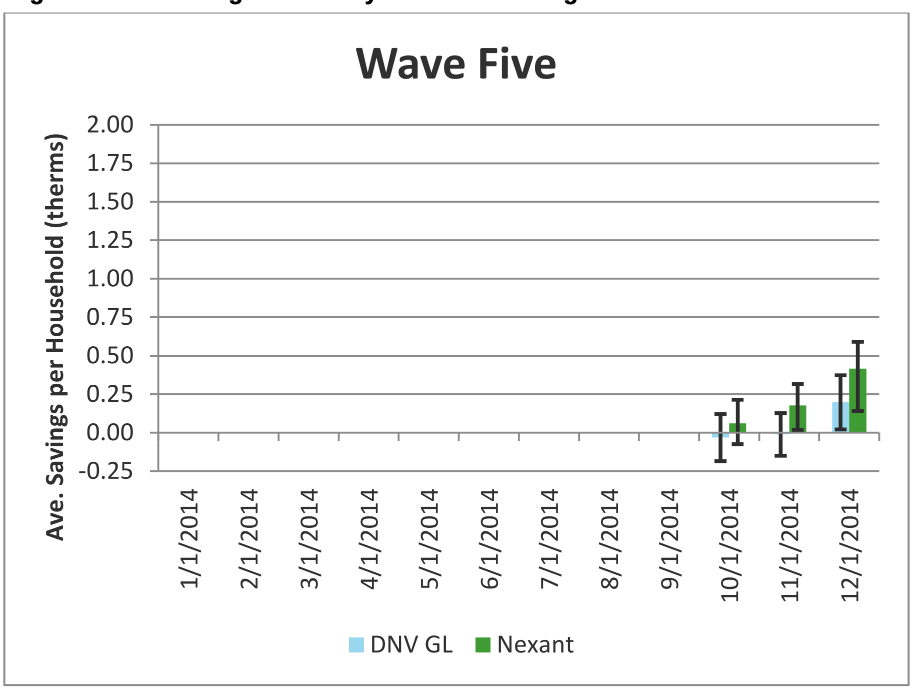


Figure 20. Average monthly therms savings for Wave Five



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 6 billing month threshold. The proportion of CARE customers varies by wave with Beta wave comprising only 8% CARE customers while Waves Four and Five consist of almost one-third CARE customers. Overall, the proportion of treatment and control is balanced within each wave and income groups (i.e. CARE and non-CARE). Similar proportions are also observed for the other two CARE thresholds.

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

HER sample	Number of households		% of households	
	Control	Treatment	Control	Treatment
Beta				
CARE	4,548	4,712	9%	10%
Non-CARE	44,639	44,441	91%	90%
Total	49,187	49,153	100%	100%
Gamma Standard				
CARE	16,604	16,511	29%	29%
Non-CARE	40,920	41,116	71%	71%
Total	57,524	57,627	100%	100%
Gamma Reduced				
CARE	16,604	16,629	29%	29%
Non-CARE	40,920	41,059	71%	71%
Total	57,524	57,688	100%	100%
Gamma Electric only				
CARE	10,297	10,037	33%	32%
Non-CARE	21,052	21,412	67%	68%
Total	31,349	31,449	100%	100%
Wave One Dual				
CARE	17,078	67,557	23%	23%
Non-CARE	57,572	231,079	77%	77%
Total	74,650	298,636	100%	100%
Wave One Electric only				

CARE	2,435	9,629	33%	32%
Non-CARE	5,057	20,069	67%	68%
Total	7,492	29,698	100%	100%
Wave Two Area 7				
CARE	8,061	12,878	18%	18%
Non-CARE	36,464	58,352	82%	82%
Total	44,525	71,230	100%	100%
Wave Two Non-Area 7				
CARE	9,710	60,548	23%	22%
Non-CARE	33,173	211,365	77%	78%
Total	42,883	271,913	100%	100%
Wave Three				
CARE	17,980	53,186	26%	26%
Non-CARE	50,516	152,276	74%	74%
Total	68,496	205,462	100%	100%
Wave Four				
CARE	22,985	61,338	31%	31%
Non-CARE	51,991	138,625	69%	69%
Total	74,976	199,963	100%	100%
Wave Five				
CARE	15,354	64,109	31%	31%
Non-CARE	34,845	145,887	69%	69%
Total	50,199	209,996	100%	100%

Figure 1 through Figure 6 compares annual electric and gas savings per household between CARE and non-CARE customers along with 90% confidence intervals. Based on the results both CARE and non-CARE groups from all experimental waves generated statistically significant electric savings while CARE and non-CARE gas savings in some waves were not statistically different from zero. Electric savings from non-CARE customers are higher than CARE customers for Beta, Gamma – Standard, Wave One-Dual, Wave Two – Not Area 7and Wave Four across all CARE definitions while CARE customers from Gamma – Electric only and Wave One – Electric only achieved higher electric savings than non-CARE customers. The rest of the experimental waves produced mixed results.

For gas, non-CARE customers from Beta, Gamma-Standard and Wave One – Dual produced higher savings than non-CARE customers while the reverse was observed for Gamma-Reduced, Wave Two – Not Area 7, Wave Three, Wave Four and Wave Five.

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

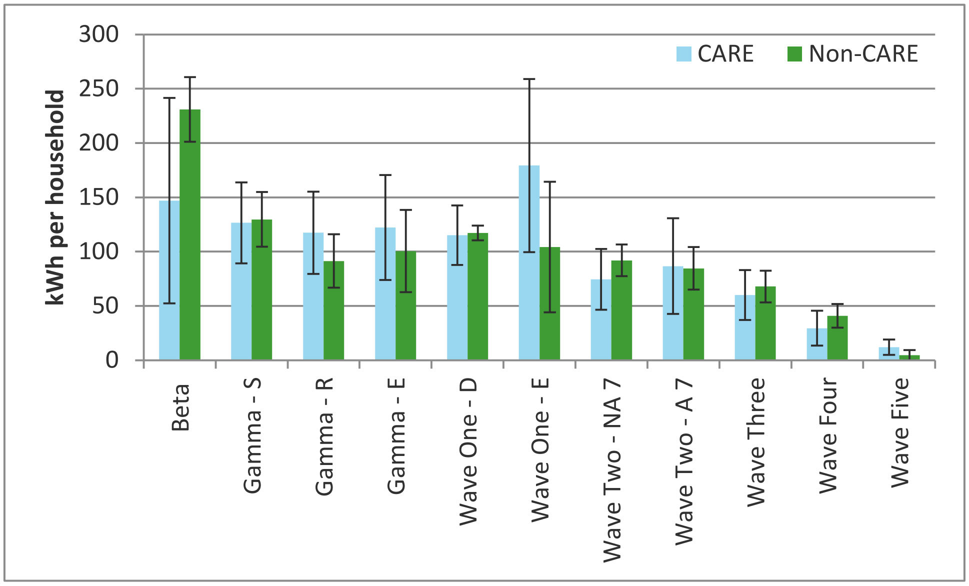


Figure 2. Annual kWh savings per household for CARE and non-CARE groups (CARE 6)

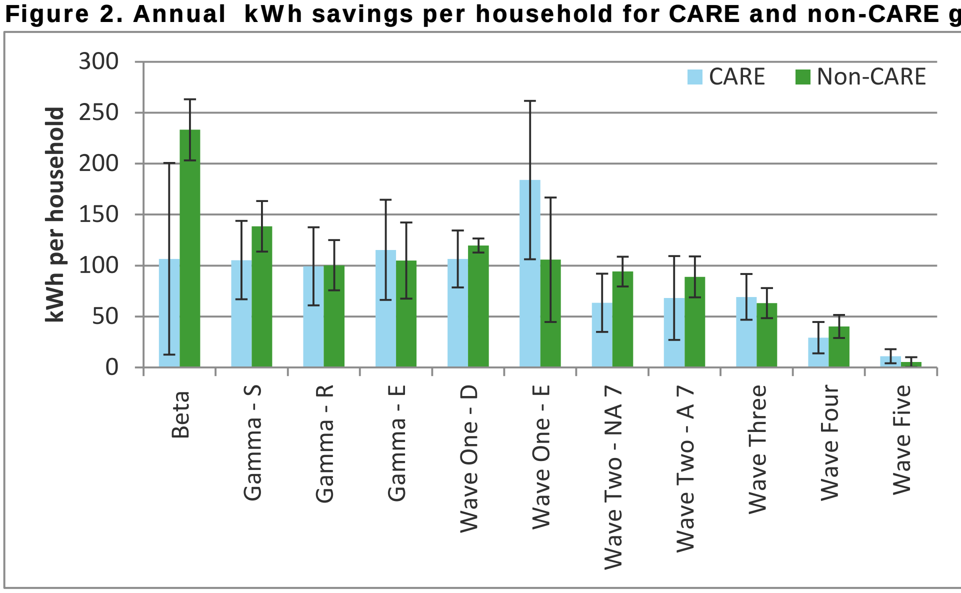


Figure 3. Annual kWh savings per household for CARE and non-CARE groups (CARE 10)

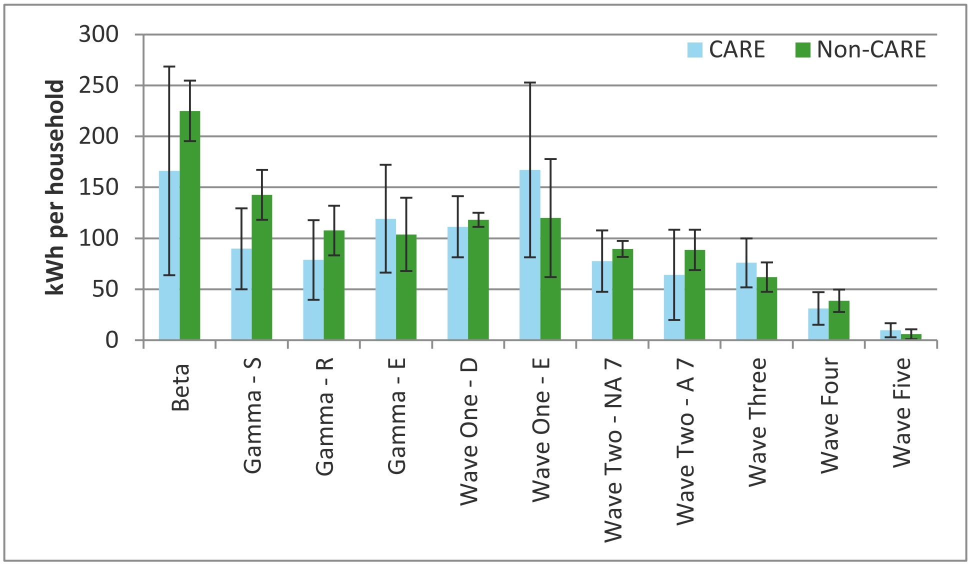


Figure 4. Annual therms savings per household for CARE and non-CARE groups (CARE 1)

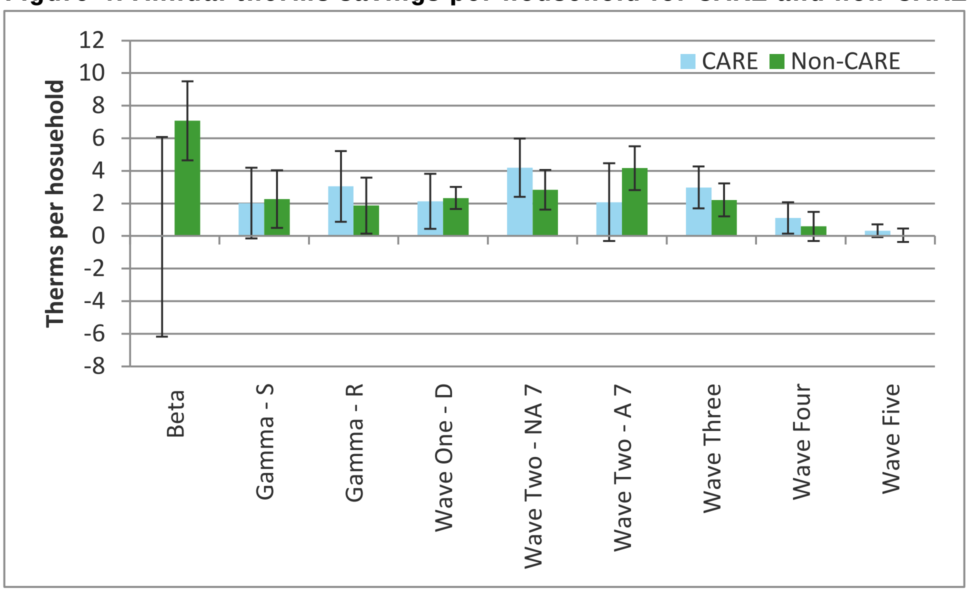


Figure 5. Annual therms savings per household for CARE and non-CARE groups (CARE 6)

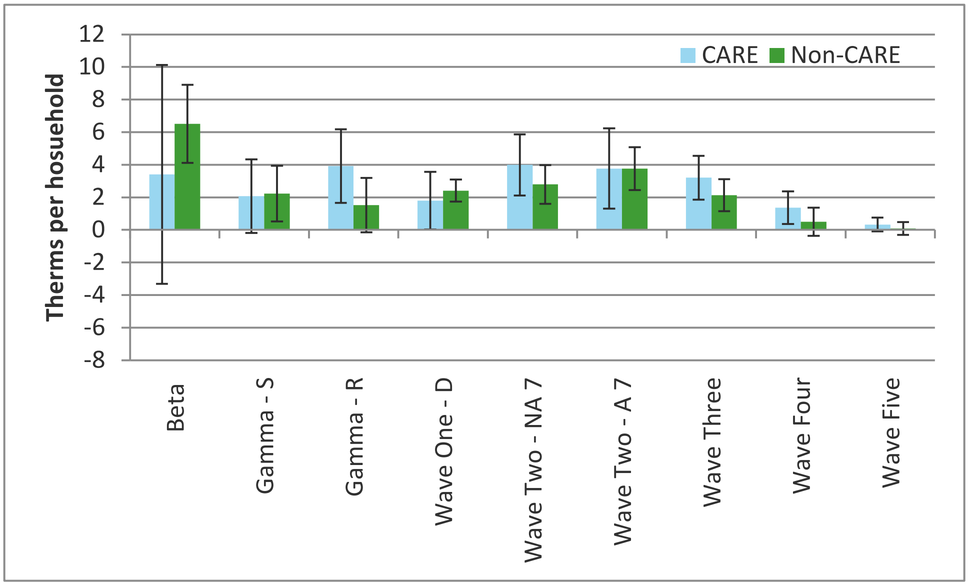


Figure 6. Annual therms savings per household for CARE and non-CARE groups (CARE 10)

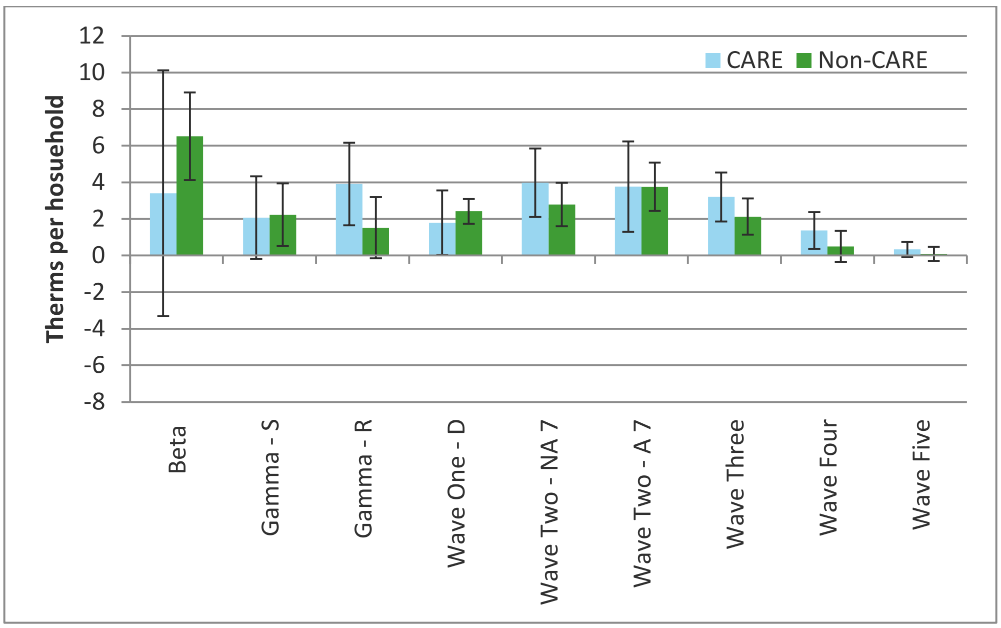


Figure 7 through Figure 12 present graphical illustrations of electric and gas savings as a percent of baseline consumption for CARE and non-CARE groups. For CARE customers, Wave One – Electric only produced the highest electric savings amounting to 2.5% of electric consumption while Wave Two produced the highest gas savings for CARE customers amounting to 1.5% of gas consumption. For non-CARE customers, Beta wave achieved the highest electric and gas savings amounting to 2.3% and 1.2% of baseline consumption, respectively.

Figure 7. Percent kWh savings for CARE and non-CARE groups (CARE 1)

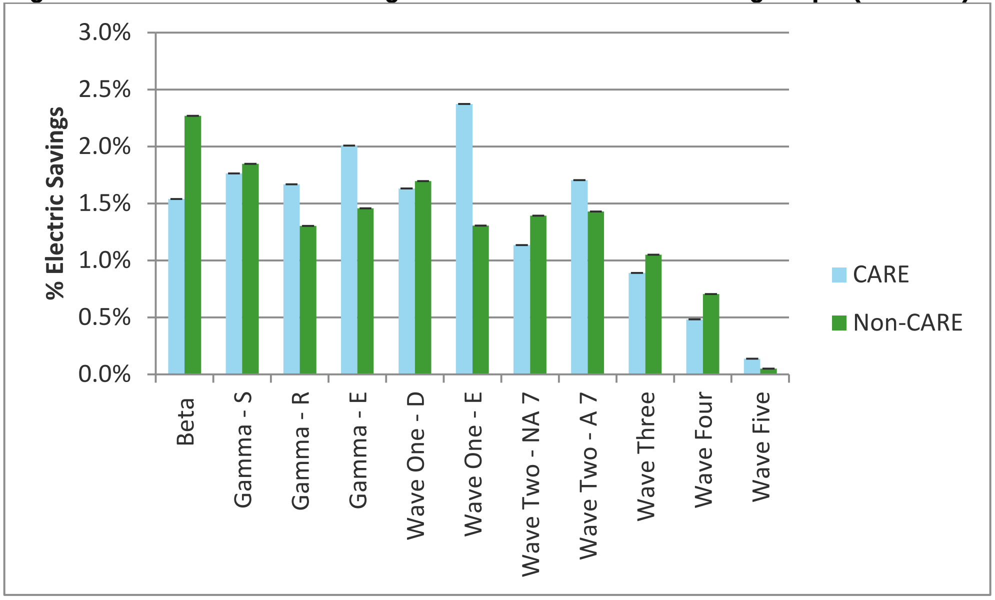


Figure 8. Percent kWh savings for CARE and non-CARE groups (CARE 6)

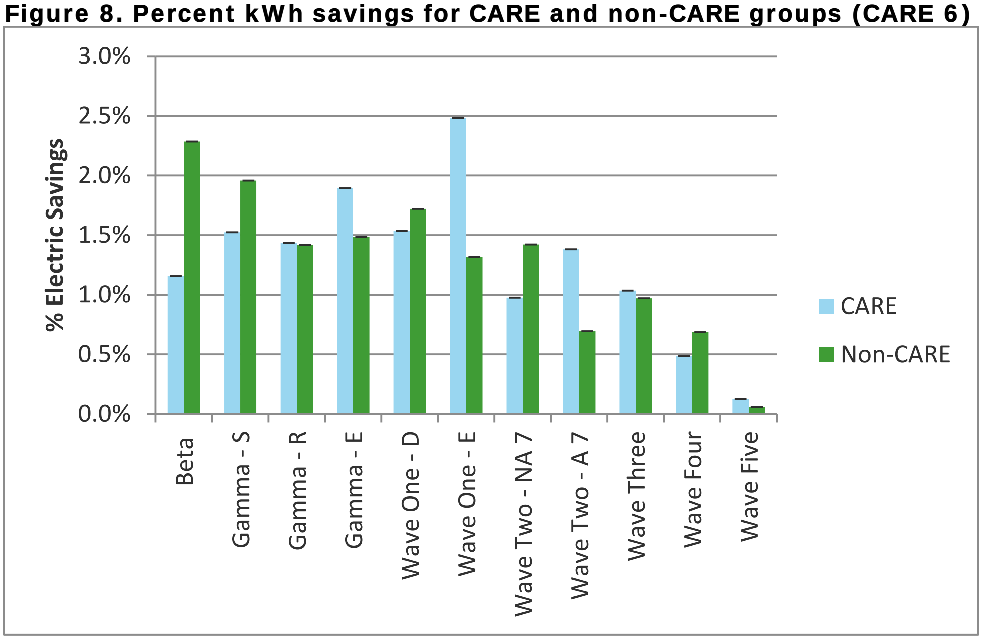


Figure 9. Percent kWh savings for CARE and non-CARE groups (CARE 10)

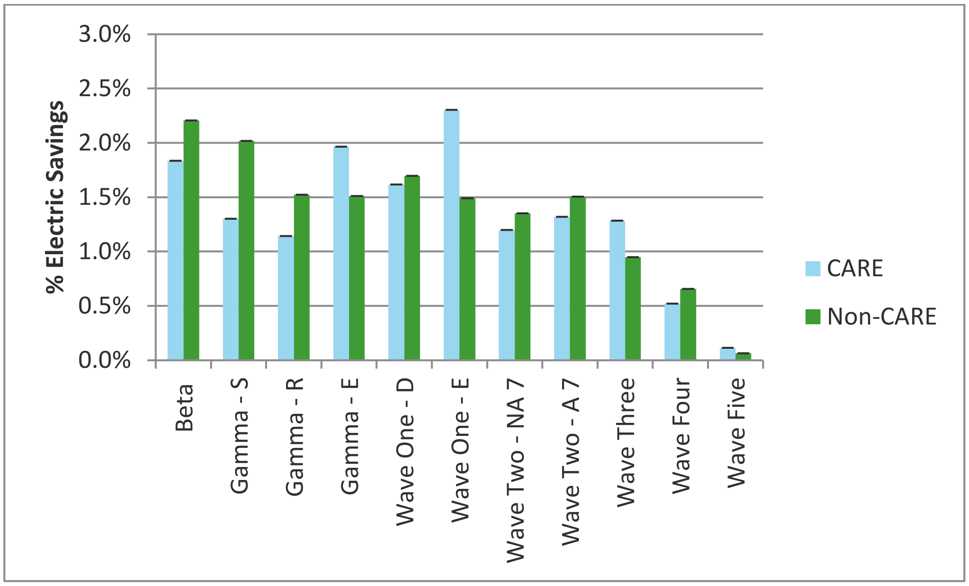


Figure 10. Percent therms savings for CARE and non-CARE groups (CARE 1)

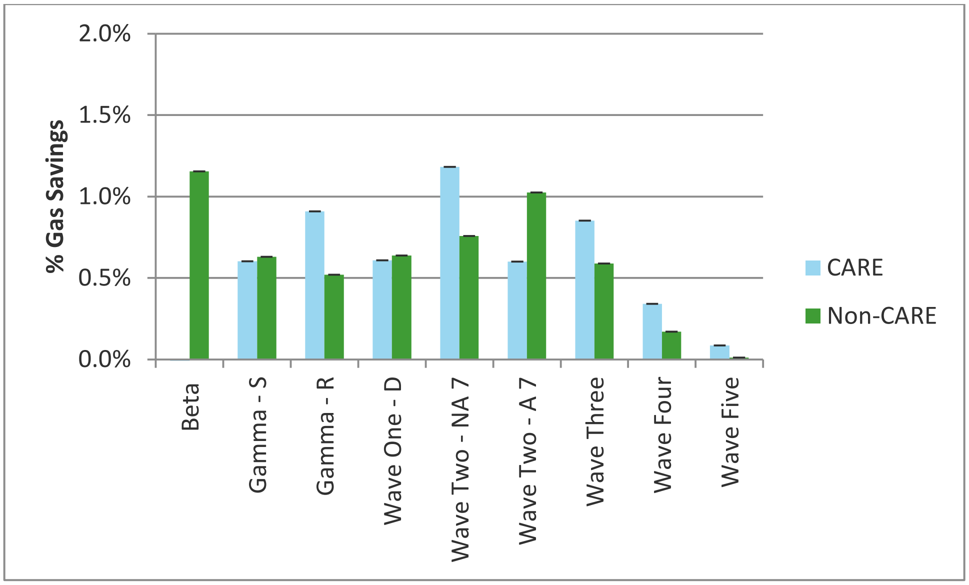


Figure 11. Percent therms savings for CARE and non-CARE groups (CARE 6)

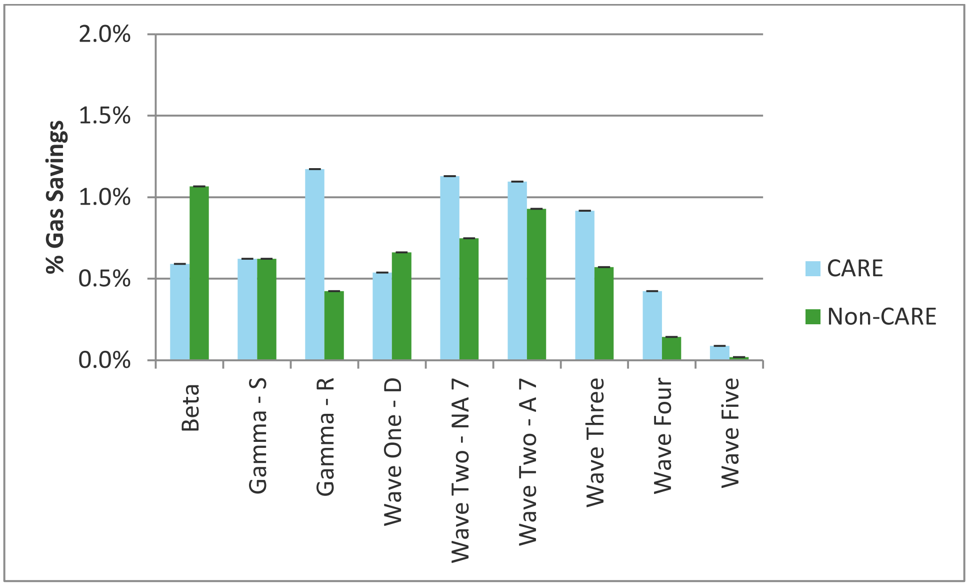
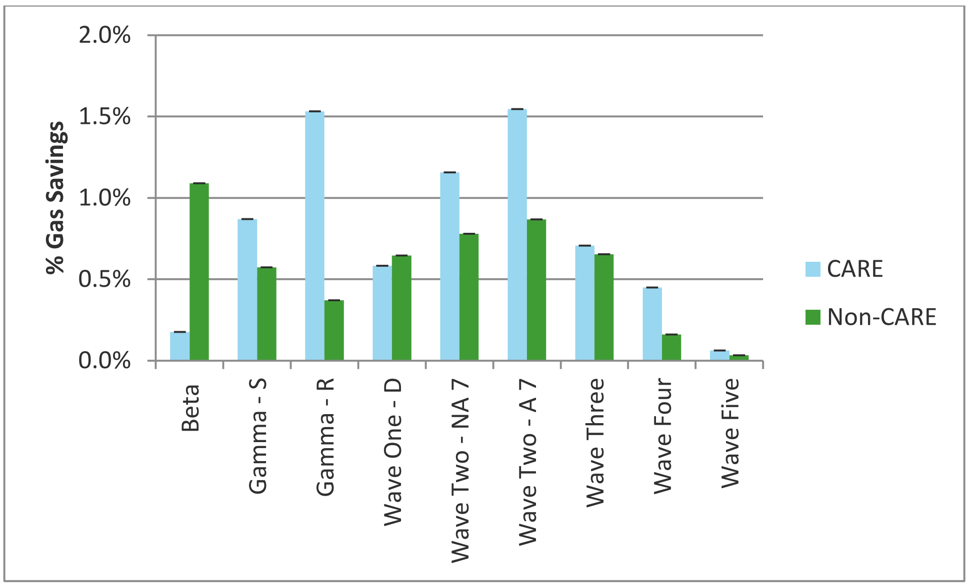


Figure 12. Percent therms savings for CARE and non-CARE groups (CARE 10)



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 PG&E HER Evaluation

No.	From	Area	Comments	DNV GL Response
1	PG&E/ Nexant	Key Findings: "Since DNV GL's unadjusted electric and gas savings are on par with Nexant's unadjusted estimates, we recommend using Nexant's estimates for unadjusted electric and gas savings...we recommend using DNV GL's joint savings estimate from downstream programs"	It is gratifying that the unadjusted electric and gas savings estimates derived from two different firms using different statistics applications result in very similar results. We believe that we should continue to work closely together to review the datasets for 2015 so that this trend may continue. Nexant has a few concerns about the proposed downstream program adjustments that we believe may be resolved prior to Nexant concluding its 2015 Early M&V work.	DNV GL will continue to work with PG&E and Nexant to resolve potential issues during the validation process.
2	PG&E/ Nexant	Energy Savings: "Nexant diverged from the SEEAction recommended approach in one major way; the SEEAction approach states that residential move-outs should be excluded when aggregating to program level consumption reductions, but Nexant allows both treatment and control group households to be included in the regression model until residents close their accounts. DNV GL supports Nexant's approach as it captures valid partial savings in households that moved out or went inactive prior to the end of the evaluation period."	Nexant will continue to follow this methodology.	No response required.
3	PG&E/ Nexant	Energy Savings: "Going forward, DNV GL will use the mid-point for assigning billing months when validating PG&E HER results in order to minimize the sources of discrepancies in results."	Nexant agrees with this methodology and will also use the mid-point in the 2015 analysis.	No response required.
4	PG&E/ Nexant	Energy Savings: "For the 2014 evaluation, Nexant used raw consumption in the analysis leaving in sites with negative values while DNV GL's approach consistently removed sites with negative values."	When assigning PG&E customers to HER treatment, Nexant filters out customers who are net metered. Some of these households may have become net-metered during treatment. We would like to capture those savings. In the 2015 analysis, Nexant will keep negative billing values if the customer is flagged as a net-metered customer. Otherwise, we will assume the negative bills are errors and they will be removed from the analysis dataset.	Including customers that switched to net metering can be problematic because of the way net metering is addressed in the billing data. If net metered households are included in the analysis, it would be necessary to incorporate household-level energy production data. Otherwise, the potential difference in solar energy production between the treatment and control groups would be conflated with program savings and could bias the results up or down.

				DNV GL will work with PG&E and Nexant to standardize the approach in dealing with net metered customers in the analysis.
5	PG&E/ Nexant	Energy Savings: "DNV GL converted billing records of each billing interval to average consumption per day for each site. Using the average consumption in a billing cycle is particularly important to avoid over- or under- estimation of consumption in a billing cycle because the number of days in an interval could vary from month to month in the billing data. DNV GL recommends Nexant to revisit data cleaning procedures to ensure consistency with previous approach."	PG&E agrees with this approach and Nexant will use this methodology in the 2015 evaluation.	No response required.
6	PG&E/ Nexant	Energy Savings: "DNV GL only considered consumption of HER customers that are active in 2014 in billing analysis. Limiting consumption to active population ensures that consumption in the pre-period is being compared to post-consumption of the same HER customers. Nexant's approach included all customers with pre- or post- consumption data regardless of whether the customer is still active or not."	Nexant has investigated the difference in these two methodologies. For the Beta wave, this results in a small decrease in estimated savings. After discussing internally, Nexant has decided to follow DNV GL's methodology for the 2015 evaluation.	No response required.
7	PG&E/ Nexant	Energy Savings: "[Nexant's] standard errors for the aggregated savings were based on an overall regression model at the wave-level where an overall post-treatment indicator was specified. This is consistent with Nexant's approach last year and is an unnecessary simplification that does not account for the different monthly counts in the aggregate estimates' standard errors. As previously recommended, the standard errors should be calculated using the combined monthly parameter standard errors weighted by the monthly counts if the annual savings estimates are calculated by combining	Nexant will update their methodology for estimating the standard errors to follow DNV-GL's approach.	No response required.

		monthly savings estimates and monthly treatment counts.”		
8	PG&E/ Nexant	Demand Savings: "DNV GL identified households as the unique combination of account and premise identifier while Nexant used only the Service Account ID. Using different identifiers produced different sets of population weights associated with the weather stations within climate zones and produced different values for zonal weighted temperatures."	Within a small time period, the combination of account ID and premise ID is nearly identical to service account ID. Nexant will use the combination of account ID and premise ID to be consistent with DNV-GL’s approach.	No response required.
9	PG&E/ Nexant	Demand Savings: "DNV GL proposes employing a separate definition of peak period that takes into account the hours when the system itself is actually peaking."	Nexant agrees with this proposal and will produce 2015 demand savings estimates during the CAISO and PG&E system peaks, in addition to the hottest 3-day period as defined in the 2014 analysis.	No response required.
10	PG&E/ Nexant	Demand Savings: “For Gamma and Wave One, DNV-GL calculated weights separately instead of combining the different sub-waves.”	In the 2015 analysis, Nexant will produce savings estimates by wave and sub-wave, eliminating the need for weighting.	No response required.
11	PG&E/ Nexant	Estimating Joint Savings: "Nexant's approach carried forward savings from measures installed by customers who are no longer receiving the report and active in 2014. Savings from rebate program participation of inactive customers should not be counted as joint savings because consumption reduction of customers after moving out are not included in the measured program savings."	Nexant agrees, and will only count these savings until the customer moves out or their account closes in the 2015 evaluation.	No response required.
12	PG&E/ Nexant	Estimating Joint Savings: "DNV GL applied DEER load shapes according to the measure while Nexant used a flat load shape 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 Wave 4 and Wave 5."	Nexant will follow DNV-GL’s methodology for the 2015 analysis if both firms can agree on assumptions.	DNV GL will work with PG&E and Nexant to standardize the approach and agree on assumptions used in rebate analysis.
13	PG&E/ Nexant	Estimating Joint Savings: "DNV GL examined potential outliers in the program tracking data. Some lighting	Nexant feels that this methodology is somewhat arbitrary and will continue to follow their original approach moving	DNV GL will work with PG&E and Nexant to standardize the approach and agree on assumptions used in rebate analysis.

		measures in Gamma wave had very high savings values. DNV GL reviewed these records and excluded these observations since indications appear that these savings were from measures installed in common areas in multifamily homes."	forward. Nexant's approach is more conservative. However, Nexant is open to further discussion on this issue during our proposed kick-off call for the 2015 HER project.	
14	PG&E/ Nexant	Estimating Joint Savings: "DNV GL separately analyzed the different Gamma (dual standard, dual reduced, and electric only) and Wave One (dual, electric only) sub-waves. This approach allowed for a better comparison of treatment and control that is consistent with the program savings calculation."	Nexant agrees with this approach and will use it moving forward.	No response required.
15	PG&E/ Nexant	Estimating Joint Savings: Regarding ULP adjustment: "While Nexant's method produced a conservative estimate for peak demand joint savings, DNV GL's approach is the better approach since instead of assumptions; we used data from the published California statewide lighting report that can also be replicated for the other CA IOU's."	PG&E notes that the largest difference between DNV GL and Nexant estimates for the 2014 program year is for peak megawatt load reduction. To avoid a recurrence of a large discrepancy in 2015, PG&E proposes that, during the kick-off call for the 2015 HER project, that Energy Division and PG&E, in consultation with their consultants DNV GL and Nexant, agree upon a method for estimating peak demand savings in advance.	DNV GL will work with PG&E and Nexant to standardize the methodology for kW joint savings calculation.

Appendix BB. Public Comments from Opower

No.	From	Section	Comments	Response
1	Opowe r		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	Opowe r	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