2013 PG&E Home Energy Reports Program

Review and Validation of Impact Evaluation

ED Res 3.1

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

This report provides the results of an ex post validation of Pacific Gas and Electric Company's (PG&E's) 2013 Home Energy Reports (HER) program energy savings estimates produced by Nexant, Inc. DNV GL conducted this review on behalf of the California Public Utilities Commission (CPUC). It includes a detailed technical assessment of the final program savings estimates and peak demand savings estimates.

This is DNV GL's second 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 had access to 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 2013. 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 under the program.

2 BACKGROUND

Under the HER program, Opower provides randomly selected residential customers with bimonthly home energy reports and Nexant facilitates implementation and evaluates program impacts. The program started in the fall of 2011 and so far has been introduced in five waves: Beta Wave, Gamma Wave, Wave One, Wave Two, and Wave Three. These waves started at different times and were drawn from different populations, and each received slightly different treatments (Table 1). Each wave consists of randomly assigned treatment and control groups.

Table 1. HER Experimental Waves and Launch Dates

Wave	Fuel type/ Frequency of report/Area	Launch date	Treatment Customers[2]
Beta	Dual fuel	August 2011	50,628
Gamma[1]	Dual fuel – Standard frequency Dual fuel – Reduced frequency Electric only	November 2011	158,002
Wave One	Dual fuel Electric only	February 2012	340,557
Wave Two	Area 7 Non-Area 7	February 2013	73,201 (Area 7) 280,520 (Non-Area 7)
Wave Three	Dual fuel	July 2013	219,052

[1] Includes Gamma Wave (gas only), but due to the removal of Sacramento Municipal Utility District (SMUD) customers, the exact number of gas only customers is not known but expected to be small.
[2] Treatment counts are based on *PG&E 2013 Demand Savings Methodology and Estimate* (prepared by Nexant, 08/28/2014).

3 FINDINGS

DNV GL reviewed four main components that resulted in final program savings and demand savings estimates for 2013. These components are:

- Consumption reduction estimates
- Downstream/tracked rebate-program joint savings estimates
- Upstream/untracked rebate-program joint savings estimates
- Peak demand analysis

DNV GL reviewed Nexant's methods stated in its evaluation report[1] and in STATA codes submitted by Nexant. Evaluators also produced a set of comparison results for validating consumption reduction estimation and peak demand analysis using DNV GL methods and data PG&E provided to the CPUC.

Consumption reduction estimation measures the total effect of a program on consumption and provides the primary estimate of program-related savings. Joint savings estimation for upstream and downstream energy efficiency program savings identifies the portion of savings that are possibly shared with other programs.

Just like last year's review, 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)[2]. In particular, Nexant followed the recommended fixed-effects regression approach and clustered standard errors to allow for arbitrary correlations within 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 in this case as it captures valid partial savings in households that move out prior to the end of the evaluation period.

3.1 Consumption Reduction Estimation

DNV GL independently estimated wave-level consumption reductions for the HER program. Consistent with last year's review, the validations used DNV GL methods and PG&E data provided to the CPUC. The objective was 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 2013 with the

[1] *PG&E 2013 Energy Efficiency Savings Estimates: Home Energy Reports*. Nexant, Inc., 2014,

[2] 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.

monthly savings provided in 2012. 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.

Following DNV GL's recommendation last year, Nexant calculated overall program savings by aggregating monthly savings estimates using monthly treatment counts in each wave. Table 2 presents a comparison of DNV GL's and Nexant's calculation of the aggregate electric and gas savings for HER program year 2013. 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[3].

Overall, DNV GL estimates are higher than Nexant's estimates for both gas and electric except for Wave Three. For electric savings, Nexant's estimates are within 5% of DNV GL's electric savings except for Gamma Wave (dual fuel, standard frequency) and Wave Three. On an aggregate-level, the difference between the two sets of results is within 2%.

Table 2. Aggregate Electric and Gas Savings

Wave	Electric			Gas		
	Nexant	DNV GL	% DNV / Nexant	Nexant	DNV GL	% DNV/ Nexant
Beta	10,813,785	11,315,192	105%	395,731	405,192	102%
Gamma - Dual Standard	6,513,038	7,073,100	109%	169,349	201,545	119%
Gamma - Dual Reduced	5,906,290	6,154,571	104%	139,183	154,144	111%
Gamma - Electric only	3,861,456	3,986,161	103%			
Wave One - Dual	33,810,261	34,774,875	103%	825,001	970,132	118%
Wave One - Electric only	3,978,532	4,193,245	105%			
Wave Two - Non-Area 7	16,346,106	16,275,011	100%	824,979	822,395	100%
Wave Two - Area 7	3,972,219	4,036,249	102%	216,229	239,120	111%
Wave Three	5,399,160	5,024,008	93%	254,765	204,337	80%
Total	**90,600,847**	**92,832,411**	**102%**	**2,825,237**	**2,996,866**	**106%**

The differences in aggregate gas savings estimates are larger than the discrepancies observed in electric savings. Only Beta Wave and Wave Two (Non-Area 7) estimates are within a 5% difference, while Gamma - Dual Standard, Wave One - Dual, and Wave Three have differences of 19%, 18%, and 20%, respectively. The 18% gap in savings estimates in Wave One is consistent with what DNV GL observed in the review of 2012 PG&E HER evaluation. On an aggregate level, DNV GL's gas savings estimate is greater by 6%.

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 an unnecessary simplification that does not

[3] DNV GL used treatment counts as reported in Nexant's results file 'Energy Savings Excel Calculations.xlsx'.

account for the different monthly counts in the aggregate estimates' standard errors. DNV GL recommends that if the annual savings estimates are calculated by combining monthly savings estimates and monthly treatment counts, the standard errors should be calculated using the combined monthly parameter standard errors weighted by the monthly counts.

3.2 Joint Savings Estimation

3.2.1 Downstream Rebate Programs

DNV GL reviewed Nexant's codes and data used in estimating electric joint savings from downstream programs. In the joint savings calculation, Nexant carried forward savings incurred by the HER population from other energy efficiency measures installed in 2011 and 2012 and included savings from measures installed in 2013. Savings from measures installed in 2013 were prorated to represent when the measures were installed. Nexant's approach included prorating kWh savings for each customer who received a rebate by multiplying the tracked kWh savings with the number of days in 2013, after installation. This weighting process is an improvement over last year's method where Nexant assumed that all energy savings from rebate programs were installed during the first month of the analysis period.

Prorating savings for 2013 measures reduced the probability of assigning savings when they could not realistically occur. However, DNV GL's review of Nexant's codes used in the rebate analysis indicates that Nexant used prorated savings for measures installed in 2013 but assigned full savings for measures installed before 2013. Because the program waves had different start periods, it is likely that measures installed before the wave's launch date are included in Nexant's joint savings calculation. DNV GL recommends a more appropriate approach is to only carry forward savings from measures installed after their program start date for each experimental wave.

In addition, DNV GL observed that the tracking datasets received from Nexant only includes rebate data through September 2012, for the period 2011 through 2012. This may indicate that downstream program participation for the last quarter of 2012 was missing when Nexant calculated joint savings; or the datasets DNV GL reviewed are not the final data used in Nexant's calculation.

DNV GL replicated the joint savings analysis using PG&E tracking datasets received from the CPUC. Table 3 compares DNV GL and Nexant's rebate savings for each experimental wave. Overall, DNV GL's joint savings estimate from downstream programs is 0.34 GWh while Nexant's estimate is 0.71 GWh. DNV GL recommends that Nexant revisit their joint savings calculation and apply necessary adjustments for future HER program evaluation. DNV GL recommends applying 0.34 GWh as the total downstream rebate savings for 2013 HER program.

Table 3. Total Downstream Rebate Savings by HER wave

	Control		Treatment		Difference	
HER Wave	Nexant	DNV GL[1]	Nexant	DNV GL	Nexant	DNV GL
Beta	2,012,281	1,286,011	2,148,928	1,344,459	136,647	58,448
Gamma Standard Dual	1,371,740	822,010	1,184,852	924,032	-186,888	102,022
Gamma Reduced Dual	1,371,740	815,761	1,182,997	889,542	-188,743	73,781
Gamma Electric Only	438,024	429,696	521,175	508,939	83,150	79,243
Wave One All*	6,982,692	4,303,496	7,356,426	4,244,663	373,734	-58,833
Wave Two Area 7*	925,595	174,543	958,988	189,716	33,394	15,173
Wave Two Not Area 7*	4,544,695	991,982	4,665,945	1,083,384	121,250	91,403
Wave Three All*	26,259,900	208,714	26,600,166	192,041	340,266	-16,673
Total Difference in Rebated Savings (kWh)					**712,810**	**344,564**
Total Difference in Rebated Savings (GWh)					**0.71**	**0.34**

[1] Control group savings were scaled for comparison with the treatment

Regarding adjustments in gas savings, Nexant noted that gas savings from downstream measures were fairly small because of the interactive effects associated with installation of energy-efficient electric measures. Consistent with their 2012 report, Nexant omitted any adjustment in gas savings that might have been due to double-counting.

Section 5.3 summarizes DNV GL's recommended method for estimating joint savings analysis, which is consistent with the approach recommended in the SEE Action report.

3.2.2 Upstream Rebate Programs

DNV GL reviewed the methodology employed for estimating the upstream joint savings estimates, but did not review the data for this aspect of the evaluation. Similar to last year's evaluation, Nexant used the assumptions based on the Upstream Lighting Program (ULP)[4] and Compact Fluorescent Lamps (CFL) Market Effects[5] reports. We note that the following assumptions were used in 2013 joint savings calculation for upstream programs:

- Excess installed CFL per HER recipient = 0.95

- Ratio of total rebated CFLs to total CFL's sold for California = 0.74
- Net to gross ratio for PG&E = 0.49
  ➔ All excess CFLs assumed to be attributable to the ULP = 0.74 x 0.49 = 0.33
- ULP CFL hours of use for PG&E = 1.9 hours per day
- Annual savings from CFL installation = 44.3 watts
  ➔ 1.9 x 365 x 44.3 / 1000 = 30.7 kWh per year per excess CFL or 2.558 kwh per month

[4] *Final Evaluation Report: Upstream Lighting Program, Volume 1.* KEMA, 2010.
[5] *Compact Fluorescent Lamps Market Effects Final Report.* The Cadmus Group, Inc.: Energy Services Group (formerly Quantec, LLC), KEMA, Itron, Inc., 2010.

For Beta, Gamma, and Wave One rollouts, Nexant assumed that all customers installed an extra CFL by the start of 2013; while for Waves 2 and 3, it was assumed that 1/12 customers installed CFLs each month after they began receiving the report. The total kWh savings attributed to CFL installations in all waves was estimated on a monthly basis, and by the end of 2013, Nexant estimated 7.1 GWh savings due to CFLs.

Based on the 2012 PG&E onsite survey, the HER treatment group installed 0.95 more CFL than the control group during the first year of the program. If the same rate is used in Year 2, the treatment group from Beta, Gamma, and Wave One would have installed 1.9 more CFLs than the control group by the end of 2013. Nexant assumed 0.95 extra CFL per HER recipient by the start of 2013 for Beta, Gamma, and Wave One and that these CFLS produced savings in 2013. Nexant's assumption implies that savings from program-induced CFL installations in Year 1 were carried forward in Year 2, but CFL uptake between the treatment and control groups was equal in Year 2.

DNV GL recommends carrying forward joint savings observed during the first year of the program. Joint savings for Beta, Gamma, and Wave One are expected to be higher in Year 2 to the extent that the HER program is still influencing customers to participate in upstream programs in Year 2. However, evaluators could not verify the increase in upstream program participation due to HER program during the second year because onsite survey was not conducted in 2013. Given that there is no documentation to indicate exactly what should be the second year adjustment, we recommend a compromise of 1.5 extra CFL per HER recipient in Beta, Gamma and Wave One and 0.95 CFL per HER recipient in Wave Two and Wave Three for this report. Going forward, we recommend ED and/or the IOUs conduct research to determine the appropriate adjustment for upstream programs with multiple treatment periods. The recommended assumption of increased CFL uptake for earlier waves increases Nexant's upstream savings from 7.1 GWH to 9.9 GWh.

3.3 Per Household Savings

Table 4 summarizes the recommended electric and gas savings per household for each experimental wave. Baseline consumption and unadjusted per household savings are based on Nexant's estimates while joint savings adjustments are based on DNV GL's analysis.

Table 4. 2013 Per Household Electric and Gas Savings

HER Wave	Baseline Consumption	Per Household Savings (Unadjusted)	Per Household Savings (Adjusted)	% Savings	
				Unadjusted	Adjusted
Electric					
Beta	10,716	221.2	204.0	2.1%	1.9%
Gamma Reduced	7,308	111.6	94.0	1.5%	1.3%
Gamma Standard	7,308	101.1	84.2	1.4%	1.2%
Gamma Elec only	7,056	117.6	99.9	1.7%	1.4%
Wave One	7,356	111.7	96.4	1.5%	1.3%
Wave One - Elec only	8,220	128.1	113.4	1.6%	1.4%
Wave Two - Area 7	5,698	52.4	48.4	0.9%	0.8%
Wave Two - Non Area 7	6,424	59.9	55.4	0.9%	0.9%
Wave Three	3,444	26.7	25.6	0.8%	0.7%
Gas					
Beta	840	8.1	8.1	1.0%	1.0%
Gamma Reduced	468	2.4	2.4	0.5%	0.5%
Gamma Standard	468	2.4	2.4	0.5%	0.5%
Wave One	492	2.7	2.7	0.6%	0.6%
Wave Two - Area 7	462	3.0	3.0	0.6%	0.6%
Wave Two - Non Area 7	429	3.0	3.0	0.7%	0.7%
Wave Three	228	1.3	1.3	0.6%	0.6%

Note: Wave Two and Wave Three were launched in February 2013 and July 2013, respectively. Baseline consumption (control usage in 2013) and savings only represent partial months of 2013.

3.4 Peak Demand Analysis

DNV GL reviewed Nexant's proposed technical approach for estimating peak demand savings. The proposed approach used peak periods provided by Database for Energy Efficiency Resources (DEER) using CZ2010 (2013 Title-24) weather files[6]. The assumed year for the weather files is 2009 and the weather files are not based on actual 2013 data. Instead of using DEER-defined peak periods, DNV GL recommends applying DEER's criteria for the three-day demand periods to the actual weather for 2013 in demand savings calculation. Nexant identified the peak periods specific for each climate zone in the HER program territory, and used the most common heat wave as the representative peak period for the program population.

[6] *Codes and Standards Update for 2013-14* Cycle (p. 18). Database for Energy Efficiency Resources. 2013.

Nexant identified Jul 1 to Jul 3, 2013 as the highest temperature, three-day demand period common to all HER program climate zones. However, this heat wave period was discarded because this period is potentially unrepresentative of normal conditions. The specific reasons given were:

- The days included in the heat wave period fell on a short work week due to Independence Day (a national holiday)
- The days included in the heat wave period coincides with the strike of the Bay Area Regional Transit System (BART) that serves the primary metropolitan area of the PG&E service territory.

Based on DNV GL's recommendation, Nexant identified the next highest three-day heat wave that was most common to all climate zones, which was Jun 26 to Jun 28, 2013. This was used for Nexant's final peak demand savings calculation for 2013. Evaluators did not verify the actual heat wave periods using actual weather data, but based on the documentation provided by Nexant, found the algorithm used to identify the three-day demand periods to be sound.

A rigorous effort was made to validate the peak demand savings since such analysis is new in the context of the HER program. Instead of just evaluating one or two program waves, DNV GL used two approaches to validate Nexant's peak demand savings calculations for all waves and climate zones.

The first method was similar to Nexant's method, which only accounts for the post differences in kW between the treatment and control groups. The second method applied a difference-in-differences framework in estimating peak demand savings. The difference-in-differences approach is our recommended approach to account for slight imbalances in household level consumption despite the fact that the allocation was done on a stratified basis with respect to consumption. The difference-in-differences used the heat waves identified by Nexant in the pre-period for each wave. Table 5 presents the peak periods identified by Nexant for each wave.

Table 5. Three-day Demand Periods for Each Wave

Wave	Launch date	Pre-Treatment Heat Wave	Post-Treatment Heat Wave
Beta	August 2011	July 5-7, 2011	August 13-15, 2012
Gamma	November 2011	July 5-7, 2011	August 13-15, 2012
Wave One	February 2012	July 5-7, 2011	August 13-15, 2012
Wave Two	February 2013	August 13-15, 2012	June 26-28, 2013
Wave Three	July 2013	August 13-15, 2012	June 26-28, 2013

DNV GL recognizes that the heat waves compared in the pre- and post-periods may not be similar and could affect results of the validation, but not accounting for the differences in the pre-period when the treatment and control were not randomly allocated within the peak demand strata is equally problematic. Peak load was not included in the stratification approach for the HER program, so there was a high chance of imbalance and a greater justification for this extra effort. DNV GL examined pre-existing differences and the results are presented in Section 5.3

Table 6 presents Nexant's and DNV GL's results for peak demand analysis. For comparison purposes, DNV GL used Nexant's results based on the specific heat waves identified for each climate zone and not from the most common heat wave to all climate zones. Nexant's final aggregate reduction is 15.4 MW per hour, which is based on Jun 26-28, 2013, the second hottest and most common heat wave period in 2013 across all climate zones.

Table 6. Comparison of Hourly Demand Reductions by Climate Zone

Climate Zone	Heat Wave Period in 2013	Number of Treated Residences		Aggregate Peak Demand Reduction (MW)		
		Nexant	DNV GL	Nexant	DNV GL1[1]	DNV GL2[2]
1	August 27-29	8,757	9,056	-0.10	-0.04	0.09
2	June 26-28	63,090	63,068	1.20	1.76	2.11
3	June 26-28	329,117	324,424	3.60	1.99	2.96
4	June 26-28	176,824	170,855	0.20	0.44	3.15
5	June 26-28	701	699	0.00	-0.02	-0.04
11	July 24-26	55,990	56,143	1.00	1.29	0.03
12	June 26-28	267,423	259,641	6.30	6.43	8.18
13	July 08-10	133,397	135,106	3.40	2.70	4.83
16	July 24-26	1,016	994	0.00	-0.06	-0.02
Total		**1,036,315**	**1,019,986**	**16**	**14**	**21**

[1] Using treatment and control difference in the post-period only

[2] Using difference-in-differences approach

Overall, results suggest that the average difference between DNV GL's and Nexant's aggregate peak demand savings estimates using 'post-only' differences is only -0.1 MW for each climate zone. However, when pre-existing differences between the control and treatment group are accounted for by applying difference-in-differences method, an increase in overall peak demand savings is observed. The increase in savings implies that treatment households have higher demand than households in the control group during the pre-treatment period.

Nexant identified a pre-treatment difference of less than 0.02 kW for each experimental wave. One source of discrepancy in results for pre-existing differences could be due to DNV GL's site exclusion criteria. In Nexant's verification of pre-existing differences, the counts for treatment and control groups vary in the pre- and post-period for each wave. The difference in counts indicates that Nexant included sites without AMI data in the post-period when testing for differences in demand. In comparison, DNV GL dropped sites when post-AMI data were not available, which guaranteed that the sample used for testing pre-existing differences reflects the HER sample used in the post-only and difference-in-differences method.

The review of Nexant's 2013 report for peak demand analysis showed different counts of customers in the treatment groups across different tables. DNV GL suggests that the report include a breakdown of the number of sites excluded for various reasons such as customer attrition, lack of data, and others for both peak demand and consumption reduction analysis.

Nexant's peak demand analysis did not discuss the potential issue of double counting savings. The issue of double counting also apply to demand impacts to the extent that other energy efficiency programs claim demand savings. DNV GL recommends that Nexant examine potential demand savings jointly caused by HER program and other upstream and downstream program activities during peak periods in future HER evaluation.

The availability of high-resolution AMI data provides an opportunity to estimate demand savings attributed to HER during the peak periods. There is not much literature available that examines peak demand savings due to behavioural-based programs. Peak demand analysis is a new concept for comparative report initiatives and there are a number of details that need to be explored. Despite the demonstrated differences in peak demand savings estimates, DNV GL recommends using Nexant's estimates of peak demand savings.

Section5.3 of the Appendix presents DNV GL's examination of pre-existing differences and a comparison of demand savings calculation for major climate zones.

4 RECOMMENDATIONS

Overall, DNV GL evaluators found no major concerns or errors with the results or methodology Nexant used for estimating kWh and kW savings other than what is noted above. DNV GL recommends accepting Nexant's energy savings and demand savings for the 2013 HER program. However, DNV GL recommends using our estimates for downstream and upstream savings adjustments due to reasons noted in Section 3.2.

Specifically, DNV GL recommends the following savings estimates for 2013 PG&E HER program:

- kWh Savings = 90,600,847 kWh
  - Joint savings for downstream programs = 344,564 kWh
  - Joint savings for upstream programs = 9,900,000 kWh
  - kWh Savings (with joint savings adjustment) = 80,356,283 kWh
- Therms Savings = 2,825,237 therms
- Demand Savings = 15,400 kW

5 APPENDIX

5.1 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. The process is complicated by ongoing attrition in both the treatment and control groups.

Nexant's peak demand report includes the counts of sites in the treatment and control groups for each HER wave. DNV GL population counts approximately recreate the counts reported by Nexant. Exact counts depend on details such as how move-out date is assigned and data quality criteria for inclusion in the regression. As a result, evaluators did not attempt to recreate the exact average population Nexant used to produce the savings estimates. DNV GL used PG&E billing data to establish a move-out date. Overall, DNV GL control and treatment counts are lower than Nexant's.

Table 7 presents the comparison of the number of customers in the treatment and control group.

Table 7. Number of Customers in the HER Treatment and Control Groups

Wave	Control		Treatment		% Difference	
	Nexant*	DNV GL	Nexant*	DNV GL	Control	Treatment
Beta	50,741	49,369	50,628	49,306	-2.7%	-2.6%
Gamma	96,510	89,605	158,002	147,745	-7.2%	-6.5%
Wave One	85,206	82,488	340,557	329,853	-3.2%	-3.1%
Wave Two - Area 7	45,649	45,961	73,201	73,650	0.7%	0.6%
Wave Two - Not Area 7	43,609	44,536	280,520	286,411	2.1%	2.1%
Wave Three	73,023	69,154	219,052	207,461	-5.3%	-5.3%
Total	**394,738**	**381,113**	**1,121,960**	**1,094,426**	**-3.5%**	**-2.5%**

*Number of sites is based on *PG&E 2013 Demand Savings Methodology and Estimate: Home Energy Reports*. Nexant, Inc., 2014.

5.2 Program savings estimation

5.2.1 Monthly Electric Savings

Figure 1 to Figure 9 display the monthly estimates of 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

In general, the monthly savings are similar 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. The largest gap is observed in Wave One – Electric only for the month of June. However, average monthly savings estimates for Wave One are comparable. Given that the bulk of our analysis of monthly savings is consistent with Nexant's results there is probably minimal benefit (relative to cost) in exploring the reasons for the minor difference. It is also worth noting that the gap in monthly savings estimates in Wave One was also observed in Year 1 when the two savings estimates diverged during the latter months in 2012.

Figure 1. Average Monthly Electric Savings for Beta Wave

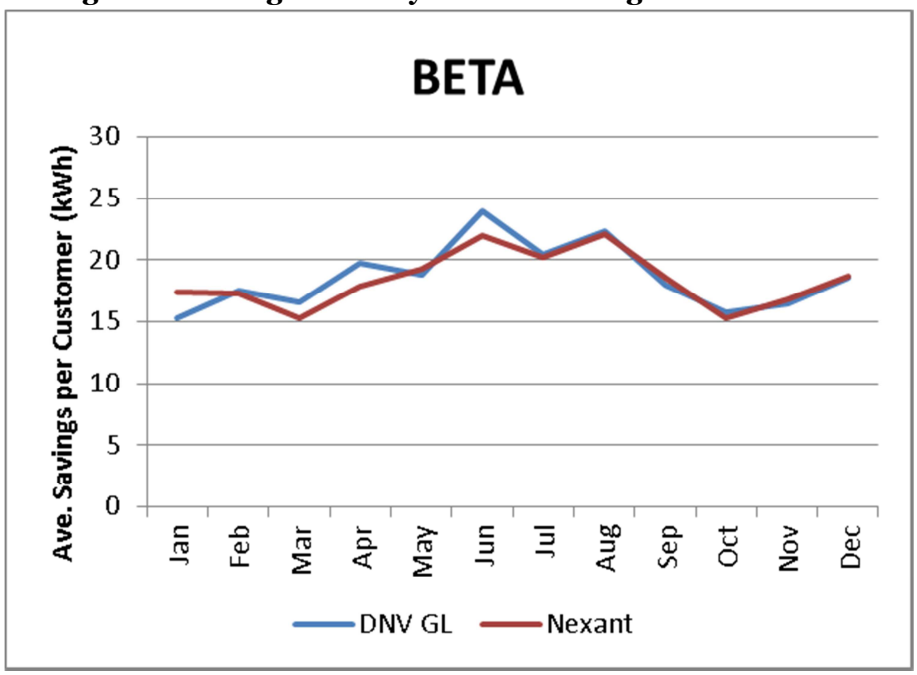


Figure 2. Average Monthly Electric Savings for Gamma Wave – Dual Standard

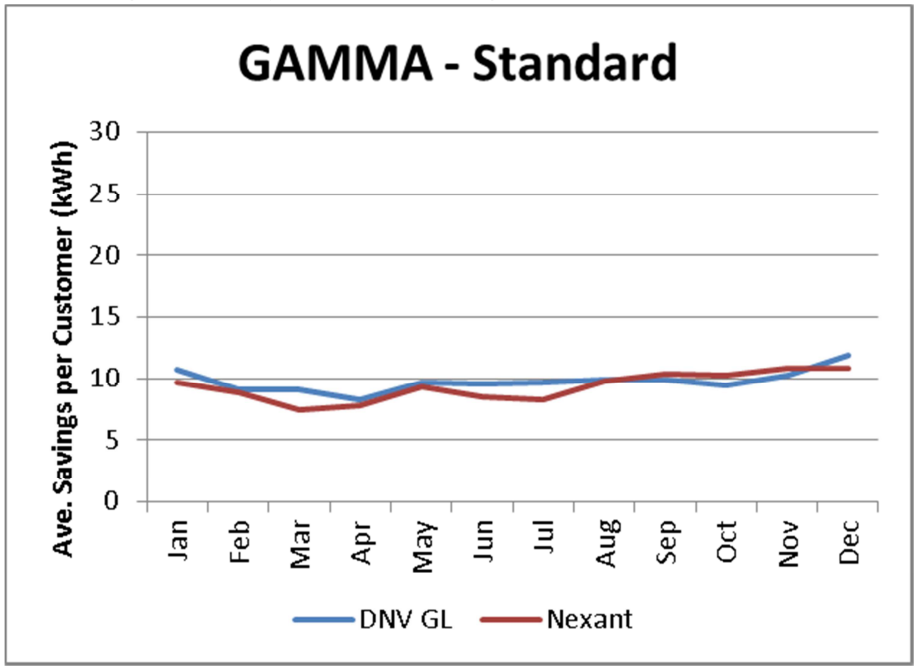


Figure 3. Average Monthly Electric Savings for Gamma Wave – Dual Reduced

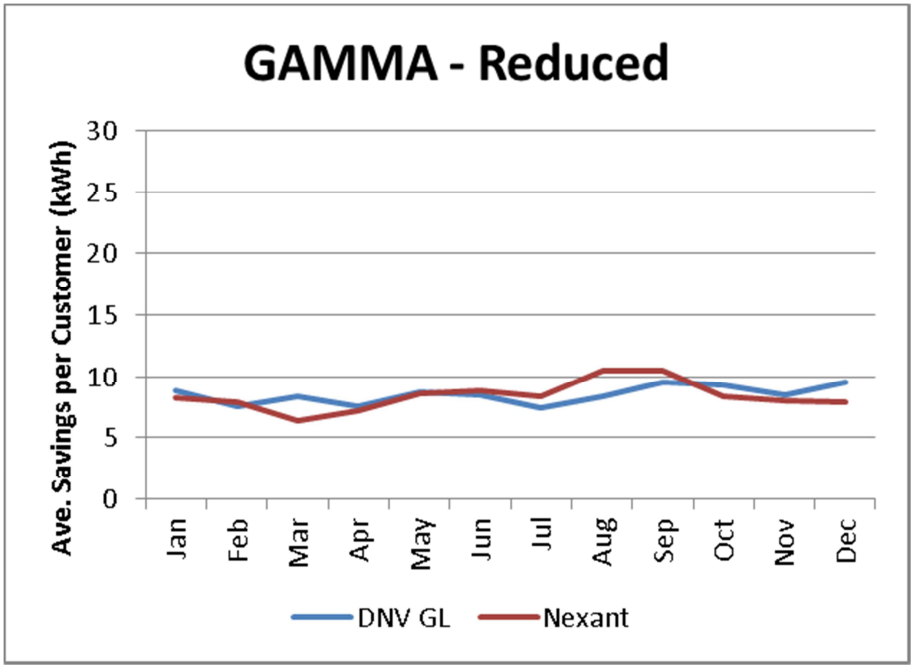


Figure 4. Average Monthly Electric Savings for Gamma Wave – Electric Only

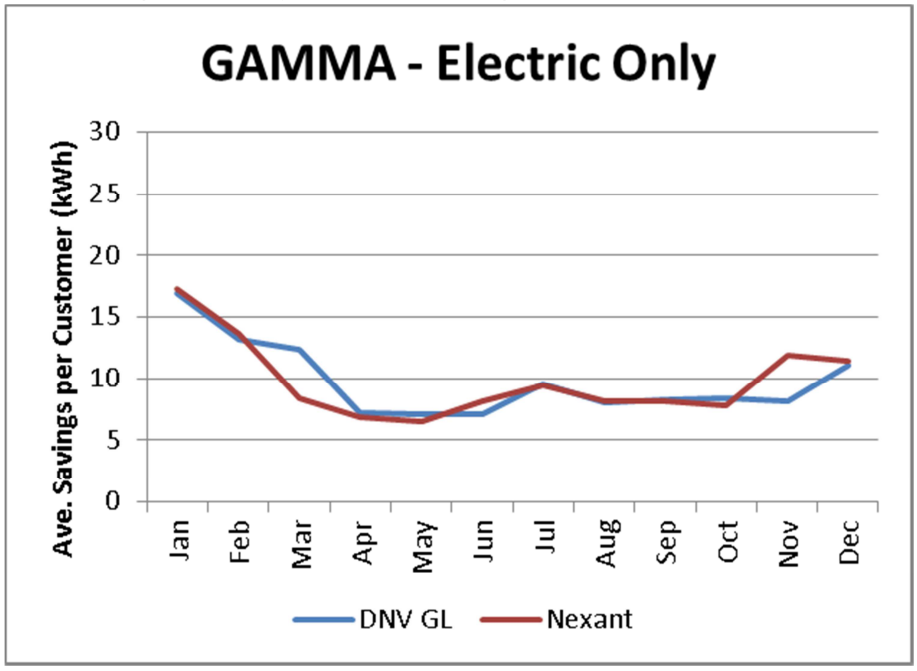


Figure 5. Average Monthly Electric Savings for Wave One – Dual

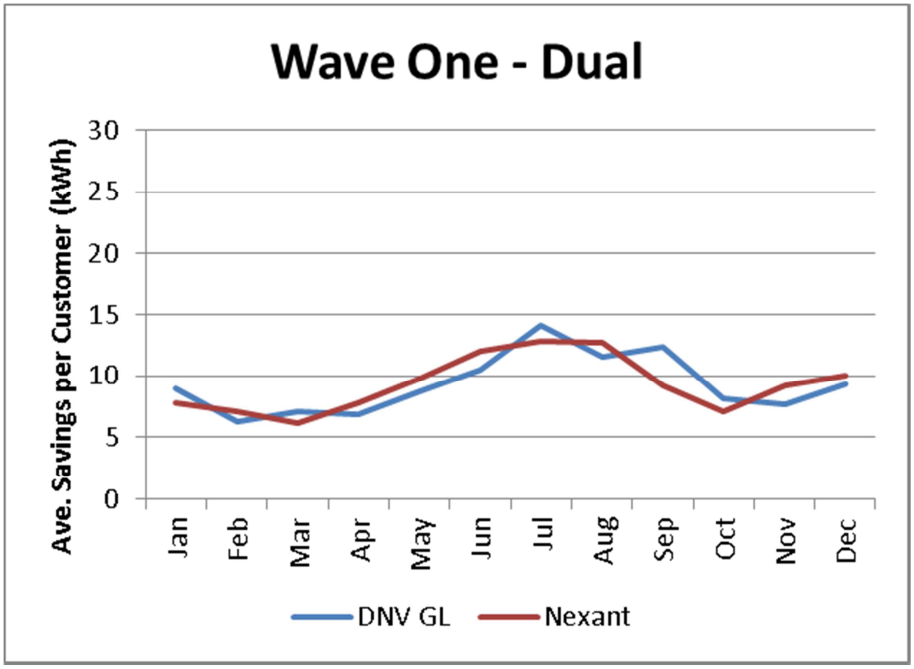


Figure 6. Average Monthly Electric Savings for Wave One – Electric Only

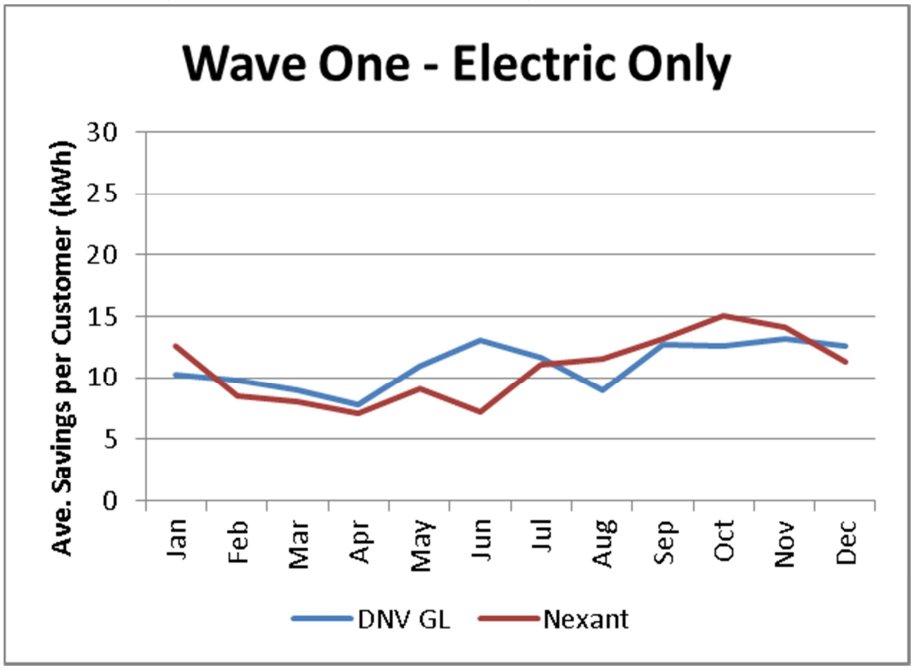


Figure 7. Average Monthly Electric Savings for Wave Two – Non Area 7

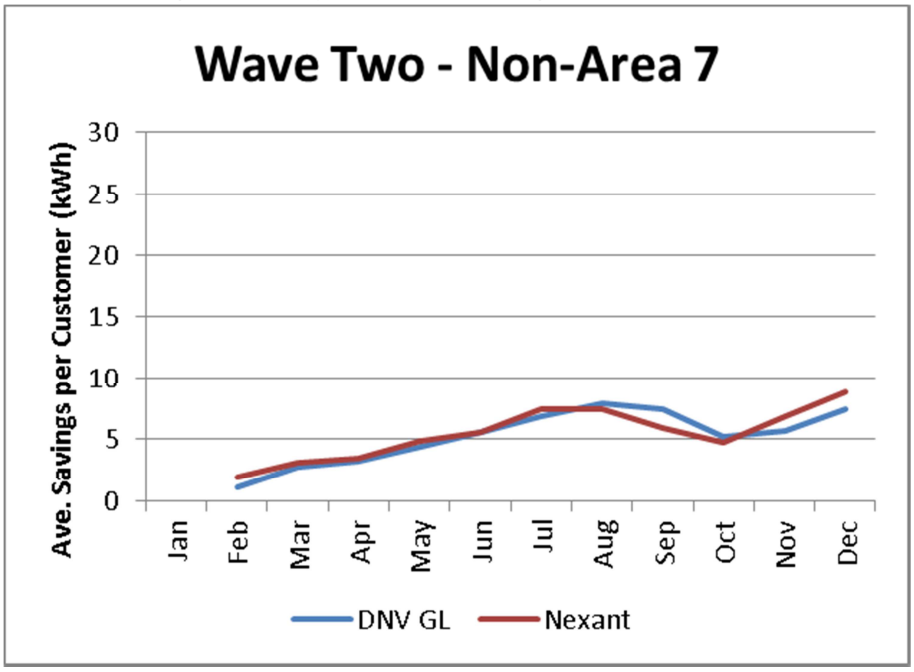


Figure 8. Average Monthly Electric Savings for Wave Two – Area 7

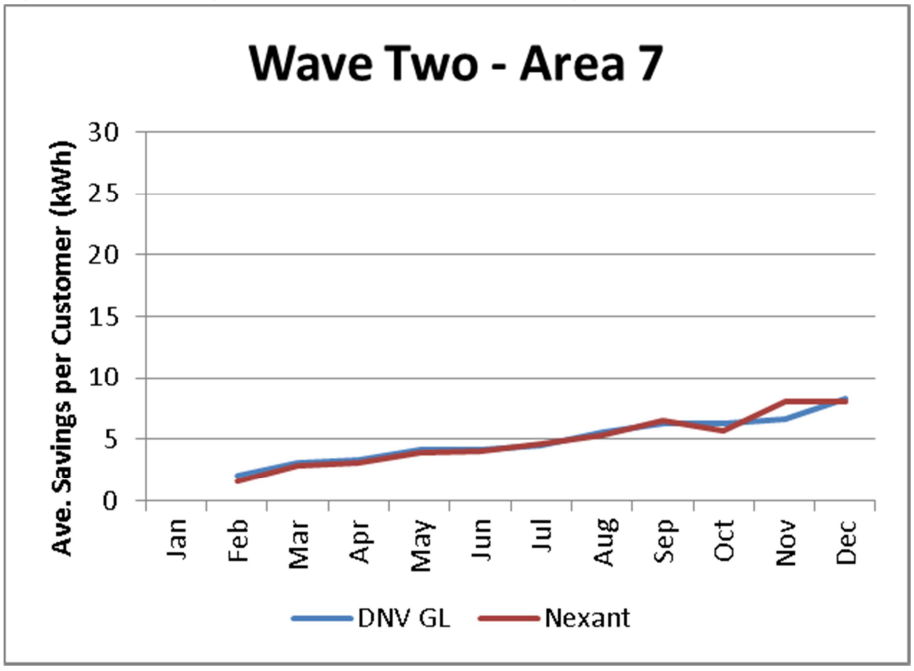
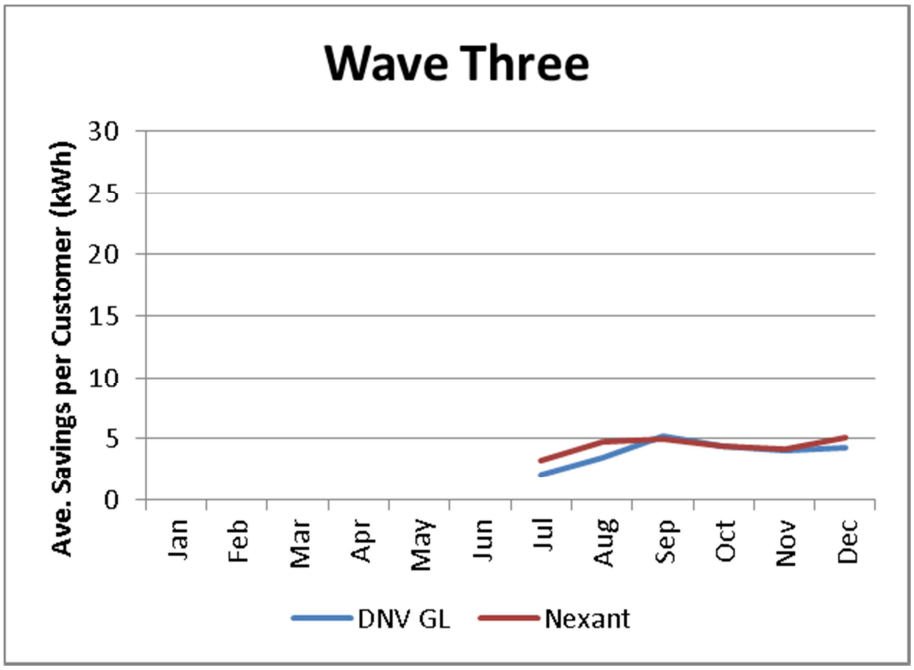


Figure 9. Average Monthly Electric Savings for Wave Three



5.2.2 Monthly Gas Savings

Figure 10 through Figure 16 compare the monthly estimates of gas savings reported by Nexant and reproduced by DNV GL. Similar to the results for monthly electric savings, the two sets of monthly gas savings estimates are comparable. However, 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. For most cases, when DNV GL shifts savings curves backward by one month, most savings estimates overlap Nexant's monthly estimates.

Figure 10. Average Monthly Gas Savings for Beta Wave

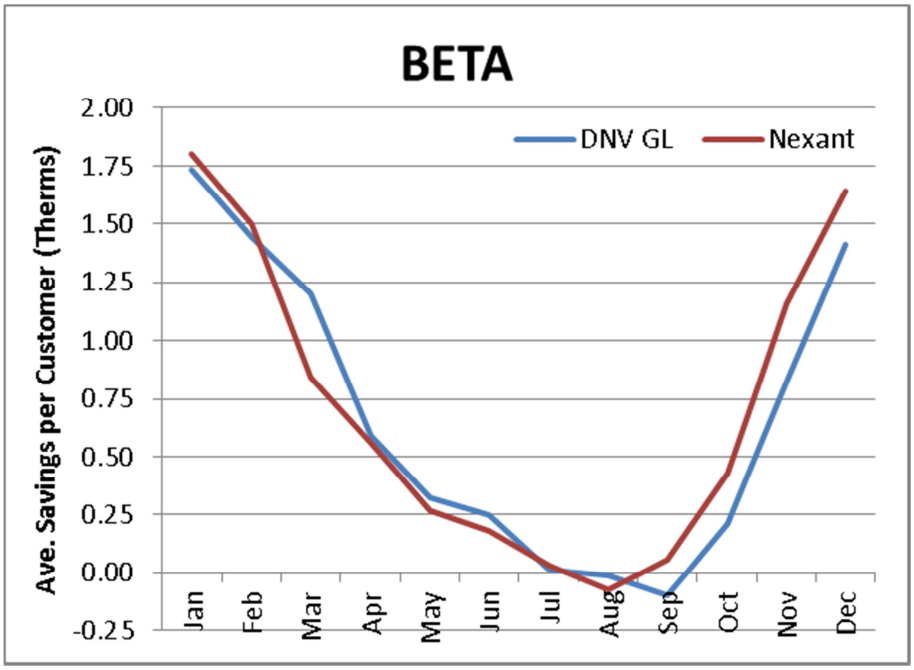


Figure 11. Average Monthly Gas Savings for Gamma Wave – Dual Standard

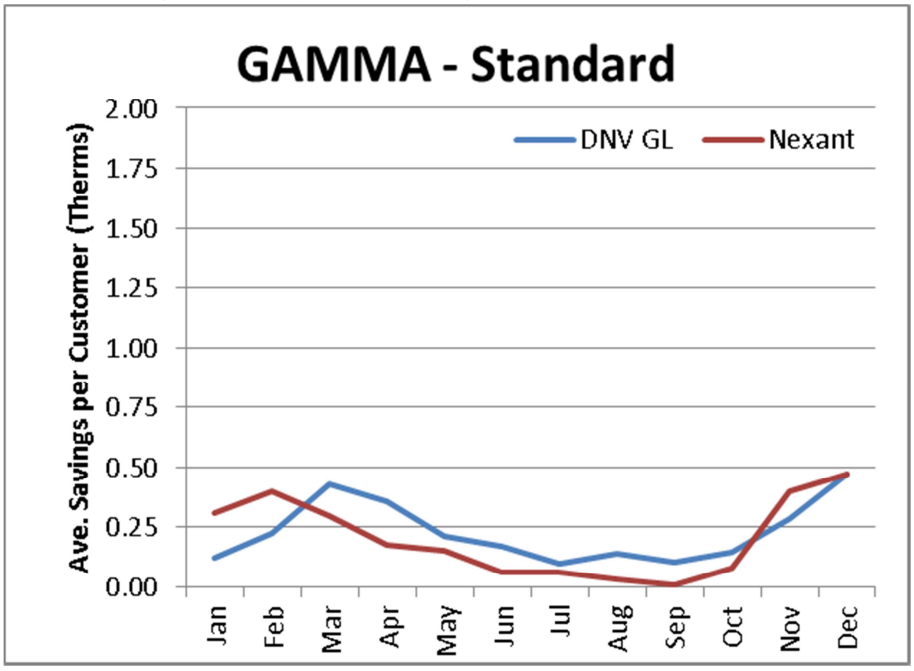


Figure 12. Average Monthly Gas Savings for Gamma Wave – Dual Reduced

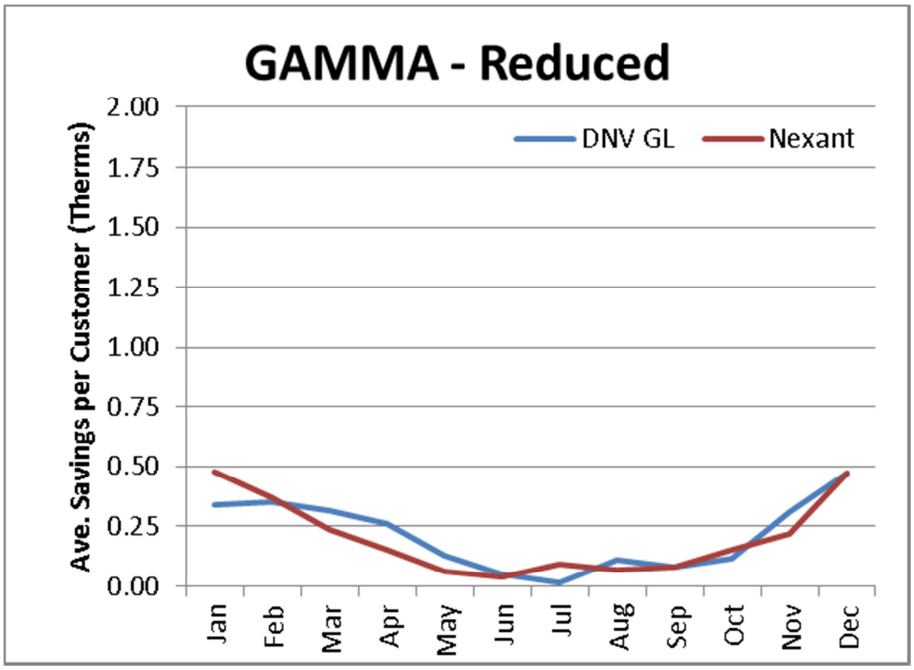


Figure 13. Average Monthly Gas Savings for Wave One – Dual

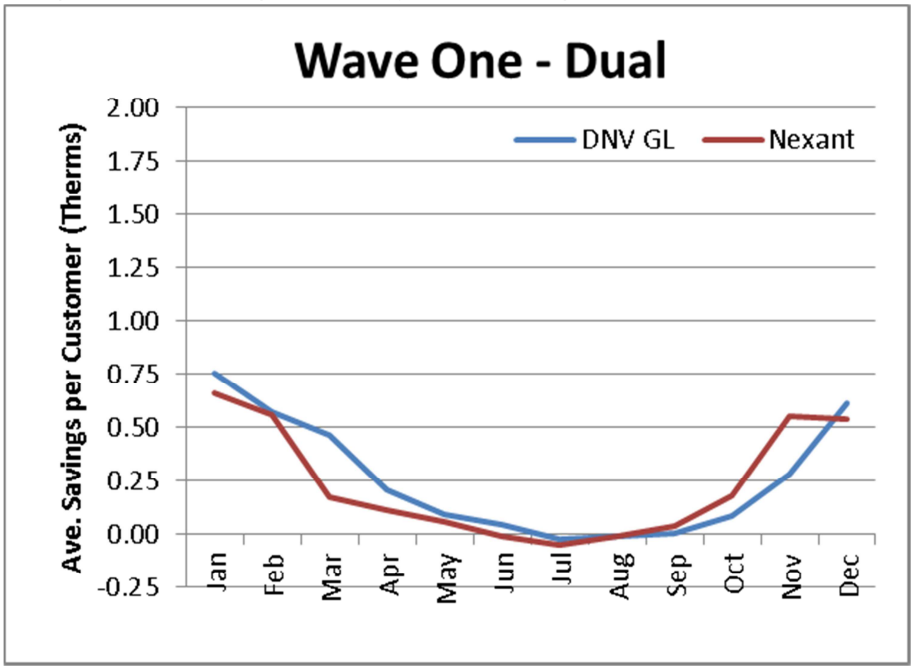


Figure 14. Average Monthly Gas Savings for Wave Two – Non Area 7

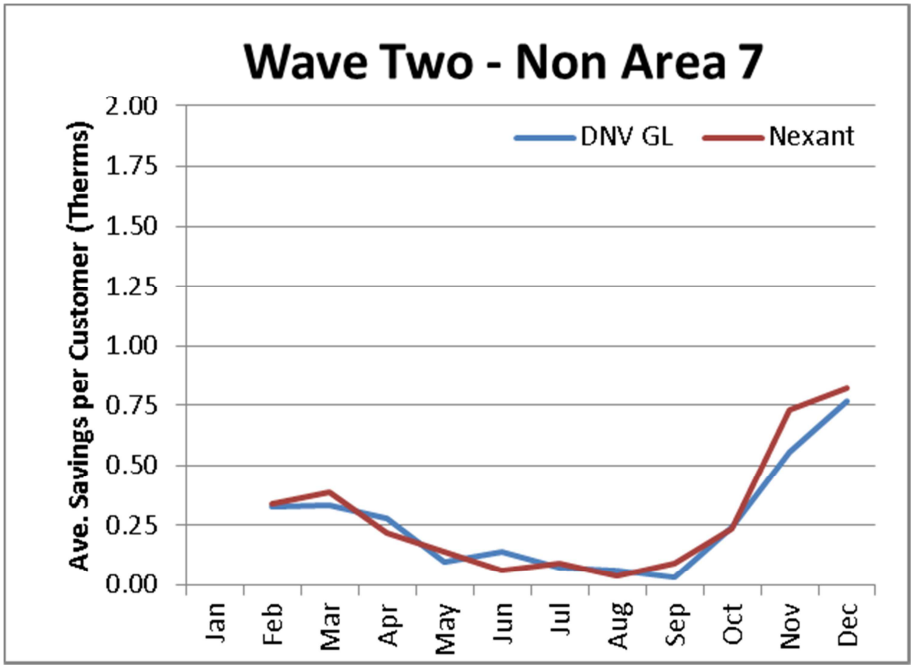


Figure 15. Average Monthly Gas Savings for Wave Two – Area 7

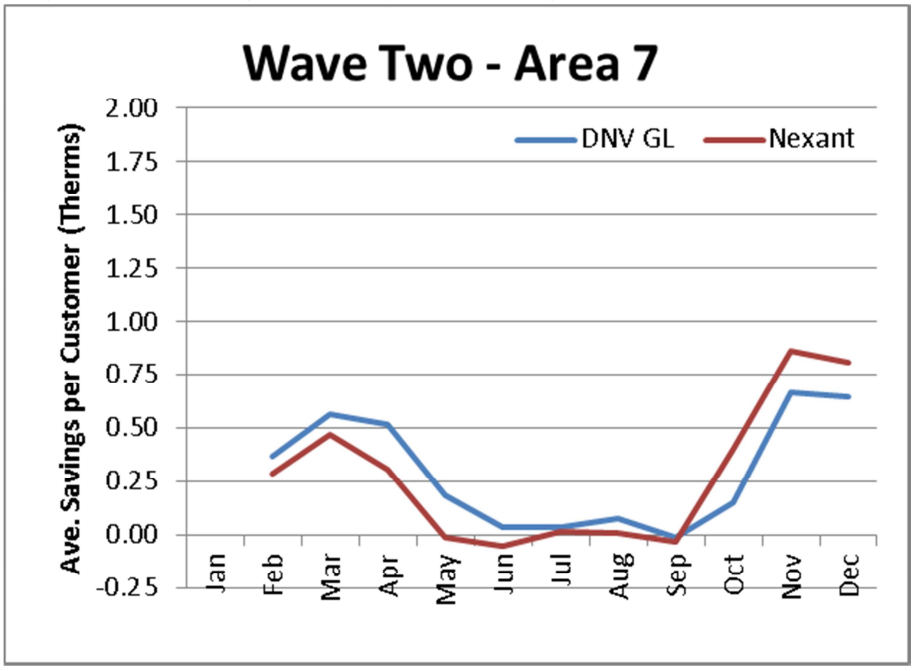
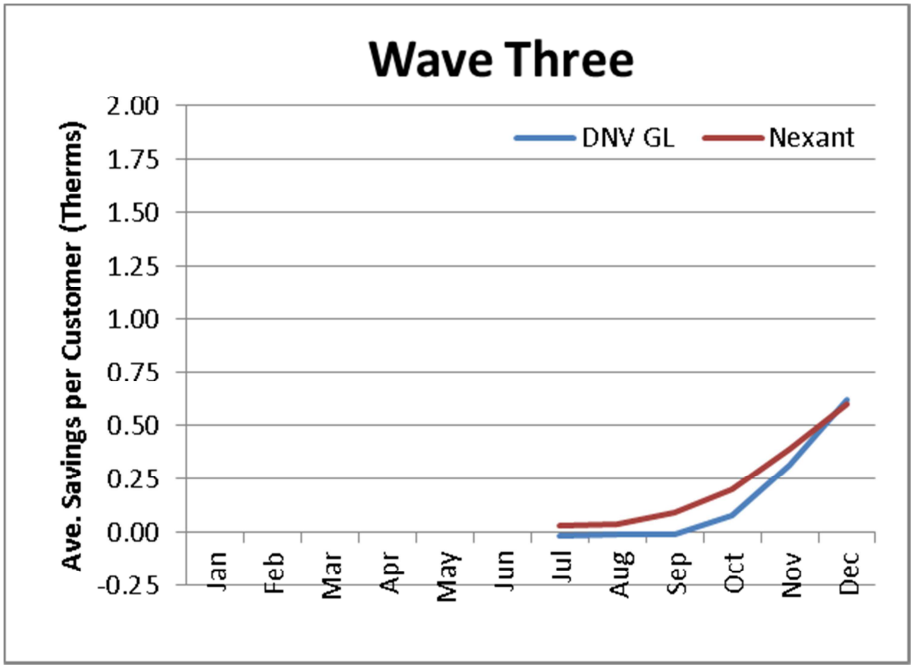


Figure 16. Average Monthly Gas Savings for Wave Three



5.3 Joint Savings Estimation - Downstream

As discussed in the 2012 report, a more precise calculation of joint savings should consider not only the timing of installation but also load profiles of the rebated measures. DNV GL's recommended approach includes:

1) Developing streams of savings for measures installed after the program for each customer in each experimental wave.

2) Daily savings are then calculated; starting from the installation date; projecting forward on a load shape-weighted basis; and continuing for the life of the measure.

3) Treatment and control savings are aggregated up to the month.

The difference between treatment and control savings represents the estimate of joint savings. This approach estimates joints savings as accurately as possible, both with respect to magnitude and timing. This means, for example, that air conditioner improvements completed late in the cooling season will provide most of their first year savings in the following cooling season.

5.4 Peak Demand Analysis

This section provides a more in depth discussion of the peak demand analysis approach. DNV GL included this section to present findings on pre-existing differences between the treatment and control groups and to compare the post-only and difference-in-differences approach for major climate zones.

Pre-existing Differences between Treatment and Control Groups

DNV GL tested for pre-existing differences between the treatment and control groups and the results are presented in Table 8. Evaluators examined for potential imbalance in peak load during the pre-period within each wave and climate zone. To maintain consistency with Nexant's peak demand analysis, potential differences at the climate zone level were also tested.

Evaluators found that for some climate zones, there are pre-existing differences in peak demand during the heat wave identified for the pre-treatment period. Based on the test, at least one of the climate zones in each wave show significant differences in average hourly demand between the treatment and control groups. This finding suggests that peak demand analysis based on post-only differences may not accurately estimate demand savings due to the HER program.

Table 8. Test of Differences in Average Hourly Use between Treatment and Control

Wave / Heat Wave	Climate zone	Avg Hourly Use from 2-5pm - Control	Avg Hourly Use from 2-5pm - Treatment	Difference	Probt
Beta	3**	1.53	1.56	0.03	0.01
	4	2.19	2.19	-0.01	0.63
	12	3.09	3.11	0.02	0.18
Gamma	3**	0.48	0.51	0.04	0.00
	4**	0.64	0.79	0.15	0.00
	11**	2.34	2.40	0.06	0.00
	12**	2.09	2.17	0.07	0.00
	13**	2.56	2.58	0.02	0.00
	16**	1.68	1.82	0.13	0.02
Wave One	3	0.73	0.73	0.00	0.11
	4	1.22	1.22	0.00	0.66
	5*	0.67	0.64	-0.03	0.09
	11**	2.60	2.54	-0.06	0.00
	12	2.22	2.22	0.00	0.61
	13	2.72	2.73	0.01	0.26
	16	1.50	1.45	-0.05	0.46
Wave Two - Area 7	1**	0.57	0.59	0.02	0.00
	2	0.79	0.79	-0.01	0.14
	3**	0.60	0.59	-0.01	0.05
	12	0.73	0.73	0.00	0.99
Wave Two - Not Area 7	3	0.64	0.64	0.00	0.78
	4*	0.99	1.00	0.01	0.09
	11	2.63	2.64	0.01	0.62
	12	2.08	2.07	-0.01	0.15
	13	2.94	2.97	0.03	0.18
Wave Three	1	0.68	0.68	0.00	0.99
	2	0.90	0.90	0.01	0.41
	3	0.56	0.56	0.00	0.58
	4	0.91	0.90	0.00	0.57
	11**	2.54	2.49	-0.05	0.01
	12	1.94	1.93	0.00	0.69
	13	2.93	2.93	0.00	0.94
	16	1.05	1.11	0.06	0.53

** indicates significant differences at 95% confidence interval

* indicates significant differences at 90% confidence interval

Demand Savings from Major Climate Zones

DNV GL compared average peak demand savings per household for the different climate zones. Nexant's average peak demand savings per household was calculated by dividing the reported aggregate peak demand reduction by Nexant's number of treated residences as reported in Table 6.

Figure 17 presents the comparison of the average hourly peak demand per household for the four major climate zones. The four major climate zones are 3, 4, 12, and 13, and comprise 87% of the HER treatment group. Based on DNV GL's and Nexant's findings, Climate zone 13 has the highest average demand savings. The two sets of demand savings are different because of the difference in methods used. DNV GL used difference-in-differences approach while Nexant used post-only differences when estimating demand savings.

Figure 17. Average Hourly Peak Demand per Household for Major Climate Zones

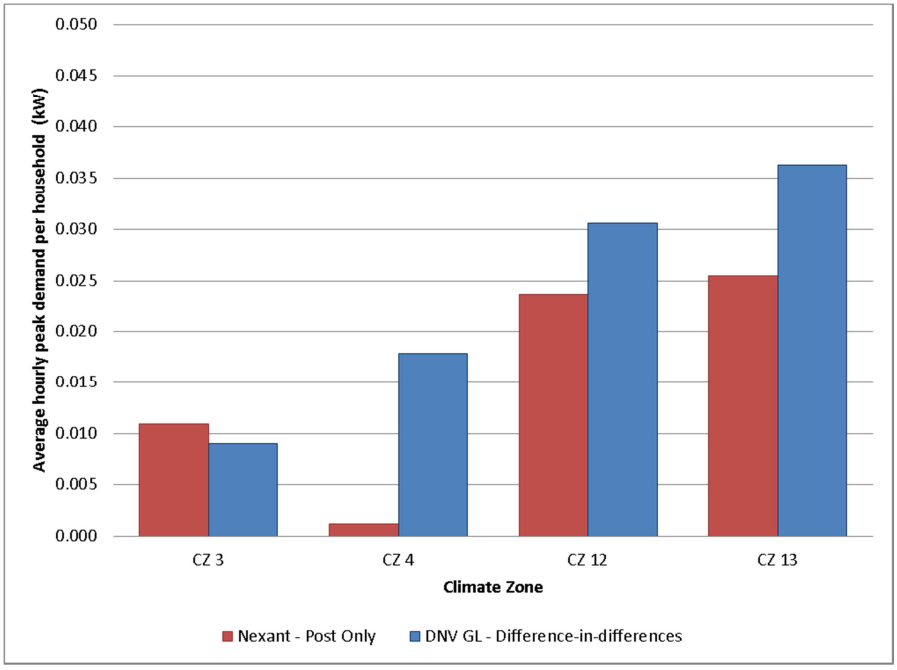


Figure 18 and Figure 19 show the comparison of the average hourly peak demand during the three-day peak periods for the four major climate zones. Results show that demand reduction tends to be higher for households in hotter climate zones (CZ 12 and 13). The average demand savings curves for CZ 12 and CZ 13 are above the overall average demand savings as shown by the black dotted curve regardless of approach used.

Figure 18. DNV GL's Demand Savings Estimates during the 3-day Peak Periods for Major Climate Zones

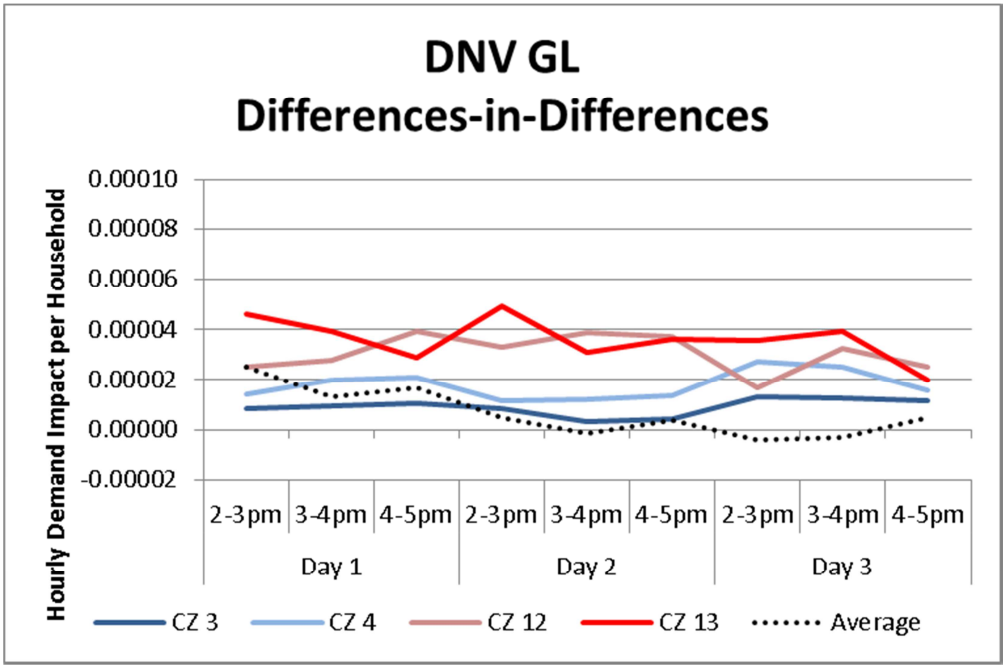
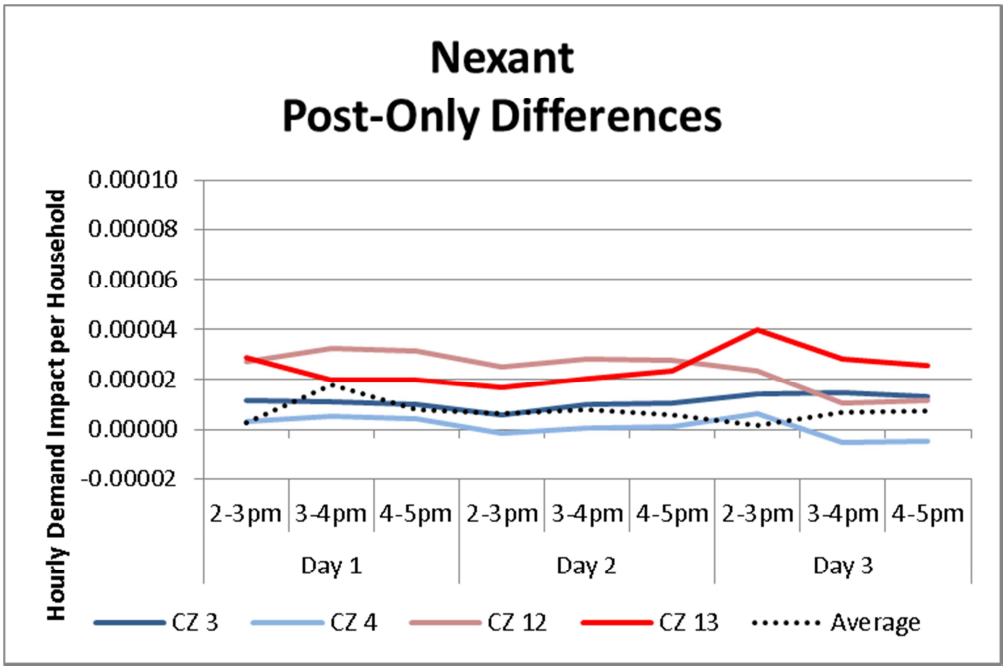


Figure 19. Nexant's Demand Savings Estimates during the 3-day Peak Periods for Major Climate Zones



5.5 Conclusion

DNV GL's demand savings from difference-in-differences are generally higher than estimates from the post-only approach. The higher demand savings estimate is attributed to the difference in demand between the treatment and control group during the pre-treatment period.

The difference-in-differences approach used in examining peak demand is simplistic as it assumes that the heat waves in the pre and post-treatment periods are similar. However, based on DNV GL's independent analysis for peak demand reduction, there is a possibility of imbalance between the treatment and control group and that the post-only difference approach will not take this difference into consideration when estimating peak demand reductions. A well-founded difference-in-differences could alter results if pre-existing differences in demand exists between the treatment and control group.