FINAL REPORT: 2015 HOME UPGRADE PROGRAM IMPACT EVALUATION

California Public Utilities Commission

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CALMAC Study ID CPU0162.01

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1 EXECUTIVE SUMMARY

1.1 Background and objectives

This report presents DNV GL's energy impact evaluation of the 2015 Home Upgrade program for the California Public Utilities Commission (CPUC). Home Upgrade is a statewide, single-family residential energy efficiency program that is part of Energy Upgrade California® and implemented by investor-owned utilities (IOUs) and regional area networks (RENs). Home Upgrade is an overarching program consisting of two programs: Home Upgrade (HUP), which uses predetermined savings estimates for each installed measure, and Advanced Home Upgrade (AHUP), which customizes savings estimates for each home. The purpose of this study is twofold; to verify the gross and net savings reported for both programs and gain insight about program activity and participants.

Six Program Administrators (PAs) offered the Home Upgrade program in 2015: San Diego Gas and Electric Company (SDGE), Southern California Edison (SCE), Pacific Gas and Electric Company (PGE), and Southern California Gas (SCG) administered both HUP and AHUP. In addition, two RENs, Bay Area Regional Network (BayREN) and SoCalREN implemented HUP on an exclusive basis within the service areas of PG&E, SCE, and SCG.

The objectives of this study are to:

1. Review the performance of these programs over time in terms of savings per project and program savings
2. Estimate the gross and net energy savings (kW, kWh, and therm) for HUP and AHUP per household and calculate a realization rate
3. Estimate the level of savings attributable to the program by estimating free-ridership
4. Explore participant perspectives relative to HUP and AHUP upgrades by researching any correlations between program activity, energy savings, project costs, demographics and homeowner preferences and choices
5. Provide recommendations, if any, to improve per-home energy savings estimates for gross savings for either path

This report presents the energy savings reported by the six PAs, the evaluated energy savings, and the level of savings that is attributable to the program. Finally, this report provides recommendations to improve the effectiveness of the program.

1.2 Historical savings

The Home Upgrade Program was evaluated twice before the current study. The first evaluation covered the 2011-2012 program year for HUP and AHUP.[1] That evaluation did not include all IOUs due to data limitations.

[1] DNV GL, Whole House Retrofit Impact Evaluation of Energy Upgrade California Programs, September 9, 2014, CALMAC ID: CPU0093.01

The second evaluation, for program year 2014, focused on HUP only.[2] Percent kWh savings from these past evaluations along with 2015 kWh savings are presented in Table 1.[3]

Table 1. kWh evaluated savings as percent of pre-upgrade usage

	HUP				AHUP			
PA	**2011**	**2012**	**2014**	**2015**	**2011**	**2012**	**2014**	**2015**
BayREN	---	---	2.3%	(3.1%)	---	---	---	---
PG&E	---	---	6.3%	1.9%	2.1%	2.7%	---	5.0%
SCE	6.8%	2.3%	1.6%	1.2%	8.2%	4.7%	---	4.3%
SCG	---	---	---	---	---	---	---	---
SDG&E	9.6%	3.5%	2.4%	(1.3%)	4.4%	(0.2%)	---	3.4%
SoCalREN	---	---	1.1%	1.9%	---	---	---	---

Source: DNVGL 660 Analysis

For billing analysis involving the entire home, one argument made is that changes of five percent or less may reflect only random fluctuations in the meter data and are not definitive changes. This may or may not be true, but it does point out one important characteristic of the home upgrade program – either electric savings are too small to measure accurately or, the program produces very small changes in household electric energy usage.

1.3 Historical realization rates

Realization rates over time are a good indicator of improvement in PA estimations of savings. The closer PA reported gross savings are to evaluated savings, the higher the realization rates will be. A low realization rate over two or more program years is a warning sign to revisit key program design factors such as;

1. the assumptions underlying the program or,
2. the engineering calculations that estimate the savings

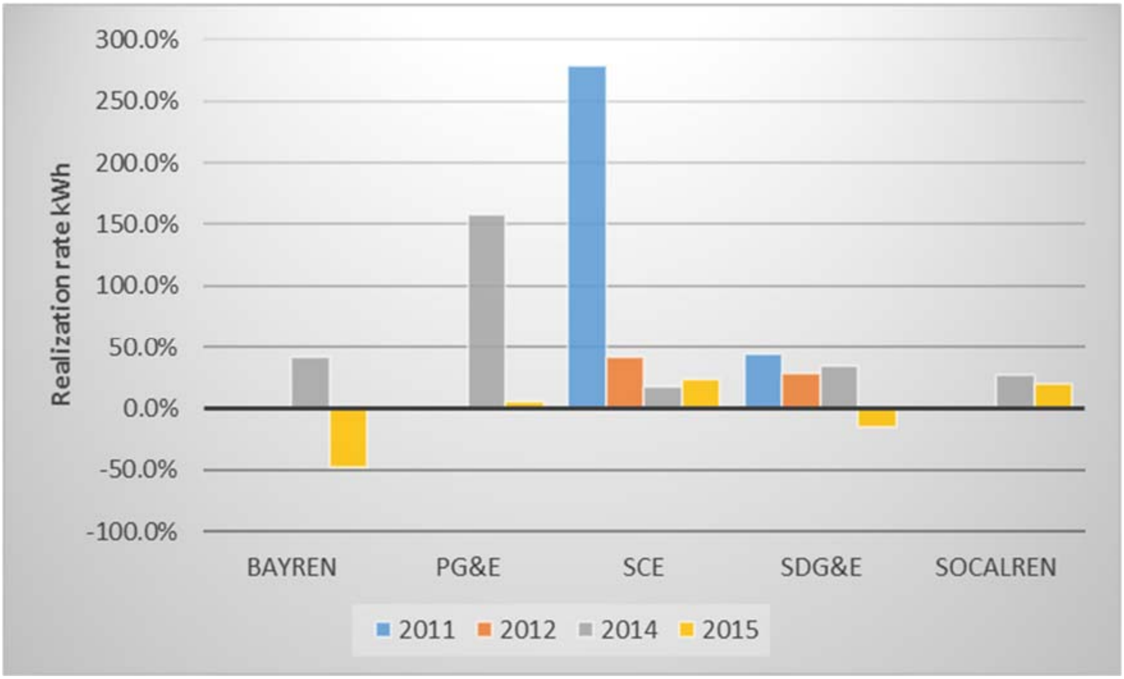
A best practice for a program is to expect realization rates to increase over time as implementers and PAs gain experience. This is not the case for the Home Upgrade Program. One factor that may have influenced the low realization rates is the several redesigns the programs have experienced over the past four years. In addition, the RENs only implemented the program since 2014.

Figure 1 provides kWh realization rates for HUP. As illustrated, realization rates can fluctuate dramatically. In 2011 SCE reported kWh savings of 267 kWh per home and their realization rate was 278%. In 2012 their reported savings was 479 kWh per home, but the realization rate for that year was only 42%. By comparison, during these same years, the average evaluated savings for SCE was 4.8% and 7.7% respectively, while in 2014, kWh savings were 1.6%. SCE savings for 2015 are reported as 1.2%. More details on realization rates are found in Section 4.2.1 of this report.

[2] DNV GL, Focused Impact Evaluation of the 2013-2014 Home Upgrade Program, May 02, 2016, CALMAC ID: CPU0118.01

[3] Percent savings is not the same as realization rate. Percent savings compares evaluated savings before and after the upgrade. Realization rate compares the post-upgrade evaluated savings to PA post-upgrade reported savings.

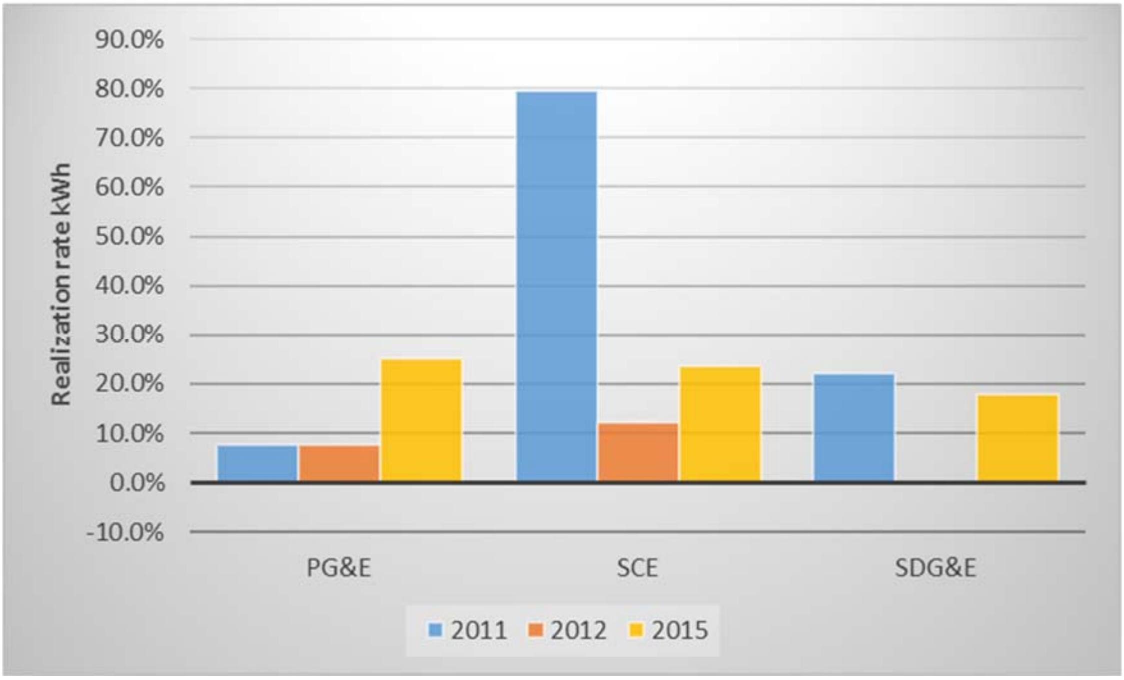
Figure 1. HUP kWh realization rates over time



Source: DNV GL 660 Analysis

As illustrated in Figure 2, all PAs except SCE in 2011 had realization rates that never reach 30%. The exception is SCE with a realization rate of 79.5% in 2011. This is the same year where SCE's realization rate for HUP is at its highest for SCE and across all PAs.

Figure 2. AHUP kWh realization rates over time



Source: DNV GL 660 Analysis

Savings from these prior evaluations are discussed in section 4.4. Overall, the home upgrade programs treat the home as a system. Savings depend on what measures are installed, how these measures interact with each other, and how the occupants interact with their home after the upgrade. Given that the evaluation focuses on pre-and post-upgrade billing analyses, these wide variations in realization rates highlight the probability that the models the PAs are using overestimate results or do not incorporate the full set of influences on household level savings. High savings reported by the PAs is consistent with findings from the 2010-2012 evaluation.[4]

1.4 Approach

DNV GL reviewed target savings, assessed reported savings, and estimated gross and net savings for HUP and AHUP separately. Target savings are the savings forecast by the PAs for the coming year. Reported savings are the total savings claimed by PAs without adjustments based on prior evaluation findings or free-ridership. Evaluated gross savings are the evaluation estimates. Evaluated net savings are the evaluated gross savings after applying net-to-gross (NTG) ratios and represent the claimable savings.

There were two main steps to estimate gross and net savings. First, we applied a billing analysis to estimate household level gross electric savings, demand reductions, and gas savings. To model electric savings, we used 60-minute interval meter data aggregated to daily usage. For gas, we used monthly data. Then we compared the evaluated savings to the savings reported by the PAs. The comparison of results are the program realization rates. Realization rates measure the difference between what PAs report as savings and the savings evaluators find.

Second, to evaluate program influence on participant decisions and calculate net savings and calculate NTG ratios, we administered an online participant survey that provided data to estimate the level of free-ridership.

1.5 Key findings

Program year 2015 is the third evaluation of the Home Upgrade Program and includes HUP and AHUP. Three impact evaluations over five years have reported similar average differences in household usage from before the upgrade to after the upgrade. In all evaluations, for all PAs evaluated, the percent of electric savings (kWh) consistently are in the single digits.

Program targets, reported savings, and evaluated savings by PA for 2015 are shown in Table 3. Each PA had one target that combined HUP and AHUP together, so the table combines results for both programs. The PAs do not provide the number of participating homes in their targets so the table does not contain results per home.

1.5.1 Budgets and spending

The PA reporting of budgets and expenditures via the “2013-2015 Monthly Energy Efficiency Program Report” combines 2013-2015 program data. These values are reproduced in Table 2. Overall, the programs are spending less than their target budget. The exception is PG&E which reported spending nearly at target

[4] DNV GL, “Residential Whole House Retrofit Impact Evaluation: Evaluation of Energy Upgrade California Programs”, September 9, 2014, CALMAC ID: CPU0093.01

(105%).[56] Collectively over this three-year period, the PAs have spent just under 82% of the statewide budget.

Table 2. Budgets and spending (2013-2015)

PA	Budget	Spending	Difference (dollars)	Difference (percent)
BayREN	$13,473,249	$12,404,541	($1,068,708)	92%
PG&E	$42,981,215	$45,298,855	$2,317,640	105%
SCE	$29,006,566	$19,282,391	($9,724,175)	66%
SoCalGas	$20,111,971	$17,691,001	($2,420,970)	88%
SDG&E	$17,207,249	$13,009,365	($4,197,884)	76%
SoCalREN	$31,732,656	$18,456,913	($13,275,743)	58%
Total	**$154,512,906**	**$126,143,066**	**(28,369,840)**	**82%**

The combined HUP and AHUP Target and Reported Gross savings for 2015 are are shown in Table 3.

Table 3. 2015 Program savings overview (HUP+AHUP)

PA	Target			Reported Gross			Evaluated Gross			Evaluated Net		
	kWh	kW	Therm	kWh	kW	Therm	kWh	kW	Therm	kWh	kW	Therm
BayREN	1,064,193	1,719	146,905	671,237	941	141,688	-320,208	54	89,758	-253,925	36	63,010
PG&E	3,159,402	2,523	429,482	3,653,868	6,011	579,253	911,276	716	61,128	618,328	485	45,558
SCE	3,694,178	2,544	-- -	1,714,697	2,039	-- -	405,232	404	-- -	381,511	357	-- -
SoCalGas	---	---	119,623	-- -	-- -	354,752	-- -	-- -	103,438	-- -	-- -	79,339
SDG&E	2,531,783	1,362	125,323	308,344	515	38,101	-39,849	-9	35,471	-32,089	-8	19,305
SoCalREN	556,816	977	108,302	288,609	469	26,326	58,674	85	25,315	54,508	81	19,037
Statewide	11,006,372	9,125	929,635	6,636,754	9,975	1,140,120	1,015,125	1,250	315,110	768,334	951	226,250

The table shows that at the statewide level for 2015, Home Upgrade produced gross and net electric and gas savings. Overall, the PA reported gross savings comparable to targets.[7] For example, collectively the PAs reported savings that were 60% of the statewide kWh target, 109% of kW targets and 123% of target therms.

The evaluated gross savings however, are much lower than target. Statewide the evaluated savings were 9% of the statewide kWh target, 14% of kW targets and 34% of target therms.

[5] California Energy Efficiency Statistics, "2013-2015 Monthly Energy Efficiency Program Report", Table 1.1: 2013-2015 SCE Monthly Summary Table, December 2015, http://eestats.cpuc.ca.gov/Views/Documents.aspx

[6] PG&E includes single family and multi-family budgets together because they consider both in the sam sub-program.

[7] In the trakcing data SoCalGas reports electric savings and SCE reports gas savings. DNV GL considered these projects in the evaluation. Savings for verified accounts are reported with the appropriate utility.

The low evaluated gross savings in 2015 are consistent with the previous evaluations discussed in Section 1.2.

Even though targets are not split by HUP and AHUP, PAs report program activity separately for HUP and AHUP. For the remainder of the report, DNV GL reports household level savings for HUP and AHUP separately. The evaluated savings per household are reported in Table 4 for HUP and Table 5 for AHUP. Positive values indicate savings. Negative values indicate that usage went up overall for program participants after the upgrade was complete.

1.5.2 HUP savings

HUP is the path with a fixed set of home upgrade options and predetermined savings per option. Table 4 summarizes average household level findings for HUP. Positive values indicate savings. Negative savings values are shown in parentheses. Negative values indicate that energy use went up overall for program participants after the upgrade was complete.

Table 4. HUP 2015 average savings per household

HUP	Item	BayREN	PG&E	SCE	SoCalGas	SDG&E	SoCalREN	Average
kWh	Reported Gross	483	1,315	566	NA	519	740	552
	Realization Rate	-48%	6%	24%	NA	-15%	20%	11%
	Net to Gross	79%	85%	94%	NA	81%	93%	67%
	Evaluated Net	(183)	63	127	NA	(62)	140	(41)
kW	Reported Gross	0.68	3.09	0.51	NA	0.88	1.20	0.76
	Realization Rate	6%	2%	14%	NA	-3%	18%	8%
	Net to Gross	68%	85%	99%	NA	90%	95%	82%
	Evaluated Net	0.04	0.06	0.07	NA	(0.02)	0.22	0.06
therm	Reported Gross	102	236	NA	25	66	68	70
	Realization Rate	63%	27%	NA	253%*	97%	96%	91%
	Net to Gross	70%	85%	NA	69%	54%	75%	68%
	Evaluated Net	45	54	NA	44	35	49	44

* SoCalGas realization rate includes therm savings originally reported by SCE. Without these savings the SoCalGas realization rate is 99%.

There are several items from Table 4 to note for HUP.

1) The large decreases in savings relative to reported savings are due to the low realizations rates and not the level of free-ridership.
2) Reported kWh savings range from a high of 1,315 kWh for PG&E to a low of 483 kWh for BayREN. This implies each PA uses very different calculations or assumptions for estimating project level savings. This is an unexpected finding since HUP uses predetermined savings for the limited set of measures it offers. In addition, BayREN operates within PG&E's service territory. While climate zone

does play a role in determining savings, PG&E's reported kWh savings per household is three times BayREN's reported kWh.

3) Realization rates for kWh and kW are very low. This is consistent however with the prior evaluation findings reported in section 1.3 of this report. The evaluation could verify only a small percentage of savings reported by the PA. PG&E had the lowest kWh realization rate at 6%. This follows from their high reported savings that were nearly double or triple savings reported by the other PAs. One recurring question related to these low realization rates is the accuracy of the models used for planning.

4) Realization rates for gas are much higher than for electric. SoCalGas, SDG&E and SoCalREN were close to reported savings with realization rates of 99% (253%), 97% and 96%, respectively. This suggests the PAs (at least in southern California) forecast HUP home level gas savings better than they do for electricity.

5) Net-to-Gross ratios are relatively high for electric and, in most cases, higher than the default value of 85%. The Net-to-Gross values for therms are lower than electric. Therm average NTG is 77% compared to 67% for electric. Overall the PAs marketing and outreach efforts are doing a good job influencing homeowners to upgrade their homes through HUP.

1.5.3 AHUP savings

AHUP is offered by the IOU PAs only. It offers a wider set of options for homeowners to choose from and savings are not based on prototype buildings as they are in HUP. In AHUP, savings are calculated for each individual home by upgrade contractors using engineering simulation software. Table 5 shows averages at the household level.

Table 5. AHUP 2015 average savings per household

HUP	Item	BayREN	PG&E	SCE	SoCalGas	SDG&E	SoCalREN	Average
kWh	Reported Gross	NA	1,490	1,497	NA	758	NA	1,487
	Realization Rate	NA	25%	24%	NA	18%	NA	25%
	Net to Gross	NA	68%	94%	NA	90%	NA	74%
	Evaluated Net	NA	255	332	NA	121	NA	274
kW	Reported Gross	NA	2.44	1.93	NA	0.84	NA	2.30
	Realization Rate	NA	12%	21%	NA	24%	NA	14%
	Net to Gross	NA	68%	87%	NA	88%	NA	74%
	Evaluated Net	NA	0.20	0.35	NA	0.18	NA	0.24
therm	Reported Gross	NA	189	NA	173	93	NA	182
	Realization Rate	NA	10%	NA	12%	21%	NA	11%
	Net to Gross	NA	74%	NA	90%	91%	NA	79%
	Evaluated Net	NA	14	NA	18	18	NA	16

Findings for AHUP are similar to HUP.

1) The large decreases in savings are due to the very low realizations rates and not the level of free-ridership.

2) Reported kWh savings relative to reported savings are relatively consistent for PG&E (1,490 average kWh) and SCE (1,497 average kWh) with the exception of SDG&E (758 kWh). SDG&E reports half the savings of the other two PAs. Perhaps each PA is using the same calculations and assumptions for estimating project level savings. Given the custom nature of AHUP, we expect to find more variation in reported savings.

3) Realization rates for kWh and kW are low. This also is consistent with the prior evaluation findings reported in section 1.3 of this report. PG&E and SCE had nearly identical realization rates. This follows from their nearly identical reported savings.

4) For AHUP, realization rates for therms are half that for electric. SDG&E had the highest realization rate at 21%. This means that the evaluated savings for SDG&E was about one-fifth the savings SDG&E reported.

5) Net-to-Gross ratios are relatively high and, with the exception of PG&E, at or higher than the default value of 85%. Overall the PAs marketing and outreach efforts are doing a good job influencing homeowners to upgrade their homes through HUP.

1.5.4 Factors Affecting Savings

Comparing Table 4 with Table 5 starts to provide insight into these two paths. First, HUP and AHUP underperform PA expectations in terms of total electric and gas savings. Second, electric savings for AHUP are nearly three times higher for most PAs than HUP savings. Third, both HUP and AHUP have positive gas savings, but gas savings for AHUP are half the gas savings of HUP.

At first glance, the take-a-way is that HUP affects gas usage more than electric. Conversely, AHUP affects electric usage more than gas. These results also highlight other characteristics of these programs.

Some PAs show negative electric (kWh or kW) savings for their programs. The fact is that all PAs will have some homes evaluated with negative savings, but this will not show up in the program totals because PAs typically have enough positive savings from most homes to offset the negative savings. There are two aspects of the program that may provide an explanation for these results: treatment measures and climate zones.

1.5.4.1 Treatment measures

HUP treatment measures include central air conditioner replacements, but predominantly rely on insulation and gas measures. These include items such as attic/wall/floor/duct insulation, windows, central gas furnace, and gas water heaters. For one PA (BayREN), electric usage increased after the upgrade. Over a quarter of homes (28%) had upgrades related to gas usage (such as furnaces) while about 16% had upgrades related to air conditioning.[8] This may help explain the savings for gas, but by itself does not explain the increase in usage for electric.

A related issue is the high-level and inconsistent reporting of measure data across the PAs that hampered a solid analysis of specific measure combinations that produce the most savings. For example, measure

8 BayREN project data supplied via data request.

descriptions such as, "*Comprehensive Whole House Retrofit*" or "*AC >= 14 SEER/12 EER, Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%, Duct Insulation*" are not complete or consistent enough to develop measure or bundle level savings. An excerpt list of the most common measures installed for HUP and AHUP is shown in APPENDIX G. The issues related to low quality tracking data were also presented in the 2014 HUP evaluation as recommendation 7.

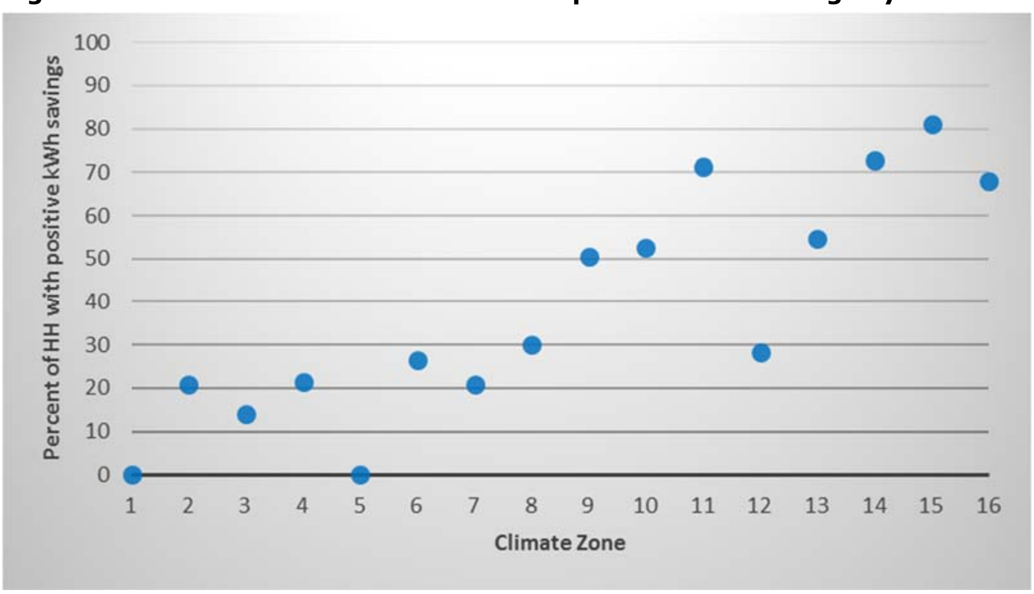
1.5.4.2 Performance by climate zone

Another possible explanation may be the climate where homes with negative savings are located. The next two figures plot the percentage of homes with positive electric savings in each climate zone for HUP and AHUP regardless of PA. Plots from gas saving are not shown since 100% of all program homes had positive gas savings in 2015.

Figure 3 shows only 14% of HUP projects in the cool coastal region of climate zone 3 result in positive savings. Not surprisingly, BayREN operates mostly in climate zone 3, in addition to a small western portion of climate zone 12.

By comparison, approximately 70% of HUP homes in climate zones 11, 14, 15, and 16 produced savings. These climate zones span the state from north (11) to south (14, 15, 16); all are located in the hotter inland parts of the state. These inland climate zones also have wider ranges of temperatures during winter months and summer months. For a map of climate zones, see the climate zone map in section 4.3.2. targeting specific climate zones for HUP was presented in the 2014 HUP evaluation under recommendations 1 and 2.

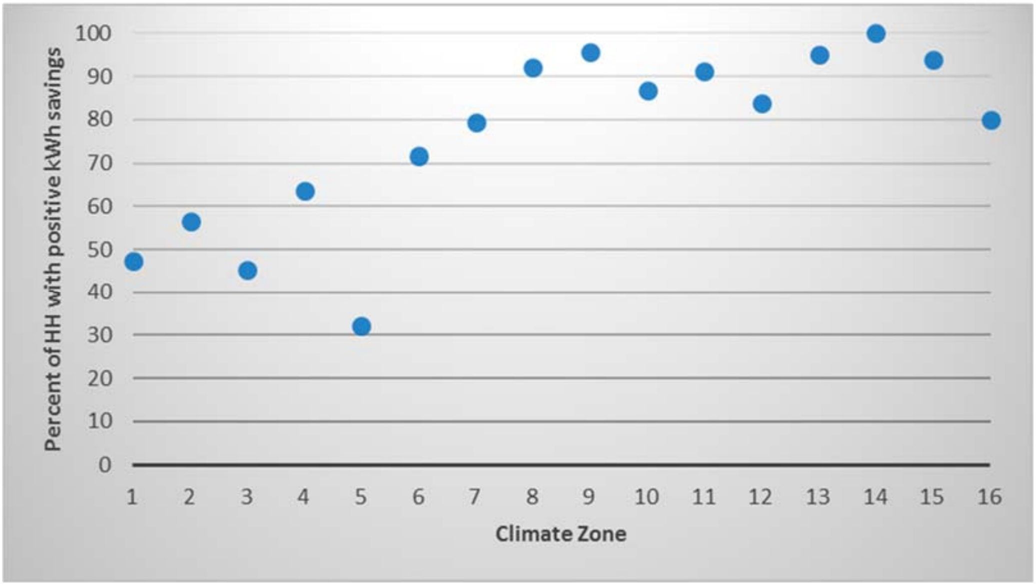
Figure 3. Percent of HUP households with positive kWh savings by climate zone



Source: DNVGL 730 Analysis

Figure 4 illustrates the percent of homes with positive savings for AHUP. Across all climate zones, the evaluation found a higher percentage of AHUP homes with positive kWh savings than in HUP. The cooler climate zones of 1 through 5 had the least homes with positive kWh savings. These homes ranged from a low of 32% in climate zone 5 to a high of 64% in climate zone 4. PG&E is the only PA offering AHUP in these climate zones.

Figure 4. Percent of AHUP households with positive kWh savings by climate zone



Source: DNVGL 730 Analysis

1.5.4.3 Survey Findings

DNV GL matched participant survey responses to savings levels and partitioned respondents into 3 segments based on the level of kWh savings: Savers, Inerts, and Gainers. Those with increases in their annual energy usage greater than 300 kWh (Gainers), those whose annual usage did not increase nor decrease by more than 300 kWh (Inerts), and those with annual savings of more than 300 kWh (Savers). If there are differences between Gainers and Savers other than evaluated savings, DNV GL could identify such differences through the survey responses. DNV GL's analysis yielded several differences.

- Savers used financing for their projects in significantly higher proportions than the Gainers (49% vs 30%).
- Gainers (92%) reported experiencing home comfort at a higher rate than Inerts (81%) and Savers (81%).
- A higher proportion of Savers (71%) live in homes built before the 1980s compared to Gainers (57%).
- Inerts and Savers (27%) acknowledged that their contractor mentioned improved safety of HVAC equipment over twice as often as the Gainers (12%).

1.6 Conclusions

DNV GL provides the following conclusions based on a review and evaluation of the available program data.

The Home Upgrade Program is considered one statewide program. The program operates in all 52 counties, spans 16 climate zones, and PA service areas overlap with each other and with the service areas of municipal providers. The contractors who implement the program also operate in multiple counties throughout the state. Taken together, this makes the home upgrade program challenging to administer and track.

The continued over estimation of gross savings by the PAs for HUP and AHUP is a key finding from this evaluation.[9] Even though DNV GL performed all evaluations to date using monthly billing data for electric and gas, hourly and monthly meter data for electric, different sets of weather data; each outcome is the same. Savings expected by the PAs for HUP and AHUP are much greater than what can be verified by the evaluations. This is true even before any NTG ratios are applied. In other words, the reduction in savings estimates from reported gross to evaluated gross is much more important than the evaluated NTG ratios.

HUP savings: For HUP, the evaluated savings were far below the PA reported savings and the overall average realization rate was -11% for kWh, 8% for kW and 91% for therms. Realization rates for kWh and kW were low across the PAs. For therm savings SDG&E (97%) and SoCalREN (96%) had the highest realization rates. The current model for HUP savings is the Energy Upgrade California (EUCA) model. This calculator is designed specifically for HUP projects and uses simulation savings estimations for prototype buildings. Savings for each individual home is imputed using these prototypes.

AHUP savings: For AHUP, the evaluated savings also were below the PA reported savings. The overall realization rate was 25% for kWh, 14% for kW, and 11% for therms. These low realization rates are unexpected since AHUP estimates savings on a house-by-house basis. This is particularly true for therm savings because the realization rate for gas is half of the HUP gas realization rate. For kWh, AHUP average home savings is just under 5%. This is much less than the 10%-30% savings marketed by the program.

For AHUP, issues with the engineering simulation models over estimating savings have been pointed out in earlier evaluations. Using these evaluation results as a guide, this overestimation continues to persist.[10]

Savings influences: The program has consistently produced savings below expectations. Potential reasons include the underlying assumptions and engineering models the PA use to estimate household savings. There also are multiple programmatic and non-programmatic influences on savings, but the pre- / post-upgrade percent savings is in line with other residential programs that are evaluated through billing analysis such as Home Energy Reports (3% electric) and smart thermostats (13% gas). Survey results indicate that while demographic factors such as contractor messaging, household income, and customer values all correlate to differences in evaluated savings, the key factor influencing savings is building vintage.

A related topic is climate zones influence. In this and prior evaluations, negative household savings are associated with climate zones 1-5. DNV GL's evaluation models did have statistically significant variables, but across all climate zones the electric model explained less than half of the overall change relative to weather.[11] In addition to the underlying increase in usage, other factors that may be contributing to these savings results are inaccurate meter data or inaccurate weather data for these regions.

Based on the results from this billing analysis and the finding from the surveys, the largest factor in achieving household savings, after dwelling vintage and climate zone, may come down to the energy savings behavior of home occupants before and after the upgrade.

Free riders: The NTG ratios for HUP and AHUP were relatively high. Both paths seem to be doing a good job influencing homeowners to participate in the program. Based on survey responses, this may be due in part

[9] PG&E and SCE subsequently found errors in their program tracking systems that counted savings multiple times. This helps explain part of the low realization rates calculated in this evaluation. Due to timing, these errors were not corrected in the CPUC tracking data and are not included in this report.

[10] The current CalTrack effort is in the process of addressing these estimation issues.

[11] Average adjusted R-squared value was 0.437 for the HUP models and 0.436 for the AHUP models.

to the aggressive marketing effort by contractors. For most PAs, the net to gross ratios DNV GL estimated from self-report surveys were close to the default value of 85% currently used by all PAs. These values were higher than the NTG values in the range of 45% estimated for the 2010-12 program. Overall, AHUP NTG for electric measures is about 10% lower than HUP. PG&E brought the average down because they had a lower NTG ratio and the highest volume of projects. NTG ratios for gas were similar for HUP (76.8%) and AHUP (79.3%). One might expect AHUP projects to have more free-riders. AHUP projects are more involved and more expensive than HUP projects on average and homeowner may already be committed to the project before talking to a program qualified contractor.

Data quality: The level and quality of project data created several issues for this evaluation. It is not a stretch to say that the low realization rates reported here can partially be traced back to extreme values and redundant reporting of savings in the program tracking data. DNV GL found single-family projects with multiple entries (i.e. one for each measure) that reported project level savings for each entry instead of the savings associated with each measure. For example, if we found 100% of the project level savings, but the savings are reported four times for the same project, the realization rate for that project declines from 100% to 25%. In other cases, extreme values (positive and negative) affected realization rates.

Only one IOU (SDG&E) was able to provide the AHUP simulation model detail data DNV GL requested for AHUP projects in a timely manner. The other AHUP PAs did not collect those files from contractors in a consistent way.

Through several evaluations cycles DNV GL found the program data reported in the CPUC tracking data is the biggest hurdle in evaluating the program. The most common issues are:

- Project miss-classification between multi-family and single family or across PA programs (i.e. Middle Income Direct Install vs Low Income vs Home Upgrade).
- Missing or bad account numbers particularly from single fuel utilities with duel fuel projects that span more than one service territory.
- Total project savings reported for each measure when a project has multiple entries in the data base
- Extreme values relative to other projects. These may be typographical errors.
- Customer email address is the contractor's (not the particpant's) or, as with SDG&E, not collected by the program.

1.7 Recommendations

DNV GL recommends that the PAs review and correct several aspects of HUP and AHUP. The details for these recommendations are listed in section 6 of this report.

HUP

Review savings expectations and tracking data for reasonableness. Specifically,:

- In the program database, filter for outliers, zero values, and negative values
- Verify the household account numbers for each fuel type and identify service provider
- Collect home vintage. Different building codes and techniques will affect savings differently and may help improve program targeting
- Report home square feet and number of floors before and after the project
- Develop a consistent definition for project duration. The ideal is date the contractor starts the installation and date they complete installation. Using current 2015 data fields, DNV GL recommends

project start date as “installation date”. For end date, we recommend “project completion date”. These should be verified. Project durations of 1 day or 365 days are most likely incorrect.

- Physically verify a sample of installations - particularly in coastal climate zones – to verify all measures are installed and performing correctly. If this is already being performed, be prepared to provide findings. Our concern is that reported upgrades may not be as complete as reported by contractors.
- Review the electric and gas assumptions and calculations in the EUCA model for reasonableness relative to customer bills. Typical savings should be about 5% to 10% of annual usage. If possible, compare savings for a sample of projects in EUCA and EnergyPro or eQuest and check for consistency of savings estimates.

AHUP

For AHUP, we recommend the same steps as those listed above for HUP to improve project documentation and tracking data for reasonableness. Other steps for AHUP specifically include:

- Collect home square feet before and after the project. Negative savings at the household level actually may be positive savings when adjusted to a per square foot basis.
- Collect and review model inputs and outputs from contractors using simulation software.
    - Check for square feet and vintage information
    - Check for number and type of measures installed

Savings influences: Upgrading the building envelope is not enough to affect usage. The program should target the inland climate zones and try to incorporate elements of behavioral to maximize potential savings. Targeting inland climate zones is consistent with the 2014 HUP evaluation recommendations. Adding a behavioral component, similar to those used in Home Energy Reports, is a new recommendation and will require additional study to effectively be incorporate into the Home Upgrade Program.

Regarding climate zones. DNV GL recommends additional research on projects in climate zones 1-5. Specifically, we recommend CalTrack[12] develop savings kWh estimates for projects in these climate zones in order to verify the savings estimates from this evaluation.

Based on the results from the customer profiles, DNV GL recommends:

- targeting customers who live in older homes
- focusing on climate zones with a wider range of heating cooling degree days and,
- underscoring immediate customer benefits in contractor messaging (comfort, savings, safety)

Regarding electric savings models, DNV GL recommends additional research, in conjunction with CalTrack, to better understand the Home Upgrade program in the climate zones with low cooling degree days (CDD). DNV GL recommends the CalTrack research include:

- Comparison of hourly, daily, and monthly electric meter data for AHUP and HUP projects,
- the CZ2010 weather data set
- other demographic variables from census or survey data and,
- various model specifications.

[12] CalTrack is an open source dashboard calculation engine that computes weather normalized meter savings. CalTrack was designed specifically to develop savings estimates for AHUP projects. www.caltrack.org

Free riders: The programs are doing a relatively good job of avoiding free riders. The recommendations to maintain low free ridership levels are similar to the recommendations under savings influences with some caveats. Targeting older homes may produce more savings, but may also increase free ridership since upgrades in older homes may be initiated by the failure of major appliance such as furnaces, water heaters or air conditioners. Also, older homes are more prone to undergo renovations in general that may include appliance upgrades where the owner is already committed to the upgrades and is using the program to reduce the project costs. As such, more upfront screening to mitigate free ridership may help.

Data quality: PAs should conduct a thorough review of the HUP and AHUP program tracking data on an on-going basis, possibly each quarter before reporting program status to CPUC. The tracking data should not require several large-scale updates after the close of the program year. This will help ensure accurate quarterly and annual reporting and avoid unnecessary delays of the impact evaluation due to shifting data.

Track and report the number and types of measures being installed in homes. This may require more detailed record keeping. For AHUP, this means collecting the contractor building simulation files and performing quality reviews before committing funds to the project.

At a minimum, reviews should include a check for:

- the correct savings fuel type. Are the savings from an IOU or a publicly owned utility?
- general data entry errors
- duplicate records and associated savings
- durations between project start and stop dates greater than six months
- extreme values in general

For AHUP projects in particular, a reasonableness review of savings should be performed by PA program staff. Check a sample of projects from each contractor to rule out systematic bias caused by misuse of the software, data entry errors, or errors transferring data from model output to program form.

2 INTRODUCTION

Home Upgrade is a statewide, single-family residential energy efficiency program implemented under the umbrella of Energy Upgrade California. This program offers two paths: Home Upgrade (HUP), which offers deemed savings measures, and Advanced Home Upgrade (AHUP), which offers custom savings measures. One major difference between the two paths is that AHUP uses engineering simulation modeling to estimate savings, while HUP uses pre-determined savings derived from a standardized calculator.[13] The purpose of the HUP program is to offer homeowners a simplified approach from the more involved and costlier AHUP projects.

This impact evaluation develops gross and net savings at the household and program level for 2015 HUP and AHUP projects.[14] Savings estimates include energy savings (kWh), demand reductions (kW), and gas savings (therms). This evaluation also studies the reasons for savings variations by correlating participant survey responses with savings estimates.

Evaluation results are shown for 2015 projects. To increase the sample size and provide points of comparison however, this evaluation included projects from 2013, 2014, and 2015. The distribution of these projects across PAs is shown in Table 6. A discussion on the sample size used to fit the model and create savings estimates for the HUP and AHUP population are in section 3.1.1 The detailed disposition leading to the final sample is located in Appendix B. A discussion on the sample size for the NTG ratio is discussed in section 3.2.1.

Table 6: Program households by PA (2013-2015)

Program Administrator	Reported Households	Used in electric billing analysis	% used for electric	Used in gas billing analysis	% used for gas
HUP					
BayREN	2,099	415	20%	542	26%
PG&E	294	100	34%	185	63%
SCE	2,031	628	31%	0	0%
SoCalGas	968	0	0%	700	72%
SDG&E	1,096	691	63%	772	70%
SoCalREN	514	394	77%	352	69%
AHUP					
PG&E	8,225	3,975	48%	5,990	73%
SCE	1,497	1,243	83%	0	0%
SoCalGas	2,906	0	0%	2391	82%
SDG&E	190	62	33%	70	37%

[13] https://www.socalenergyupgradecontractors.com/sites/default/files/public/Home_Upgrade_Incentive_Calculator.xlsm

[14] The estimates are applied to the 2015 program but are derived using a sample of projects from 2013, 2014, and 2015. Estimating savings requires at least 24 months of meter data. Combining multiple years compensates for the small sample size that results from using only one year of program activity.

Source: CPUC program claims dataset (tracking data)

2.1 Background

The Home Upgrade program promotes long-term energy savings in single-family dwellings through comprehensive energy efficiency retrofit measures. The program seeks to transform the single-family retrofit market from one of discrete appliances and shell upgrades to a comprehensive building system approach. This includes bundling building shell upgrades such as attic, wall, and floor insulation, windows, high-efficiency HVAC units, hot water heating, and other deep energy savings opportunities.

The structure and offerings of the Home Upgrade Program have evolved since the program's introduction in 2010. As noted earlier, two groups of entities implemented the Home Upgrade for program year (PY) 2015: the IOUs and the RENs.[15] This was a continuation of the rebranded program from Energy Upgrade California to Energy Upgrade California Home Upgrade Program and Advanced Home Upgrade Program launched during the 2013-14 program year.

Home Upgrade: The HUP path is similar for IOUs and RENs. In this menu-driven approach customers are required to install a minimum of three measures total and achieve a minimum point threshold of 100 points that equates to 10% energy savings. For the IOU program, at least one of the three must be a "base" measure (to support a loading order). REN programs are not required to follow this loading order. Savings are calculated using an Excel based calculator known as the "Energy Upgrade California Measure Package Energy Savings Calculator" (EUCA). It includes sets of simulations of energy saving measures and packages of measures. The HUP savings values are pre-determined from eQuest simulations using home prototypes developed by the CEC.

Both the IOU and REN program designs allocate project points with tiered incentive dollar values. To encourage customers to more fully adhere to the loading order, customers are eligible for additional bonus points for installing additional base measures; that is, when installing one or two additional base measures beyond the required one measure, customers received bonus points (and incentives) for each additional base measure installed.[16]

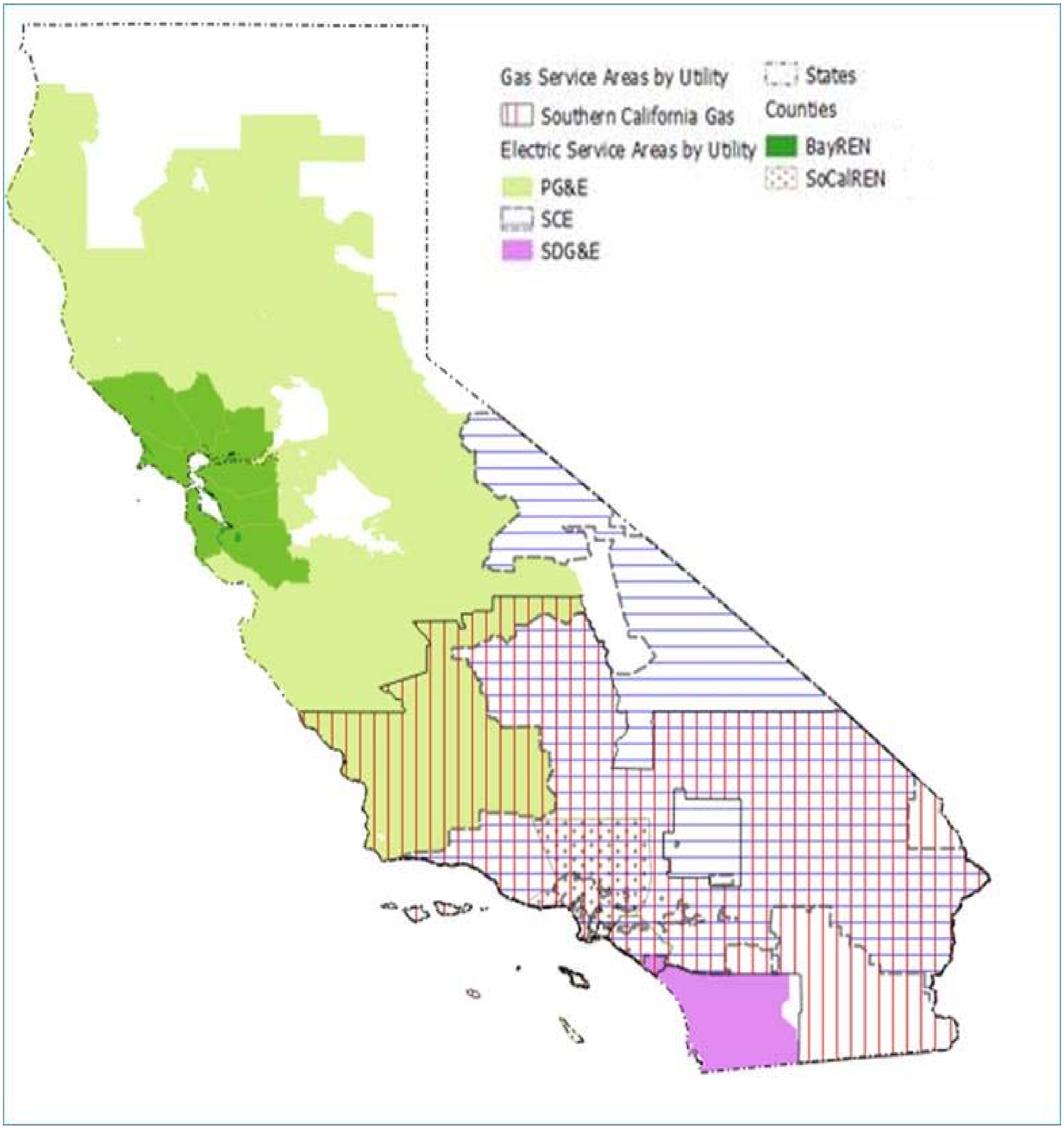
Home Upgrade is offered statewide, but each entity offers it in predetermined areas. The IOUs maintain their service territories, but the RENs operate within these. For example, BayREN is the exclusive implementer of Home Upgrade to PG&E customers in the nine Bay Area counties of San Francisco, Sonoma, Marin, Napa, Solano, Contra Costa, Alameda, Santa Clara, and San Mateo. The lead agency is the Association of Bay Area Governments (ABAG). SoCalREN operates in 12 counties in southern California and parts of central California. These counties are Los Angeles, Orange, Ventura, Santa Barbara, Riverside, San Bernardino, Kern, Tulare, Inyo, Mono, and portions of Kings and Fresno.

In northern California, there is a clear distinction between an IOU service area and REN service area. In southern California, the boundaries between PAs is less clear. In Figure 5 illustrates the IOU and REN service areas. The multiple patterns illustrate the potential confusion for customers and contractors particularly in southern California. Customers may not know who is offering the program and contractors may not differentiate on what data to collect and report for specific fuel types.

[15] Pursuant to (D.) 12.11.015, two Regional Energy Networks (RENs), collaborations of local governments, were approved. These are the San Francisco Bay Area Regional Energy Network (BayREN) and the Southern California Regional Energy Network (SoCalREN).

[16] Joint IOU/REN advice letter April 2, 2013

Figure 5. Home upgrade program service areas



Source: DNVGL

Advanced Home Upgrade: The AHUP path offered by IOUs starts with an on-site assessment from a program qualified contractor. Recommendations are developed from the audit findings. These recommendations are then modelled using EnergyPro simulation software to develop energy and bill savings from building shell and HVAC upgrades. Incentives are paid based on the project savings.

Rebates are consistent across PAs for HUP and have a maximum value of $3,000.[17] AHUP upgrade incentives have a tiered structure similar to HUP and have no cap. Rebates for AHUP can increase depending on the level of savings achieved (i.e. 10%, 20%, 30% savings or more).

Table 7. Incentive levels

Program Administrator	HUP	AHUP
BayREN	$3,000	NA
PG&E	$3,000	$5,500
SCE	$3,000	$5,500
SoCalGas	$3,000	$5,500
SDG&E	$3,000	$5,500
SoCalREN[18]	$3,000	NA

Incentives are paid through the IOUs using IOU program dollars. BayREN and SoCalREN provide up to $300 to pay for home audits and safety inspections for customers in their service counties that choose the AHUP path offered through PG&E.

Program expenditures and savings as reported in PA annual reports are shown in Table 8. For the RENs these values are for HUP only. For the IOUs, these values reflect totals for the HUP and AHUP combined. The reports provide projected energy savings in terms of targets and their reported savings based on accomplishments. For the remainder of the report we will present results for HUP and AHUP separately.

Table 8. 2015 program gross savings projections and goals

PA	Target			Reported Gross			Evaluated Gross			Evaluated Net		
	kWh	kW	Therm	kWh	kW	Therm	kWh	kW	Therm	kWh	kW	Therm
BayREN	1,064,193	1,719	146,905	671,237	941	141,688	-320,208	54	89,758	-253,925	36	63,010
PG&E	3,159,402	2,523	429,482	3,653,868	6,011	579,253	911,276	716	61,128	618,328	485	45,558
SCE	3,694,178	2,544	-- -	1,714,697	2,039	-- -	405,232	404	-- -	381,511	357	-- -
SoCalGas	---	---	119,623	-- -	-- -	354,752	-- -	-- -	103,438	-- -	-- -	30,338
SDG&E	2,531,783	1,362	125,323	308,344	515	38,101	-39,849	-9	35,471	-32,089	-8	19,305
SoCalREN	556,816	977	108,302	288,609	469	26,326	58,674	85	25,315	54,508	81	19,037
Statewide	**11,006,372**	**9,125**	**929,635**	6,636,754	9,975	1,140,120	1,015,125	1,250	315,110	768,334	951	177,248

Source: Target from California Energy Efficiency Statistics, http://eestats.cpuc.ca.gov/Views/Documents.aspx, Reported Gross from CPUC program tracking data

17 BayREN and SoCalREN offer an additional $150-$300 rebate for combustion testing after the upgrade is complete.

18 Delivered through The Energy Network

2.2 Evaluation objectives

The overarching purpose of this study was to evaluate the accuracy of the savings values used by PAs to forecast program savings and to provide actionable recommendations to improve the effectiveness of the program. DNV GL investigated four research questions:

- What are the evaluated gross kWh, kW, and therm savings compared to the PA reported gross energy savings?
- What are the realization rates for this program?[19]
- What are the net savings after accounting for free riders?
- What are the recommendations, if any, to improve energy savings estimates and realization rates for gross savings estimates of these upgrade packages?[20]

To answer these questions, we evaluated energy usage for program participants before and after the home upgrade was performed, calculated the difference, and compared these to savings reported by the PAs. To assess free ridership, we asked program participants about their project, their home and how they made their upgrade decisions and what influenced them to upgrade their home.

2.3 Report organization

The report presents the impact analysis method in section 3.1 and the survey method in Section 3.2. Findings are in section 4 and recommendations in section 5. Details of the impact analysis are in APPENDIX A, APPENDIX B and APPENDIX C. APPENDIX K lists a summary of findings and recommendations.

The next section discusses the methods used to estimate:

- energy savings estimates
- free rider values
- the exploratory analysis on customer decisions and savings relationships

[19] IOUs report savings goals in aggregate combining Home Upgrade and Advanced. As a result, evaluated savings are compared to claimed savings and not to forecast savings.

[20] The net-to-gross ratio is deemed as part of the program forecast.

3 METHODS

DNV GL employed a billing analysis to estimate the gross electric savings (kWh and kW), and gas savings (therms) of participants in HUP and AHUP programs. For each program, we used hourly electric meter data and monthly gas meter data

3.1 Billing analysis approach

Estimating savings for a whole-building retrofit program requires an approach that comprehensively captures the combined effect of all measures installed in the home. The primary approach for this type of estimation is a billing analysis that incorporates both a treatment group (participants) with a comparison group (non-participants).[21]

The program design does not include a pre-identified comparison group. For this evaluation, we used a "pooled", fixed-effects regression[22] as the primary method of analysis. Pooled refers to the fact that both participants and known future participants are used to estimate savings at any point in time. Fixed effect means the contribution of any particular variable in the model is the same for all participants. The pooled model combines all participants and time intervals into a single regression model specification. In addition to being appropriate for smaller sample sizes, this approach is recommended for programs such as Home Upgrade where there is no valid pre-determined independent control or comparison group.

The approach uses statistical models to incorporate weather data (CZ2010)[23], various temporal variables such as year, month, day, and hour, and several household-level variables as predictors to measure energy usage (kWh or therms). In order to take advantage of advanced metering infrastructure (AMI) hour-level kWh consumption data, independent models were fit to predict kWh usage for each calendar day and hour of the year. The full model combined (summed) 365 individual equations to predict electric savings for each day of the year.

At any particular point in time, there are program participants who have had an upgrade, and some who are scheduled in the future; both sets are used for estimating model parameters. Future upgrade participants serve as a comparison group for current participant at a given point in time but future participants were not "matched" with current homes.[24]

One of the main advantages of using future participants as a control group when estimating model parameters is that the future participants are likely to be similar to a current group of participants. The fixed-effects aspect of the model controls for effects that are constant across time within a household and any influences from outside the program that are constant across all households during a specific time period. For example, future participants likely reside in a home that needs various program measures to increase its energy efficiency and, similar to current participants, are residents who are willing to take actions to increase the efficiency of their homes.

Details of the billing analysis used for this analysis are reported in APPENDIX D.

[21] This method is consistent with the recommended International Performance Measurement and Verification Protocol (IPMVP) option Method C, Whole Facility, and the CPUC evaluation protocols [Jayaweera, T. and Haeri, H. (2013)].

[22] For a discussion of approaches, see Chapter 8: Whole-Building Retrofit with Consumption Data Analysis Evaluation Protocol, The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures NREL/SR-7A30-53827 April 2013

[23] CZ2010 is a weather series developed especially for billing analysis of California single-family home upgrades http://www.energy.ca.gov/title24/2013standards/prerulemaking/documents/2010-11-16_workshop/presentations/06-Huang-Weather_Data.pdf

[24] All participants are from 2013-2014. Past and future participants are relative to each other in the program cycle.

3.1.1 Project counts and blackout periods

Table 9 summarizes the total number of program participants reported by the PAs, the total number of participants identified in the initial tracking data, and the number of participants used in the billing analysis.

Table 9. Household counts (2013-2015)

Program Administrator	Program Path	Projects from Tracking Data	Used in Electric Billing Analysis	Used in Gas Billing Analysis
BayREN	HUP	2,099	415	542
PG&E	HUP	294	100	185
SCE	HUP	2,031	628	0
SoCalGas	HUP	968	0	700
SDG&E	HUP	1,096	691	772
SoCalREN	HUP	514	394	352
Statewide	**HUP**	**7,002**	**2,229**	**2,551**
BayREN	AHUP	NA	NA	NA
PG&E	AHUP	8,225	3,975	5,990
SCE	AHUP	1,497	1,243	0
SoCalGas	AHUP	2,906	0	2,391
SDG&E	AHUP	190	62	70
SoCalREN	AHUP	NA	NA	NA
Statewide	**AHUP**	**12,818**	**5,281**	**8,451**

For an evaluation using meter data, the goal is to include a census of program participants. In the end, the sample is determined by the number of accounts in the tracking database that can be associated with meter data; have at least 12 months of data for the appropriate fuel type before the blackout period; and have 12 months of data after the blackout period. For example, given the fixed months of available meter data, longer blackout durations reduced the number of months available for those participants, causing them to drop out of the analysis. APPENDIX B presents more detail on the derivation of the sample along with blackout dates and their treatment; it also provides a disposition of the sample count per PA and the criteria for removal.

The population also included many duel fuel homes (electric and gas) where only a single fuel was supplied by an IOU, especially around Sacramento (Climate Zone 12) and Los Angeles (Climate Zone 9 and 10). As a result, project-billing data was available for one fuel only.

The blackout period represents the days when the upgrade is being performed. This period is the demarcation of periods before and after the upgrade. These days are accounted for in the estimation models so that energy used during this period does not influence the estimation of savings. Once the model has been established however, savings is estimated for the full year. See APPENDIX A for a full distribution of projects by blackout duration.

3.1.2 Weather data

For this analysis, we applied the same data series recommended by the CalTrack initiative (CZ2010 weather files). These weather files are California specific and were developed for the CEC. They combine weather station data on the ground with satellite-derived solar radiation readings. For comparison purposes, we also produced estimates using the traditional TMY weather data series.

3.1.3 Participation in other programs

DNV GL reviewed the program tracking data to understand the degree that participants in the Home Upgrade path participated in other IOU residential programs. The evaluation team did not adjust savings reported for home upgrade by other program savings for two reasons; 1) It is not clear how to attribute savings across programs because we don't know when participation occurred relative to the upgrade, and 2) DNV GL's low confidence in the quality of the tracking data for residential program in general and the home upgrade program in particular.

3.2 Survey approach

The primary objective of the impact evaluation survey is to develop attribution factors for estimating free-riders. The survey data also provide information to identify and understand any trends observed in the results from factors outside the program. This includes participant demographics, house characteristics, as well as personal attitudes and knowledge about energy and climate in general.

DNV GL administered an on-line survey from November 2016 through February 2017 with participants in the 2013-15 cycle of HUP and AHUP. The survey included a series of warm-up or setup questions that served to remind the respondents of the details of their participation in the program and that helped validate the internal consistency of responses.

This self-reported approach involved asking participants a series of questions that were aimed at establishing if the measure(s) would have been installed in the absence of the program, and if so, the extent to which their choices might have differed.

Complete (full) free riders were those participants who would have installed exactly the same measure with quantity, efficiency, and time (QET) being unchanged, even in the absence of the program. The questions captured both complete and partial free-ridership. Partial free-riders are participants who would have undertaken/installed the measure(s), but of lesser quantity, and/or lesser efficiency, or at a different time.

Respondents selected one of two options when they began the survey. They either:

1. Considered the project as one decision or,
2. Considered each measure installed as a separate buying decision.

If they selected “one purchase decision”, they received one set of QET questions that applied to the entire project. When they selected “separate buying decision,” they were give the QET battery for each measure they reported installing.

Apart from the core free-ridership question modules, the survey also includes questions on the following:

- Information received by the respondent from their project contractor
- Project financing
- Prior implementation of energy efficiency measures (as excerpted from the standard segmentation questions provided by the IOUs)
- Attitude towards the environment, price sensitivity (as excerpted from the standard segmentation questions provided by the IOUs)
- Changes to operating conditions in the household – lighting use, heating use, appliance use, occupancy etc.
- Standard respondent demographics and household characteristics

The survey development process followed by the evaluation team solicited IOU input, incorporated changes to the survey based on feedback, and finalized the survey subsequent to multiple rounds of this process. Considerations were made for respondent fatigue, complexity of instrument, timing and budget constraints.

3.2.1 Sample design and disposition

The Home Upgrade Program Impact Evaluation web survey was fielded using DNV GL's WorldApp platform from November 2016 to February 2017. All Home Upgrade Program participants for whom email addresses were available were part of the sample frame. The survey was emailed to this entire frame. Two reminders were sent over the field period. The last reminder included an incentive to complete the survey with a 1:100 chance to win a $100 gift card[25]. The final response rate was 6.1%. Details are as shown in Table 10.

Table 10. Home Upgrade survey sample disposition

Description		Number	Percent
Original sample frame	all Program participants	10,148	100%
Click-through	those who responded to the survey (partial and complete responses)	944	9.3%
Completes	eligible respondents who completed the entire survey	622	6.1%

3.2.2 Free-ridership

Respondents who indicated that they considered all the measures installed as a package and made a single purchase decision answered questions related to free-ridership as shown in Table 11. The free-ridership score for each respondent is based on the project quantity, efficiency level, and timing (QET). Respondents that indicated they made decisions on a measure-by-measure basis received an expanded version of the survey. The structure of that survey was similar to the example in Table 11, but included similar questions for the purchase decision made for each installed measure.

Table 11 displays the questions used to address overall free-ridership, response options and associated scoring. A score of 1 indicates a total/pure free-rider (zero influence is attributed to the program). With this score the program receives zero credit and energy savings is zero. A score between 0 and 1 indicates partial

[25] Respondents who completed the survey prior to the introduction of the incentive also were entered into the drawing. 6 winners were identified through a random drawing from all eligible completes.

free-ridership, and a score of zero indicates zero free ridership (i.e. 100% of savings are attributed to the program).

The shaded rows in the below are used as an example of a response sequence which would result in the respondent being assigned an overall free-ridership score of 0.0 (1.0 * 0.75 *0 0). As a result, the program receives 100% credit for the savings. See highlighted rows in Table 11 to trace questions in the example calculation.

The scores for each QET question are multiplied together to receive an overall score. The individual scores are multiplied because a zero in any one of the questions implies the project would not have been implemented as it was without intervention by the program.

Table 11. Free-ridership scoring for short-form survey respondents

OVERALL PROJECT		
OF1. Without the program, how likely would you have been to undertake this project?		
Response	**Free-ridership score**	**Attribution**
Very likely	*1*	*Complete free-rider, Zero credit to program*
Somewhat likely	*0.75*	*Partial free-rider, Partial credit to program*
Somewhat unlikely	*0.25*	*Partial free-rider, Partial credit to program*
Very unlikely	*0*	*Full credit to program*
Don't Know	*0*	*Full credit to program*
OVERALL PROJECT - TIMING		
OF2. Without the program, when would you have undertaken this project…?		
Response	**Free-ridership score**	**Attribution**
at the same time or sooner	*1*	*Complete free-rider, Zero credit to program*
1 to 24 months later (record response) –e.g. 6	*1 – (number of months/24) =1-(6/24) =0.75*	*Partial free-rider, Partial credit to program*
Never	*0*	*Full credit to program*

OVERALL PROJECT - EFFICIENCY		
OF3. Without the program, would you have installed insulation and equipment …?		
Response	**Free-ridership score**	**Attribution**
That was the same or higher efficiency as what you installed	*1*	*Complete free-rider, Zero credit to program*
Above minimum standards/ building code but lower efficiency than what you installed	*0.5*	*Partial free-rider, Partial credit to program*
Minimum standards/building code	*0*	*Full credit to program*
Don't know	*0*	*Full credit to program*

The level of savings attributed to program activity is expressed as an attribution rate and contributes to the net-to-gross (NTG) ratio. Once free ridership is estimated, attribution is determent by the reciprocal of the free ridership. Specifically, program attribution is defined as 1-FR. The attribution value is applied to realized (evaluated) savings to determine net savings attributed to the program.

3.2.3 Exploratory analysis

The California Energy Commission (CEC) provides climate zone classifications that cover all the service territories served by the IOUs. DNV GL consolidated these classifications into three climate zone groups for desert, inland, and mild climate conditions. In Table 12 climate zones are mapped to their group.

Table 12: Climate zone groups for stratified matching

Climate Zone Group	Title 24 Climate Zone
Desert	15
Inland	8, 9, 10, 11, 12, 13, 14
Mild/Coastal	1, 2, 3, 4, 5, 6, 7, 16

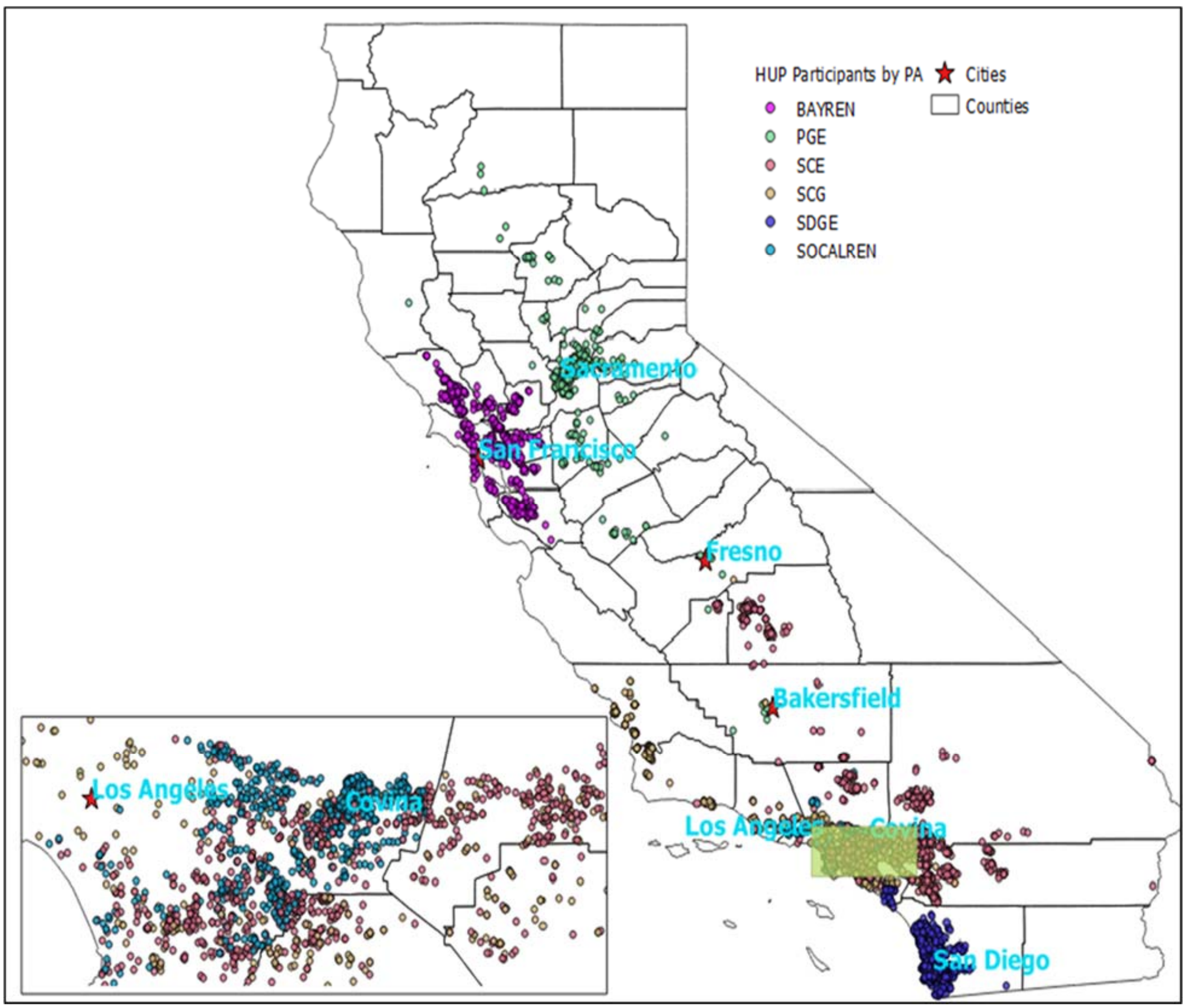
4 FINDINGS

This section presents the savings from the billing analysis and the attribution estimates from the survey analysis.

4.1 Geographic Distribution

The maps in this section show projects that are electric only, gas only or gas and electric combined. Figure 6 illustrates the regions where the HUP projects took place. In 2015, BayREN reported completing 1,415 projects. This is the majority of all HUP projects statewide. These projects were located in the nine Bay Area counties around San Francisco. PG&E projects were concentrated in the Sacramento Valley. As expected SCE and SoCalGas cluster around Los Angeles County. The cut out of the Los Angeles region in Figure 6 illustrates the overlap of households between SCE, SoCalGas, and SoCalREN. SDG&E projects are shown in the southwestern corner of the state (San Diego County).

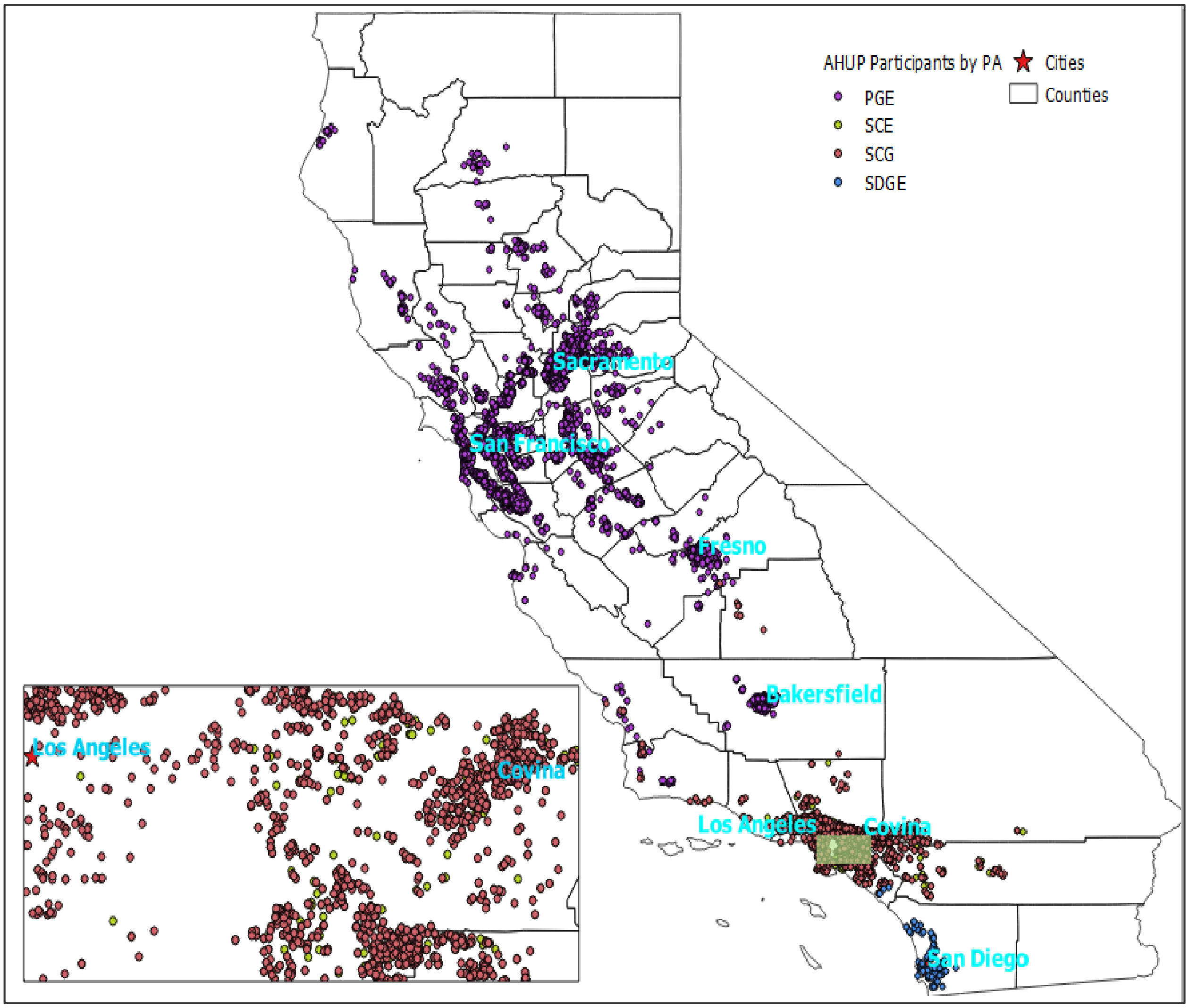
Figure 6. Geographic location of HUP participants



Source: DNVGL

AHUP projects are plotted in Figure 7. PG&E has the largest service territory geographically and the locations of AHUP projects in northern and central California highlight this fact. The majority of AHUP project in the Los Angeles region are SoCalGas projects. Again, these projects overlap with SCE projects.

Figure 7. Geographic location of AHUP participants



Source: DNVGL

4.2 Billing data findings

As noted earlier in this report the analysis leveraged hourly interval AMI meter data for the electric analysis and monthly meter data for gas. The approach is discussed in section 3.1 and in APPENDIX D. The disposition of records from tracking data to model dataset is provided in APPENDIX B.

4.2.1 Evaluated savings comparison

To provide an estimate of the percent change in energy usage following the upgrade, DNV GL compared the meter data of the household usage before the upgrade occurred to the evaluated savings. The results are provided in Table 12.

Table 12. Average savings per household (before upgrade vs after)

	HUP			AHUP		
PA	**kWh**	**kW**	**Therm**	**kWh**	**kW**	**Therm**
BayREN	-3.1%	1.5%	3.3%	NA	NA	NA
PG&E	1.9%	5.9%	20.8%	5.0%	13.3%	5.1%
SCE	1.2%	6.5%	NA	4.3%	16.5%	NA
SoCalGas	NA	NA	19.9%	NA	NA	9.8%
SDG&E	-1.3%	-1.6%	23.1%	3.4%	16.4%	7.7%
SoCalREN	1.9%	8.9%	19.6%	NA	NA	NA
Statewide	-0.7%	3.0%	21.1%	4.8%	14.2%	6.3%

Source: DNVGL 600 analysis
Note: Electric savings reported by SoCalGas and gas savings reported by SCE are not reported.

Savings as a percent of pre-upgrade usage for HUP kWh range from just nearly 2% for SoCalREN to nearly -3% (BayREN). Demand savings range from just under 9% for SoCalREN to negative -1.6% at SDG&E. Therm savings range from a high of 23% for SDG&E to a low of 3% for BayREN. These percentages represent savings based on meter data after being adjusted for weather. These values are not related to the realization rates presented in other sections of this report.

By kWh, kW or therm savings type, AHUP percent savings are relatively consistent across PAs. AHUP kWh ranges from a high of 5% for PG&E to just above 3% for SDG&E. Percent savings for kW averages about 14%. The overall average therm savings of 6.3% is low given that AHUP is a custom program focused on whole building performance. However, the low savings may be due to an emphasis on savings for cooling in the hotter climate zones.

4.2.2 Savings estimates, energy (kWh)

This section discusses the program level savings for HUP and AHUP. These tables show the evaluated savings, but not all of these savings necessarily are the direct result of program activities. Factors contributing to net savings are discussed in Section 4.3.

4.2.2.1 HUP kWh savings

Table 13 summarizes the evaluated gross kWh savings for the 2015 HUP program year. Overall, across PAs the evaluated result for HUP is an increase in usage of 193,087 kWh. The program statewide average realization rate was negative -11%.

At the PA level, BayREN and SDG&E both had negative savings. This reflects the fact that average household savings for both PAs was negative. Not all homes produced negative savings for these PAs, just as not all homes produced positive savings for the remaining PAs. For BayREN and SDG&E the homes with negative savings offset the homes with positive savings to a greater degree than the other PAs. For example, for 2015 projects, BayREN had 257 homes that saved kWh and 1,132 with an increase in usage. These ranged from a high of 840 kWh savings to a low of -1,424 kWh savings. These negative savings are statistically valid, but not the key finding by themselves. The key finding for HUP is that across PAs the evaluated savings from before the upgrade to after the upgrade are below 2.0%. Savings estimates from billing analysis below 5% sometimes are discounted as “noise” and not reflective of true savings. We do not consider this an issue for HUP due to the low standard errors associated with the model.

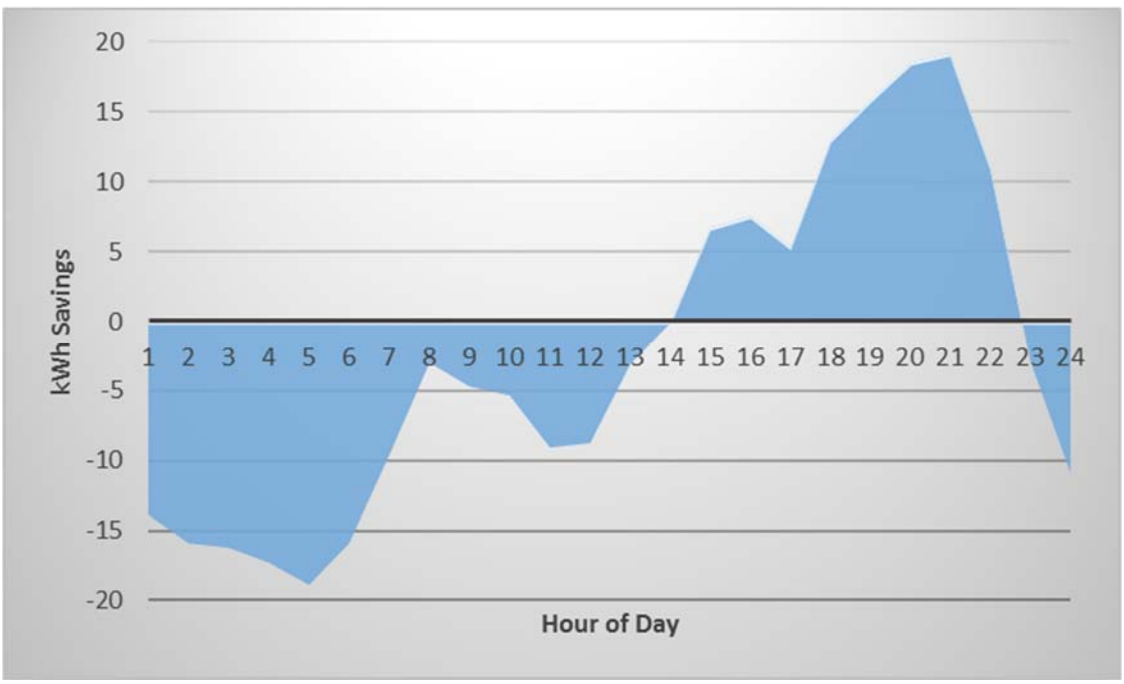
Table 13. HUP kWh program savings 2015

Program Administrator	Sample Households	Reported kWh Savings	Evaluated kWh Savings	Realization Rate	kWh Savings (%)	Savings per Home
BayREN	1,389	671,237	(320,208)	-48%	-3.1%	(231)
PG&E	38	49,966	2,805	6%	1.9%	74
SCE	801	452,970	108,443	24%	1.2%	135
SoCalGas	---	---	---	---	0.0%	---
SDG&E	562	291,670	(42,802)	-15%	-1.3%	(76)
SoCalREN	390	288,609	58,674	20%	1.9%	150
Statewide	3,180	1,754,451	(193,087)	-11%	-0.7%	-61

Source: DNVGL 600 analysis-kWh
Note: Electric savings reported by SoCalGas and gas savings reported by SCE are not reported.

The kWh billing analysis model uses hourly-level AMI metered data. One of the advantages of modeling data at the hourly-level is that we can generate reasonable time-specific predictions from the model. Figure 8 displays the estimated kWh savings per household by hour for an average day from HUP path projects.

Figure 8. HUP hourly kWh savings estimates per household



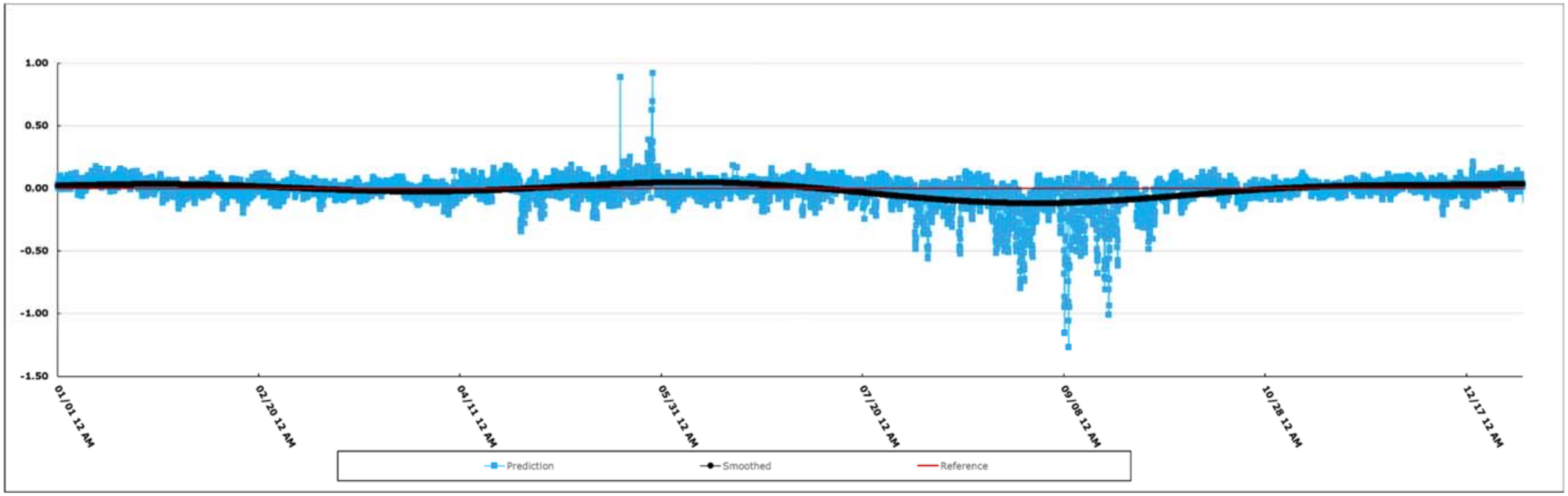
Source: DNVGL 600 analysis-kWh

The figure shows kWh savings in the afternoon and through most of the evening, but no savings from approximately 11:00 p.m. though nearly 2:00 pm. The billing analysis detects usage patterns, but does not include the informatin necessary to explain why. Possible reasons are new thermostats settings, and/or electric heating systems working correctly.

Figure 9 displays the evaluated HUP energy savings across an entire year by day and hour.[26] Each point represents one day. This figure illustrates the variability in the estimated savings during each day with the greatest increases in usage occurring in June through September.

[26] This is often referred to as an 8,760 graph (365 days x 24 hours = 8,760 hours).

Figure 9. Percent savings change after the HUP upgrade, by hour for 8760 hours



Source: DNVGL 600 analysis-kWh 8760

The black line in Figure 9 represents a “smoothed” representation of the daily and hourly savings to highlight the seasonal pattern of savings. According to the graph, the savings for HUP homes fluctuates around zero percent for most of the year. May through September is the exception showing a predominant increase in usage (negative savings). This pattern is similar for all PAs and may be due partially to the phenomenon known as “snapback”. One possible explanation is that once people upgrade their homes, they want to enjoy the added comfort and expect the upgrade investment to offset their utility bill. Findings from the survey of particpants are addressed in section 4.5 later in this report.

4.2.2.2 AHUP kWh savings

Table 14 summarizes the kWh savings from the 3,281 AHUP participants included from 2015. Across the PAs, evaluated savings from AHUP was 1,208,212 kWh. This represents a 4.8% savings in the average energy used from before the upgrade occurred.

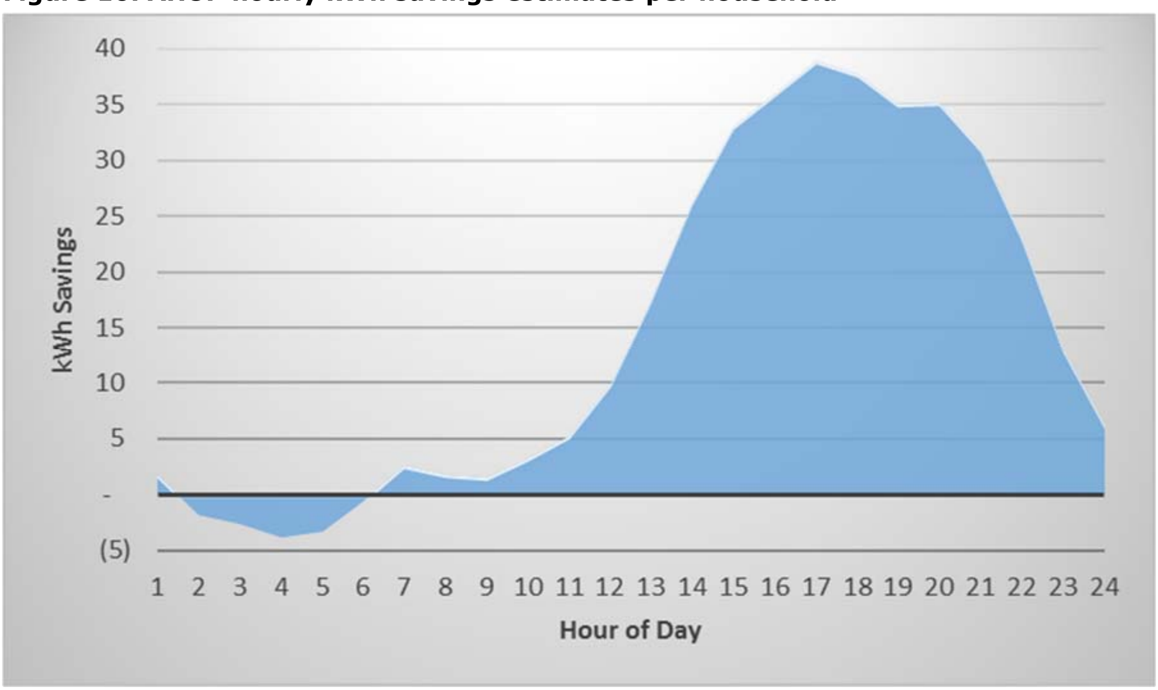
Table 14. AHUP kWh program savings 2015

Program Administrator	Sample Households	Reported kWh Savings	Evaluated kWh Savings	Realization Rate	kWh Savings (%)	Savings per Home
BayREN	NA	NA	NA	NA	NA	NA
PG&E	2,419	3,603,902	908,471	25.2%	5.0%	376
SCE	843	1,261,727	296,788	23.5%	4.3%	352
SoCalGas	---	---	---	---	---	---
SDG&E	22	16,674	2,953	17.7%	3.4%	134
SoCalREN	NA	NA	NA	NA	NA	NA
Statewide	3,284	4,882,203	1,208,212	24.7%	4.8%	368

Source: DNVGL 600 analysis-kWh
Note: Electric savings reported by SoCalGas and gas savings reported by SCE are not reported.

The pattern of average AHUP savings across a typical 24-hour period is illustrated in Figure 10. From noon to about 10:00 p.m., kWh savings are at their highest. During the remaining hours, there are little savings. In the earliest hours (1:00 a.m. to 6:00 a.m.) energy usage increases slightly. This pattern of savings is consistent between weekend days and weekday days. The billing analysis cannot give reasons for this pattern, but possibilities include new thermostat settings and heating systems working correctly.

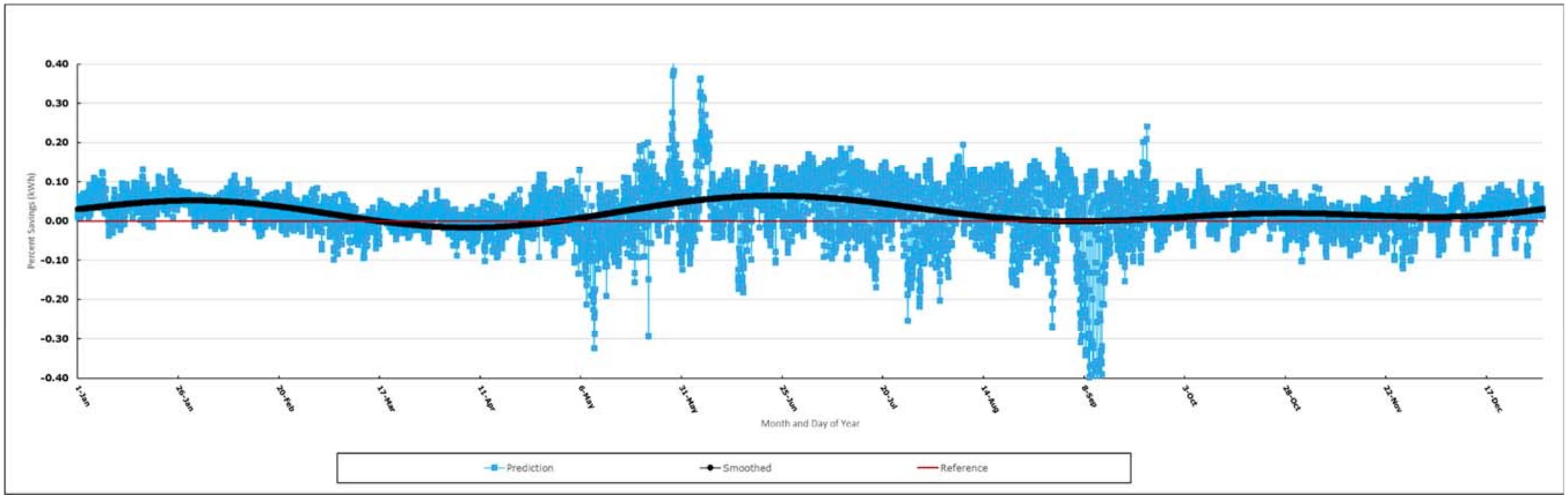
Figure 10. AHUP hourly kWh savings estimates per household



Source: DNVGL 600 analysis-kWh

Figure 11 displays the estimated energy savings from the upgrade by day and hour.[27] This figure shows the variability in the estimated savings during each day.

Figure 11. Percent energy usage change after the AHUP upgrade by day and hour



Source: DNVGL 600 analysis-kWh 8760

The black line in Figure 11 represents a "smoothed" representation of the daily and hourly savings to highlight the seasonal pattern of savings. According to the graph, the periods January through February and from May through July shows positive savings. The month of September shows % changes in usage that are both positive and negative. The extreme negative savings in September are not surprising given the September 1 statewide peak day in 2015, along with the large portion of projects located in climate zone 12 and the temperatures in the 90s and above 100 degrees Fahrenheit on several days that month. We would expect to see greater use of cooling equipment such as air conditioners and fans.

[27] This is often referred to as an 8,760 graph (365 days x 24 hours = 8,760 hours).

4.2.3 Savings estimates, demand (kW)

To calculate the kW savings attributed to the Home Upgrade Program, DNV GL used the kWh billing model results along with the definition of kW savings suggested by the PG&E Avoided Cost Calculator.[28] In that model Peak kW savings are defined as:

> "…the average grid impact for the measure from 2 pm to 5 pm during the three-consecutive weekday period containing the weekday with the hottest temperature of the year. This definition is consistent with the definition used in the 2005 Database for Energy Efficiency Resources (DEER)."[29] Details for this analysis are provided in Section APPENDIX D.

The hottest day of the year for both HUP and AHUP was September 1, 2015 . All kW estimates are based on the average Tuesday-Thursday temperatures for August 31 through September 2, 2015, between 2:00 p.m. and 5:00 p.m.

4.2.3.1 HUP kW Estimates

The HUP path produced an estimated overall demand savings of 187 kW or a 3.0% savings. This represents an average decrease in household demand of 0.06 kW. The realization rate for HUP was 7.7%. At the household level, SoCalREN experienced the largest kW savings. This PA had savings of 0.22 kW. BayREN and PG&E experienced similar results with savings of 0.4 kW and 0.6 kW respectively.

Table 15. HUP kW program savings 2015

Program Administrator	Sample Households	Reported kW Savings	Evaluated kW Savings	Realization Rate	kW Savings (%)	Savings per Home
BayREN	1,389	941	54	5.7%	1.5%	0.04
PG&E	38	118	2	1.9%	5.9%	0.06
SCE	801	411	59	14.3%	6.5%	0.07
SoCalGas	---	---	---	0.0%	---	---
SDG&E	562	496	(13)	-2.7%	-1.6%	-0.02
SoCalREN	390	469	85	18.2%	8.9%	0.22
Statewide	3,180	2,435	187	7.7%	3.0%	0.06

Source: DNVGL 600 analysis-kW
Note: Electric savings reported by SoCalGas and gas savings reported by SCE are not reported.

The negative kW savings for SDG&E is in line with the negative kWh savings. The kW savings for BayREN homes however, is counter to the increase in kWh use reported in section 4.2.2.1. If the increase is due to central air conditioners, it implies that after the upgrade, air conditioners in climate zone 3 (the Bay Area) are running longer hours or over more days, but fewer ran during the hottest hour of the hottest day.

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[28] "INSTRUCTIONS for PG&E Avoided Cost Calculator (E-3 Calculator, Version 2d3)" (PGE, 2015). http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/resources/otherprograms/3penergyefficiencyrfp/instructions_for_pge_avoided_cost_calculator_06-0627.pdf

[29] http://www.deeresources.com/

4.2.3.2 AHUP kW Savings

Overall the AHUP path saved 1,063 kW. This represents a 14.2% savings statewide. The overall realization rate for kW however, was only 14.1%. Table 16 shows the kW savings for each PA. As with HUP, the largest savings per household are in southern California. DNV GL estimated 0.41 kW savings for SCE. Average kW savings for PG&E was 0.29 kW. Given the large percentage of PG&E AHUP projects in the hotter regions of the Central Valley we would expect to see kW savings similar to values produce to inland Southern California.

Table 16. AHUP kW program savings 2015

Program Administrator	Sample Households	Reported kW Savings	Evaluated kW Savings	Realization Rate	kW Savings (%)	Savings per Home
BayREN	NA	NA	NA	NA	NA	NA
PG&E	2,419	5,893	714	12.1%	13.3%	0.29
SCE	843	1,628	345	21.2%	16.5%	0.41
SoCalGas	---	---	---	---	---	---
SDG&E	22	19	5	24.4%	16.4%	0.21
SoCalREN	NA	NA	NA	NA	NA	NA
Statewide	3,284	7,540	1,063	14.1%	14.2%	0.32

Source: DNVGL 600 analysis-kW
Note: Electric savings reported by SoCalGas and gas savings reported by SCE are not reported.

4.2.4 Savings estimates, gas (therms)

To develop gas estimates DNV GL used monthly meter data. Interval meters are not used on gas to a degree that an hourly analysis was feasible. The evaluated savings and realization rates for HUP and AHUP gas are presented in the next two sub sections.

4.2.4.1 HUP gas savings

The HUP path produced positive gas savings across all PAs. Realization rates were higher for gas than electric as were actual percent savings. Table 17 summarizes the therm savings for participating homes. Program savings were 284,620 therms or approximately 64 therms per home. The overall realization rate was 91.3%. SoCalGas contributed one-third of the total homes and had a realization rate of 253.7%. The SoCalGas realization rate is high due to the evaluated savings including gas savings that were not reported by SoCalGas but found in home upgrades completed by SCE.

Table 17. HUP therm program savings 2015

Program Administrator	Population Households	Reported therm Savings	Evaluated therm Savings	Realization Rate	therm Savings (%)	Savings per Home
BayREN	1,388	141,688	89,758	63.3%	3.3%	65
PG&E	38	8,962	2,404	26.8%	20.8%	63
SCE	NA	NA	NA	NA	NA	NA
SoCalGas	1,030	25,901	65,720	253.7%	19.9%	64
SDG&E	545	36,148	35,057	97.0%	23.1%	64
SoCalREN	390	26,326	25,315	96.2%	19.6%	65
Statewide	3,391	284,620	218,254	91.3%	21.1%	64

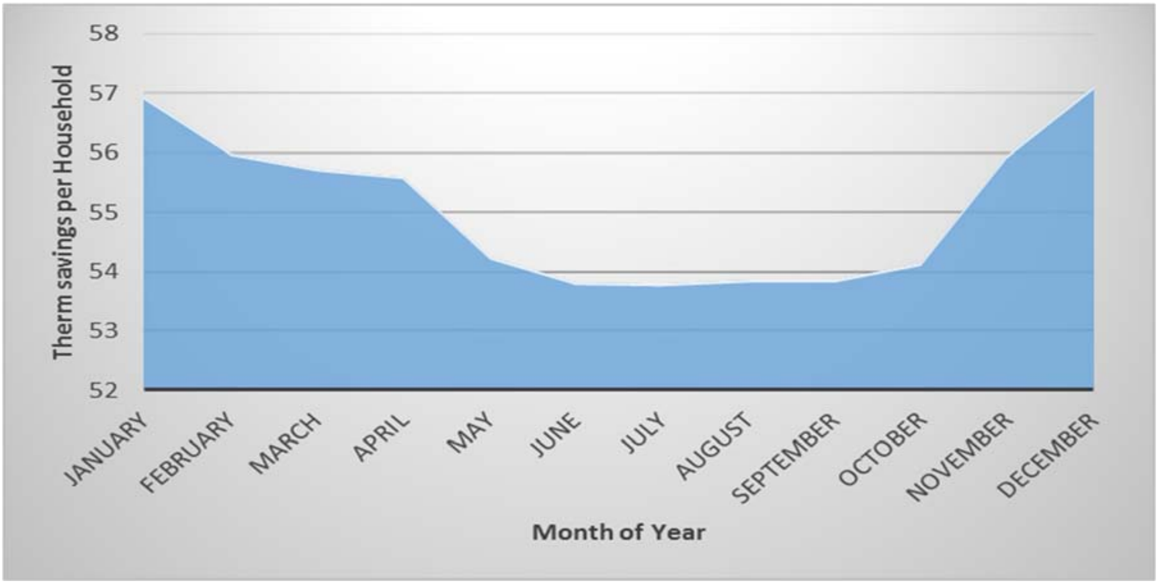
Source: DNVGL 600 analysis-therm

Overall, all PAs produced positive therm savings. Also, when compared to their reported savings, the evaluated savings are somewhat consistent. The similar savings per home may look odd at first glance, but are consistent with what was reported by three of the six the PAs. In addition, the options for the upgrade are limited to furnaces and insulation. For example, "Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%, Duct Insulation", was the most common gas measure group installed.

Realization rates for the southern California PA are above 90%. The realization rate for BayREN is just over 63%. PG&E had the lowest realization rate at 26.8%. Given that evaluated savings are nearly the same across PAs, the low PG&E realization rate may be due to assumptions in their simulation model or in their reported savings.

Figure 12 illustrates gas savings during the year. Savings should follow the typical usage pattern for this fuel type. The expectation is that the greatest savings occur in the coldest months of the year (November through March). Figure 12 confirms this pattern. Since more gas is used in the coldest months of the year for heating, the potential for savings is greatest during these same months.

Figure 12. Gas savings after the HUP upgrade (per household, by month)



Source: DNVGL 600 analysis

4.2.4.2 AHUP gas savings

Evaluated therm savings for AHUP were positive for all PAs and totaled 96,856 therms statewide. The overall realization rate was only 10.7%. This means the evaluated savings were only about 11% of savings reported by the PAs. Realization rates for PG&E and SoCalGas were about 11%. The exception was SDG&E with a realization rate of 21% - nearly double the two other PAs. SDG&E also had the highest percent evaluated savings (7.7%).

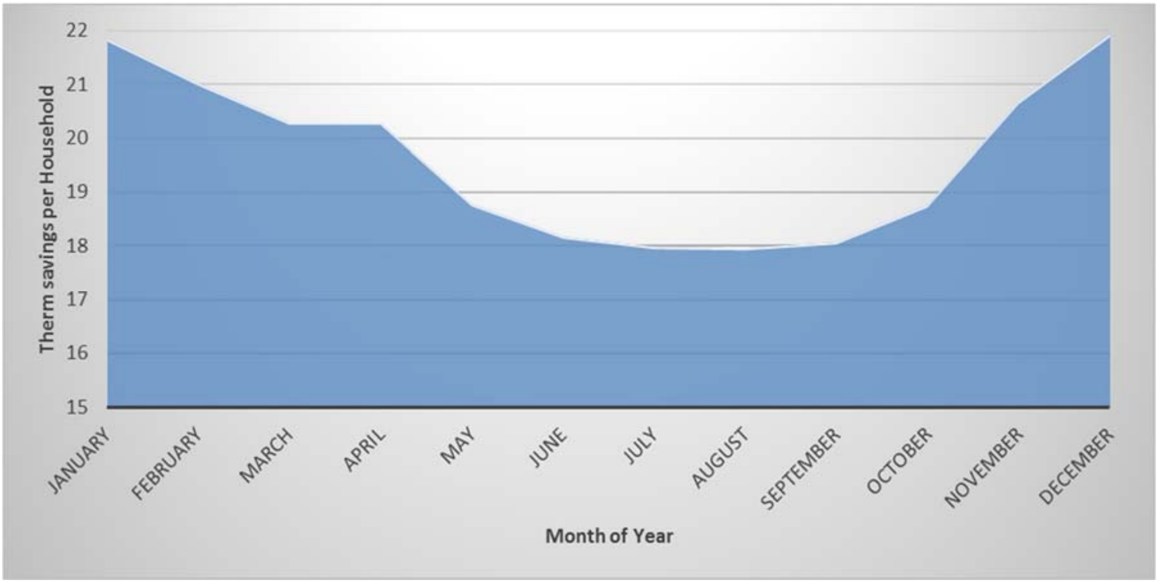
Table 18. AHUP therm program savings 2015

Program Administrator	Population Households	Reported therm Savings	Evaluated therm Savings	Realization Rate	therm Savings (%)	Savings per Home
BayREN	NA	NA	NA	NA	NA	NA
PG&E	3,025	570,291	58,724	10.3%	5.1%	19
SCE	NA	NA	NA	NA	NA	NA
SoCalGas	1,904	328,851	37,718	11.5%	9.8%	20
SDG&E	21	1,953	414	21.2%	7.7%	20
SoCalREN	NA	NA	NA	NA	NA	NA
Statewide	4,950	901,095	96,856	10.7%	6.3%	20

Source: DNVGL 600 analysis-therm

Like HUP, AHUP gas savings typically follow a consistent usage pattern during the year. The greatest savings should occur in the coldest months of the year (November through March) when more gas is being used. The pattern is confirmed in Figure 13. More savings occur in the coldest months of the year from November through March. Unlike HUP however, savings continue through April.

Figure 13. Gas savings after the AHUP upgrade (per household, by month



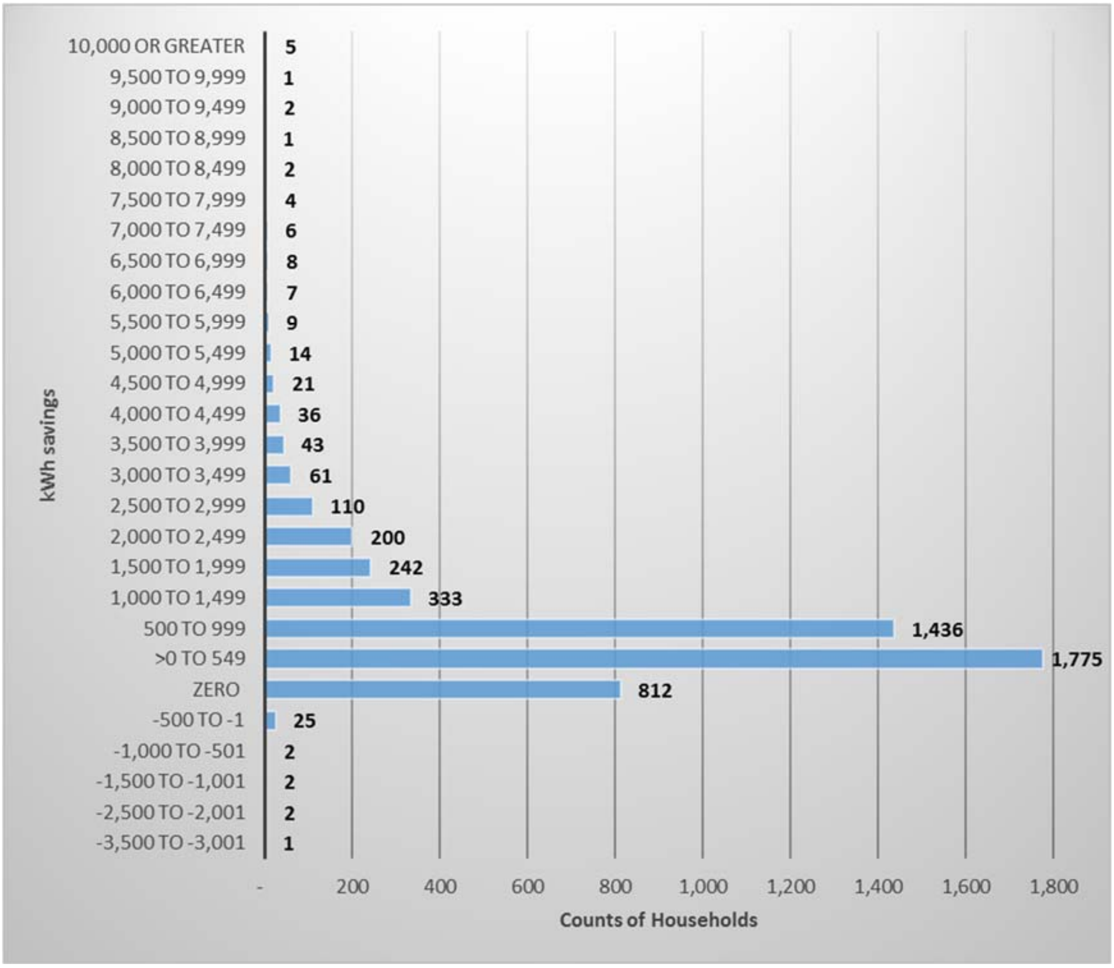
Source: DNVGL 600 analysis

4.2.5 Tracking data distribution

The tracking data for the home upgrade program continues to be challenging from an analysis perspective. Household level savings values are widely distributed and include projects that report positive energy savings, zero savings and negative savings (an increase in energy usage). The full distribution of projects in the tracking data is illustrated in Figure 14 (HUP) and Figure 15 (AHUP). The billing analysis did not include all of these projects, but they are shown here to provide a complete overview of HUP and AHUP reported savings.

For HUP projects, household savings ranged between zero (0) kWh and 1,999 kWh for 90% of homes. Reported annual savings per household ranged from 12,370 kWh to an increase in usage (negative savings) of 3,452 kWh.

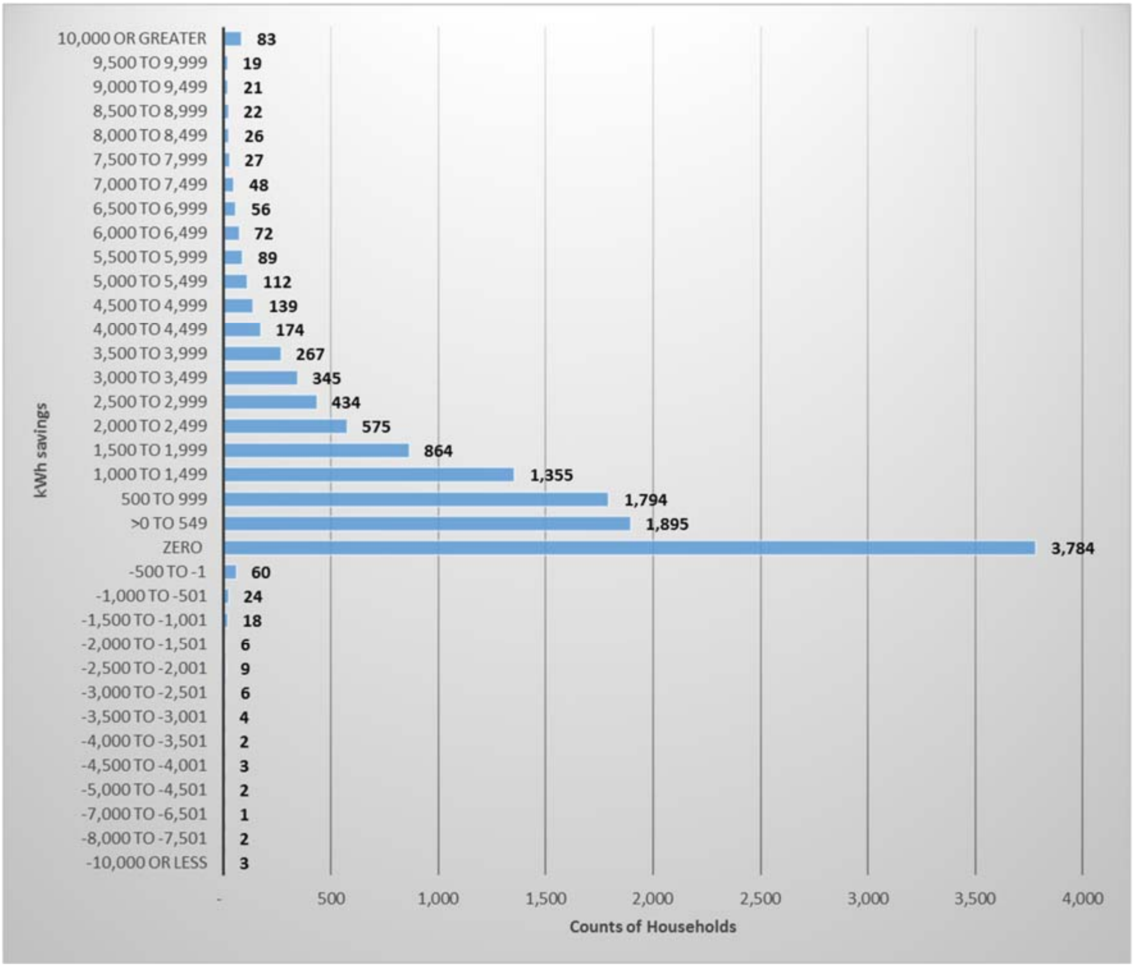
Figure 14. HUP household-level reported savings distribution



Source: DNVGL 650 analysis

For AHUP, PAs reported 1,257 kWh average household savings per project. In this path, approximately 90% of household reported savings were between zero kWh and 3,499 kWh. Reported annual savings per household ranged from 17,750 kWh to an increase in usage (negative savings) of 15,220 kWh. The full HUP distribution is illustrated in Figure 15.

Figure 15. AHUP household-level savings distribution



Source: DNVGL 650 analysis

Including projects with negative savings does not make intuitive sense. Possible reasons are that the simulation software is being used incorrectly, project savings are not being reported correctly, projects are known to increase energy usage but are being implemented anyway, or a combination of all three reasons. Increases in home square footage could explain some negative savings but, based on our sample of available data, these were a small portion of overall projects and would not explain the level of negative results uncovered during the evaluation.

4.3 Factors Affecting Savings

Several findings can be deduced from a review of section 4.2. First, HUP and AHUP underperform PA expectations in terms of total electric and gas savings. Not only are evaluated electric savings lower than reported, in some cases the net effect is negative savings. Second, electric savings for AHUP are nearly three times higher for most PAs than HUP savings. AHUP is a custom program that offers a wider range of measures. The expectation is that AHUP homes should save more electricity than HUP homes. Third, both HUP and AHUP have positive gas savings, but gas savings for AHUP are half the gas savings of HUP.

The initial take-a-way is that HUP affects gas usage more than electric. Conversely, AHUP affects electric usage more than gas. The program does not operate in insolation. There are other factors, inside and outside the program that contribute to these findings. Across all PAs, three aspect of the program affect the evaluated savings: participation in other programs, treatment measures, and climate zones.

4.3.1 Participation in other programs

As a part of the data management process, DNV GL reviewed the entire program tracking dataset to identify home upgrade participants that also participated in other energy efficiency programs such as rebates for lighting, refrigerators, water heaters, air conditioners or pool pumps. In 2015, the number of HUP participants reportedly participating in energy efficiency programs other than home upgrade was approximately 18%. Many of these end-uses were in fact home upgrade, for example lighting and pool pumps.

The mix of participants in multiple programs for 2015 was split evenly. For HUP, 18% participated in other programs. For AHUP 16% participated in other programs). The breakout across PA is presented in Table 19. Of the homes that did participate in other programs the majority (23.3%) received rebates for heating and cooling equipment. PG&E had the highest percentage of cross program participants at 32.7%.[30]

Table 19. Cross program participants (HUP and AHUP)

PA	DHW	Shell	HVAC	Lighting	Other	Pool Pump	Refrigerator / Freezer	RNC	Surveys	Total
BAYREN	1.6%	0.1%	1.4%	3.9%	0.0%	0.6%	1.6%	0.0%	0.0%	9.2%
PGE	5.1%	0.5%	8.9%	11.4%	1.3%	1.8%	3.7%	0.1%	0.0%	32.7%
SCE	1.8%	0.7%	3.3%	1.5%	0.3%	2.0%	6.2%	0.1%	2.1%	18.0%
SCG	4.9%	1.4%	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	8.2%
SDGE	4.2%	1.5%	6.8%	1.4%	0.0%	1.4%	4.3%	0.0%	0.0%	19.5%
SOCALREN	3.0%	1.6%	1.1%	0.4%	0.6%	1.5%	3.0%	0.0%	1.3%	12.3%
Total	**20.5%**	**5.8%**	**23.3%**	**18.6%**	**2.2%**	**7.3%**	**18.8%**	**0.2%**	**3.4%**	**100.0%**

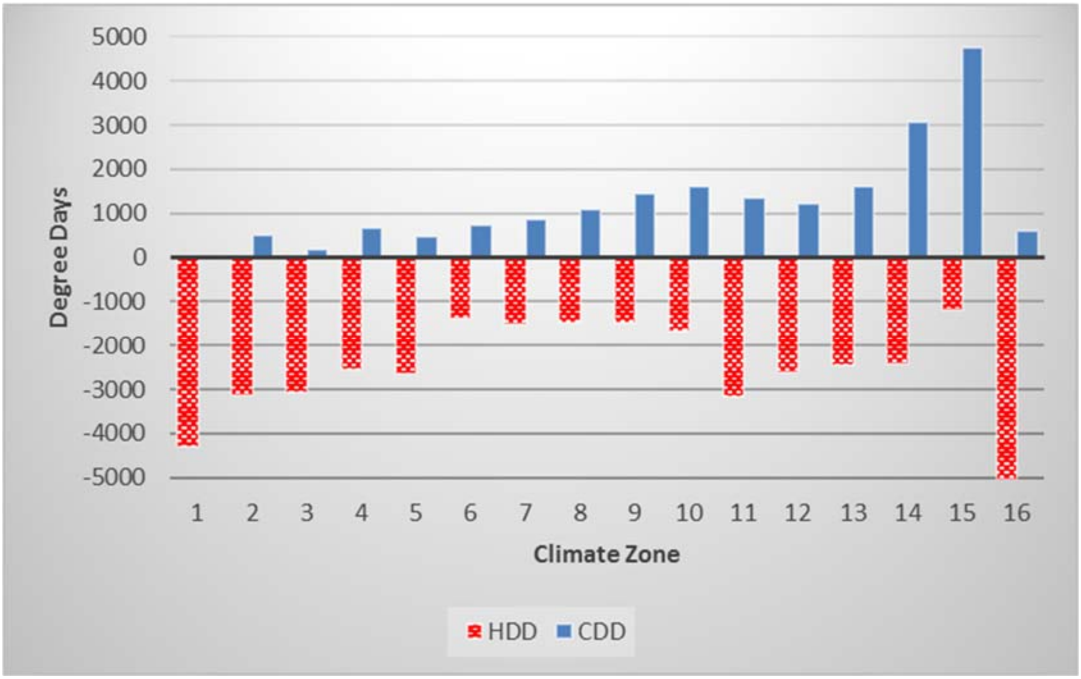
Source: CPUC program tracking data, October 2016
DHW = water heaters, clothes washers, dishwashers, water savings kits
HVAC = air conditioners and furnaces
Shell = insulation

4.3.2 Climate zones

The CEC partitions the state of California into 16 climate zones. Climate zones are based on heating degree days (HDD) and cooling degree days (CDD). HDD is the summation of degrees of the average temperature per day below 65F for the year. CDD is the summation of degrees of the average temperature per day above 80F for the year.[31] Figure 16, illustrates these days. Using only degree day as a guide, opportunity for savings from cooling loads (i.e. central A/C) is more prevalent in climate zones 10 through 16. Opportunities for savings from heating loads (i.e. gas furnace) is high in all climate zones except 6 through 10 and 15.

[30] The quality of the tracing data is poor. Many of these cross program measures, may be mis-classifications in the dataset.
[31] Pacific gas and Electric, The Pacifc Energy Center's Guide to California Climate Zones and Bioclimatic Design, October 2006

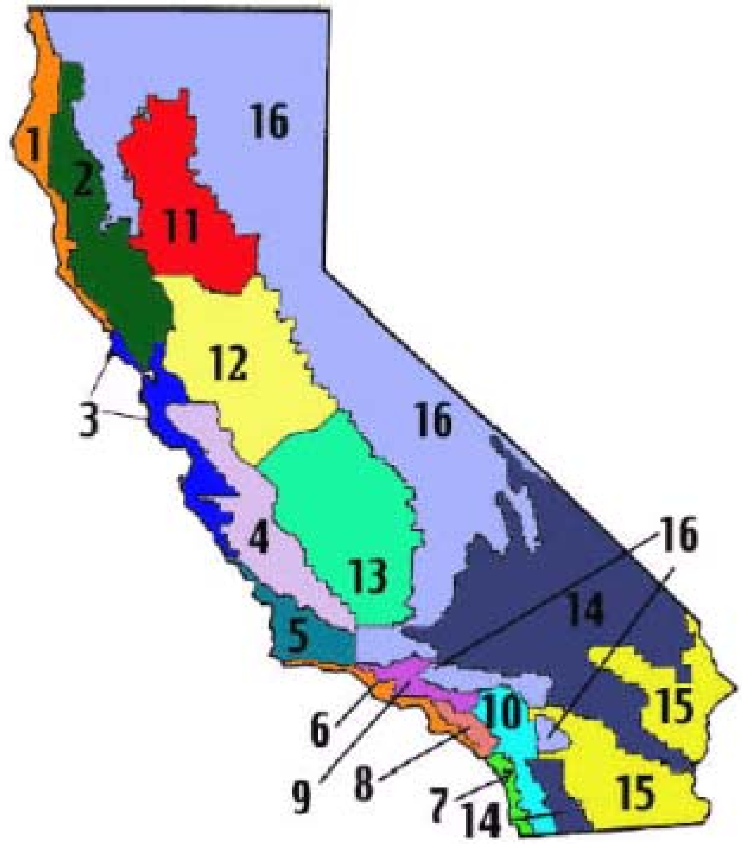
Figure 16. Typical heating and cooling degree days



Source: California Energy Commission, Base CDD = 80F, HDD = 60F

Climate zones with the lower numbers 1-8 tend to be the coastal regions and represent cooler climates. Climate zones 9-16 tend to be inland and represent areas with a wide range of temperatures over the course of the year. A map of these climate zones is provided in Figure 17.

Figure 17. Building climate zones



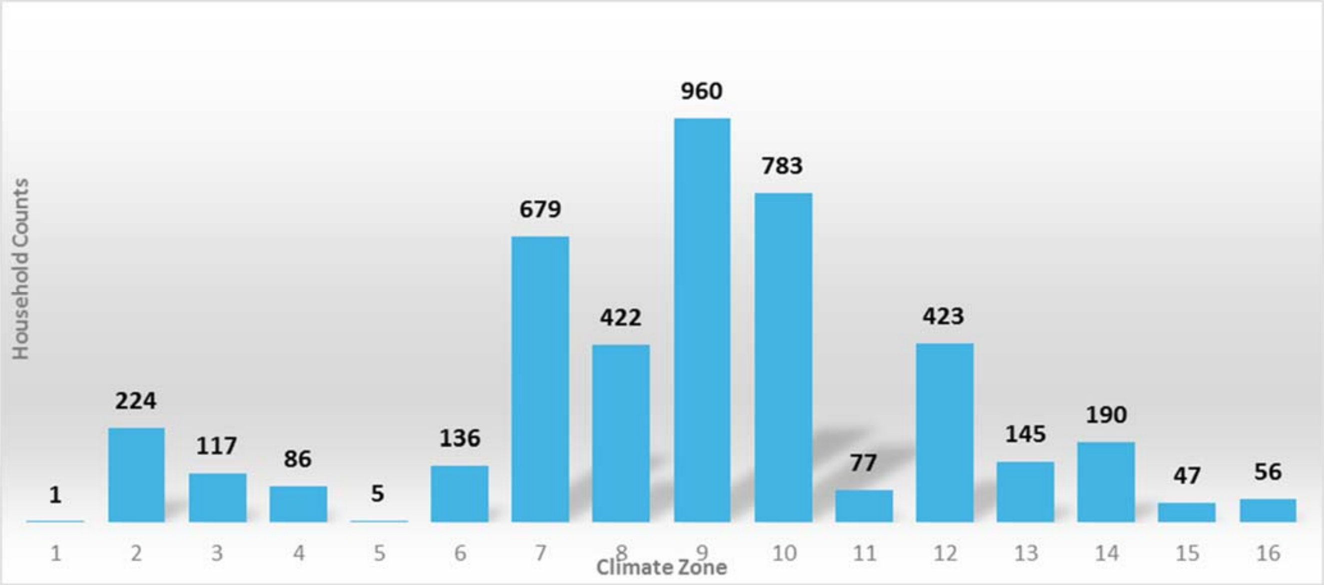
Source: California Energy Commission

Both HUP and AHUP completed at least one fuel type in all 16 climate zones.

4.3.2.1 HUP climate zones

Statewide, 56% of HUP projects were in climate zones 7, 9, and 10. The highest concentration of projects across all climate zones was in climate zone 9 (22%). Climate zone 9 contains SCE, SoCalGas and SoCalREN projects. Climate zone 10 (18%) was the next highest concentration. Climate zone 10 includes SCE, SoCalGas and SDG&E. Using Figure 16 as a guide, these two climate zones have low cooling degree days and therefore do not have the potential to produce the most electric savings. The reported distribution of projects from the tracking data is shown in Figure 18.

Figure 18. HUP distribution of tracking data projects



Source: CPUC program claims dataset (tracking data)

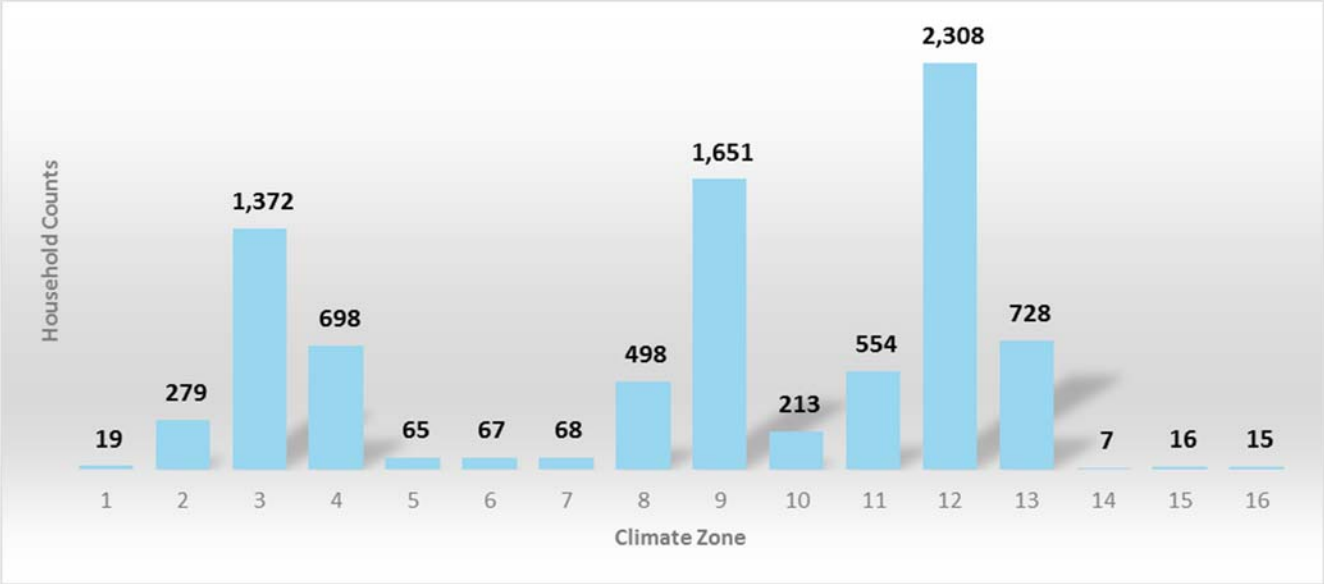
For HUP we estimated overall savings in only seven of the sixteen climate zones. These were climate zones, 10, 11, 13, 14, 15 and 16. These inland climate zones typically have higher summer temperatures and lower winter temperatures than the remaining climate zones. Among these seven climate zones with estimated energy savings, three-fourths (76%) of this energy savings was found in three climate zones: 10 (32%), 14 (30%) and 15 (14%).

In climate zones 1, 3 and 5 (coastal regions in central and northern California) we estimated a net increase in energy usage.

4.3.2.2 AHUP climate zones

Statewide for the AHUP path 62% of projects were in climate zones 3, 9, and 12. The highest concentration of projects across all climate zones was in climate zone 12 (27%). Climate zone 12 contains PG&E projects. Climate zone 9 (19%) was the next highest concentration. The reported distribution of projects from the tracking data is shown in Figure 19.

Figure 19. AHUP distribution of tracking data projects



Source: CPUC program claims dataset (tracking data

Despite the AHUP projects being dispersed across all climate zones we estimated overall savings in twelve of these climate zones. These were climate zones 4 and 6 through 16. Most of these tend to be warmer climate zones within the state. Within these eleven zones, the majority of savings (79%) came from three climate zones: 12 (31%), 9 (29%) and 13 (19%). These are inland climate zones with higher summer temperatures than the other coastal zones with milder temperatures

Climate zones 1, 3 and 5 (coastal regions in central and northern California) a net increase in energy usage.

4.3.3 Weather data

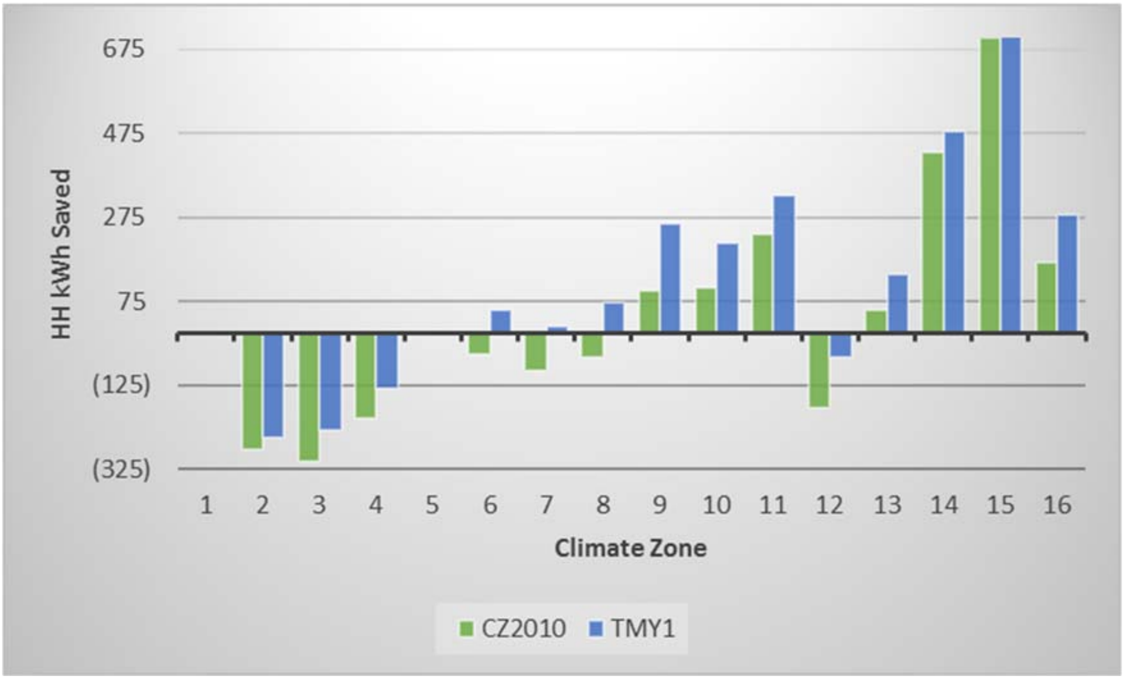
The analysis applied CZ2010 weather data to hourly usage data to construct weather normalized savings estimates consistent with the CalTrack initiative. As part of the review of findings we also applied TMY weather data and generated separate estimates of savings. Interestingly, the CZ2010 and TMY weather series produced very different results for mean household savings. In addition to the difference in the savings, the model using TMY data generated estimates with much better precision than with the CZ2010 data. Using HUP as an example, Table 20 shows mean kWh savings per household across all climate zones and Figure 20 shows the component savings for each climate zone. At the climate zone level, however, savings for climate zones 1-4 remain negative. The difference is that at the statewide level, positive savings from the other climates zones are sufficient to offset the negative savings in climate zones 1-4.

Table 20. Weather data selection

	HUP		AHUP	
	CZ2010	TMY	CZ2010	TMY
Mean kWh Savings	-57.87	43.77	346.57	333.02
Standard error	3.03	2.80	2.11	2.74

In Figure 20, the mean kWh savings per household is illustrated for each climate zone. Holding all factors constant, other than weather, for each zone savings estimates are greater with the TMY weather series than with the CZ2010.

Figure 20. Weather data and kWh savings



Source: DNVGL 600 Analysis

The kWh savings bars in Figure 20 also show that regardless of which weather data series is applied, the climate zones with the hotter temperatures (zones 11 – 16) produce the most energy savings. The milder climate zones (zones 6 – 10) tend toward flatter or neutral energy savings. The climate zones with the cooler temperatures do not produce savings and may even increase usage.

4.4 Program Savings over Time

The HUP and AHUP paths have been operating under different names since the 2010-12 program cycle.[32] DNV GL performed the earliest impact evaluation for HUP and AHUP in 2014 for the 2010-12 program year.[33] Not all PAs currently offering the home upgrade or advanced home upgrade paths were included in prior analysis. Either they did not offer the program or the number of households was too small to evaluate. In addition, not all fuels types were evaluated. The following charts show the evaluated program savings for kWh and therms over time as a percentage of usage before the upgrade.

The results are mixed. Figure 21 shows that for HUP, savings has been decreasing for all PAs except SoCalREN. This PA experienced a slight increase in savings in 2015. The changes are most dramatic for BayREN and SDG&E. The evaluation resulted in increases in usage (negative savings) for both of these PAs.

[32] The program began California Energy Commission's Comprehensive Residential Retofit Prorgam funded by the American Reivestment and Recovery Act of 2009

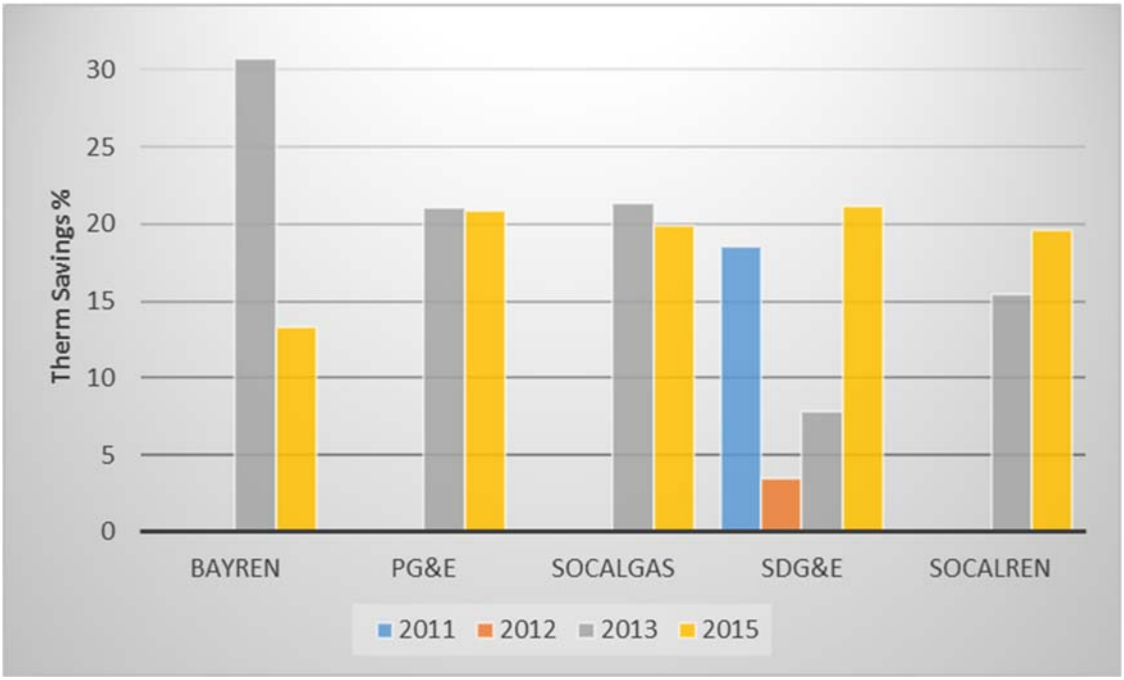
[33] DNV GL, Whole House Retrofit Impact Evaluation, Evaluation of Energy Upgrade California Programs, Work Order 46, 2014

Figure 21. HUP kWh percent savings over time

Source: DNVGL 660 Analysis
Note: In 2011 and 2012 HUP was marketed as the “Basic Upgrade”.

Gas savings also have varied over time. Figure 22 illustrates the changes in therm savings. For example, SDG&E was just under 20% savings in 2011 and dropped to less than 10% in 2011 and 2013. Then in 2015, SDG&E gas savings were back up to about 20%.

Figure 22. HUP percent therm savings over time



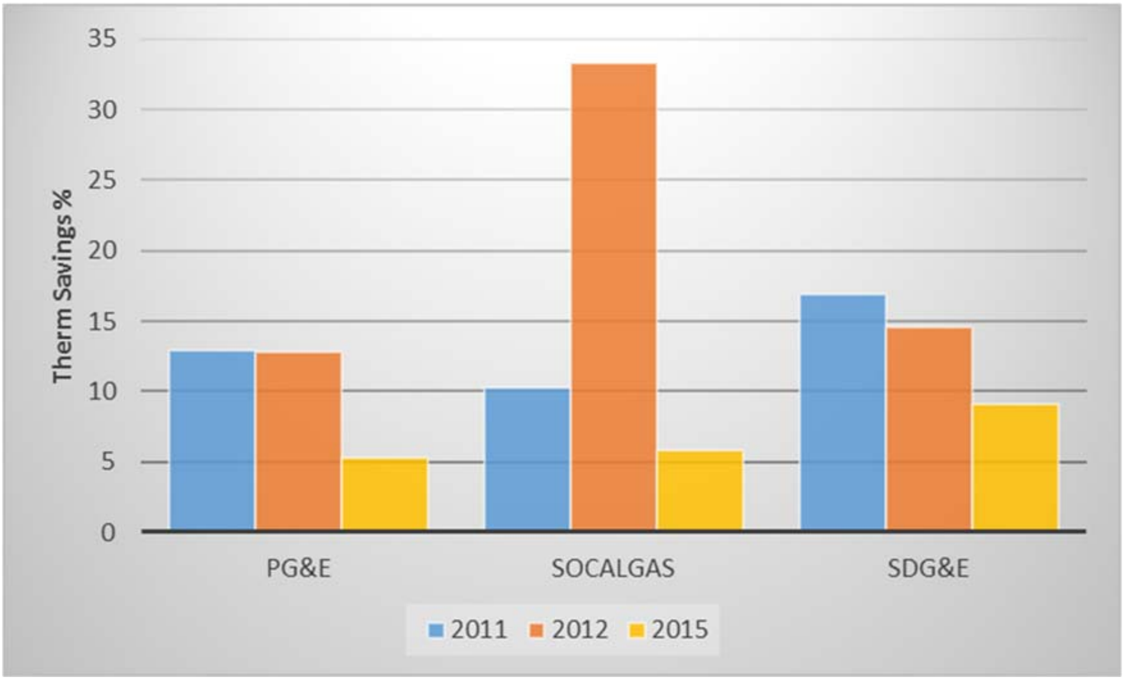
Source: DNVGL 660 Analysis

For AHUP, Figure 23 shows a steady increase in the percent of electric savings for PG&E from 2011 to 2015. SDG&E's percent savings increased from 2012, but achieved less than half the savings evaluated in 2011. DNV GL found the percentage savings for SCE to be comparable with 2012, but still half of 2011.

Figure 23. AHUP kWh percent savings over time

Source: DNVGL 660 Analysis
Note: AHUP was not evaluated for 2013 or 2014

Figure 24. AHUP therm percent savings over time



Source: DNVGL 660 Analysis
Note: AHUP was not evaluated for 2013 or 2014

4.5 Survey findings

This section includes the findings from the survey of participants from HUP and AHUP.

4.5.1 Free ridership and net-to-gross

Homeowners make choices about home upgrades in different ways. Some homeowners consider the upgrade as a single purchase and one buying decision. Others consider each component of the upgrade as a separate purchase and make decisions accordingly. Respondents that considered all the measures installed as a single package, and a single purchase decision, answered a short-form questionnaire. That questionnaire is shown in section 3.2.2. Thes estimated value is reported along with its standard error in parenthesis. Participants making multiple decisions answered similar questions but related to each measure installed. A full set of attribution tables at the equipment level are in APPENDIX B.

DNV GL developed savings weighted estimates from survey responses to account for program influence. These are expressed as net-to-gross ratios (NTG). A higher NTG equates to higher program influence on the customer's decision to participate in the program. Where sample size was small or estimates not statistically significant, DNV GL applied the current default rate of 85%. For example, some participants may have already planned to perform all or some of the upgrades and participated in the program only to receive the rebates and offset their project costs.

4.5.1.1 HUP net-to-gross

To calculate net savings attributable to the program, the NTG ratio for each PA in the first row of Table 21 is applied to the evaluated gross savings from section 4.1. Overall the program influence was high with the PAs influencing the majority of household decisions to implement an upgrade. Single decision participants tended to report less program influence than multi-decision participants. These homeowners indicated that they were already thinking of at least some part of the upgrade without prompting from the program.

The program had higher attribution on upgrades that homeowners typically do not think about. This includes insulation and duct work. For upgrades on air conditioners, furnaces and water heaters, the program had less influence in prompting homeowners to upgrade. This is expected since homeowners typically replace these items when they break or when conditions in the home become sufficiently uncomfortable to initiate a change.

Table 21. HUP NTG (kWh)

Measure	BayREN	PGE	SCE	SCG	SDGE	SoCalREN
Overall (All) Participants	79.3 (21.0)	85.0	94.0 (6.5)	NA	81.2 (19.1)	92.9 (6.2)
Overall-Single Decision	33.3 (0.0)		90.4 (11.2)		58.8 (34.2)	38.8 (7.9)
Overall-Multi-Decision	100.0 (0.0)		100.0 (0.0)		100.0 (0.0)	98.5 (1.4)
Attic Insulation			100.0 (0.0)		96.8 (4.4)	
Wall Insulation			100.0 (0.0)			
Floor Insulation			100.0 (0.0)			
Air Duct Sealing					100.0 (0.0)	
Heat Pump						
Furnace	0.0 (0.0)				91.7 (0.0)	56.9 (8.1)
Air Conditioning					0.0 (0.0)	48.4 (6.9)
Duct Leakage Reduction			82.2 (20.8)		100.0 (0.0)	97.8 (2.9)
Water Heater			82.2 (20.8)		4.4 (6.1)	15.2 (15.6)
Windows			14.3 (17.7)			

Note: empty cells represent sample with less than five responses or not statistically significant. The current NTG ratio of 85% is applied to PG&E due to small sample size.

Table 22. HUP NTG (kW)

Measure	BayREN	PGE	SCE	SCG	SDGE	SoCalREN
Overall (All) Participants	72.7 (19.8)	85.0	99.0 (0.9)	NA	79.2 (16.9)	65.9 (15.3)
Overall-Single Decision	43.4 (7.7)		96.3 (1.0)		37.4 (24.5)	48.5 (6.3)
Overall-Multi-Decision	85.9 (17.8)		100.0 (0.0)		99.7 (0.3)	77.2 (21.3)
Attic Insulation			100.0 (0.0)		84.2 (19.1)	
Wall Insulation			100.0 (0.0)			
Floor Insulation			100.0 (0.0)			
Air Duct Sealing					100.0 (0.0)	
Heat Pump						
Furnace	26.0 (20.8)				10.1 (7.9)	85.0 (13.7)
Air Conditioning					14.1 (2.7)	26.1 (18.4)
Duct Leakage Reduction			100.0 (0.0)		100.0 (0.0)	98.3 (2.1)
Water Heater			100.0 (0.0)		100.0 (0.0)	24.1 (25.6)
Windows			100.0 (0.0)			

Table 23. HUP NTG (therm)

Measure	BayREN	PGE	SCE	SCG	SDGE	SoCalREN
Overall (All) Participants	66.9 (7.1)	85.0	NA	68.1 (12.6)	54.6 (13.4)	72.5 (10.3)
Overall-Single Decision	60.1 (5.9)			77.5 (18.9)	37.0 (12.6)	55.5 (6.0)
Overall-Multi-Decision	72.2 (8.1)			55.6 (14.3)	93.4 (4.9)	81.2 (11.1)
Attic Insulation				98.5 (1.4)	93.2 (5.2)	
Wall Insulation						
Floor Insulation						
Air Duct Sealing					30.1 (26.4)	
Heat Pump						
Furnace	56.9 (1.8)				8.9 (5.4)	94.7 (4.4)
Air Conditioning				55.1 (32.1)	12.9 (5.1)	17.4 (14.2)
Duct Leakage Reduction				65.2 (27.2)	45.4 (30.5)	54.6 (20.5)
Water Heater					82.3 (12.9)	36.1 (18.7)
Windows						

Note: empty cells represent sample with less than five responses or not statistically significant. The current NTG ratio of 85% is applied to PG&E due to small sample size.

4.5.1.2 AHUP net-to-gross

To calculate net savings attributable to the program, the factor for each PA in the first row of Table 24 is applied to the evaluated gross savings from section 4.1. Net-to-gross for AHUP is about the same as for HUP. The exception were the PG&E multi-decision participants. Just over half (63.6%) attributed their upgrade decisions to the program. Again, the program had less influence on decision for major appliances such as air conditioners, furnaces and water heaters.

Table 24. AHUP NTG estimates (kWh)

Measure	BayREN	PGE	SCE	SCG	SDGE	SoCalREN
Overall (All) Participants	NA	67.8 (5.2)	94.2 (3.0)	NA	90.3 (6.0)	NA
Overall-Single Decision	NA	72.8 (5.6)	88.7 (4.4)		79.9 (8.3)	NA
Overall-Multi Decision	NA	63.6 (8.2)	95.5 (3.6)			NA
Attic Insulation	NA	77.1 (9.5)	82.2 (10.8)		92.7 (5.1)	NA
Wall Insulation	NA	83.7 (8.2)	100.0 (0.0)			NA
Floor Insulation	NA	97.5 (2.2)	93.9 (6.2)			NA
Air Duct Sealing	NA	93.5 (5.6)			100.0 (0.0)	NA
Heat Pump	NA	100.0 (0.0)				NA
Furnace	NA	64.0 (11.4)				NA
Air Conditioning	NA	67.4 (12.2)				NA
Duct Leakage Reduction	NA	63.3 (10.2)	100.0 (0.0)			NA
Water Heater	NA	62.0 (8.6)			52.4 (25.0)	NA
Windows	NA	79.4 (6.3)	92.4 (7.7)			NA

Table 25. AHUP NTG estimates (kW)

Measure	BayREN	PGE	SCE	SCG	SDGE	SoCalREN
Overall (All) Participants	NA	67.7 (4.4)	86.6 (5.9)	NA	88.3 (6.1)	NA
Overall-Single Decision	NA	74.1 (3.9)	84.4 (3.8)		79.2 (6.8)	NA
Overall-Multi Decision	NA	62.2 (7.0)	87.1 (7.2)			NA
Attic Insulation	NA	73.6 (7.9)	78.3 (10.7)		90.5 (4.5)	NA
Wall Insulation	NA	87.0 (5.6)	100.0 (0.0)			NA
Floor Insulation	NA	94.3 (3.6)	91.5 (8.2)			NA
Air Duct Sealing	NA	92.4 (3.9)			100.0 (0.0)	NA
Heat Pump	NA	100.0 (0.0)				NA
Furnace	NA	63.3 (7.7)				NA
Air Conditioning	NA	66.1 (11.6)				NA
Duct Leakage Reduction	NA	67.4 (7.4)	99.7 (0.3)			NA
Water Heater	NA	65.2 (6.8)			70.9 (19.8)	NA
Windows	NA	65.9 (7.9)	82.5 (13.0)			NA

Table 26. AHUP NTG (therm)

Measure	BayREN	PGE	SCE	SCG	SDGE	SoCalREN
Overall (All) Participants	NA	74.1 (2.7)	NA	89.6 (2.8)	90.5 (4.9)	NA
Overall-Single Decision	NA	76.0 (2.9)		80.3 (6.6)	83.7 (6.6)	NA
Overall-Multi Decision	NA	72.4 (4.2)		92.8 (2.8)		NA
Attic Insulation	NA	77.0 (5.0)		81.8 (7.5)	93.3 (4.1)	NA
Wall Insulation	NA	82.2 (5.7)		86.9 (7.2)		NA
Floor Insulation	NA	84.8 (6.2)		92.8 (7.1)		NA
Air Duct Sealing	NA	89.7 (3.7)		97.6 (2.4)	100.0 (0.0)	NA
Heat Pump	NA	100.0 (0.0)				NA
Furnace	NA	65.9 (5.9)		87.3 (8.2)		NA
Air Conditioning	NA	68.5 (8.2)		58.6 (13.5)		NA
Duct Leakage Reduction	NA	71.9 (4.9)		65.4 (15.7)		NA
Water Heater	NA	72.0 (5.1)		89.8 (9.6)	79.3 (15.3)	NA
Windows	NA	72.3 (5.9)		67.4 (14.2)		NA

4.5.2 Net savings

The realization rates are a measure of evaluated savings relative to reported savings. Evaluated savings tells how much saving can be verified, but not how much of the savings is attributable to the effectiveness of the program's marketing, outreach and incentives. The online survey discussed above provided the insights to understand this influence.

To calculate net savings, two metrics from this evaluation are applied to reported savings. These are realization rates, from the billing analysis, and net-to-gross ratios, derived from the survey results. The net savings for HUP and AHUP, by PA, are presented in Table 27 and Table 28. Detailed NTG ratios are presented in APPENDIX C.

4.5.2.1 HUP net savings

Net evaluated saving for kWh, kW, and therms are shown in Table 27. The difference from reported gross savings to evaluated net savings are due almost entirely to the low realization rates estimated from this evaluation.

Table 27. HUP program savings summary

HUP		BayREN	PG&E	SCE	SoCalGas	SDG&E	SoCalREN
kWh	Reported Gross	671,237	49,966	452,970	NR	291,670	288,609
	Realization Rate	-47.7%	5.6%	23.9%	NR	-14.7%	20.3%
	Net to Gross	79.3%	85.0%	94.0%	NR	81.2%	92.9%
	Evaluated Net	(253,925)	2,384	101,937	NR	(34,755)	54,509
kW	Reported Gross	941	118	441	NA	496	469
	Realization Rate	5.7%	1.9%	14.3%	NA	-2.7%	18.2%
	Net to Gross	67.7%	85.0%	99.1%	NA	90.2%	95.0%
	Evaluated Net	36	2	59	NA	(13)	85
therm	Reported Gross	141,688	8,962	NA	25,901	36,148	26,326
	Realization Rate	63.3%	26.8%	NA	253.7%	97.0%	96.2%
	Net to Gross	70.2%	85.0%	NA	69.3%	54.0%	75.2%
	Evaluated Net	60,010	2,044	NA	45,544	18,931	19,037

Note: Duel fuel findings are not included for single fuel PAs

In most cases the net-to-gross ratios are comparable with the 85% default value reported by the PAs. In general, net-to-gross values tend to be higher for HUP than for AHUP

4.5.2.2 AHUP net savings

Net evaluated saving for kWh, kW, and therms for AHUP are presented in Table 28.

Table 28. AHUP program savings summary

HUP		BayREN	PG&E	SCE	SoCalGas	SDG&E	SoCalREN
kWh	Reported Gross	NA	3,603,902	1,261,727	NA	16,674	NA
	Realization Rate	NA	25.2%	23.5%	NA	17.7%	NA
	Net to Gross	NA	67.8%	94.2%	NA	90.3%	NA
	Evaluated Net	NA	615,943	296,788	NA	2,953	NA
kW	Reported Gross	NA	5,893	1,628	NA	19	NA
	Realization Rate	NA	12.1%	21.2%	NA	24.4%	NA
	Net to Gross	NA	67.7%	86.6%	NA	88.3%	NA
	Evaluated Net	NA	714	345	NA	5	NA
therm	Reported Gross	NA	570,291	NA	328,851	1,953	NA
	Realization Rate	NA	10.3%	NA	11.5%	21.2%	NA
	Net to Gross	NA	74.1%	NA	89.6%	90.5%	NA
	Evaluated Net	NA	43,514	NA	33,795	375	NA

Note: NA = not applicable

4.5.3 Customer profile by evaluated savings

This section summarizes the results of an exploratory analysis that looks "under the hood" to understand some of the reasons behind participant savings. This analysis is limited to the subset of participants that returned a completed survey and evaluated savings.

DNV GL partitioned respondents into 3 segments based on the level of kWh savings. Those with increases in their annual energy usage greater than 300kWh, those whose annual usage did not increase nor decrease by more than 300kWh, and those with annual savings of more than 300 kWh. There are significant differences in the level of savings achieved by PA with SoCalGas, PG&E, and SoCalREN having the highest proportion of customers achieving evaluated savings (Table 29).

Table 29. Level of savings by segment and PA

Segment	Total (n=409)	BayREN (n=13)	PG&E (n=212)	SCE (n=72)	SoCalGas (n=53)	SDG&E (n=40)	SoCalREN (n=19)
Gainers - Negative savings > 300 kWh	12%	44%	9%	6%	1%	0%	1%
Inerts – No change >= 300 kWh	60%	56%	51%	76%	10%	99%	77%
Savers – Positive savings > 300 kWh	28%	0%	39%	18%	89%	1%	22%

DNV GL constructed customer profiles by program for the three segments defined in Table 29. These profiles include factors internal and external to the program. Program internal factors include differences by PA, contractor messaging, and customer choices on the program. Program external factors include dwelling characteristics, behaviors and attitudes, and demographics.

Contractor Messaging: Inerts and Savers (27%) acknowledged that their contractor mentioned improved safety of HVAC equipment over twice as often as the Gainers (12%).

The Gainers reported that their contractor discussed energy savings with them more than either the Inerts or Savers. For other topics, such as rebates, comfort, or air quality, Gainers also report higher incidences than Inerts or Savers. These differences however, are not statistically significant for the current sample sizes.

Customer choices on the program: The Savers used financing for their projects in significantly higher proportions than the Gainers (49% vs 30%). They also exhibited significantly lower free-ridership than the Gainers (18% vs 37%) and implemented more measures on average (4.7 vs 3.9). Among these measures, a higher portion of Gainers (82%) implemented some form of HVAC measure than their Inert (63%) or Saver (54%) counterparts.

Customer comfort: While the majority of customers in all segments agree that the project increased the comfort of their home, Gainers (92%) reported this at a higher rate than Inerts (81%) and Savers (81%). This is consistent with Gainers reporting higher contractor messaging on comfort.

Demographics: A higher proportion of Savers (71%) live in homes built before the 1980s, have annual incomes less than $100,000 (37%), and are employed full-time (70%). This group also reported the highest rate of financing their project (49%) versus 30% for the Gainers.

Customer values and attitudes: On average, Savers had the highest installation of energy efficiency measures in their home prior to the upgrade.[34] They also had a higher incidence of being motivated to save money that Gainers (62% vs 50%).

Table 30. Customer profile by savings segments

	Gainers (n=39)	Inerts (n=235)	Savers (n=139)
SAVINGS			
Electric savings (kWh)	-544	13	644
Gas savings (therm)	47	43	25
CONTRACTOR MESSAGING			
Energy savings on monthly bill	86%	70%*	70%*
Rebates on equipment purchases and contractor services	63%	56%	53%
Effect of renovation in improving comfort in your home due to elimination of hot or cold spots	63%	56%	53%
Effect of renovation in improving air quality in your home	43%	34%	34%
Effect of renovation in improving safety of heating and cooling equipment	15%	27%	27%
CUSTOMER CHOICES ON PROGRAM			
Financed their project	30%	39%	49%*
Thought of all the measures installed as a PACKAGE and made one purchasing decision for the whole project	50%	53%	61%
Free-ridership	37%	22%	18%
Number of measures implemented as part of the project	3.9	5.2	4.7
HVAC measure installed (heat pump, furnace, or air conditioner)	82%	63%	54%
Advanced Home Upgrade Program (AHUP) participants	39%	52%	89%
CUSTOMER VERDICT ON PROGRAM			
Project increased the comfort of the home	92%	81%	81%
DEMOGRAPHICS			
Building vintage – built before 1980	57%	74%	71%
Annual income less than $100,000	20%	33%	37%*
Employed full-time	58%	65%	70%
CUSTOMER VALUES AND ATTITUDES			
Number of energy efficiency measures in the home	2.3	2.4	2.6
Motivator – Save money or maintain health	50%	57%	62%
Motivator – For the benefit of future generations or to protect the environment	49%	39%	32%
Motivator – Help California lead the way on saving energy or to reduce dependence on foreign oil	1%	4%	7%

Note: * indicates statistically significant

The findings in Table 29 provide evidence of differences in customer attitudes and demographics between saver and non-savers. These results, though not conclusive, do indicate that contractor messaging, building vintage, household income, and customer values all contribute to differences in evaluated savings.[35]

[34] Respondents are asked to indicate which of the 4 energy efficiency measures they have implemented in their home – Attic vent, ceiling fans, programmable thermostats, and motion detectors for lights

[35] Further research with larger samples will corroborate the directional evidence presented in Table 26.

Examining savings segments in Table 31 by climate zone group reveals the expected results. The Savers are concentrated inland (87%). Customers who live inland in the state are likely to have higher CDD than those who live in coastal areas where temperatures are relatively milder and cooling needs are lower. In fact, the majority of Gainers (75%) live in mild coastal areas.

Table 31. Geography of survey respondents

Climate Zone Group	Total	Gainers	Inerts	Savers
n=	413	39	235	139
Desert	0.2%	0%	0%	0.7%
Inland	64%	25%	61%	87%
Mild/Coastal	36%	75%	39%	12%

Savings by climate zone group confirms that participants located inland achieve significantly higher savings than their counterparts from the coast. We are unable to make inferences on participants located in the desert climate zone group as we do not have sufficient sample, but directional evidence in this case lines up with the finding that participants in locations with higher cooling needs are more likely to achieve greater savings.

Table 32. Savings by climate group

Climate zone group	N	Mean (kWh savings)	Standard Error of Mean
Desert	1	1290	0
Inland	242	236	37
Mild/Coastal	170	-83	42

Our exploratory research provides significant evidence that the following factors contribute to improved program performance:

Program path: Almost 90% of all Savers are AHUP participants. Gainers account for only 40% of AHUP participants. In general, AHUP survey respondents achieved an annual average savings of 265 kWh. Those in HUP averaged savings of -95 kWh.

Climate Zone: Almost 90% of all Savers are inland and achieved an average savings of 236 kWh. Those in the versus mild/coastal climate zones averaged -83 kWh.

Our research also found a higher prevalence of Savers relative to the Gainers for the following types of respondents:

- those who live in homes built before the 1990s,
- were employed full-time, and
- responded to messaging that communicated direct personal benefits.

While these findings are not statistically significant at current sample sizes, there is some directional evidence that these factors are correlated with energy usage.

Creative targeting methods based on the above findings could include;

- Using load shapes to identify households that have a flatter pattern during the work day. This can serve as a proxy for households with full-time employed occupants. Those who stated that they were employed full-time achieved savings of 135 kWh on average versus the remainder who achieved 101 kWh.
- Identifying homes built before the 1990s. These participants achieved savings of 136 kWh on average versus just 40 kWh for homes built after the 1990s. This reflects the fact that more recently built homes comply with more stringent building codes. The older the home, the more the room for potential savings.
- Finally, respondents who are motivated by more personal reasons such as saving money and maintaining health save 165 kWh on average versus those who were motivated by messaging about the environment, benefit of future generations, California's leadership in saving energy, or reducing the nation's dependence on foreign oil. Respondent's indicating these less tangible motivations to upgrade on average saved less than half annually (65 kWh) than their counterparts motivated by immediate personal reasons.

5 CONCLUSIONS

DNV GL's conclusions in this section include an overview of program savings and data issues underlying, but outside, the analysis. Conclusions are as follows:

The Home Upgrade Program is considered one statewide program. The program operates in all 52 counties, spans 16 climate zones, and PA service areas overlap with each other and with the service areas of municipal providers. The contractors who implement the program also operate in multiple counties throughout the state. Taken together, this makes the home upgrade program challenging to administer and track. Based on a review and evaluation of the available program data, DNV GL's conclusions are as follows:

The continued over estimation of gross savings by the PAs for HUP and AHUP is a key finding from this evaluation. Even though DNV GL performed all of these evaluations, the evaluations used monthly billing data for electric and gas, hourly and monthly meter data for electric, different sets of weather data, and different project teams. Each conclusion is the same: Savings expected by the PAs for HUP and AHUP are much greater than what can be verified by the evaluations. This is true even before any NTG ratios are applied. In other words, the reduction in savings estimates from reported gross to evaluated gross is much more important than the evaluated NTG ratios.

Home upgrade treats the home as a system. Savings depend on what measures are installed, how these measures interact with each other, and how the occupants interact with their home.

HUP savings: For HUP, the evaluated savings for kWh, kW and therm were far below the PA reported savings. The realization rate for kWh was negative -11.0%. By PA, realization rates ranged from less than zero for BayREN and SDG&E (an increase in usage), to 20.3% for SoCalREN. Realization rates for demand savings averaged 8% statewide. SoCalREN was highest at 18% followed by SCE with 14%. Gas savings fared better with an overall realization rate of 91.3%. At the PA level, realization rates ranged from 26.8% for PG&E to 253.7% for SoCalGas.

The current EUCA model uses simulation savings estimations for three prototype buildings. Savings for each individual home is imputed using these three prototypes.

AHUP savings: For AHUP, the evaluated savings for kWh, kW, and therms also were below the PA reported savings, but closer than HUP. The overall realization rate for kWh was 24.7%. These rates ranged from decreases of 25.2% for PG&E to 17.7% for SDG&E. Realized therm savings were 10.7%.

For AHUP, issues with the engineering simulation models over estimating savings have been pointed out in earlier evaluations. The current CalTrack effort is in the process of addressing this issue.

Savings influences: The program has consistently produced savings below expectations. Potential reasons include the underlying assumptions and engineering models the PA use to estimate household savings. There are multiple programmatic and non-programmatic influences on savings. The percent of evaluated savings is in line with other residential programs such as Home Energy Reports (3% electric) and smart thermostats (13% gas). Survey results indicate that while demographic factors such as, contractor messaging, household income, and customer values all correlate to differences in evaluated savings, the key factor influencing savings is building vintage.

A related topic is climate zones influence. In this and prior evaluations, negative household savings are associated with climate zones 1-4. Billing data did show increases over time. Simultaneously, weather data (primary predictor in billing analysis models) was not well correlated with electric energy usage in these zones throughout the year. DNV GL included other variables such as neighborhood characteristics, day of the week, and hour of the day along with interactive and lag variables, to explain the savings we were finding, but overall the correlation between weather and energy savings was relatively low. Data diagnostics did not reveal an obvious reason for this poor fit.

Recommendations for the program are to target boosting program participation in inland and desert climate zone groups and to promote AHUP with these potential participants to improve program performance. Specifically:

- those who live in homes built before the 1990s,
- were employed full-time, and
- responded to messaging that communicated direct personal benefits.

Free riders: The NTG ratios for HUP and AHUP were relatively high. Both paths seem to be doing a good job influencing homeowners to participate in the program. Based on survey responses, this may be due in part to the aggressive marketing effort by contractors. For most PAs, the net to gross ratios DNV GL estimated from self-report surveys were close to the default value of 85% currently used by all PAs. These were higher than the NTG values in the range of 45% estimated for the 2010-12 program. Overall, AHUP NTG for electric measures is about 10% lower than HUP. PG&E brought the average down because they had a lower NTG ratio and the highest volume of projects. NTG ratios for gas were similar for HUP (76.8%) and AHUP (79.3%). One would expect AHUP projects to have more free-riders. AHUP projects are more involved and more expensive than HUP projects on average, so homeowner may already be committed to the project before talking to a program qualified contractor.

Data quality: The level and quality of project data created several issues for this evaluation. It is not a stretch to say that the low realization rates reported here can partially be traced back to extreme values and redundant reporting of savings in the program tracking data. We found single-family projects with multiple entries (i.e. one for each measure) that reported project level savings for each entry instead of the savings associated with each measure. For example, if we found 100% of the project level savings, but these savings were reported four times for the same project, the realization rate for that project reduces from 100% to 25%. In other cases, extreme values (positive and negative) affected realization rates.

In addition, only one IOU (SDG&E) was able to provide the simulation model detail data requested for AHUP projects in a timely manner.

Through several evaluations cycles the program data reported in the CPUC tracking data is the biggest hurdle in evaluating the program. The most common issues are:

- Project miss-classification between multi-family and single family or across PA programs (i.e. Middle Income Direct Install vs Low Income vs Home Upgrade).
- Missing or bad account numbers particularly from duel fuel projects that span two service territories
- Total project savings reported for each measure when a project has multiple entries in the data base
- Extreme values relative to other projects. These may be typographical errors.
- Customer email address is the contractor’s or, as with SDG&E, not collected by the program.

6 RECOMMENDATIONS

DNV GL recommends that the PAs review several aspects of the program.

HUP

Review and correct savings expectations and tracking data for reasonableness. Specifically,

- In the program database, filter for outliers, zero values, and negative values
- Verify the household account numbers for each fuel type and identify service provider
- Collect home vintage. Different building codes and techniques will affect savings differently and may help improve program targeting
- Collect home square feet and number of floors before and after the project
- Develop a consistent definition for project duration. DNV GL recommends project start date as "date of contract signing". For end date, we recommend "project inspection date".
- Continue or begin to verify measure installations for a wider sample of homes - particularly in coastal climate zones
- Review the electric and gas assumptions and calculations in the EUCA model for reasonableness relative to customer bills. Typical savings should be about 5% to 10% of annual usage. If possible, compare a sample of projects in EUCA and EnergyPro or eQuest for consistency of savings estimates.

AHUP

Review and correct savings expectations and tracking data for reasonableness. Specifically,

- In the program database, filter for outliers, zero values, and negative values
- Verify the household account numbers for each fuel type and identify service provider
- Collect home vintage. Different building codes and techniques will affect savings differently
- Collect home square feet before and after the project. A household increase actually may be decrease on a per square foot basis
- Develop a consistent definition for project duration. DNV GL recommends project start date as "date of contract signing". For end date, we recommend, "project inspection date".
- Collect and review model inputs and outputs from contractors using simulation software.
    - Check for square feet and vintage information
    - Check for number and type of measures installed
- Continue or begin to verify measure installations for a wider sample of homes particularly in coastal climate zones

Savings influences: Upgrading the building envelope is not enough to affect usage. The program should target the inland climate zones and should incorporate a behavioral component to account for potential savings.

Regarding climate zones. DNV GL recommends additional research on projects in climate zones 1-4. Specifically, CalTrack should develop savings kWh estimates for projects in these climate zones to verify the savings estimates from this evaluation.

Based on the results from the customer profiles, DNV GL recommends,

- targeting customers who live in older homes
- focusing on climate zones with a wider range of heating cooling degree days and,

- underscoring immediate customer benefits in contractor messaging (comfort, savings, safety)

Free riders: The programs are doing a relatively good job of avoiding free riders. The recommendations to maintain low free ridership levels are similar to the recommendations under savings influences with some caveats. Targeting older homes may produce more savings, but may also increase free ridership since upgrades in older homes may be initiated by the failure of major appliance such as furnaces, water heaters or air conditioners.

Data quality: A thorough review of the HUP and AHUP program tracking data should be completed by each PA on an on-going basis and certainly each quarter before reporting program status to CPUC. The tracking data should not require several large-scale updates after the close of the program year. This will help ensure accurate quarterly and annual reporting and avoid unnecessary delays of the impact evaluation due to shifting data.

Track and report the number and types of measures being installed in homes. This may require more detailed record keeping. For AHUP, this means collecting the contractor building simulation files and performing quality reviews before committing funds to the project.

At minimum, reviews should include a check for,

- general data entry errors
- duplicate records and associated savings
- durations between project start and stop dates greater than six months
- extreme values in general
- Savings for same measures reported under multiple programs

For AHUP projects in particular, a reasonableness review of savings should be performed by PA program staff on a sample of projects from each contractor to rule out systematic bias caused by misuse of the software, data entry errors, or errors transferring data from model output to program form.

APPENDIX A. PROJECT BLACK-OUT DAYS

The distribution of blackout day duration for electric projects is provided in Table 33. The table shows that approximately 60% of the upgrade projects were in progress between 61 and 120 days. This is true for HUP and AHUP. The exception is SDG&E. For AHUP they report two-thirds (68%) of projects taking from 121 to 365 days. We suspect this long-time period is due primarily to the definition of reported start and stop dates rather than the actual project duration.

Table 33. Blackout period distribution (electric)

PA	Program Path	30 Days	31-60 Days	61-120 Days	121-180 Days	181-365 Days	366+ Days
BayREN	HUP	1.6%	17.6%	56.0%	17.8%	7.0%	0.0%
PG&E	HUP	3.2%	26.6%	70.1%	0.0%	0.0%	0.0%
SCE	HUP	1.2%	29.1%	60.6%	6.3%	2.4%	0.4%
SoCalGas	HUP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SDG&E	HUP	0.0%	11.3%	57.4%	16.9%	12.5%	1.9%
SoCalREN	HUP	6.3%	32.8%	60.9%	0.0%	0.0%	0.0%
PG&E	AHUP	2.9%	36.4%	60.5%	0.0%	0.1%	0.1%
SCE	AHUP	0.9%	24.6%	60.8%	6.0%	6.7%	1.0%
SDG&E	AHUP	0.0%	2.2%	18.9%	25.6%	42.2%	11.1%
SoCalGas	AHUP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Source: DNV GL 101 analysis-blackout
Note: For projects were blackout period was reported as less than 30 days (i.e. 1 day), the blackout duration was set to 30 days to avoid inadvertently overlapping with the upgrade period.

The distribution of blackout day duration for gas projects is provided in Table 34. Not surprisingly the distribution is similar to the electric blackout distribution with about 58% of the upgrade projects between 61 and 120 days of blackout. This is true for HUP and AHUP. The exception is SDG&E. For AHUP they report two-thirds (68%) of projects taking from 121 to 365 days. We suspect this long-time period is due primarily to the definition of reported start and stop dates rather than the actual project duration.

Table 34. Blackout period distribution (gas)

PA	Program Path	30 Days	31-60 Days	61-120 Days	121-180 Days	181-365 Days	366+ Days
BayREN	HUP	1.6%	17.6%	56.0%	17.8%	7.0%	0.0%
PG&E	HUP	3.2%	26.6%	70.1%	0.0%	0.0%	0.0%
SCE	HUP	1.2%	29.1%	60.6%	6.3%	2.4%	0.4%
SoCalGas	HUP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SDG&E	HUP	0.0%	11.3%	57.4%	16.9%	12.5%	1.9%
SoCalREN	HUP	6.3%	32.8%	60.9%	0.0%	0.0%	0.0%
PG&E	AHUP	1.8%	36.3%	61.7%	0.0%	0.0%	0.1%
SCE	AHUP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SoCalGas	AHUP	1.2%	20.1%	44.2%	15.1%	18.9%	0.4%
SDG&E	AHUP	0.0%	3.5%	19.8%	24.4%	41.9%	10.5%

Note: For projects were blackout period was reported as less than 30 days (i.e. 1 day), the blackout duration was set to 30 days to avoid inadvertently overlapping with the upgrade period.

APPENDIX B. DISPOSITION OF HOUSEHOLDS

Before conducting any analysis, the source dataset needs to be validated. For this evaluation, DNV GL started with claim records from the CPUC 2013-2015 program tracking dataset. Using identifier data in the dataset, these claims combined into households. For example, over 40,957 claim records condensed into 19,820 households. To perform the billing analysis, DNV GL matched data from the programs with customer meter data requested from the IOUs. From the 19,820 households in the tracking data, 7,509 households met the criteria to perform a billing analysis for electric savings and 11,002 met the criteria for gas. The disposition of household records during the validation process is tracked in Table 35 (electric) and Table 36 (gas).

Table 35. Disposition of household counts for electric from CPUC tracking file

PA	Path	Not Type = SFH, RES or ANY	Different Accounts / Addresses Linked to Claims	All Account Numbers Are Faulty	Gross Savings=0	Not Enough Usage Data	Data Not Sufficient for Billing Analysis	Data Used in Billing Analysis	Total reported
BayREN	HUP	0	0	14	26	1,633	11	**415**	2,099
PGE	HUP	19	0	0	7	165	3	**100**	294
SCE	HUP	144	0	1	116	1,103	39	**628**	2,031
SCG	HUP	28	0	19	851	70	0	**0**	968
SDGE	HUP	18	5	8	0	295	79	**691**	1,096
SoCalREN	HUP	2	0	4	0	95	19	**394**	514
Total	HUP	211	5	46	1,000	3,361	150	**2,229**	7,002
PGE	AHUP	0	5	1	2,196	1,892	156	**3,975**	8,225
SCE	AHUP	0	0	1	3	203	47	**1,243**	1,497
SCG	AHUP	8	1	2	1,961	934	0	**0**	2,906
SDGE	AHUP	77	1	0	4	36	10	**62**	190
Total	AHUP	85	7	4	4,164	3,065	212	**5,281**	12,818
Total	**Both**	296	12	50	5,164	6,426	363	**7,509**	19,820

Source: DNV GL 660 Analysis

Table 36. Disposition of household counts for gas from CPUC tracking file

PA	Path	Not Type = SFH, RES or ANY	Different Accounts / Addresses Linked to Claims	All Account Numbers Are Faulty	Gross Savings=0	Not Enough Usage Data	Data Not Sufficient for Billing Analysis	Data Used in Billing Analysis	Total reported
BayREN	HUP	0	0	14	28	1,515	0	**542**	2,099
PGE	HUP	19	0	0	7	83	0	**185**	294
SCE	HUP	144	0	1	150	1,736	0	**0**	2,031
SCG	HUP	28	0	19	42	178	1	**700**	968
SDGE	HUP	18	5	8	17	276	0	**772**	1096
SoCalREN	HUP	2	0	4	0	156	0	**352**	514
Total	HUP	211	5	46	244	3,944	1	**2,551**	7,002
PGE	AHUP	0	5	1	931	1,295	3	**5,990**	8,225
SCE	AHUP	0	0	1	9	1487	0	**0**	1,497
SCG	AHUP	8	1	2	2	502	0	**2391**	2,906
SDGE	AHUP	77	1	0	5	37	0	**70**	190
Total	AHUP	85	7	4	947	3,321	3	**8,451**	12,818
Total	**Both**	296	12	50	1,191	7,265	4	**11,002**	19,820

Source: DNV GL 660 Analysis

APPENDIX C. FREE-RIDER AT THE EQUIPMENT LEVEL

The net-to-gross tables in this appendix present the percentages of evaluated gross savings that the programs can claim

Values are for measure selected as installed by survey respondents. Values in parenthesis are standard errors of the attribution estimates.

Table 37 through **Table 39** present the net-to-gross ratios for HUP.

Table 37: HUP, Electric kWh, NTG ratio estimates and standard errors

Measure	BayREN	PGE	SCE	SCG	SDGE	SoCalREN
All Participants	79.3 (21.0)	85.0	94.0 (6.5)	---	81.2 (19.1)	92.9 (6.2)
Overall-Single Decision	33.3 (0.0)		90.4 (11.2)		58.8 (34.2)	38.8 (7.9)
Overall-Multi Decision	100.0 (0.0)		100.0 (0.0)		100.0 (0.0)	98.5 (1.4)
Attic Insulation			100.0 (0.0)		96.8 (4.4)	
Wall Insulation			100.0 (0.0)			
Floor Insulation			100.0 (0.0)			
Air Duct Sealing					100.0 (0.0)	
Heat Pump						
Furnace	0.0 (0.0)				91.7 (0.0)	56.9 (8.1)
Air Conditioning					0.0 (0.0)	48.4 (6.9)
Duct Leakage Reduction			82.2 (20.8)		100.0 (0.0)	97.8 (2.9)
Water Heater			82.2 (20.8)		4.4 (6.1)	15.2 (15.6)
Windows			14.3 (17.7)			

Source: DNVGL 480 analysis

Note: Where sample size was less than 5, attribution was set to the default value of 85% and no standard error is shown.

Table 38: HUP, Electric kW, NTG ratio estimates and standard errors

Measure	BayREN	PGE	SCE	SCG	SDGE	SoCalREN
All Participants	67.7 (21.5)	85.0 (0.0)	99.1 (0.9)	---	90.2 (9.1)	95.0 (5.0)
Overall-Single Decision	43.5 (8.3)		96.6 (1.3)		52.8 (30.5)	44.4 (9.7)
Overall-Multi Decision	79.7 (23.6)		100.0 (0.0)		99.6 (0.3)	99.0 (1.2)
Attic Insulation			100.0 (0.0)		96.4 (5.0)	
Wall Insulation			100.0 (0.0)			
Floor Insulation			100.0 (0.0)			
Air Duct Sealing					100.0 (0.0)	
Heat Pump						
Furnace	23.3 (19.6)				6.8 (3.7)	70.6 (14.5)
Air Conditioning					15.0 (1.9)	42.5 (11.3)
Duct Leakage Reduction			100.0 (0.0)		100.0 (0.0)	98.9 (1.5)
Water Heater			100.0 (0.0)		100.0 (0.0)	11.0 (13.4)
Windows			100.0 (0.0)			

Source: DNVGL 480 analysis
Note: Where sample size was less than 5, attribution was set to the default value of 85% and no standard error is shown.

Table 39: HUP, Gas, NTG ratio estimates and standard errors

Measure	BayREN	PGE	SCE	SCG	SDGE	SoCalREN
All Participants	70.2 (8.0)	85.0 (0.0)	---	69.3 (13.6)	54.0 (12.1)	75.2 (9.4)
Overall-Single Decision	68.1 (8.8)			73.9 (20.7)	38.9 (11.3)	49.1 (4.4)
Overall-Multi Decision	71.7 (11.9)			62.9 (16.0)	91.5 (5.7)	85.8 (7.3)
Attic Insulation				95.9 (4.2)	96.3 (2.8)	
Wall Insulation						
Floor Insulation						
Air Duct Sealing					22.9 (23.4)	
Heat Pump						
Furnace	56.9 (7.2)				6.6 (3.9)	90.6 (8.2)
Air Conditioning				55.0 (32.3)	10.9 (5.5)	10.1 (8.9)
Duct Leakage Reduction				64.4 (27.6)	34.7 (29.1)	35.9 (21.6)
Water Heater					84.2 (12.3)	29.5 (18.8)
Windows						

Source: DNVGL 480 analysis
Note: Where sample size was less than 5, attribution was set to the default value of 85% and no standard error is shown.

Table 40 though **Table 42** present the net-to-gross ratios for AHUP.

Table 40: AHUP, Electric kWh, NTG ratio estimates and standard errors

Measure	BayREN	PGE	SCE	SCG	SDGE	SoCalREN
All Participants	NA	67.8 (5.2)	94.2 (3.0)	---	90.3 (6.0)	NA
Overall-Single Decision	NA	72.8 (5.6)	88.7 (4.4)		79.9 (8.3)	NA
Overall-Multi Decision	NA	63.6 (8.2)	95.5 (3.6)			NA
Attic Insulation	NA	77.1 (9.5)	82.2 (10.8)		92.7 (5.1)	NA
Wall Insulation	NA	83.7 (8.2)	100.0 (0.0)			NA
Floor Insulation	NA	97.5 (2.2)	93.9 (6.2)			NA
Air Duct Sealing	NA	93.5 (5.6)			100.0 (0.0)	NA
Heat Pump	NA	100.0 (0.0)				NA
Furnace	NA	64.0 (11.4)				NA
Air Conditioning	NA	67.4 (12.2)				NA
Duct Leakage Reduction	NA	63.3 (10.2)	100.0 (0.0)			NA
Water Heater	NA	62.0 (8.6)			52.4 (25.0)	NA
Windows	NA	79.4 (6.3)	92.4 (7.7)			NA

Source: DNVGL 480 analysis
Note: Where sample size was less than 5, attribution was set to the default value of 85% and no standard error is shown.

Table 41: AHUP, Electric kW, NTG ratio estimates and standard errors

Measure	BayREN	PGE	SCE	SCG	SDGE	SoCalREN
All Participants	NA	67.7 (4.4)	86.6 (5.9)	---	88.3 (6.1)	NA
Overall-Single Decision	NA	74.1 (3.9)	84.4 (3.8)		79.2 (6.8)	NA
Overall-Multi Decision	NA	62.2 (7.0)	87.1 (7.2)			NA
Attic Insulation	NA	73.6 (7.9)	78.3 (10.7)		90.5 (4.5)	NA
Wall Insulation	NA	87.0 (5.6)	100.0 (0.0)			NA
Floor Insulation	NA	94.3 (3.6)	91.5 (8.2)			NA
Air Duct Sealing	NA	92.4 (3.9)			100.0 (0.0)	NA
Heat Pump	NA	100.0 (0.0)				NA
Furnace	NA	63.3 (7.7)				NA
Air Conditioning	NA	66.1 (11.6)				NA
Duct Leakage Reduction	NA	67.4 (7.4)	99.7 (0.3)			NA
Water Heater	NA	65.2 (6.8)			70.9 (19.8)	NA
Windows	NA	65.9 (7.9)	82.5 (13.0)			NA

Source: DNVGL 480 analysis
Note: Where sample size was less than 5, attribution was set to the default value of 85% and no standard error is shown.

Table 42: AHUP, Gas, NTG ratio estimates and standard errors

Measure	BayREN	PGE	SCE	SCG	SDGE	SoCalREN
All Participants	NA	74.1 (2.7)	---	89.6 (2.8)	90.5 (4.9)	NA
Overall-Single Decision	NA	76.0 (2.9)		80.3 (6.6)	83.7 (6.6)	NA
Overall-Multi Decision	NA	72.4 (4.2)		92.8 (2.8)		NA
Attic Insulation	NA	77.0 (5.0)		81.8 (7.5)	93.3 (4.1)	NA
Wall Insulation	NA	82.2 (5.7)		86.9 (7.2)		NA
Floor Insulation	NA	84.8 (6.2)		92.8 (7.1)		NA
Air Duct Sealing	NA	89.7 (3.7)		97.6 (2.4)	100.0 (0.0)	NA
Heat Pump	NA	100.0 (0.0)				NA
Furnace	NA	65.9 (5.9)		87.3 (8.2)		NA
Air Conditioning	NA	68.5 (8.2)		58.6 (13.5)		NA
Duct Leakage Reduction	NA	71.9 (4.9)		65.4 (15.7)		NA
Water Heater	NA	72.0 (5.1)		89.8 (9.6)	79.3 (15.3)	NA
Windows	NA	72.3 (5.9)		67.4 (14.2)		NA

Source: DNVGL 480 analysis

Note: Where sample size was less than 5, attribution was set to the default value of 85% and no standard error is shown.

APPENDIX D. BILLING ANALYSIS METHODOLOGY

This appendix provides a detailed discussion of the billing analysis methodology used in this study. It may be used as a reference for the study results or as a standalone document on the technical aspects of this evaluation. As such, some of the language and exhibits from the main report are repeated in the appendix.

The purpose of this impact evaluation was to estimate the change in electric demand (kW), and electric and gas energy savings (kWh, therms) for Home Upgrade Program participants who completed their upgrade in program year 2013-2014.

To quantify the energy savings estimates for this study, DNV GL used "pooled billing analysis," a method that involves comparing energy consumption among participants before and after program participation. The billing analysis for this study is considered pooled because the models used to estimate the impact of the program were estimated using all participants.[36]

With this type of a model, for any particular time under consideration, those participants who enrolled after the time period are considered a control group when estimating model parameters and those participants who enrolled before the time period are considered the treatment group. The use of later participants as a control group allows the billing analysis—at least to some extent—to control for the effects of participant self-selection bias and various exogenous factors that are unrelated to the program and might otherwise affect a participant's energy consumption in the pre-program and post-program periods.

In a pooled billing analysis, energy consumption is modeled using regression techniques in order to account for year-specific anomalies that might affect consumption, such as outside temperature extremes and various additional fixed effects. An average normalized annual consumption (NAC) is computed among program participants using the fitted models for both the pre- and post-program periods. The difference between the two is the gross savings estimate that might be attributed to the program. Note the estimate is largely considered a "gross" savings estimate because it does not account for effects of factors such as free ridership and spillover.[37]

For this evaluation, we modeled, energy usage for two fuels - electricity (kWh) and gas (therms) - using a pooled billing analysis.[38] The kWh fitted model was subsequently used to estimate the effect of the program on electricity demand (kW). Details of the modeling and estimation process are presented in this Appendix. Additional final results from this billing analysis can be found in Appendix B.

Basic model

The billing analysis used to evaluate the effect of the Home Upgrade Program on electricity and gas consumption used a two-phase, fixed effects pooled billing model methodology. The analysis is considered two-phased because models were estimated at two different steps in the process[39] (this is discussed below).

[36] BayREN and SoCalREN values are not reported due to the small sample sizes available, but the results in this appendix include 10 BayREN and 42 SoCalREN home upgrade projects.

[37] See Jayaweera and Haeri (2013) for more details on pooled analysis

[38] The "pool" is statewide, however HDD and CDD are taken into account for each participating home since two homes in the same climate zone can experience different temperatures during the same hour.

[39] A set of models were estimated to obtain an appropriate heating, cooling, and dew-point degree day base value for each participant. This is considered phase 1. The estimation of the final billing models is considered phase 2. These are discussed in Steps #2 and #4 later in this section.

The various models estimated during the billing analysis used linear regression techniques, and were a variation of the well-documented and widely used PRISM®[40]

An important feature of the PRISM model is its use of weather data as predictors. This makes it both unique and applicable for measuring energy savings. Weather predictors were included in the models by constructing heating, cooling, and dew-point degree day values for each participant and each time period.[41] The computation of the heating, cooling, and dew-point degree day values for this billing analysis is discussed in Section A.3.

The following equation shows the basic PRISM linear model that was considered in this billing analysis:

$$E_{ki} = \mathbf{z}_{ki}\boldsymbol{\gamma} + \mathbf{x}_{ki}\boldsymbol{\beta} + \varepsilon_{ki} \tag{1}$$

Where the subscript i denotes participant, k is time period (time period can be month, day, or hour in this evaluation, depending on the specific model under consideration), and

E_{ki} is the energy consumption for participant i and time period k. This equals kWh for the electric billing models and therms for the gas billing models. This data item came from billing data and metered interval data from the six PAs noted in the previous section.

$\mathbf{z}_{ki}$ is a vector of model explanatory variables that are not a function of any program-related variables. For this evaluation, this vector included an assortment of variables, including weather data (degree-days), year/month indicators, and house-level (or participant-level) indicators.

$\mathbf{x}_{ki}$ is a set of model explanatory variables that are a function of program-related variable(s). Elements in this vector were equal to zero for time period k in the pre-blackout period (blackout period is defined below) for each participant and were generally something other than zero for periods in the post-blackout period. Often some or all of the components of $\mathbf{x}_{ki}$ are interaction terms between a 0/1 program indicator for (k,i) and the variables in $\mathbf{z}_{ki}$

$\boldsymbol{\gamma}$, $\boldsymbol{\beta}$ are the model coefficients that are estimated in a least squares, regression estimation process.

ε_{ki} is the model random error term.

The blackout period for a participant refers to the total time period in which program measures were installed. This is defined uniquely and independently for each participant as the time period between the participant's earliest installation date among all Home Upgrade measures and the latest completion date among all Home Upgrade measures. If the blackout period was less than 30 days, it was assumed to equal the time period between the installation date and installation date + 30 days.

[40] PRISM® (PRInceton Scorekeeping Method) is copyright protected. Copyright 1995, Princeton University. All rights reserved.

[41] One of the earliest references to the PRISM model can be found in Fels (1986).

Returning to Equation (1), assume the estimated $\boldsymbol{\gamma}$ and $\boldsymbol{\beta}$ are $\hat{\gamma}$ and $\hat{\boldsymbol{\beta}}$ respectively, and note that for any particular $\mathbf{z}_{ki} = \tilde{\mathbf{z}}_i$ and $\mathbf{x}_{ki} = \tilde{\mathbf{x}}_i$, the model-predicted amount of energy use before program participation for participant i is the following:

$$\hat{E}_{i,before} = \tilde{\mathbf{z}}_i \hat{\boldsymbol{\gamma}} \tag{2}$$

And the predicted amount of energy use <u>after</u> program participation is the following:

$$\hat{E}_{i,after} = \tilde{\mathbf{z}}_i \hat{\boldsymbol{\gamma}} + \tilde{\mathbf{x}}_i \hat{\boldsymbol{\beta}} \tag{3}$$

So, the difference in energy use that can be attributed to the program is found by subtracting Equation (2) from Equation (3), which results in the following:

$$\Delta\hat{E}_i = \hat{E}_{i,after} - \hat{E}_{i,before} = \left(\tilde{\mathbf{z}}_i \hat{\boldsymbol{\gamma}} + \tilde{\mathbf{x}}_i \hat{\boldsymbol{\beta}}\right) - \left(\tilde{\mathbf{z}}_i \hat{\boldsymbol{\gamma}}\right) = \tilde{\mathbf{x}}_i \hat{\boldsymbol{\beta}} \tag{4}$$

When $\Delta\hat{E}_i$ is negative, this indicates some energy *savings* can be attributed to the program. Energy savings are reported in tabulations as $-\tilde{\mathbf{x}}_i \hat{\boldsymbol{\beta}}$.

Also, when needed, an estimate of <u>annual</u> energy savings is logically found by multiplying the change $\Delta\hat{E}_i$ from Equation (4) by an appropriate scale factor that depends on the time period associated with *k*. For example, for the gas billing model, Equation (1) was estimated using monthly billing data, *k* represented day, and $\Delta\hat{E}_i$ was multiplied by 365 to arrive at an annual estimate.

This pooled billing analysis conducted for this evaluation was a six-step process:

- **Step 1:** First, we aggregated consumption data into one analysis file, defined the blackout period for each participant, and identified the participants who were eligible for the billing analysis. Ultimately there were 619 participants used in the electric billing analysis, 623 participants used in the gas billing analysis, and the two sets overlapped for 41 participants. In other words, 41 participants were used in both the electric and gas billing analyses. This step is discussed further in Section A.2.
- **Step 2:** We obtained weather data for the weather station(s) closest to each participant and defined heating, cooling, and dew-point degree days. A variation of Equation (1) was used to determine an optimal, individual heating, cooling, and de- point degree day base value for each participant. The base values were used in the computation of degree days. This step is discussed further in Section A.3.
- **Step 3:** We obtained additional explanatory variables that were considered for inclusion in the vectors $\mathbf{x}_{ki}$ and $\mathbf{z}_{ki}$. For this evaluation, additional zip-code level variables were obtained from the 2009-2013 5-Year American Community Survey (ACS) available from the U.S. Census Bureau. This step is discussed further in Section A.4.
- **Step 4:** The final, full billing models were fitted using the data from Steps #1 through #3. Four pooled billing model sets were fit for this evaluation. Two of these were fit for quality control and comparative purposes only.

1. The first set involved fitting 365 pooled billing models to predict kWh savings for each day of the calendar year. These models contained hour-specific indicators so that both a day and hour effect could be estimated.
2. A more classical, monthly billing model was estimated to predict kWh savings.
3. A monthly billing model was fit to estimate therm savings over an entire calendar year.
4. A monthly billing model was fit to estimate therm savings for the winter monthly only in a calendar year.

 The winter months are defined as the six-month period between November and April. Model sets #1 and #4 were used to produce the final estimate of savings attributed to the program for kWh and therms, respectably. Models #2 and #3 were estimated for comparative and quality control purposes only. This step is discussed further in Section A.5.

- **Step 5:** The estimated model parameters from Step #4 were used to derive an estimate of kWh and therm savings attributed to the program by various characteristics such as region, day, and hour. This is discussed further in Section A.6.
- **Step 6:** The fitted 365 kWh models were used to estimate the average peak demand (kW) for each program participant. This is discussed further in Section A.7.

Section A.8 presents a discussion of the computation of realization rates associated with this program. Realization rates for electricity savings, gas savings, and demand are discussed. The last section of this Appendix, Section A.9, presents some suggestions for any subsequent billing analysis that might be conducted with this population.

Gathering data from billing files

The analysis file that used during the model estimation process is a critical component of the billing analysis.

Goals when Creating an Analysis File for the Billing Analysis

For a billing analysis, the goals are:

- To identify and account for all evaluation-eligible participants during the reference period of interest
- To define exactly when each participant enrolled in the program and received all their program measures (i.e., to define each participant's blackout period)
- To gather at least 12 full months of data before and after each participant's blackout period so that seasonal fluctuations can be accounted for in the pre/post comparisons

For a variety of reasons, virtually no billing analyses attain this goal for *all* participants, so the challenge is to come as close as possible given the time, data, and budget constraints for the analysis.

Data Inputs

For this evaluation, the analysis began with several files obtained from the six regions. These included:

- A list of account numbers corresponding to 2013-2015 program participants. Depending on the region, sometimes these referred to electric accounts, sometimes gas accounts, and sometimes both.
- Master account-level files for all 2015 customers. DNV GL has these files for all regions, all customers, and for both gas and electric accounts.
- Hourly, and for some regions 15-minute, kWh interval data and daily therm interval data for program participants. The 15-minute interval data was aggregated to the hour level to be consistent with other regions. Because therm interval data was only available for some regions and for a small number of

- customers, monthly billing data was used for the therm-level evaluation instead. Electric (kWh) interval data was available from 2011-2015, depending on the region and participant.
- Monthly gas billing data for all customers in the six regions. This was available for 2011-2016.
- A program tracking file that provided measure-level installation and completion dates for participants in all IOU and REN efficiency programs initiated within each service territory.

For quality control purposes, the hourly kWh interval data was compared to the monthly kWh billing data that were available for all customers in the six regions. The billing data was used to fit both models. The agreement rate between the two sources was quite high (greater than 94%).

The Day-level models predict usage and savings at the day and hour level, and thus contain various day and hour-level variables. The monthly model predicts usage and savings at the monthly level only and does not contain day or hour-level predictors.

The results suggest the monthly model yields savings estimates that are larger than the day-level models but this doesn't necessarily mean the monthly model predictions are more accurate. In fact, the standard errors on the monthly model estimates are much larger than the day-level model estimates - and this was expected because the number of sample points used to fit the monthly model is quite a bit less than the day-level models.

In addition to yielding smaller standard errors, the day-level models are more likely to yield prediction estimates that have less bias since the model accounts for variation in usage between hours of the day and days of the year - something the more classical monthly billing model does not account for very well.

The important finding from a quality control perspective was the pattern in the estimates. We found, for example, that the results from both models suggested the BayREN estimate were less than the overall “Total” estimate; the PG&E estimates was greater than the Total estimate and the SDG&E estimate was quite a bit less than the Total estimate.

Data Editing Steps

Given the input files above and the goals for creating the analysis file, the editing and file creation process proceeded as follows:

1. The process began with the list of accounts associated with all participants (File #1). Since data quality varied by region, the initial step was to identify any missing gas accounts associated with electric accounts—and any missing electric accounts associated with gas accounts—in this file. We assumed that this file contained at least one of the two accounts (gas or electric) for all participants that should be considered for this billing analysis.
2. For some PA, a participant’s gas and electric account number and/or premise number were the same; identifying missing gas or electric records in the file was relatively straightforward for these PAs. For others, the master account file was used (File #2) to link gas and electric accounts for all participants considered for this evaluation. Customer name, address, and telephone number were used in this record linkage exercise, accounting for potential variations in spelling and abbreviations in the text fields.
3. Next, the output file from the previous step was linked to the tracking file (File #5) in order to determine when Home Upgrade measures were installed. The data items of interest at this step were measure installation date and completion date. As noted earlier, a blackout period was defined using

these data items for each participant. Additional discussion on the duration and timing of the blackout period is presented below.

4. The consumption data from File #3 and #4 above were then merged with the gas/electric participant-level file from the previous step. Consumption data were sought and retained (if possible) for each participant for the 460-day period before and after the participant's blackout period.

5. Lastly, DNV GL examined records and determined whether they were suitable for inclusion in the final billing analysis. For various reasons, a large number of participants could not be included in the billing analysis and were therefore omitted from the analysis file at this final step.

6. The primary reason customers were not included in the billing analysis was that they did not have enough monthly data in either the pre-or post-periods. Some of this is due to data simply not being available; for example, a new customer may not have enough data prior to the blackout period, and a customer who moved may not have enough data in the post period. Since most Home Upgrade projects occurred later in the program cycle most customers were excluded because they did not have sufficient data available in the post-period due to the timing of the consumption data files that were used. As an example, the disposition of records for the gas analysis is reported in **Error! Reference source not found.**.

Timing and Duration of the Participants' Blackout Period

As noted earlier, the blackout period for any participant is defined as the time span between the earliest installation date and the latest completion date for the home. These fields are in the tracking data identified as "StartDate" and "ProjectCompletionDate". These are separate from other fields for application dates, contract sign dates, and rebate payment dates. The average blackout period varied across PAs and ranged from 1 to 300 days. For our analysis when the blackout period was one-day, the minimum blackout period was adjusted to 30 days (project start date plus 30 days). We adjusted this period to mitigate any date reporting quality issues and to be sure that the upgrade was fully completed for pre- and post- comparisons. The PA with the longest average blackout period was SCE with 179 days. The shortest average was SoCalREN at 30 days.

Weather data and defining heating, cooling, and dew-point degree days

The next step in the billing analysis was to gather appropriate temperature and dew-point data that would be used to construct some independent variables for the billing models. Two sets of data were obtained. The first set is the CZ2010 hourly temperature and dew-point data recorded from various weather stations in California. Temperature and dew-point values were assigned to each program participant using weather station data from the three geographically closest weather stations to the participant. These data were obtained from the National Oceanic and Atmospheric Administration (NOAA). Three stations were considered in order to account for anomalous weather data in the NOAA files. For each day and each hour in the participant's pre- and post-blackout periods, an outside temperature and dew point were assigned to the participant as the median value from the three closest stations that had data available.

The second set of weather data obtained was the Typical Meteorological Year (TMY) weather data[42] for the same set of weather stations in California. The TMY data are also available from NOAA. These temperatures and dew points were derived using 30 years of historical data. These normalized temperatures and dew

[42] The TYM3 data sets derived from the 1961-1990 and 1991-2005 National Solar Radiation Data Base (NSRDB) archives (http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/).

points represent the outside temperature/dew point per hour for every day in a “typical” calendar year that one would expect at any given weather station. For this analysis, DNV GL used the third edition of the published TMY data (TMY3 data, for short) to derive normalized annual predications of energy savings from the Home Upgrade Program. As with the CZ2010 data for 2011-2016, TMY data were assigned as the median value of temperature and dew point among the three geographically closest stations to each participant.

As noted earlier, one of the distinguishing features of the PRISM linear regression model is the use of weather data as predictors. Weather data were included in the billing models estimated in this evaluation in the form of heating, cooling, and dew-point degree days, and are included in the PRISM model [see Equation (1)] as components of the explanatory variables in the vectors $\mathbf{z}_{ki}$ and $\mathbf{x}_{ki}$. The degree days are computed by comparing the outside temperature and dew point to some fixed base values. Optimal base values for the heating, cooling, and dew-point degree days were computed separately for each participant. The use of base values that are allowed to vary among participants improved the fit of the pooled billing model (discussed below) by accounting for a greater proportion of the variation in energy use among participants.

In general, heating and cooling degree days are a measure of the deviation between the outside temperature and some specified heating and cooling degree base values. For each billing period and for each household participant, heating and cooling degree days are defined as:

Heating Degree Days

$$HDD_{i,k} = \sum_{\substack{j \in Hours\ in \\ Time\ Period\ k}} Max\{BASE_{heat,i} - Hourly\ Temperature_j, 0\} \quad (5)$$

Cooling Degree Days

$$CDD_{i,k} = \sum_{\substack{j \in Hours\ in \\ Time\ Period\ k}} Max\{Hourly\ Temperature_j - BASE_{cool,i}, 0\} \quad (6)$$

Dew-Point Degree Days

The dew point degree days were computed in a manner similar to the cooling degree days, as follows:

$$DDD_{i,k} = \sum_{\substack{j \in Hours\ in \\ Time\ Period\ k}} Max\{Hourly\ Dewpoint_j - BASE_{dew,i}\} \quad (7)$$

The heating and cooling degree base values were computed for each program participant by fitting the following variation of Equation (1) for each household participant independently.

$$E_{ki} = \mathbf{z}_{ki}\boldsymbol{\gamma}_i + \mathbf{x}_{ki}\boldsymbol{\beta}_i + \varepsilon_{ki} \quad (8)$$

Where:

- E_{ki} is the kWh or therm consumption value for participant *i* and time period *k*.
- $\mathbf{z}_{ki}$ is a set of model explanatory variables that are not a function of any program-related variables. This vector included an intercept term, HDD_{ki} and CDD_{ki}.

- $\mathbf{x}_{ki}$ is a set of model explanatory variables that are a function of program-related variable(s). This vector included the main effect term $PROGRAM_{ki}$ (0/1 program indicator for *k,i*) as well as the interaction terms $PROGRAM_{ki} \cdot HDD_{ki}$ and $PROGRAM_{ki} \cdot CDD_{ki}$.

For each participant, the model parameters that were estimated in Equation (8) via nonlinear least squares are $\hat{\gamma}_i$, $\hat{\boldsymbol{\beta}}_i$ as well as the base values $BASE_{heat,i}$ and $BASE_{cool,i}$. This is considered a nonlinear model because the base values, in addition to the model parameters, are model unknowns whose values are determined via the least squares process. At this step, the primary outcomes of interest are the estimated base values $BASE_{heat,i}$ and $BASE_{cool,i}$ for each participant *i*.

The optimal dew-point degree day base value was computed using a second set of participant-level models that were analogous to those used to obtain the heating and cooling degree day base values for each participant. For the dew-point degree day base value models, the vector $\mathbf{z}_{ki}$ contained the term DDD_{ki}, and $\mathbf{x}_{ki}$ contained $PROGRAM_{ki}$ and $PROGRAM_{ki} \cdot DDD_{ki}$.

The average degree day base values by region are presented in Table 43. The average heating, cooling, and dew-point degree base values over the 619 participants used in the kWh billing analysis were 61.1, 70.7, and 49.0 degrees, respectively. For the therm billing analysis, only heating degree day base values were computed, since cooling and dew-point degree days are generally not correlated with gas use. The average heating degree day base value over the 132 participants used in the therm billing analysis was 63.5 degrees. A generally accepted assumption is that households would begin using their heating systems at around 60 degrees and their air conditioning systems at around 70 degrees,[43] and that dew points greater than 60 are generally considered "uncomfortable."

[43] The 60 and 70-degree heating and cooling degree base values are recommended in Jayaweera and Haeri (2013) when individual base values are not computed.

Table 43. Average degree-day base value among participants used in the billing analysis

Fuel	PA	Heating	Cooling	Dew Point
Electric	Total	61.1	70.7	49.0
	BayREN	59.5	70.3	46.8
	PG&E	61.0	71.5	48.0
	SCE	61.6	70.2	49.6
	SoCalREN	61.1	68.6	51.4
	SDG&E	61.5	67.6	53.4
Gas	Total	63.5	n/a	n/a
	BayREN	70.1	n/a	n/a
	PG&E	69.7	n/a	n/a
	SoCalGas	63.1	n/a	n/a
	SoCalREN	61.4	n/a	n/a
	SDG&E	61.4	n/a	n/a

Gathering additional explanatory variables

In order to account for a greater portion of the variability in the consumption data, various additional data items were extracted from the 2009-2013 American Community Survey (ACS) and merged to the analysis file by zip code. Data items included:

- Percent of households in zip code with gas heat
- Percent of households in zip code with electric heat
- Median number of rooms in households
- Number of occupants per room
- House value
- Number of bedrooms
- Year house built

These variables were categorized by computing the 33rd and 66th percentiles among participants; the categorical versions of the variables were included in the vectors $\mathbf{Z}_{ki}$ and $\mathbf{X}_{ki}$ in Equation (1). The exact boundaries established in the categorization are displayed—along with some additional model-fitting statistics—in Section A.5 and in Appendix B.

We acknowledge there is measurement error associated with variables constructed from the American Community Survey (ACS). The measurement error is small however relative to the model prediction error. The effect of measurement error is further reduced because (1) the ACS variables were only used to classify zip codes into categories and membership in these categories were used as independent indicator variables in the models and (2) the overall effect of using the ACS variables on the model fit was relatively small. For example, we found on average, including the ACS variables in the model improved the fit of the kWh day-level models by only 0.6%.

Estimating the final fixed effects models

As noted in the introduction of this appendix, two separate billing analyses were conducted: one to estimate the effect of the Home Upgrade Program on electric (kWh) use, and a second to estimate the effect of the program on gas (therm) use. Results from the electric billing analysis were also used to estimate electric demand (kW); this is discussed in Section A.7. Additionally, Section A.1 noted two variations of Equation (1) were fit for each of the two fuel types. So, in total, four model sets were estimated:

Electricity

- **Day-Level kWh Model.** The first model was actually a set of 365-pooled billing models, each of the form displayed in Equation (1). This was model was used to produce the final estimates of kWh savings attributed to the Home Upgrade Program.[44]
- **Monthly-Level kWh Model**. Hourly interval data was collapsed to the month level and a more classical monthly billing analysis was performed. This was done for comparative and quality control purposes only.

Gas

- **Monthly-Level Therm Model, Annual**. A billing analysis was conducted using the monthly therm billing data. This analysis used billing data associated with all months in the pre- and post-program periods. The final estimates of the impact of the program on gas use were derived from this model.
- **Monthly-Level Therm Model, Winter Months Only**. A billing analysis was conducted using the monthly therm billing data, winter months only. The winter months were November 1 to April 30. Using the winter months only to examine the effect of a program on gas usage is common. Gas use tends to be relatively low and constant during the warmer months, and the fixed effects billing model tends to fit the therm billing data better when only the winter months are considered.

This section discusses each of these four model sets in turn.

Day-level kWh model

To estimate the effect of the HUP and AHUP programs on hourly electric use, a separate billing model was fit for each program and for each day of the year. So, 365 models were estimated for each program. For any particular day of the year, billing data for those program participants that had billing data available for the day of the year during the 12-month period strictly before and after their program installation period were used to estimate model parameters.

Table 1 below summarizes the sample sizes used to estimate the model parameters. There were 4,351 eligible households in the HUP program and 51% of these (2,229) had available and sufficient billing data to be used in the model estimation process (on average over the 365 models). And there were 8,558 eligible households in the AHUP program and 62% of these (5,281) had available and sufficient billing data to be used in the model estimation process.

Table 1. Eligible Households and Sample Sizes Used to Estimate kWh Model Parameters

Program	Total Eligible Households	Average[1] Number of Households Used to Estimate Parameters in kWh Savings Models	Average[1] Number of Data Points (Hour-Level Consumption Values) Used to Estimate Parameters in kWh Savings Models
HUP	4,351	2,229	1,576,631

[44] Prediction estimates of kWh savings and consumption were computed for each day in a typical meteorological year (TMY) using the day-level models. These estimates were summed across days to get the annual estimates.

AHUP	8,558	5,281	3,729,998

[1]Average over the 365 models

Model parameters were estimated by fitting a weighted linear regression model. Weights were constructed so that the sample of participants used in the billing analysis would represent the total eligible population of participants for each program. Ultimately, model predictions of program savings were desired for each eligible participant, not just those were used to estimate the model parameters.

Parameters for each of these day-level models were estimated using the billing data for the day under consideration, as well as the seven days prior to and the seven days after the day under consideration. For example, the model used to estimate savings on January 1 used billing data from January 1, as well as billing data from December 25-31 and January 2-8. The 15-day period was included in each of the day-level models for two main reasons:

1. To include the effect of the day of the week in the model. For example, a calendar day such as January 1 will not fall on the same day of the week each year.
2. Using 15 days of data helped ensure continuity among model predictions for consecutive days. Note the parameters of the models associated with any two consecutive days will be estimated using 14/15 = 93% of the same consumption data, so one would not expect to see unnatural, sudden jumps in the estimated savings between consecutive days in an 8,760 day-by-hour analysis.

Each of the 365 models included 15 intercept terms to identify whether the consumption value was associated with the day under consideration (considered day=0), day-1,…, day-7 or day+1,…, day+7. Other terms incorporated in each of the day-level models included:

1. A separate intercept term for each participant
2. Year indicator to identify whether a consumption value was from the 2011, 2012, 2013, 2014, 2015 or 2016 billing data
3. Hour-level indicators for each hour of the day
4. Day of the week and holiday indicators. The holiday indicator flagged particular “holiday” days of the year that don’t naturally fall on the weekend and in which one would expect energy consumption to be atypical. For this billing analysis, holidays were defined as: Christmas Eve, Christmas Day, New Year’s Eve, New Year’s Day, Labor Day, Memorial Day, Independence Day, Thanksgiving, and the Friday after Thanksgiving.
5. Heating, cooling, and heat index degree days
6. Temperature and heat index 1 hour ago.
7. Average daily temperature, heat index, heating, cooling and heat index degree days for the previous day and two days ago.
8. The interaction of heating degree days with a weekday/weekend indicator and hour-level indicators
9. The interaction of cooling degree days with a weekday/weekend indicator and hour-level indicators
10. The interaction of heat index degree days with a weekday/weekend indicator and hour-level indicators
11. The interactions of heating and cooling degree days with various zip code level indicators derived from the American Community Survey (ACS)
12. PROGRAM indicator. This was set to 1 when a billing consumption value corresponded to a post period for a participant; otherwise, it was set to 0
13. PROGRAM indicator interaction with #3-#11 above

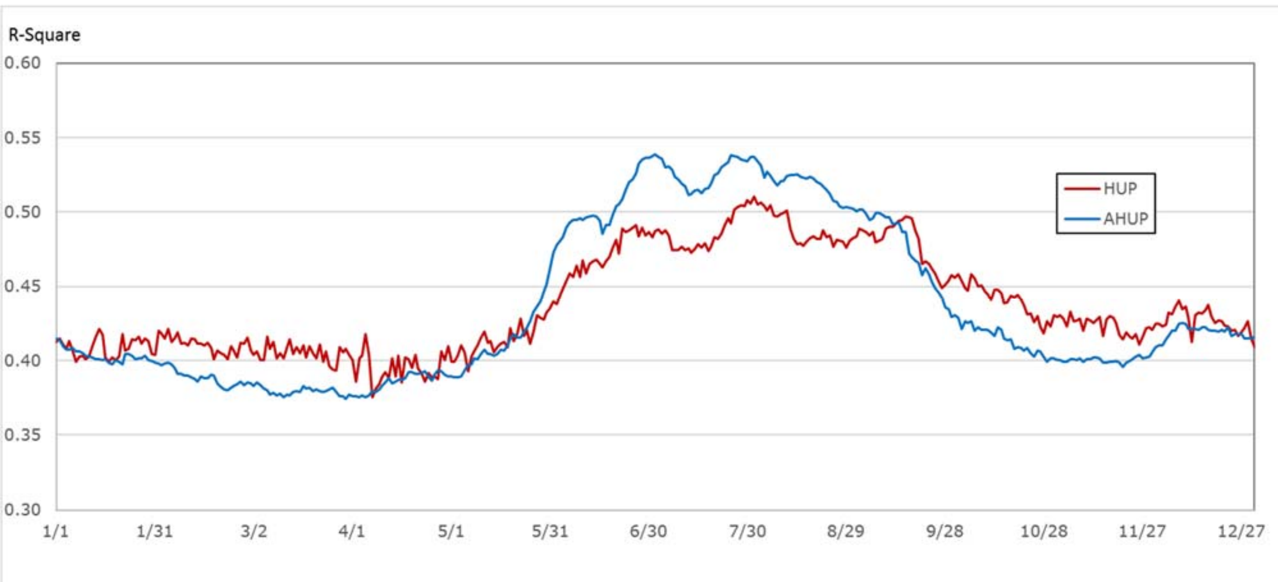
Main effects for ACS indicators mentioned in #11 were not included in the day-level models because these are participant-level variables, and the model already contained a separate intercept for each participant.

A summary of the significance of the model parameters in the 365 models for both the HUP and AHUP programs is presented in APPENDIX E.

One of the statistics that is often used to measure the fit of a fixed-effects model is the coefficient of determination, or R-squared. The coefficient of determination ranges from 0 to 1 for a linear model, and values closer to 1 indicate a "better fit." Higher R-squared values indicate the explanatory variables are explaining a larger proportion of the variation in the dependent variable, and hence the model is a "better fit" for the data.

Figure 2 shows the adjusted R-squared estimates for the 365 HUP and AHUP models. The average R-squared value was 0.437 for the HUP models and 0.436 for the AHUP models. These values tend to be a little greater during warmer months when consumption is greater, i.e. between June and September.

Figure 2: Adjusted R-Square by Day for HUP and AHUP kWh Models



Monthly level therm model

To estimate therm savings for eligible participants in the HUP and AHUP programs, a monthly level model was estimated. Table 2 summarizes the eligible population and sample sizes for the Therm model for both the HUP and AHUP programs:

Table 2. Eligible Households and Sample Sizes Used to Estimate Therm Model Parameters

Program	Total Eligible Households	Number of Households Used to Estimate Parameters in Therm Savings Models	Number of Data Points (Monthly-Level Consumption Values) Used to Estimate Parameters in Therm Savings Models
HUP	5,108	2,551	72,746
AHUP	11,775	8,451	248,871

The explanatory variables used in the model included:

1. A separate intercept term for each participant
2. Month-level indicator
3. Year indicator to identify whether a consumption value was from the 2011, 2012, 2013, 2014, 2014, or 2016 billing data
4. The interaction of year and month
5. Heating, cooling and heat index degree days
6. The interactions of heating and cooling degree days with various zip code level indicators derived from the American Community Survey (ACS)
7. PROGRAM indicator. This was set to 1 when a billing consumption value was taken in the post period for a participant; otherwise, it was set to 0.
8. PROGRAM indicator interaction with #5 and #6 above

A summary of the model parameters is presented in APPENDIX E.

The adjusted R-squared from the fitted therm model for the HUP program was 0.661 and the adjusted R-square for the AHUP model was .746. This indicated the linear model fit the observed therm values slightly better for those homes in the AHUP program than for the HUP program.

Estimating demand (kW) savings

Peak kW savings was estimated using predictions from the day-level kWh billing models and the definition of kW savings suggested by the PG&E Avoided Cost Calculator in the document "INSTRUCTIONS for PG&E Avoided Cost Calculator (E-3 Calculator, Version 2d3)" (PGE, 2015). These instructions indicate peak kW savings should be estimated as follows:

> "…peak kW savings is defined as the average grid impact for the measure from 2 pm to 5 pm during the three-consecutive weekday period containing the weekday with the hottest temperature of the year. This definition is consistent with the definition used in the 2005 Database for Energy Efficiency Resources (DEER)."

To apply this definition to our billing analysis model predictions, DNV GL first identified the hottest day in a typical year for the eligible program participants. This was September 1 for both the HUP and AHUP programs. And the hourly level predictions for August 31, September 1 and September 2 during the hours of 2 pm to 5 pm were combined and averaged to derive the final estimate of demand.

APPENDIX E. SUMMARY OF THE SIGNIFICANCE OF THE MODEL EXPLANATORY VARIABLES

This appendix summarizes the significance of the model parameters estimated for each of the four model sets discussed in APPENDIX D. Four exhibits are presented for the models used to generate the final estimates of kWh and gas savings from HUP and AHUP:

- Table 44 summarizes the significance of the model parameters from the 365 fitted models associated with the HUP/AHUP day-level, kWh model set.

Separate intercept terms for each participant were included in all models. The statistical significance of these terms is not available due to the methodology used to estimate the model parameters.

Some model parameters will have a significance of "n/a." These are generally associated with levels of categorical variables that are serving as the reference cell in the model.

Table 44. Summary of the significance of the model parameters for kWh AHUP models

Parameter Number	Variable	Label	Percent of Time Variable Was Included in HUP Models	Percent of Time Variable Was Significant in the HUP Models at .10 Level	Percent of Time Variable Was Included in AHUP Models	Percent of Time Variable Was Significant in the AHUP Models at .10 Level
1	X2011	2010/2011 Indicator	0.0%	0.0%	0.0%	0.0%
2	X2012	2012 Indicator	95.1%	97.1%	95.6%	98.3%
3	X2013	2013 Indicator	92.1%	97.3%	94.5%	96.8%
4	X2014	2014 Indicator	90.4%	94.8%	95.6%	98.3%
5	X2015	2015 Indicator	93.2%	97.9%	90.1%	94.5%
6	X2016	2016 Indicator	0.0%	0.0%	0.0%	0.0%
7	XDIFF0	Difference Between Current Day and Model Target Day=0, Current Day	87.1%	91.8%	87.9%	92.5%
8	XDIFF1	Difference Between Current Day and Model Target Day=-7 Days Ago	87.4%	95.9%	92.6%	94.1%
9	XDIFF2	Difference Between Current Day and Model Target Day=-6 Days Ago	86.6%	95.9%	90.4%	96.1%
10	XDIFF3	Difference Between Current Day and Model Target Day=-5 Days Ago	91.8%	95.5%	91.2%	95.8%
11	XDIFF4	Difference Between Current Day and Model Target Day=-4 Days Ago	89.6%	92.7%	91.5%	96.4%
12	XDIFF5	Difference Between Current Day and Model Target Day=-3 Days Ago	86.3%	94.6%	89.9%	97.6%
13	XDIFF6	Difference Between Current Day and Model Target Day=-2 Days Ago	89.0%	91.4%	91.5%	94.3%
14	XDIFF7	Difference Between Current Day and Model Target Day=-1 Days Ago	86.6%	94.6%	89.0%	93.8%
15	XDIFF8	Difference Between Current Day and Model Target Day=+1 Days Ago	84.7%	93.9%	85.5%	95.8%
16	XDIFF9	Difference Between Current Day and Model Target Day=+2 Days Ago	85.2%	93.6%	89.6%	94.2%

17	XDIFF10	Difference Between Current Day and Model Target Day=+3 Days Ago	82.7%	91.1%	88.8%	93.8%
18	XDIFF11	Difference Between Current Day and Model Target Day=+4 Days Ago	81.1%	92.6%	88.8%	95.1%
19	XDIFF12	Difference Between Current Day and Model Target Day=+5 Days Ago	80.0%	92.5%	87.9%	95.0%
20	XDIFF13	Difference Between Current Day and Model Target Day=+6 Days Ago	74.5%	90.4%	82.2%	92.7%
21	XDIFF14	Difference Between Current Day and Model Target Day=+7 Days Ago	0.0%	0.0%	0.0%	0.0%
22	XHOUR1	Hour = 1 Indicator	100.0%	100.0%	100.0%	100.0%
23	XHOUR2	Hour = 2 Indicator	100.0%	100.0%	100.0%	100.0%
24	XHOUR3	Hour = 3 Indicator	100.0%	100.0%	100.0%	100.0%
25	XHOUR4	Hour = 4 Indicator	100.0%	100.0%	100.0%	100.0%
26	XHOUR5	Hour = 5 Indicator	100.0%	100.0%	100.0%	100.0%
27	XHOUR6	Hour = 6 Indicator	92.3%	92.3%	86.8%	95.9%
28	XHOUR7	Hour = 7 Indicator	92.1%	95.5%	98.4%	98.3%
29	XHOUR8	Hour = 8 Indicator	95.9%	95.4%	97.3%	99.7%
30	XHOUR9	Hour = 9 Indicator	96.7%	96.0%	97.3%	99.7%
31	XHOUR10	Hour = 10 Indicator	97.0%	98.0%	96.7%	99.4%
32	XHOUR11	Hour = 11 Indicator	98.6%	98.3%	97.8%	99.2%
33	XHOUR12	Hour = 12 Indicator	97.0%	94.6%	99.2%	99.7%
34	XHOUR13	Hour = 13 Indicator	96.4%	91.8%	97.0%	99.2%
35	XHOUR14	Hour = 14 Indicator	89.0%	95.4%	96.2%	94.6%
36	XHOUR15	Hour = 15 Indicator	94.8%	99.1%	97.8%	98.3%
37	XHOUR16	Hour = 16 Indicator	100.0%	99.7%	97.0%	98.3%
38	XHOUR17	Hour = 17 Indicator	100.0%	100.0%	99.7%	99.7%
39	XHOUR18	Hour = 18 Indicator	100.0%	100.0%	100.0%	100.0%
40	XHOUR19	Hour = 19 Indicator	100.0%	100.0%	100.0%	100.0%
41	XHOUR20	Hour = 20 Indicator	100.0%	100.0%	100.0%	100.0%
42	XHOUR21	Hour = 21 Indicator	100.0%	100.0%	100.0%	100.0%
43	XHOUR22	Hour = 22 Indicator	100.0%	100.0%	100.0%	100.0%
44	XHOUR23	Hour = 23 Indicator	100.0%	100.0%	100.0%	100.0%
45	XHOUR24	Hour = 24 Indicator	0.0%	0.0%	0.0%	0.0%
46	XSUN	Sunday Indicator	92.1%	94.6%	98.1%	97.8%
47	XMON	Monday Indicator	89.9%	92.7%	94.2%	97.7%
48	XTUE	Tuesday Indicator	89.6%	94.2%	95.1%	97.4%
49	XWED	Wednesday Indicator	91.2%	97.6%	93.7%	98.2%
50	XTHU	Thursday Indicator	88.2%	93.5%	94.2%	96.8%
51	XFRI	Friday Indicator	86.8%	94.3%	92.6%	99.1%
52	XSAT	Saturday Indicator	0.0%	0.0%	0.0%	0.0%
53	XHOLIDAY	Holiday Indicator	14.8%	87.0%	16.7%	93.4%
54	XWEEKEND	Weekend/Holiday Indicator	8.5%	87.1%	5.8%	100.0%

55	XWEEKDAY	Weekday Indicator	0.0%	0.0%	0.0%	0.0%
56	XTEMP1	Current Temperature	50.4%	89.1%	65.5%	84.5%
57	XINDEX1	Current Heat Index	33.2%	93.4%	47.1%	77.9%
58	XHDD	Heating DD	81.9%	96.0%	83.8%	94.8%
59	XCDD	Cooling DD	57.0%	91.8%	44.9%	94.5%
60	XIDD	Heat Index DD	0.0%	0.0%	0.0%	0.0%
61	XTEMP2	Temperature 1 Hour Ago	60.8%	82.4%	71.5%	84.3%
62	XINDEX2	Heat Index 1 Hour Ago	45.2%	83.6%	59.7%	86.2%
63	XTEMP3	Temperature 2 Hours Ago	65.2%	86.1%	78.6%	91.3%
64	XINDEX3	Heat Index 2 Hours Ago	53.2%	91.8%	62.7%	91.3%
65	XTEMP4	Mean Temperature 1 Day Ago	64.9%	84.8%	64.9%	86.9%
66	XINDEX4	Mean Heat Index 1 Day Ago	40.8%	79.2%	46.0%	84.5%
67	XHDD4	Mean Heating DD 1 Day Ago	79.7%	80.8%	80.3%	89.4%
68	XCDD4	Mean Cooling DD 1 Day Ago	73.2%	89.1%	61.9%	91.6%
69	XIDD4	Mean Heat Index DD 1 Day Ago	34.0%	79.8%	37.0%	90.4%
70	XTEMP5	Mean Temperature 2 Days Ago	64.1%	88.0%	67.7%	91.1%
71	XINDEX5	Mean Heat Index 2 Days Ago	39.2%	86.7%	40.0%	85.6%
72	XHDD5	Mean Heating DD 2 Days Ago	86.6%	89.2%	86.0%	89.2%
73	XCDD5	Mean Cooling DD 2 Days Ago	61.9%	79.6%	61.6%	88.0%
74	XIDD5	Mean Heat Index DD 2 Days Ago	40.3%	84.4%	45.5%	88.6%
75	XCZIP1	Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HU with Gas Heat <= 64.7%	81.9%	91.6%	93.7%	94.2%
76	XCZIP2	Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HU with Gas Heat <= 85.0%	86.8%	89.0%	94.0%	91.5%
77	XCZIP3	Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HU with Gas Heat > 85.0%	0.0%	0.0%	0.0%	0.0%
78	XCZIP4	Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HU with Electric Heat <= 11.8%	80.8%	91.5%	95.9%	97.7%
79	XCZIP5	Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HU with Electric Heat <= 29.2%	92.6%	95.9%	85.2%	86.5%
80	XCZIP6	Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HU with Electric Heat > 29.2%	0.0%	0.0%	0.0%	0.0%
81	XCZIP7	Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HU with Other Heat <= 0.0%	88.5%	96.0%	85.5%	93.3%
82	XCZIP8	Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HU with Other Heat <= 5.6%	87.9%	93.5%	89.0%	95.1%
83	XCZIP9	Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HU with Other Heat > 5.6%	0.0%	0.0%	0.0%	0.0%
84	XCZIP10	Cooling DD * Neighborhood Indicator Variable: Median	76.7%	91.4%	89.3%	92.9%

		Number of Rooms in HUs <= 5.1				
85	XCZIP11	Cooling DD * Neighborhood Indicator Variable: Median Number of Rooms in HUs <= 6.4	88.2%	93.2%	88.2%	95.7%
86	XCZIP12	Cooling DD * Neighborhood Indicator Variable: Median Number of Rooms in HUs > 6.4	0.0%	0.0%	0.0%	0.0%
87	XCZIP13	Cooling DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs <= 54.5%	87.9%	93.5%	87.7%	92.2%
88	XCZIP14	Cooling DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs <= 84.7%	94.2%	98.3%	75.6%	83.3%
89	XCZIP15	Cooling DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs > 84.7%	0.0%	0.0%	0.0%	0.0%
90	XCZIP16	Cooling DD * Neighborhood Indicator Variable: Percent of Renter Occupied HUs <= 15.3%	0.0%	0.0%	0.0%	0.0%
91	XCZIP17	Cooling DD * Neighborhood Indicator Variable: Percent of Renter Occupied HUs <= 45.5%	0.0%	0.0%	0.0%	0.0%
92	XCZIP18	Cooling DD * Neighborhood Indicator Variable: Percent of Renter Occupied HUs > 45.5%	0.0%	0.0%	0.0%	0.0%
93	XCZIP19	Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 0-.50 Occupants Per Room <= 52.6%	90.7%	94.9%	87.1%	85.2%
94	XCZIP20	Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 0-.50 Occupants Per Room <= 75.7%	86.3%	90.2%	87.9%	87.9%
95	XCZIP21	Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 0-.50 Occupants Per Room > 75.7%	0.0%	0.0%	0.0%	0.0%
96	XCZIP22	Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with .51-1.00 Occupants Per Room <= 22.0%	94.2%	95.6%	86.6%	84.5%
97	XCZIP23	Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with .51-1.00 Occupants Per Room <= 40.1%	90.1%	92.7%	84.4%	98.4%
98	XCZIP24	Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with .51-1.00 Occupants Per Room > 40.1%	0.0%	0.0%	0.0%	0.0%
99	XCZIP25	Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 1.01-1.50 Occupants Per Room <= 0.0%	83.8%	89.9%	94.0%	91.5%
100	XCZIP26	Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 1.01-1.50 Occupants Per Room <= 5.3%	83.0%	90.4%	89.9%	82.0%
101	XCZIP27	Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 1.01-1.50 Occupants Per Room > 5.3%	0.0%	0.0%	0.0%	0.0%
102	XCZIP28	Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 1.51-2.00 Occupants Per Room <= 0.0%	83.8%	95.4%	79.7%	93.5%
103	XCZIP29	Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 1.51-2.00 Occupants Per Room <= 0.7%	85.5%	88.1%	72.1%	90.5%
104	XCZIP30	Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 1.51-2.00	0.0%	0.0%	0.0%	0.0%

		Occupants Per Room > 0.7%				
105	XCZIP31	Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 2.01 Plus Occupants Per Room <= 0.0%	87.4%	90.6%	88.5%	88.2%
106	XCZIP32	Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 2.01 Plus Occupants Per Room <= 0.0%	0.0%	0.0%	0.0%	0.0%
107	XCZIP33	Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 2.01 Plus Occupants Per Room > 0.0%	0.0%	0.0%	0.0%	0.0%
108	XCZIP34	Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 1 Unit Structure <= 68.8%	90.1%	91.8%	76.2%	86.0%
109	XCZIP35	Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 1 Unit Structure <= 100.0%	0.0%	0.0%	0.0%	0.0%
110	XCZIP36	Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 1 Unit Structure > 100.0%	0.0%	0.0%	0.0%	0.0%
111	XCZIP37	Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 2 Unit Structure <= 0.0%	87.9%	95.3%	94.2%	96.2%
112	XCZIP38	Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 2 Unit Structure <= 1.7%	88.5%	93.2%	77.8%	93.0%
113	XCZIP39	Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 2 Unit Structure > 1.7%	0.0%	0.0%	0.0%	0.0%
114	XCZIP40	Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 3+ Unit Structure <= 0.0%	85.8%	88.5%	86.0%	92.4%
115	XCZIP41	Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 3+ Unit Structure <= 24.4%	86.3%	89.2%	86.3%	87.0%
116	XCZIP42	Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 3+ Unit Structure > 24.4%	0.0%	0.0%	0.0%	0.0%
117	XCZIP43	Cooling DD * Neighborhood Indicator Variable: Percent of HUs That Are Mobile Homes, Boat, RV, Van, Etc. <= 0.0%	88.5%	89.2%	83.8%	94.4%
118	XCZIP44	Cooling DD * Neighborhood Indicator Variable: Percent of HUs That Are Mobile Homes, Boat, RV, Van, Etc. <= 0.0%	0.0%	0.0%	0.0%	0.0%
119	XCZIP45	Cooling DD * Neighborhood Indicator Variable: Percent of HUs That Are Mobile Homes, Boat, RV, Van, Etc. > 0.0%	0.0%	0.0%	0.0%	0.0%
120	XCZIP46	Cooling DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $0 - $149,999 <= 0.0%	96.4%	97.2%	92.3%	97.9%
121	XCZIP47	Cooling DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $0 - $149,999 <= 12.9%	96.7%	98.3%	92.9%	99.7%
122	XCZIP48	Cooling DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $0 - $149,999 > 12.9%	0.0%	0.0%	0.0%	0.0%
123	XCZIP49	Cooling DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $150,000 - $299,999 <= 1.9%	88.8%	92.0%	83.8%	88.9%
124	XCZIP50	Cooling DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $150,000 - $299,999 <= 39.3%	94.8%	91.6%	84.1%	93.5%

125	XCZIP51	Cooling DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $150,000 - $299,999 > 39.3%	0.0%	0.0%	0.0%	0.0%
126	XCZIP52	Cooling DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $300,000 - Plus <= 36.5%	92.9%	95.0%	84.4%	94.5%
127	XCZIP53	Cooling DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $300,000 - Plus <= 95.0%	85.5%	91.7%	76.2%	90.6%
128	XCZIP54	Cooling DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $300,000 - Plus > 95.0%	0.0%	0.0%	0.0%	0.0%
129	XCZIP55	Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 0-1 Bedroom <= 0.0%	87.9%	95.0%	93.2%	93.2%
130	XCZIP56	Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 0-1 Bedroom <= 13.6%	85.8%	94.6%	95.9%	95.4%
131	XCZIP57	Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 0-1 Bedroom > 13.6%	0.0%	0.0%	0.0%	0.0%
132	XCZIP58	Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 2 Bedrooms <= 5.9%	91.2%	97.6%	79.5%	84.8%
133	XCZIP59	Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 2 Bedrooms <= 30.8%	77.8%	88.0%	80.8%	81.0%
134	XCZIP60	Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 2 Bedrooms > 30.8%	0.0%	0.0%	0.0%	0.0%
135	XCZIP61	Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 3+ Bedrooms <= 53.7%	83.6%	94.4%	72.3%	89.0%
136	XCZIP62	Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 3+ Bedrooms <= 91.7%	96.2%	99.7%	64.4%	88.1%
137	XCZIP63	Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 3+ Bedrooms > 91.7%	0.0%	0.0%	0.0%	0.0%
138	XCZIP64	Cooling DD * Neighborhood Indicator Variable: Percent of HUs Built in Year 2000 + <= 0.0%	88.2%	93.2%	78.9%	85.8%
139	XCZIP65	Cooling DD * Neighborhood Indicator Variable: Percent of HUs Built in Year 2000 + <= 8.6%	87.1%	96.2%	89.9%	91.8%
140	XCZIP66	Cooling DD * Neighborhood Indicator Variable: Percent of HUs Built in Year 2000 + > 8.6%	0.0%	0.0%	0.0%	0.0%
141	XCZIP67	Cooling DD * Neighborhood Indicator Variable: Percent of HUs Built in Years 1980-1999 <= 4.7%	93.4%	95.6%	88.8%	92.3%
142	XCZIP68	Cooling DD * Neighborhood Indicator Variable: Percent of HUs Built in Years 1980-1999 <= 35.3%	87.9%	90.7%	76.7%	91.8%
143	XCZIP69	Cooling DD * Neighborhood Indicator Variable: Percent of HUs Built in Years 1980-1999 > 35.3%	0.0%	0.0%	0.0%	0.0%
144	XCZIP70	Cooling DD * Neighborhood Indicator Variable: Percent of HUs Built in Year 1979 or Older <= 49.9%	88.2%	96.0%	84.7%	86.1%
145	XCZIP71	Cooling DD * Neighborhood Indicator Variable: Percent of HUs Built in Year 1979 or Older <= 93.1%	89.9%	89.0%	84.7%	91.9%
146	XCZIP72	Cooling DD * Neighborhood Indicator Variable: Percent of HUs	0.0%	0.0%	0.0%	0.0%

		Built in Year 1979 or Older > 93.1%				
147	XCZIP73	Cooling DD * Neighborhood Indicator Variable: Percent of HUs with Income in the past 12 Months Below Poverty Level <= 3.4%	88.2%	96.3%	90.7%	95.2%
148	XCZIP74	Cooling DD * Neighborhood Indicator Variable: Percent of HUs with Income in the past 12 Months Below Poverty Level <= 14.4%	81.9%	92.0%	91.0%	96.4%
149	XCZIP75	Cooling DD * Neighborhood Indicator Variable: Percent of HUs with Income in the past 12 Months Below Poverty Level > 14.4%	0.0%	0.0%	0.0%	0.0%
150	XCZIP76	Cooling DD * Neighborhood Indicator Variable: Percent of HUs with Income in the past 12 Months Above Poverty Level <= 85.6%	0.0%	0.0%	0.0%	0.0%
151	XCZIP77	Cooling DD * Neighborhood Indicator Variable: Percent of HUs with Income in the past 12 Months Above Poverty Level <= 96.6%	0.0%	0.0%	0.0%	0.0%
152	XCZIP78	Cooling DD * Neighborhood Indicator Variable: Percent of HUs with Income in the past 12 Months Above Poverty Level > 96.6%	0.0%	0.0%	0.0%	0.0%
153	XHZIP1	Heating DD * Neighborhood Indicator Variable: Percent of Occupied HU with Gas Heat <= 64.7%	90.1%	96.7%	78.1%	93.7%
154	XHZIP2	Heating DD * Neighborhood Indicator Variable: Percent of Occupied HU with Gas Heat <= 85.0%	88.5%	92.6%	81.9%	96.3%
155	XHZIP3	Heating DD * Neighborhood Indicator Variable: Percent of Occupied HU with Gas Heat > 85.0%	0.0%	0.0%	0.0%	0.0%
156	XHZIP4	Heating DD * Neighborhood Indicator Variable: Percent of Occupied HU with Electric Heat <= 11.8%	90.1%	95.7%	81.1%	95.3%
157	XHZIP5	Heating DD * Neighborhood Indicator Variable: Percent of Occupied HU with Electric Heat <= 29.2%	87.9%	96.3%	88.2%	95.7%
158	XHZIP6	Heating DD * Neighborhood Indicator Variable: Percent of Occupied HU with Electric Heat > 29.2%	0.0%	0.0%	0.0%	0.0%
159	XHZIP7	Heating DD * Neighborhood Indicator Variable: Percent of Occupied HU with Other Heat <= 0.0%	78.9%	94.1%	79.5%	92.8%
160	XHZIP8	Heating DD * Neighborhood Indicator Variable: Percent of Occupied HU with Other Heat <= 5.6%	79.2%	91.3%	88.8%	97.2%
161	XHZIP9	Heating DD * Neighborhood Indicator Variable: Percent of Occupied HU with Other Heat > 5.6%	0.0%	0.0%	0.0%	0.0%
162	XHZIP10	Heating DD * Neighborhood Indicator Variable: Median Number of Rooms in HUs <= 5.1	81.9%	92.3%	90.4%	96.4%
163	XHZIP11	Heating DD * Neighborhood Indicator Variable: Median Number of Rooms in HUs <= 6.4	91.8%	96.4%	91.5%	96.7%
164	XHZIP12	Heating DD * Neighborhood Indicator Variable: Median Number of Rooms in HUs > 6.4	0.0%	0.0%	0.0%	0.0%
165	XHZIP13	Heating DD * Neighborhood Indicator Variable: Percent of	74.2%	96.3%	89.9%	93.0%

		Owner Occupied HUs <= 54.5%				
166	XHZIP14	Heating DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs <= 84.7%	92.9%	97.3%	77.0%	86.8%
167	XHZIP15	Heating DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs > 84.7%	0.0%	0.0%	0.0%	0.0%
168	XHZIP16	Heating DD * Neighborhood Indicator Variable: Percent of Renter Occupied HUs <= 15.3%	0.0%	0.0%	0.0%	0.0%
169	XHZIP17	Heating DD * Neighborhood Indicator Variable: Percent of Renter Occupied HUs <= 45.5%	0.0%	0.0%	0.0%	0.0%
170	XHZIP18	Heating DD * Neighborhood Indicator Variable: Percent of Renter Occupied HUs > 45.5%	0.0%	0.0%	0.0%	0.0%
171	XHZIP19	Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 0-.50 Occupants Per Room <= 52.6%	71.0%	94.6%	72.1%	92.8%
172	XHZIP20	Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 0-.50 Occupants Per Room <= 75.7%	71.8%	88.9%	82.2%	91.7%
173	XHZIP21	Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 0-.50 Occupants Per Room > 75.7%	0.0%	0.0%	0.0%	0.0%
174	XHZIP22	Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with .51-1.00 Occupants Per Room <= 22.0%	62.5%	91.7%	86.0%	93.3%
175	XHZIP23	Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with .51-1.00 Occupants Per Room <= 40.1%	86.6%	96.2%	94.5%	99.1%
176	XHZIP24	Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with .51-1.00 Occupants Per Room > 40.1%	0.0%	0.0%	0.0%	0.0%
177	XHZIP25	Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 1.01-1.50 Occupants Per Room <= 0.0%	95.1%	97.4%	87.9%	92.8%
178	XHZIP26	Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 1.01-1.50 Occupants Per Room <= 5.3%	74.5%	91.2%	78.9%	90.3%
179	XHZIP27	Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 1.01-1.50 Occupants Per Room > 5.3%	0.0%	0.0%	0.0%	0.0%
180	XHZIP28	Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 1.51-2.00 Occupants Per Room <= 0.0%	81.6%	89.3%	89.0%	90.8%
181	XHZIP29	Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 1.51-2.00 Occupants Per Room <= 0.7%	75.3%	88.0%	84.7%	91.9%
182	XHZIP30	Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 1.51-2.00 Occupants Per Room > 0.7%	0.0%	0.0%	0.0%	0.0%
183	XHZIP31	Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 2.01 Plus Occupants Per Room <= 0.0%	83.0%	94.1%	73.2%	92.5%
184	XHZIP32	Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 2.01 Plus Occupants Per Room <= 0.0%	0.0%	0.0%	0.0%	0.0%

185	XHZIP33	Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 2.01 Plus Occupants Per Room > 0.0%	0.0%	0.0%	0.0%	0.0%
186	XHZIP34	Heating DD * Neighborhood Indicator Variable: Percent of HUs with 1 Unit Structure <= 68.8%	79.7%	91.8%	84.1%	93.2%
187	XHZIP35	Heating DD * Neighborhood Indicator Variable: Percent of HUs with 1 Unit Structure <= 100.0%	0.0%	0.0%	0.0%	0.0%
188	XHZIP36	Heating DD * Neighborhood Indicator Variable: Percent of HUs with 1 Unit Structure > 100.0%	0.0%	0.0%	0.0%	0.0%
189	XHZIP37	Heating DD * Neighborhood Indicator Variable: Percent of HUs with 2 Unit Structure <= 0.0%	94.2%	98.3%	85.8%	91.7%
190	XHZIP38	Heating DD * Neighborhood Indicator Variable: Percent of HUs with 2 Unit Structure <= 1.7%	78.1%	87.4%	88.8%	93.5%
191	XHZIP39	Heating DD * Neighborhood Indicator Variable: Percent of HUs with 2 Unit Structure > 1.7%	0.0%	0.0%	0.0%	0.0%
192	XHZIP40	Heating DD * Neighborhood Indicator Variable: Percent of HUs with 3+ Unit Structure <= 0.0%	84.4%	94.5%	76.2%	91.7%
193	XHZIP41	Heating DD * Neighborhood Indicator Variable: Percent of HUs with 3+ Unit Structure <= 24.4%	80.8%	93.2%	75.6%	90.9%
194	XHZIP42	Heating DD * Neighborhood Indicator Variable: Percent of HUs with 3+ Unit Structure > 24.4%	0.0%	0.0%	0.0%	0.0%
195	XHZIP43	Heating DD * Neighborhood Indicator Variable: Percent of HUs That Are Mobile Homes, Boat, RV, Van, Etc. <= 0.0%	86.6%	91.1%	91.0%	95.8%
196	XHZIP44	Heating DD * Neighborhood Indicator Variable: Percent of HUs That Are Mobile Homes, Boat, RV, Van, Etc. <= 0.0%	0.0%	0.0%	0.0%	0.0%
197	XHZIP45	Heating DD * Neighborhood Indicator Variable: Percent of HUs That Are Mobile Homes, Boat, RV, Van, Etc. > 0.0%	0.0%	0.0%	0.0%	0.0%
198	XHZIP46	Heating DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $0 - $149,999 <= 0.0%	97.8%	99.4%	86.0%	95.9%
199	XHZIP47	Heating DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $0 - $149,999 <= 12.9%	86.0%	97.1%	84.4%	94.5%
200	XHZIP48	Heating DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $0 - $149,999 > 12.9%	0.0%	0.0%	0.0%	0.0%
201	XHZIP49	Heating DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $150,000 - $299,999 <= 1.9%	89.0%	95.1%	67.1%	89.4%
202	XHZIP50	Heating DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $150,000 - $299,999 <= 39.3%	97.5%	97.8%	91.8%	97.0%
203	XHZIP51	Heating DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $150,000 - $299,999 > 39.3%	0.0%	0.0%	0.0%	0.0%
204	XHZIP52	Heating DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $300,000 - Plus <= 36.5%	87.4%	95.6%	83.8%	97.7%
205	XHZIP53	Heating DD * Neighborhood Indicator Variable: Percent of	95.9%	98.6%	94.8%	96.8%

		Owner Occupied HUs with Value = $300,000 - Plus <= 95.0%				
206	XHZIP54	Heating DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $300,000 - Plus > 95.0%	0.0%	0.0%	0.0%	0.0%
207	XHZIP55	Heating DD * Neighborhood Indicator Variable: Percent of HUs with 0-1 Bedroom <= 0.0%	99.7%	100.0%	80.0%	94.9%
208	XHZIP56	Heating DD * Neighborhood Indicator Variable: Percent of HUs with 0-1 Bedroom <= 13.6%	98.6%	98.6%	84.4%	98.1%
209	XHZIP57	Heating DD * Neighborhood Indicator Variable: Percent of HUs with 0-1 Bedroom > 13.6%	0.0%	0.0%	0.0%	0.0%
210	XHZIP58	Heating DD * Neighborhood Indicator Variable: Percent of HUs with 2 Bedrooms <= 5.9%	77.8%	91.2%	80.5%	95.2%
211	XHZIP59	Heating DD * Neighborhood Indicator Variable: Percent of HUs with 2 Bedrooms <= 30.8%	83.8%	93.1%	90.4%	96.1%
212	XHZIP60	Heating DD * Neighborhood Indicator Variable: Percent of HUs with 2 Bedrooms > 30.8%	0.0%	0.0%	0.0%	0.0%
213	XHZIP61	Heating DD * Neighborhood Indicator Variable: Percent of HUs with 3+ Bedrooms <= 53.7%	87.7%	96.3%	80.5%	98.3%
214	XHZIP62	Heating DD * Neighborhood Indicator Variable: Percent of HUs with 3+ Bedrooms <= 91.7%	90.4%	96.4%	65.5%	86.6%
215	XHZIP63	Heating DD * Neighborhood Indicator Variable: Percent of HUs with 3+ Bedrooms > 91.7%	0.0%	0.0%	0.0%	0.0%
216	XHZIP64	Heating DD * Neighborhood Indicator Variable: Percent of HUs Built in Year 2000 + <= 0.0%	100.0%	100.0%	77.5%	90.1%
217	XHZIP65	Heating DD * Neighborhood Indicator Variable: Percent of HUs Built in Year 2000 + <= 8.6%	77.5%	93.6%	84.1%	93.5%
218	XHZIP66	Heating DD * Neighborhood Indicator Variable: Percent of HUs Built in Year 2000 + > 8.6%	0.0%	0.0%	0.0%	0.0%
219	XHZIP67	Heating DD * Neighborhood Indicator Variable: Percent of HUs Built in Years 1980-1999 <= 4.7%	79.2%	93.8%	94.2%	97.1%
220	XHZIP68	Heating DD * Neighborhood Indicator Variable: Percent of HUs Built in Years 1980-1999 <= 35.3%	91.2%	96.4%	92.9%	97.6%
221	XHZIP69	Heating DD * Neighborhood Indicator Variable: Percent of HUs Built in Years 1980-1999 > 35.3%	0.0%	0.0%	0.0%	0.0%
222	XHZIP70	Heating DD * Neighborhood Indicator Variable: Percent of HUs Built in Year 1979 or Older <= 49.9%	90.1%	96.7%	84.7%	89.3%
223	XHZIP71	Heating DD * Neighborhood Indicator Variable: Percent of HUs Built in Year 1979 or Older <= 93.1%	90.7%	95.5%	88.5%	93.8%
224	XHZIP72	Heating DD * Neighborhood Indicator Variable: Percent of HUs Built in Year 1979 or Older > 93.1%	0.0%	0.0%	0.0%	0.0%
225	XHZIP73	Heating DD * Neighborhood Indicator Variable: Percent of HUs with Income in the past 12 Months Below Poverty Level <= 3.4%	81.6%	93.6%	83.3%	89.1%
226	XHZIP74	Heating DD * Neighborhood Indicator Variable: Percent of HUs with Income in the past 12 Months Below Poverty Level <= 14.4%	78.1%	94.4%	86.8%	94.0%

227	XHZIP75	Heating DD * Neighborhood Indicator Variable: Percent of HUs with Income in the past 12 Months Below Poverty Level > 14.4%	0.0%	0.0%	0.0%	0.0%
228	XHZIP76	Heating DD * Neighborhood Indicator Variable: Percent of HUs with Income in the past 12 Months Above Poverty Level <= 85.6%	0.0%	0.0%	0.0%	0.0%
229	XHZIP77	Heating DD * Neighborhood Indicator Variable: Percent of HUs with Income in the past 12 Months Above Poverty Level <= 96.6%	0.0%	0.0%	0.0%	0.0%
230	XHZIP78	Heating DD * Neighborhood Indicator Variable: Percent of HUs with Income in the past 12 Months Above Poverty Level > 96.6%	0.0%	0.0%	0.0%	0.0%
231	XHDD_TIME1	Heating DD * Weekday * Hour = 1 Indicator	69.0%	90.5%	87.9%	96.0%
232	XHDD_TIME2	Heating DD * Weekday * Hour = 2 Indicator	70.1%	96.9%	91.8%	99.4%
233	XHDD_TIME3	Heating DD * Weekday * Hour = 3 Indicator	78.9%	98.6%	94.8%	99.1%
234	XHDD_TIME4	Heating DD * Weekday * Hour = 4 Indicator	88.2%	98.1%	97.5%	100.0%
235	XHDD_TIME5	Heating DD * Weekday * Hour = 5 Indicator	94.2%	100.0%	99.7%	100.0%
236	XHDD_TIME6	Heating DD * Weekday * Hour = 6 Indicator	100.0%	100.0%	100.0%	100.0%
237	XHDD_TIME7	Heating DD * Weekday * Hour = 7 Indicator	100.0%	100.0%	100.0%	100.0%
238	XHDD_TIME8	Heating DD * Weekday * Hour = 8 Indicator	100.0%	100.0%	97.3%	98.6%
239	XHDD_TIME9	Heating DD * Weekday * Hour = 9 Indicator	100.0%	100.0%	80.3%	94.2%
240	XHDD_TIME10	Heating DD * Weekday * Hour = 10 Indicator	92.3%	99.4%	74.2%	95.2%
241	XHDD_TIME11	Heating DD * Weekday * Hour = 11 Indicator	80.3%	95.2%	76.2%	89.6%
242	XHDD_TIME12	Heating DD * Weekday * Hour = 12 Indicator	60.8%	91.0%	73.7%	94.8%
243	XHDD_TIME13	Heating DD * Weekday * Hour = 13 Indicator	61.9%	90.7%	77.8%	93.0%
244	XHDD_TIME14	Heating DD * Weekday * Hour = 14 Indicator	59.7%	72.0%	81.1%	85.5%
245	XHDD_TIME15	Heating DD * Weekday * Hour = 15 Indicator	54.8%	64.5%	75.9%	87.4%
246	XHDD_TIME16	Heating DD * Weekday * Hour = 16 Indicator	74.2%	77.5%	77.8%	85.9%
247	XHDD_TIME17	Heating DD * Weekday * Hour = 17 Indicator	81.4%	86.2%	95.3%	94.5%
248	XHDD_TIME18	Heating DD * Weekday * Hour = 18 Indicator	83.0%	94.7%	97.0%	97.5%
249	XHDD_TIME19	Heating DD * Weekday * Hour = 19 Indicator	90.7%	97.6%	95.1%	97.4%
250	XHDD_TIME20	Heating DD * Weekday * Hour = 20 Indicator	95.3%	99.1%	96.2%	98.0%
251	XHDD_TIME21	Heating DD * Weekday * Hour = 21 Indicator	89.0%	99.4%	95.6%	96.6%
252	XHDD_TIME22	Heating DD * Weekday * Hour = 22 Indicator	76.4%	98.2%	91.0%	97.9%
253	XHDD_TIME23	Heating DD * Weekday * Hour = 23 Indicator	60.0%	90.9%	70.1%	98.4%
254	XHDD_TIME24	Heating DD * Weekday * Hour = 24 Indicator	53.4%	89.2%	78.1%	96.1%
255	XHDD_TIME25	Heating DD * Weekend * Hour = 1 Indicator	50.4%	71.2%	67.1%	85.3%
256	XHDD_TIME26	Heating DD * Weekend * Hour = 2 Indicator	50.4%	75.0%	79.7%	89.7%
257	XHDD_TIME27	Heating DD * Weekend * Hour = 3 Indicator	53.7%	83.2%	81.9%	89.0%
258	XHDD_TIME28	Heating DD * Weekend * Hour = 4 Indicator	64.1%	79.1%	78.6%	90.2%

259	XHDD_TIME29	Heating DD * Weekend * Hour = 5 Indicator	53.7%	86.7%	60.3%	92.3%
260	XHDD_TIME30	Heating DD * Weekend * Hour = 6 Indicator	54.2%	87.9%	60.0%	90.4%
261	XHDD_TIME31	Heating DD * Weekend * Hour = 7 Indicator	81.1%	97.6%	73.4%	93.3%
262	XHDD_TIME32	Heating DD * Weekend * Hour = 8 Indicator	99.2%	99.2%	78.6%	98.3%
263	XHDD_TIME33	Heating DD * Weekend * Hour = 9 Indicator	100.0%	100.0%	87.7%	97.2%
264	XHDD_TIME34	Heating DD * Weekend * Hour = 10 Indicator	100.0%	99.2%	80.5%	96.6%
265	XHDD_TIME35	Heating DD * Weekend * Hour = 11 Indicator	100.0%	98.9%	79.5%	95.5%
266	XHDD_TIME36	Heating DD * Weekend * Hour = 12 Indicator	97.3%	92.7%	76.7%	96.8%
267	XHDD_TIME37	Heating DD * Weekend * Hour = 13 Indicator	86.3%	93.7%	78.4%	95.8%
268	XHDD_TIME38	Heating DD * Weekend * Hour = 14 Indicator	86.0%	85.4%	82.7%	92.1%
269	XHDD_TIME39	Heating DD * Weekend * Hour = 15 Indicator	83.6%	78.4%	80.0%	93.5%
270	XHDD_TIME40	Heating DD * Weekend * Hour = 16 Indicator	82.2%	82.0%	83.8%	91.2%
271	XHDD_TIME41	Heating DD * Weekend * Hour = 17 Indicator	80.3%	85.0%	88.5%	94.1%
272	XHDD_TIME42	Heating DD * Weekend * Hour = 18 Indicator	75.6%	93.5%	92.3%	97.9%
273	XHDD_TIME43	Heating DD * Weekend * Hour = 19 Indicator	78.1%	92.6%	98.1%	98.9%
274	XHDD_TIME44	Heating DD * Weekend * Hour = 20 Indicator	80.8%	95.9%	96.7%	99.4%
275	XHDD_TIME45	Heating DD * Weekend * Hour = 21 Indicator	71.5%	93.1%	95.9%	98.0%
276	XHDD_TIME46	Heating DD * Weekend * Hour = 22 Indicator	60.8%	88.3%	92.9%	96.2%
277	XHDD_TIME47	Heating DD * Weekend * Hour = 23 Indicator	30.1%	75.5%	67.4%	95.1%
278	XHDD_TIME48	Heating DD * Weekend * Hour = 24 Indicator	0.0%	0.0%	0.0%	0.0%
279	XCDD_TIME1	Cooling DD * Weekday * Hour = 1 Indicator	38.9%	71.1%	41.6%	78.9%
280	XCDD_TIME2	Cooling DD * Weekday * Hour = 2 Indicator	37.0%	65.9%	39.7%	74.5%
281	XCDD_TIME3	Cooling DD * Weekday * Hour = 3 Indicator	33.4%	83.6%	39.2%	76.2%
282	XCDD_TIME4	Cooling DD * Weekday * Hour = 4 Indicator	35.6%	73.1%	42.2%	70.1%
283	XCDD_TIME5	Cooling DD * Weekday * Hour = 5 Indicator	40.5%	75.7%	39.5%	79.2%
284	XCDD_TIME6	Cooling DD * Weekday * Hour = 6 Indicator	41.9%	74.5%	38.6%	79.4%
285	XCDD_TIME7	Cooling DD * Weekday * Hour = 7 Indicator	40.0%	84.9%	42.7%	84.0%
286	XCDD_TIME8	Cooling DD * Weekday * Hour = 8 Indicator	41.6%	90.8%	41.1%	88.7%
287	XCDD_TIME9	Cooling DD * Weekday * Hour = 9 Indicator	39.5%	92.4%	42.5%	85.8%
288	XCDD_TIME10	Cooling DD * Weekday * Hour = 10 Indicator	38.4%	94.3%	37.8%	89.9%
289	XCDD_TIME11	Cooling DD * Weekday * Hour = 11 Indicator	37.8%	89.1%	42.5%	85.2%
290	XCDD_TIME12	Cooling DD * Weekday * Hour = 12 Indicator	37.3%	89.7%	37.0%	87.4%
291	XCDD_TIME13	Cooling DD * Weekday * Hour = 13 Indicator	34.8%	89.8%	40.8%	85.2%
292	XCDD_TIME14	Cooling DD * Weekday * Hour = 14 Indicator	31.8%	82.8%	39.5%	85.4%
293	XCDD_TIME15	Cooling DD * Weekday * Hour = 15 Indicator	34.2%	82.4%	43.8%	87.5%
294	XCDD_TIME16	Cooling DD * Weekday * Hour = 16 Indicator	32.1%	90.6%	41.9%	85.0%

295	XCDD_TIME17	Cooling DD * Weekday * Hour = 17 Indicator	37.0%	89.6%	40.0%	86.3%
296	XCDD_TIME18	Cooling DD * Weekday * Hour = 18 Indicator	36.4%	91.7%	40.5%	84.5%
297	XCDD_TIME19	Cooling DD * Weekday * Hour = 19 Indicator	39.5%	93.1%	42.7%	89.1%
298	XCDD_TIME20	Cooling DD * Weekday * Hour = 20 Indicator	48.5%	84.2%	44.4%	79.6%
299	XCDD_TIME21	Cooling DD * Weekday * Hour = 21 Indicator	41.4%	80.8%	44.4%	77.8%
300	XCDD_TIME22	Cooling DD * Weekday * Hour = 22 Indicator	37.5%	86.1%	43.6%	81.8%
301	XCDD_TIME23	Cooling DD * Weekday * Hour = 23 Indicator	37.5%	81.8%	43.3%	74.7%
302	XCDD_TIME24	Cooling DD * Weekday * Hour = 24 Indicator	36.7%	83.6%	38.1%	70.5%
303	XCDD_TIME25	Cooling DD * Weekend * Hour = 1 Indicator	28.5%	69.2%	34.5%	72.2%
304	XCDD_TIME26	Cooling DD * Weekend * Hour = 2 Indicator	32.3%	71.2%	45.5%	74.1%
305	XCDD_TIME27	Cooling DD * Weekend * Hour = 3 Indicator	31.5%	65.2%	46.3%	70.4%
306	XCDD_TIME28	Cooling DD * Weekend * Hour = 4 Indicator	30.7%	55.4%	41.4%	72.8%
307	XCDD_TIME29	Cooling DD * Weekend * Hour = 5 Indicator	28.2%	75.7%	43.6%	77.4%
308	XCDD_TIME30	Cooling DD * Weekend * Hour = 6 Indicator	32.1%	78.6%	42.2%	79.2%
309	XCDD_TIME31	Cooling DD * Weekend * Hour = 7 Indicator	34.5%	78.6%	45.2%	83.0%
310	XCDD_TIME32	Cooling DD * Weekend * Hour = 8 Indicator	32.6%	79.0%	46.8%	94.2%
311	XCDD_TIME33	Cooling DD * Weekend * Hour = 9 Indicator	40.5%	87.8%	43.6%	76.1%
312	XCDD_TIME34	Cooling DD * Weekend * Hour = 10 Indicator	36.4%	90.2%	43.6%	76.7%
313	XCDD_TIME35	Cooling DD * Weekend * Hour = 11 Indicator	36.7%	90.3%	40.8%	84.6%
314	XCDD_TIME36	Cooling DD * Weekend * Hour = 12 Indicator	32.9%	84.2%	42.2%	83.8%
315	XCDD_TIME37	Cooling DD * Weekend * Hour = 13 Indicator	33.7%	87.8%	42.7%	79.5%
316	XCDD_TIME38	Cooling DD * Weekend * Hour = 14 Indicator	36.7%	83.6%	35.9%	87.0%
317	XCDD_TIME39	Cooling DD * Weekend * Hour = 15 Indicator	35.9%	92.4%	39.7%	80.7%
318	XCDD_TIME40	Cooling DD * Weekend * Hour = 16 Indicator	33.4%	86.1%	38.4%	84.3%
319	XCDD_TIME41	Cooling DD * Weekend * Hour = 17 Indicator	35.6%	90.0%	47.1%	90.7%
320	XCDD_TIME42	Cooling DD * Weekend * Hour = 18 Indicator	41.6%	87.5%	42.5%	82.6%
321	XCDD_TIME43	Cooling DD * Weekend * Hour = 19 Indicator	39.2%	93.7%	43.8%	82.5%
322	XCDD_TIME44	Cooling DD * Weekend * Hour = 20 Indicator	35.3%	90.7%	45.2%	77.6%
323	XCDD_TIME45	Cooling DD * Weekend * Hour = 21 Indicator	38.1%	79.9%	37.0%	84.4%
324	XCDD_TIME46	Cooling DD * Weekend * Hour = 22 Indicator	32.1%	76.1%	36.4%	58.6%
325	XCDD_TIME47	Cooling DD * Weekend * Hour = 23 Indicator	34.8%	80.3%	31.2%	68.4%
326	XCDD_TIME48	Cooling DD * Weekend * Hour = 24 Indicator	0.0%	0.0%	0.0%	0.0%
327	XIDD_TIME1	Heat Index DD * Weekday * Hour = 1 Indicator	20.0%	68.5%	26.3%	76.0%
328	XIDD_TIME2	Heat Index DD * Weekday * Hour = 2 Indicator	13.4%	75.5%	23.6%	72.1%
329	XIDD_TIME3	Heat Index DD * Weekday * Hour = 3 Indicator	13.2%	83.3%	21.9%	62.5%
330	XIDD_TIME4	Heat Index DD * Weekday * Hour = 4 Indicator	9.9%	86.1%	20.0%	61.6%

331	XIDD_TIME5	Heat Index DD * Weekday * Hour = 5 Indicator	15.6%	84.2%	21.6%	74.7%
332	XIDD_TIME6	Heat Index DD * Weekday * Hour = 6 Indicator	17.3%	69.8%	20.3%	73.0%
333	XIDD_TIME7	Heat Index DD * Weekday * Hour = 7 Indicator	16.4%	80.0%	25.2%	80.4%
334	XIDD_TIME8	Heat Index DD * Weekday * Hour = 8 Indicator	17.8%	93.8%	29.0%	84.0%
335	XIDD_TIME9	Heat Index DD * Weekday * Hour = 9 Indicator	17.5%	90.6%	33.4%	80.3%
336	XIDD_TIME10	Heat Index DD * Weekday * Hour = 10 Indicator	23.8%	93.1%	32.6%	90.8%
337	XIDD_TIME11	Heat Index DD * Weekday * Hour = 11 Indicator	24.7%	92.2%	40.3%	85.0%
338	XIDD_TIME12	Heat Index DD * Weekday * Hour = 12 Indicator	25.2%	89.1%	37.0%	88.9%
339	XIDD_TIME13	Heat Index DD * Weekday * Hour = 13 Indicator	27.1%	90.9%	39.5%	87.5%
340	XIDD_TIME14	Heat Index DD * Weekday * Hour = 14 Indicator	24.7%	85.6%	41.1%	87.3%
341	XIDD_TIME15	Heat Index DD * Weekday * Hour = 15 Indicator	27.9%	82.4%	43.8%	82.5%
342	XIDD_TIME16	Heat Index DD * Weekday * Hour = 16 Indicator	21.9%	92.5%	40.3%	84.4%
343	XIDD_TIME17	Heat Index DD * Weekday * Hour = 17 Indicator	26.6%	88.7%	37.8%	84.8%
344	XIDD_TIME18	Heat Index DD * Weekday * Hour = 18 Indicator	27.1%	92.9%	37.0%	84.4%
345	XIDD_TIME19	Heat Index DD * Weekday * Hour = 19 Indicator	26.6%	100.0%	40.3%	89.8%
346	XIDD_TIME20	Heat Index DD * Weekday * Hour = 20 Indicator	31.5%	88.7%	35.6%	81.5%
347	XIDD_TIME21	Heat Index DD * Weekday * Hour = 21 Indicator	20.8%	82.9%	33.4%	82.0%
348	XIDD_TIME22	Heat Index DD * Weekday * Hour = 22 Indicator	20.5%	88.0%	30.7%	93.8%
349	XIDD_TIME23	Heat Index DD * Weekday * Hour = 23 Indicator	21.1%	94.8%	30.7%	92.0%
350	XIDD_TIME24	Heat Index DD * Weekday * Hour = 24 Indicator	23.0%	86.9%	23.8%	88.5%
351	XIDD_TIME25	Heat Index DD * Weekend * Hour = 1 Indicator	14.8%	72.2%	16.4%	81.7%
352	XIDD_TIME26	Heat Index DD * Weekend * Hour = 2 Indicator	12.6%	76.1%	20.8%	73.7%
353	XIDD_TIME27	Heat Index DD * Weekend * Hour = 3 Indicator	10.7%	69.2%	17.0%	75.8%
354	XIDD_TIME28	Heat Index DD * Weekend * Hour = 4 Indicator	16.4%	51.7%	16.7%	75.4%
355	XIDD_TIME29	Heat Index DD * Weekend * Hour = 5 Indicator	9.6%	82.9%	16.2%	67.8%
356	XIDD_TIME30	Heat Index DD * Weekend * Hour = 6 Indicator	14.0%	82.4%	14.2%	61.5%
357	XIDD_TIME31	Heat Index DD * Weekend * Hour = 7 Indicator	19.2%	81.4%	25.2%	78.3%
358	XIDD_TIME32	Heat Index DD * Weekend * Hour = 8 Indicator	15.9%	86.2%	32.1%	89.7%
359	XIDD_TIME33	Heat Index DD * Weekend * Hour = 9 Indicator	21.6%	87.3%	36.2%	72.7%
360	XIDD_TIME34	Heat Index DD * Weekend * Hour = 10 Indicator	21.6%	91.1%	37.3%	74.3%
361	XIDD_TIME35	Heat Index DD * Weekend * Hour = 11 Indicator	23.6%	88.4%	35.6%	82.3%
362	XIDD_TIME36	Heat Index DD * Weekend * Hour = 12 Indicator	22.7%	88.0%	40.5%	85.1%
363	XIDD_TIME37	Heat Index DD * Weekend * Hour = 13 Indicator	23.3%	94.1%	43.0%	82.2%
364	XIDD_TIME38	Heat Index DD * Weekend * Hour = 14 Indicator	25.5%	79.6%	34.8%	88.2%
365	XIDD_TIME39	Heat Index DD * Weekend * Hour = 15 Indicator	26.6%	90.7%	39.2%	81.8%
366	XIDD_TIME40	Heat Index DD * Weekend * Hour = 16 Indicator	24.9%	82.4%	37.0%	87.4%

367	XIDD_TIME41	Heat Index DD * Weekend * Hour = 17 Indicator	24.1%	86.4%	41.4%	92.7%
368	XIDD_TIME42	Heat Index DD * Weekend * Hour = 18 Indicator	27.1%	89.9%	41.1%	92.0%
369	XIDD_TIME43	Heat Index DD * Weekend * Hour = 19 Indicator	23.8%	90.8%	38.1%	89.2%
370	XIDD_TIME44	Heat Index DD * Weekend * Hour = 20 Indicator	22.2%	93.8%	31.5%	84.3%
371	XIDD_TIME45	Heat Index DD * Weekend * Hour = 21 Indicator	21.1%	81.8%	29.9%	85.3%
372	XIDD_TIME46	Heat Index DD * Weekend * Hour = 22 Indicator	16.4%	83.3%	22.5%	61.0%
373	XIDD_TIME47	Heat Index DD * Weekend * Hour = 23 Indicator	18.6%	86.8%	13.4%	73.5%
374	XIDD_TIME48	Heat Index DD * Weekend * Hour = 24 Indicator	0.0%	0.0%	0.0%	0.0%
375	PROGRAM	Program Indicator	100.0%	90.1%	100.0%	91.5%
382	TDIFF0	Program * Lag=0, Current Day	81.9%	93.3%	81.6%	90.6%
383	TDIFF1	Program * Lag=-7 Days Ago	79.2%	91.7%	81.6%	93.6%
384	TDIFF2	Program * Lag=-6 Days Ago	81.6%	94.3%	82.7%	92.7%
385	TDIFF3	Program * Lag=-5 Days Ago	82.2%	92.3%	81.4%	89.6%
386	TDIFF4	Program * Lag=-4 Days Ago	84.9%	94.5%	81.1%	95.9%
387	TDIFF5	Program * Lag=-3 Days Ago	85.8%	93.3%	82.2%	94.0%
388	TDIFF6	Program * Lag=-2 Days Ago	83.8%	92.2%	81.9%	91.0%
389	TDIFF7	Program * Lag=-1 Days Ago	81.4%	94.3%	79.5%	92.1%
390	TDIFF8	Program * Lag=+1 Days Ago	83.8%	91.5%	79.5%	91.4%
391	TDIFF9	Program * Lag=+2 Days Ago	83.0%	95.7%	83.0%	92.4%
392	TDIFF10	Program * Lag=+3 Days Ago	83.0%	89.4%	81.6%	92.6%
393	TDIFF11	Program * Lag=+4 Days Ago	79.2%	91.0%	79.5%	91.4%
394	TDIFF12	Program * Lag=+5 Days Ago	79.5%	89.0%	76.7%	92.5%
395	TDIFF13	Program * Lag=+6 Days Ago	72.6%	89.1%	77.3%	86.2%
396	TDIFF14	Program * Lag=+7 Days Ago	0.0%	0.0%	0.0%	0.0%
397	THOUR1	Program * Hour = 1 Indicator	51.0%	74.7%	37.3%	69.9%
398	THOUR2	Program * Hour = 2 Indicator	61.1%	74.4%	54.0%	73.6%
399	THOUR3	Program * Hour = 3 Indicator	70.4%	77.0%	58.6%	78.0%
400	THOUR4	Program * Hour = 4 Indicator	80.0%	86.0%	62.5%	82.0%
401	THOUR5	Program * Hour = 5 Indicator	82.5%	90.7%	68.8%	86.9%
402	THOUR6	Program * Hour = 6 Indicator	82.7%	87.4%	75.3%	87.6%
403	THOUR7	Program * Hour = 7 Indicator	96.7%	96.3%	97.5%	98.6%
404	THOUR8	Program * Hour = 8 Indicator	99.5%	98.6%	97.8%	96.4%
405	THOUR9	Program * Hour = 9 Indicator	96.4%	93.8%	98.6%	96.9%
406	THOUR10	Program * Hour = 10 Indicator	92.9%	94.4%	91.5%	93.1%
407	THOUR11	Program * Hour = 11 Indicator	87.7%	93.8%	86.0%	90.4%
408	THOUR12	Program * Hour = 12 Indicator	84.7%	87.4%	84.4%	85.7%
409	THOUR13	Program * Hour = 13 Indicator	86.8%	91.5%	86.0%	85.4%
410	THOUR14	Program * Hour = 14 Indicator	86.8%	92.7%	84.1%	81.4%
411	THOUR15	Program * Hour = 15 Indicator	89.3%	94.2%	74.5%	89.0%
412	THOUR16	Program * Hour = 16 Indicator	92.6%	89.9%	67.9%	91.1%
413	THOUR17	Program * Hour = 17 Indicator	90.4%	91.2%	71.2%	87.3%

414	THOUR18	Program * Hour = 18 Indicator	82.5%	93.0%	75.6%	84.8%
415	THOUR19	Program * Hour = 19 Indicator	90.7%	95.8%	73.4%	83.6%
416	THOUR20	Program * Hour = 20 Indicator	95.6%	92.8%	70.1%	87.1%
417	THOUR21	Program * Hour = 21 Indicator	91.0%	93.4%	73.4%	84.7%
418	THOUR22	Program * Hour = 22 Indicator	89.6%	89.9%	67.9%	83.9%
419	THOUR23	Program * Hour = 23 Indicator	55.1%	76.6%	40.8%	81.9%
420	THOUR24	Program * Hour = 24 Indicator	0.0%	0.0%	0.0%	0.0%
421	TSUN	Program * Sunday Indicator	73.7%	80.3%	77.8%	86.6%
422	TMON	Program * Monday Indicator	77.5%	87.6%	82.7%	87.1%
423	TTUE	Program * Tuesday Indicator	81.1%	90.2%	80.5%	92.5%
424	TWED	Program * Wednesday Indicator	83.3%	91.4%	82.7%	92.7%
425	TTHU	Program * Thursday Indicator	78.4%	89.2%	84.7%	90.3%
426	TFRI	Program * Friday Indicator	70.4%	82.5%	82.5%	89.7%
427	TSAT	Program * Saturday Indicator	0.0%	0.0%	0.0%	0.0%
428	THOLIDAY	Program * Holiday Indicator	13.7%	88.0%	14.2%	92.3%
429	TWEEKEND	Program * Weekend/Holiday Indicator	6.8%	100.0%	4.1%	100.0%
430	TWEEKDAY	Program * Weekday Indicator	0.0%	0.0%	0.0%	0.0%
431	TTEMP1	Program * Current Temperature	56.7%	87.9%	52.1%	91.1%
432	TINDEX1	Program * Current Heat Index	19.5%	76.1%	23.6%	84.9%
433	THDD	Program * Heating DD	80.8%	96.6%	86.0%	92.0%
434	TCDD	Program * Cooling DD	32.9%	89.2%	32.9%	96.7%
435	TIDD	Program * Heat Index DD	1.9%	57.1%	0.0%	0.0%
436	TTEMP2	Program * Temperature 1 Hour Ago	43.3%	59.5%	55.6%	86.2%
437	TINDEX2	Program * Heat Index 1 Hour Ago	32.1%	78.6%	45.8%	93.4%
438	TTEMP3	Program * Temperature 2 Hours Ago	83.3%	88.2%	72.9%	91.0%
439	TINDEX3	Program * Heat Index 2 Hours Ago	41.6%	80.9%	55.9%	92.6%
440	TTEMP4	Program * Mean Temperature 1 Day Ago	73.2%	88.4%	65.2%	82.4%
441	TINDEX4	Program * Mean Heat Index 1 Day Ago	37.3%	88.2%	38.6%	74.5%
442	THDD4	Program * Mean Heating DD 1 Day Ago	75.1%	76.6%	77.0%	84.7%
443	TCDD4	Program * Mean Cooling DD 1 Day Ago	73.2%	87.6%	63.3%	79.7%
444	TIDD4	Program * Mean Heat Index DD 1 Day Ago	31.5%	81.7%	36.7%	69.4%
445	TTEMP5	Program * Mean Temperature 2 Days Ago	82.2%	93.3%	73.4%	92.5%
446	TINDEX5	Program * Mean Heat Index 2 Days Ago	30.7%	88.4%	35.9%	86.3%
447	THDD5	Program * Mean Heating DD 2 Days Ago	85.2%	88.4%	85.8%	85.6%
448	TCDD5	Program * Mean Cooling DD 2 Days Ago	67.7%	87.0%	55.6%	81.8%
449	TIDD5	Program * Mean Heat Index DD 2 Days Ago	41.6%	91.4%	37.8%	86.2%
450	TCZIP1	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HU with Gas Heat <= 64.7%	95.6%	98.6%	79.7%	86.6%
451	TCZIP2	Program * Cooling DD * Neighborhood Indicator Variable:	94.8%	95.4%	88.8%	90.7%

		Percent of Occupied HU with Gas Heat <= 85.0%				
452	TCZIP3	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HU with Gas Heat > 85.0%	0.0%	0.0%	0.0%	0.0%
453	TCZIP4	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HU with Electric Heat <= 11.8%	91.5%	93.7%	73.7%	84.8%
454	TCZIP5	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HU with Electric Heat <= 29.2%	92.1%	92.6%	87.7%	88.8%
455	TCZIP6	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HU with Electric Heat > 29.2%	0.0%	0.0%	0.0%	0.0%
456	TCZIP7	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HU with Other Heat <= 0.0%	89.6%	93.9%	81.1%	98.6%
457	TCZIP8	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HU with Other Heat <= 5.6%	89.3%	90.5%	76.7%	84.3%
458	TCZIP9	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HU with Other Heat > 5.6%	0.0%	0.0%	0.0%	0.0%
459	TCZIP10	Program * Cooling DD * Neighborhood Indicator Variable: Median Number of Rooms in HUs <= 5.1	88.2%	93.8%	88.2%	92.5%
460	TCZIP11	Program * Cooling DD * Neighborhood Indicator Variable: Median Number of Rooms in HUs <= 6.4	91.5%	95.8%	87.7%	93.8%
461	TCZIP12	Program * Cooling DD * Neighborhood Indicator Variable: Median Number of Rooms in HUs > 6.4	0.0%	0.0%	0.0%	0.0%
462	TCZIP13	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs <= 54.5%	88.2%	93.5%	81.4%	90.9%
463	TCZIP14	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs <= 84.7%	89.3%	96.0%	84.1%	90.9%
464	TCZIP15	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs > 84.7%	0.0%	0.0%	0.0%	0.0%
465	TCZIP16	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Renter Occupied HUs <= 15.3%	0.0%	0.0%	0.0%	0.0%
466	TCZIP17	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Renter Occupied HUs <= 45.5%	0.0%	0.0%	0.0%	0.0%
467	TCZIP18	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Renter Occupied HUs > 45.5%	0.0%	0.0%	0.0%	0.0%
468	TCZIP19	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 0-.50 Occupants Per Room <= 52.6%	88.5%	89.2%	77.3%	82.6%
469	TCZIP20	Program * Cooling DD * Neighborhood Indicator Variable:	89.9%	89.3%	79.7%	83.5%

		Percent of Occupied HUs with 0-.50 Occupants Per Room <= 75.7%				
470	TCZIP21	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 0-.50 Occupants Per Room > 75.7%	0.0%	0.0%	0.0%	0.0%
471	TCZIP22	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with .51-1.00 Occupants Per Room <= 22.0%	92.1%	96.1%	84.7%	86.4%
472	TCZIP23	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with .51-1.00 Occupants Per Room <= 40.1%	94.5%	93.3%	79.5%	86.9%
473	TCZIP24	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with .51-1.00 Occupants Per Room > 40.1%	0.0%	0.0%	0.0%	0.0%
474	TCZIP25	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 1.01-1.50 Occupants Per Room <= 0.0%	83.3%	93.8%	79.7%	89.3%
475	TCZIP26	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 1.01-1.50 Occupants Per Room <= 5.3%	83.8%	91.5%	82.5%	84.7%
476	TCZIP27	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 1.01-1.50 Occupants Per Room > 5.3%	0.0%	0.0%	0.0%	0.0%
477	TCZIP28	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 1.51-2.00 Occupants Per Room <= 0.0%	94.8%	96.5%	84.9%	95.8%
478	TCZIP29	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 1.51-2.00 Occupants Per Room <= 0.7%	81.9%	93.6%	75.9%	88.4%
479	TCZIP30	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 1.51-2.00 Occupants Per Room > 0.7%	0.0%	0.0%	0.0%	0.0%
480	TCZIP31	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 2.01 Plus Occupants Per Room <= 0.0%	92.9%	95.0%	96.4%	98.6%
481	TCZIP32	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 2.01 Plus Occupants Per Room <= 0.0%	0.0%	0.0%	0.0%	0.0%
482	TCZIP33	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 2.01 Plus Occupants Per Room > 0.0%	0.0%	0.0%	0.0%	0.0%
483	TCZIP34	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 1 Unit Structure <= 68.8%	87.7%	91.3%	80.0%	88.0%
484	TCZIP35	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 1 Unit	0.0%	0.0%	0.0%	0.0%

		Structure <= 100.0%				
485	TCZIP36	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 1 Unit Structure > 100.0%	0.0%	0.0%	0.0%	0.0%
486	TCZIP37	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 2 Unit Structure <= 0.0%	88.8%	94.1%	81.6%	91.9%
487	TCZIP38	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 2 Unit Structure <= 1.7%	86.8%	92.1%	81.6%	90.3%
488	TCZIP39	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 2 Unit Structure > 1.7%	0.0%	0.0%	0.0%	0.0%
489	TCZIP40	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 3+ Unit Structure <= 0.0%	89.9%	91.2%	86.6%	87.0%
490	TCZIP41	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 3+ Unit Structure <= 24.4%	92.6%	92.9%	83.6%	89.2%
491	TCZIP42	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 3+ Unit Structure > 24.4%	0.0%	0.0%	0.0%	0.0%
492	TCZIP43	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs That Are Mobile Homes, Boat, RV, Van, Etc. <= 0.0%	95.1%	96.3%	87.9%	96.6%
493	TCZIP44	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs That Are Mobile Homes, Boat, RV, Van, Etc. <= 0.0%	0.0%	0.0%	0.0%	0.0%
494	TCZIP45	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs That Are Mobile Homes, Boat, RV, Van, Etc. > 0.0%	0.0%	0.0%	0.0%	0.0%
495	TCZIP46	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $0 - $149,999 <= 0.0%	85.8%	92.0%	81.6%	86.6%
496	TCZIP47	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $0 - $149,999 <= 12.9%	82.5%	90.7%	89.9%	94.8%
497	TCZIP48	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $0 - $149,999 > 12.9%	0.0%	0.0%	0.0%	0.0%
498	TCZIP49	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $150,000 - $299,999 <= 1.9%	92.3%	94.7%	79.7%	88.7%
499	TCZIP50	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $150,000 - $299,999 <= 39.3%	88.2%	90.1%	84.4%	91.6%
500	TCZIP51	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $150,000 -	0.0%	0.0%	0.0%	0.0%

		$299,999 > 39.3%				
501	TCZIP52	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $300,000 - Plus <= 36.5%	85.2%	90.0%	83.6%	92.8%
502	TCZIP53	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $300,000 - Plus <= 95.0%	90.1%	92.1%	74.8%	85.0%
503	TCZIP54	Program * Cooling DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $300,000 - Plus > 95.0%	0.0%	0.0%	0.0%	0.0%
504	TCZIP55	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 0-1 Bedroom <= 0.0%	91.2%	94.3%	93.4%	96.8%
505	TCZIP56	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 0-1 Bedroom <= 13.6%	92.6%	94.1%	90.1%	96.4%
506	TCZIP57	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 0-1 Bedroom > 13.6%	0.0%	0.0%	0.0%	0.0%
507	TCZIP58	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 2 Bedrooms <= 5.9%	84.9%	87.4%	84.7%	88.7%
508	TCZIP59	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 2 Bedrooms <= 30.8%	78.9%	93.8%	80.3%	82.6%
509	TCZIP60	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 2 Bedrooms > 30.8%	0.0%	0.0%	0.0%	0.0%
510	TCZIP61	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 3+ Bedrooms <= 53.7%	89.0%	93.8%	81.6%	86.9%
511	TCZIP62	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 3+ Bedrooms <= 91.7%	88.2%	93.5%	81.4%	84.2%
512	TCZIP63	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs with 3+ Bedrooms > 91.7%	0.0%	0.0%	0.0%	0.0%
513	TCZIP64	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs Built in Year 2000 + <= 0.0%	90.7%	94.9%	76.2%	89.6%
514	TCZIP65	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs Built in Year 2000 + <= 8.6%	86.6%	94.0%	86.0%	92.4%
515	TCZIP66	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs Built in Year 2000 + > 8.6%	0.0%	0.0%	0.0%	0.0%
516	TCZIP67	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs Built in Years 1980-1999 <= 4.7%	86.8%	93.4%	87.7%	93.1%
517	TCZIP68	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs Built in Years 1980-1999 <= 35.3%	91.2%	95.5%	85.8%	90.7%

518	TCZIP69	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs Built in Years 1980-1999 > 35.3%	0.0%	0.0%	0.0%	0.0%
519	TCZIP70	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs Built in Year 1979 or Older <= 49.9%	87.1%	91.5%	83.8%	91.5%
520	TCZIP71	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs Built in Year 1979 or Older <= 93.1%	83.0%	90.1%	94.0%	96.2%
521	TCZIP72	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs Built in Year 1979 or Older > 93.1%	0.0%	0.0%	0.0%	0.0%
522	TCZIP73	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs with Income in the past 12 Months Below Poverty Level <= 3.4%	88.2%	95.3%	86.6%	93.0%
523	TCZIP74	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs with Income in the past 12 Months Below Poverty Level <= 14.4%	91.2%	93.7%	86.3%	93.7%
524	TCZIP75	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs with Income in the past 12 Months Below Poverty Level > 14.4%	0.0%	0.0%	0.0%	0.0%
525	TCZIP76	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs with Income in the past 12 Months Above Poverty Level <= 85.6%	0.0%	0.0%	0.0%	0.0%
526	TCZIP77	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs with Income in the past 12 Months Above Poverty Level <= 96.6%	0.0%	0.0%	0.0%	0.0%
527	TCZIP78	Program * Cooling DD * Neighborhood Indicator Variable: Percent of HUs with Income in the past 12 Months Above Poverty Level > 96.6%	0.0%	0.0%	0.0%	0.0%
528	THZIP1	Program * Heating DD * Neighborhood Indicator Variable: Percent of Occupied HU with Gas Heat <= 64.7%	73.4%	92.5%	81.4%	90.6%
529	THZIP2	Program * Heating DD * Neighborhood Indicator Variable: Percent of Occupied HU with Gas Heat <= 85.0%	71.5%	88.9%	81.4%	92.3%
530	THZIP3	Program * Heating DD * Neighborhood Indicator Variable: Percent of Occupied HU with Gas Heat > 85.0%	0.0%	0.0%	0.0%	0.0%
531	THZIP4	Program * Heating DD * Neighborhood Indicator Variable: Percent of Occupied HU with Electric Heat <= 11.8%	74.2%	95.2%	88.5%	96.3%
532	THZIP5	Program * Heating DD * Neighborhood Indicator Variable: Percent of Occupied HU with Electric Heat <= 29.2%	68.2%	89.2%	87.9%	96.0%
533	THZIP6	Program * Heating DD * Neighborhood Indicator Variable: Percent of Occupied HU with Electric Heat > 29.2%	0.0%	0.0%	0.0%	0.0%
534	THZIP7	Program * Heating DD * Neighborhood Indicator Variable: Percent of Occupied HU with Other	81.1%	95.9%	70.4%	92.6%

		Heat <= 0.0%				
535	THZIP8	Program * Heating DD * Neighborhood Indicator Variable: Percent of Occupied HU with Other Heat <= 5.6%	83.3%	94.7%	75.1%	91.2%
536	THZIP9	Program * Heating DD * Neighborhood Indicator Variable: Percent of Occupied HU with Other Heat > 5.6%	0.0%	0.0%	0.0%	0.0%
537	THZIP10	Program * Heating DD * Neighborhood Indicator Variable: Median Number of Rooms in HUs <= 5.1	64.9%	89.5%	93.4%	97.1%
538	THZIP11	Program * Heating DD * Neighborhood Indicator Variable: Median Number of Rooms in HUs <= 6.4	78.4%	95.1%	92.6%	96.7%
539	THZIP12	Program * Heating DD * Neighborhood Indicator Variable: Median Number of Rooms in HUs > 6.4	0.0%	0.0%	0.0%	0.0%
540	THZIP13	Program * Heating DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs <= 54.5%	74.2%	93.7%	87.1%	95.3%
541	THZIP14	Program * Heating DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs <= 84.7%	83.6%	92.1%	78.9%	91.0%
542	THZIP15	Program * Heating DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs > 84.7%	0.0%	0.0%	0.0%	0.0%
543	THZIP16	Program * Heating DD * Neighborhood Indicator Variable: Percent of Renter Occupied HUs <= 15.3%	0.0%	0.0%	0.0%	0.0%
544	THZIP17	Program * Heating DD * Neighborhood Indicator Variable: Percent of Renter Occupied HUs <= 45.5%	0.0%	0.0%	0.0%	0.0%
545	THZIP18	Program * Heating DD * Neighborhood Indicator Variable: Percent of Renter Occupied HUs > 45.5%	0.0%	0.0%	0.0%	0.0%
546	THZIP19	Program * Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 0-.50 Occupants Per Room <= 52.6%	86.3%	98.1%	77.8%	94.7%
547	THZIP20	Program * Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 0-.50 Occupants Per Room <= 75.7%	86.3%	94.6%	74.2%	92.6%
548	THZIP21	Program * Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 0-.50 Occupants Per Room > 75.7%	0.0%	0.0%	0.0%	0.0%
549	THZIP22	Program * Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with .51-1.00 Occupants Per Room <= 22.0%	81.6%	98.0%	76.7%	88.2%
550	THZIP23	Program * Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with .51-1.00 Occupants Per Room <= 40.1%	78.6%	94.1%	82.7%	94.4%
551	THZIP24	Program * Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with .51-	0.0%	0.0%	0.0%	0.0%

		1.00 Occupants Per Room > 40.1%				
552	THZIP25	Program * Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 1.01-1.50 Occupants Per Room <= 0.0%	69.6%	87.8%	66.3%	92.6%
553	THZIP26	Program * Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 1.01-1.50 Occupants Per Room <= 5.3%	74.2%	95.6%	64.1%	92.7%
554	THZIP27	Program * Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 1.01-1.50 Occupants Per Room > 5.3%	0.0%	0.0%	0.0%	0.0%
555	THZIP28	Program * Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 1.51-2.00 Occupants Per Room <= 0.0%	88.2%	96.0%	86.3%	89.2%
556	THZIP29	Program * Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 1.51-2.00 Occupants Per Room <= 0.7%	66.6%	84.4%	82.2%	85.7%
557	THZIP30	Program * Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 1.51-2.00 Occupants Per Room > 0.7%	0.0%	0.0%	0.0%	0.0%
558	THZIP31	Program * Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 2.01 Plus Occupants Per Room <= 0.0%	81.4%	89.9%	84.7%	88.7%
559	THZIP32	Program * Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 2.01 Plus Occupants Per Room <= 0.0%	0.0%	0.0%	0.0%	0.0%
560	THZIP33	Program * Heating DD * Neighborhood Indicator Variable: Percent of Occupied HUs with 2.01 Plus Occupants Per Room > 0.0%	0.0%	0.0%	0.0%	0.0%
561	THZIP34	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs with 1 Unit Structure <= 68.8%	75.6%	89.1%	76.4%	90.7%
562	THZIP35	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs with 1 Unit Structure <= 100.0%	0.0%	0.0%	0.0%	0.0%
563	THZIP36	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs with 1 Unit Structure > 100.0%	0.0%	0.0%	0.0%	0.0%
564	THZIP37	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs with 2 Unit Structure <= 0.0%	81.1%	92.2%	91.2%	95.8%
565	THZIP38	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs with 2 Unit Structure <= 1.7%	58.9%	77.7%	86.0%	94.6%
566	THZIP39	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs with 2 Unit Structure > 1.7%	0.0%	0.0%	0.0%	0.0%
567	THZIP40	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs with 3+ Unit	72.6%	93.6%	73.2%	91.8%

		Structure <= 0.0%				
568	THZIP41	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs with 3+ Unit Structure <= 24.4%	74.8%	93.4%	69.6%	90.6%
569	THZIP42	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs with 3+ Unit Structure > 24.4%	0.0%	0.0%	0.0%	0.0%
570	THZIP43	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs That Are Mobile Homes, Boat, RV, Van, Etc. <= 0.0%	81.1%	89.5%	84.7%	92.2%
571	THZIP44	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs That Are Mobile Homes, Boat, RV, Van, Etc. <= 0.0%	0.0%	0.0%	0.0%	0.0%
572	THZIP45	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs That Are Mobile Homes, Boat, RV, Van, Etc. > 0.0%	0.0%	0.0%	0.0%	0.0%
573	THZIP46	Program * Heating DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $0 - $149,999 <= 0.0%	72.3%	94.3%	74.8%	89.0%
574	THZIP47	Program * Heating DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $0 - $149,999 <= 12.9%	78.6%	91.6%	83.6%	96.4%
575	THZIP48	Program * Heating DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $0 - $149,999 > 12.9%	0.0%	0.0%	0.0%	0.0%
576	THZIP49	Program * Heating DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $150,000 - $299,999 <= 1.9%	65.5%	87.4%	84.7%	93.5%
577	THZIP50	Program * Heating DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $150,000 - $299,999 <= 39.3%	67.9%	89.1%	91.5%	98.5%
578	THZIP51	Program * Heating DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $150,000 - $299,999 > 39.3%	0.0%	0.0%	0.0%	0.0%
579	THZIP52	Program * Heating DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $300,000 - Plus <= 36.5%	76.4%	95.0%	86.8%	97.5%
580	THZIP53	Program * Heating DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $300,000 - Plus <= 95.0%	67.4%	91.5%	77.5%	89.8%
581	THZIP54	Program * Heating DD * Neighborhood Indicator Variable: Percent of Owner Occupied HUs with Value = $300,000 - Plus > 95.0%	0.0%	0.0%	0.0%	0.0%
582	THZIP55	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs with 0-1 Bedroom <= 0.0%	79.2%	92.7%	81.6%	95.6%

583	THZIP56	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs with 0-1 Bedroom <= 13.6%	70.7%	86.4%	74.0%	92.6%
584	THZIP57	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs with 0-1 Bedroom > 13.6%	0.0%	0.0%	0.0%	0.0%
585	THZIP58	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs with 2 Bedrooms <= 5.9%	71.8%	90.5%	81.9%	94.3%
586	THZIP59	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs with 2 Bedrooms <= 30.8%	79.7%	91.8%	80.5%	93.9%
587	THZIP60	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs with 2 Bedrooms > 30.8%	0.0%	0.0%	0.0%	0.0%
588	THZIP61	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs with 3+ Bedrooms <= 53.7%	69.9%	88.6%	85.5%	96.5%
589	THZIP62	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs with 3+ Bedrooms <= 91.7%	79.2%	93.4%	69.3%	89.7%
590	THZIP63	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs with 3+ Bedrooms > 91.7%	0.0%	0.0%	0.0%	0.0%
591	THZIP64	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs Built in Year 2000 + <= 0.0%	81.9%	90.3%	84.9%	96.1%
592	THZIP65	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs Built in Year 2000 + <= 8.6%	86.6%	94.3%	81.9%	95.3%
593	THZIP66	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs Built in Year 2000 + > 8.6%	0.0%	0.0%	0.0%	0.0%
594	THZIP67	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs Built in Years 1980-1999 <= 4.7%	84.7%	93.9%	68.2%	88.4%
595	THZIP68	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs Built in Years 1980-1999 <= 35.3%	81.4%	86.9%	57.8%	80.6%
596	THZIP69	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs Built in Years 1980-1999 > 35.3%	0.0%	0.0%	0.0%	0.0%
597	THZIP70	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs Built in Year 1979 or Older <= 49.9%	84.4%	94.8%	88.8%	92.9%
598	THZIP71	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs Built in Year 1979 or Older <= 93.1%	81.1%	91.6%	94.2%	95.9%
599	THZIP72	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs Built in Year 1979 or Older > 93.1%	0.0%	0.0%	0.0%	0.0%
600	THZIP73	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs with Income in the past 12 Months Below Poverty Level <= 3.4%	87.1%	93.1%	91.0%	94.6%

601	THZIP74	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs with Income in the past 12 Months Below Poverty Level <= 14.4%	74.0%	90.4%	69.0%	86.5%
602	THZIP75	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs with Income in the past 12 Months Below Poverty Level > 14.4%	0.0%	0.0%	0.0%	0.0%
603	THZIP76	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs with Income in the past 12 Months Above Poverty Level <= 85.6%	0.0%	0.0%	0.0%	0.0%
604	THZIP77	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs with Income in the past 12 Months Above Poverty Level <= 96.6%	0.0%	0.0%	0.0%	0.0%
605	THZIP78	Program * Heating DD * Neighborhood Indicator Variable: Percent of HUs with Income in the past 12 Months Above Poverty Level > 96.6%	0.0%	0.0%	0.0%	0.0%
606	THDD_TIME1	Program * Heating DD * Weekday * Hour = 1 Indicator	49.3%	87.8%	48.5%	84.7%
607	THDD_TIME2	Program * Heating DD * Weekday * Hour = 2 Indicator	53.4%	88.7%	52.1%	84.2%
608	THDD_TIME3	Program * Heating DD * Weekday * Hour = 3 Indicator	62.7%	92.1%	55.1%	88.1%
609	THDD_TIME4	Program * Heating DD * Weekday * Hour = 4 Indicator	74.5%	93.8%	63.8%	86.3%
610	THDD_TIME5	Program * Heating DD * Weekday * Hour = 5 Indicator	76.7%	96.4%	69.0%	92.5%
611	THDD_TIME6	Program * Heating DD * Weekday * Hour = 6 Indicator	74.5%	95.6%	71.2%	91.5%
612	THDD_TIME7	Program * Heating DD * Weekday * Hour = 7 Indicator	78.1%	92.6%	78.9%	93.1%
613	THDD_TIME8	Program * Heating DD * Weekday * Hour = 8 Indicator	76.4%	86.4%	74.8%	92.3%
614	THDD_TIME9	Program * Heating DD * Weekday * Hour = 9 Indicator	77.0%	88.6%	67.1%	86.9%
615	THDD_TIME10	Program * Heating DD * Weekday * Hour = 10 Indicator	75.3%	88.0%	58.1%	86.8%
616	THDD_TIME11	Program * Heating DD * Weekday * Hour = 11 Indicator	55.9%	74.0%	65.8%	85.4%
617	THDD_TIME12	Program * Heating DD * Weekday * Hour = 12 Indicator	57.8%	73.5%	66.0%	84.2%
618	THDD_TIME13	Program * Heating DD * Weekday * Hour = 13 Indicator	52.9%	79.8%	59.2%	85.2%
619	THDD_TIME14	Program * Heating DD * Weekday * Hour = 14 Indicator	48.2%	75.0%	57.5%	79.0%
620	THDD_TIME15	Program * Heating DD * Weekday * Hour = 15 Indicator	62.5%	82.5%	58.6%	81.3%
621	THDD_TIME16	Program * Heating DD * Weekday * Hour = 16 Indicator	59.2%	75.5%	58.9%	83.3%
622	THDD_TIME17	Program * Heating DD * Weekday * Hour = 17 Indicator	50.1%	86.3%	70.1%	74.2%
623	THDD_TIME18	Program * Heating DD * Weekday * Hour = 18 Indicator	60.8%	83.8%	77.3%	85.8%
624	THDD_TIME19	Program * Heating DD * Weekday * Hour = 19 Indicator	65.2%	84.9%	80.3%	84.3%
625	THDD_TIME20	Program * Heating DD * Weekday * Hour = 20 Indicator	55.6%	85.2%	84.4%	86.7%
626	THDD_TIME21	Program * Heating DD * Weekday * Hour = 21 Indicator	50.4%	86.4%	81.1%	93.2%
627	THDD_TIME22	Program * Heating DD * Weekday * Hour = 22 Indicator	58.4%	93.0%	64.9%	92.0%
628	THDD_TIME23	Program * Heating DD * Weekday * Hour = 23 Indicator	50.1%	80.3%	46.6%	91.8%
629	THDD_TIME24	Program * Heating DD * Weekday * Hour = 24 Indicator	43.8%	78.1%	45.5%	81.3%

630	THDD_TIME25	Program * Heating DD * Weekend * Hour = 1 Indicator	37.8%	73.9%	38.9%	78.2%
631	THDD_TIME26	Program * Heating DD * Weekend * Hour = 2 Indicator	37.0%	81.5%	49.9%	82.4%
632	THDD_TIME27	Program * Heating DD * Weekend * Hour = 3 Indicator	55.3%	85.6%	61.9%	86.3%
633	THDD_TIME28	Program * Heating DD * Weekend * Hour = 4 Indicator	74.5%	89.3%	67.4%	92.3%
634	THDD_TIME29	Program * Heating DD * Weekend * Hour = 5 Indicator	72.1%	93.5%	66.3%	88.8%
635	THDD_TIME30	Program * Heating DD * Weekend * Hour = 6 Indicator	64.4%	94.0%	68.2%	92.0%
636	THDD_TIME31	Program * Heating DD * Weekend * Hour = 7 Indicator	65.8%	94.6%	80.0%	90.4%
637	THDD_TIME32	Program * Heating DD * Weekend * Hour = 8 Indicator	77.5%	85.9%	76.7%	88.2%
638	THDD_TIME33	Program * Heating DD * Weekend * Hour = 9 Indicator	71.8%	81.7%	61.1%	89.2%
639	THDD_TIME34	Program * Heating DD * Weekend * Hour = 10 Indicator	62.2%	81.1%	50.7%	79.5%
640	THDD_TIME35	Program * Heating DD * Weekend * Hour = 11 Indicator	57.0%	68.8%	52.9%	84.5%
641	THDD_TIME36	Program * Heating DD * Weekend * Hour = 12 Indicator	58.6%	73.4%	55.1%	81.6%
642	THDD_TIME37	Program * Heating DD * Weekend * Hour = 13 Indicator	53.2%	75.8%	52.1%	80.5%
643	THDD_TIME38	Program * Heating DD * Weekend * Hour = 14 Indicator	54.8%	77.5%	53.2%	69.1%
644	THDD_TIME39	Program * Heating DD * Weekend * Hour = 15 Indicator	52.6%	75.0%	54.0%	77.2%
645	THDD_TIME40	Program * Heating DD * Weekend * Hour = 16 Indicator	55.1%	72.1%	57.8%	78.2%
646	THDD_TIME41	Program * Heating DD * Weekend * Hour = 17 Indicator	58.6%	72.0%	65.8%	85.0%
647	THDD_TIME42	Program * Heating DD * Weekend * Hour = 18 Indicator	55.9%	77.9%	68.2%	87.1%
648	THDD_TIME43	Program * Heating DD * Weekend * Hour = 19 Indicator	57.0%	79.3%	67.9%	83.5%
649	THDD_TIME44	Program * Heating DD * Weekend * Hour = 20 Indicator	50.4%	83.7%	72.9%	85.0%
650	THDD_TIME45	Program * Heating DD * Weekend * Hour = 21 Indicator	36.2%	87.1%	69.6%	87.8%
651	THDD_TIME46	Program * Heating DD * Weekend * Hour = 22 Indicator	38.9%	81.7%	53.2%	87.6%
652	THDD_TIME47	Program * Heating DD * Weekend * Hour = 23 Indicator	31.0%	92.9%	36.2%	90.2%
653	THDD_TIME48	Program * Heating DD * Weekend * Hour = 24 Indicator	0.0%	0.0%	0.0%	0.0%
654	TCDD_TIME1	Program * Cooling DD * Weekday * Hour = 1 Indicator	26.6%	77.3%	30.7%	67.0%
655	TCDD_TIME2	Program * Cooling DD * Weekday * Hour = 2 Indicator	26.0%	71.6%	33.2%	63.6%
656	TCDD_TIME3	Program * Cooling DD * Weekday * Hour = 3 Indicator	21.9%	68.8%	28.5%	61.5%
657	TCDD_TIME4	Program * Cooling DD * Weekday * Hour = 4 Indicator	27.4%	73.0%	30.1%	57.3%
658	TCDD_TIME5	Program * Cooling DD * Weekday * Hour = 5 Indicator	30.7%	72.3%	35.1%	57.0%
659	TCDD_TIME6	Program * Cooling DD * Weekday * Hour = 6 Indicator	38.1%	71.9%	33.4%	63.9%
660	TCDD_TIME7	Program * Cooling DD * Weekday * Hour = 7 Indicator	24.9%	79.1%	27.1%	66.7%
661	TCDD_TIME8	Program * Cooling DD * Weekday * Hour = 8 Indicator	31.2%	80.7%	24.7%	78.9%
662	TCDD_TIME9	Program * Cooling DD * Weekday * Hour = 9 Indicator	23.6%	90.7%	29.0%	84.9%
663	TCDD_TIME10	Program * Cooling DD * Weekday * Hour = 10 Indicator	23.0%	90.5%	29.6%	84.3%
664	TCDD_TIME11	Program * Cooling DD * Weekday * Hour = 11 Indicator	23.6%	95.3%	31.8%	82.8%
665	TCDD_TIME12	Program * Cooling DD * Weekday * Hour = 12 Indicator	21.4%	88.5%	31.0%	92.9%

666	TCDD_TIME13	Program * Cooling DD * Weekday * Hour = 13 Indicator	23.6%	81.4%	34.2%	85.6%
667	TCDD_TIME14	Program * Cooling DD * Weekday * Hour = 14 Indicator	19.7%	84.7%	35.6%	87.7%
668	TCDD_TIME15	Program * Cooling DD * Weekday * Hour = 15 Indicator	23.6%	90.7%	34.2%	74.4%
669	TCDD_TIME16	Program * Cooling DD * Weekday * Hour = 16 Indicator	24.9%	92.3%	31.0%	77.0%
670	TCDD_TIME17	Program * Cooling DD * Weekday * Hour = 17 Indicator	26.6%	90.7%	31.5%	79.1%
671	TCDD_TIME18	Program * Cooling DD * Weekday * Hour = 18 Indicator	21.9%	88.8%	26.3%	86.5%
672	TCDD_TIME19	Program * Cooling DD * Weekday * Hour = 19 Indicator	24.9%	91.2%	31.2%	91.2%
673	TCDD_TIME20	Program * Cooling DD * Weekday * Hour = 20 Indicator	23.0%	89.3%	34.2%	81.6%
674	TCDD_TIME21	Program * Cooling DD * Weekday * Hour = 21 Indicator	26.3%	79.2%	36.7%	69.4%
675	TCDD_TIME22	Program * Cooling DD * Weekday * Hour = 22 Indicator	24.1%	76.1%	33.7%	69.9%
676	TCDD_TIME23	Program * Cooling DD * Weekday * Hour = 23 Indicator	29.9%	79.8%	31.5%	74.8%
677	TCDD_TIME24	Program * Cooling DD * Weekday * Hour = 24 Indicator	29.9%	85.3%	26.6%	75.3%
678	TCDD_TIME25	Program * Cooling DD * Weekend * Hour = 1 Indicator	32.3%	84.7%	23.0%	83.3%
679	TCDD_TIME26	Program * Cooling DD * Weekend * Hour = 2 Indicator	29.0%	66.0%	24.7%	56.7%
680	TCDD_TIME27	Program * Cooling DD * Weekend * Hour = 3 Indicator	26.6%	70.1%	29.0%	61.3%
681	TCDD_TIME28	Program * Cooling DD * Weekend * Hour = 4 Indicator	27.4%	84.0%	29.6%	57.4%
682	TCDD_TIME29	Program * Cooling DD * Weekend * Hour = 5 Indicator	24.1%	80.7%	31.8%	72.4%
683	TCDD_TIME30	Program * Cooling DD * Weekend * Hour = 6 Indicator	26.8%	91.8%	24.1%	65.9%
684	TCDD_TIME31	Program * Cooling DD * Weekend * Hour = 7 Indicator	26.0%	84.2%	35.6%	70.8%
685	TCDD_TIME32	Program * Cooling DD * Weekend * Hour = 8 Indicator	32.1%	89.7%	35.6%	80.0%
686	TCDD_TIME33	Program * Cooling DD * Weekend * Hour = 9 Indicator	26.6%	85.6%	27.9%	73.5%
687	TCDD_TIME34	Program * Cooling DD * Weekend * Hour = 10 Indicator	26.6%	86.6%	30.1%	79.1%
688	TCDD_TIME35	Program * Cooling DD * Weekend * Hour = 11 Indicator	21.9%	88.8%	28.8%	84.8%
689	TCDD_TIME36	Program * Cooling DD * Weekend * Hour = 12 Indicator	25.8%	83.0%	30.4%	80.2%
690	TCDD_TIME37	Program * Cooling DD * Weekend * Hour = 13 Indicator	23.8%	92.0%	27.1%	89.9%
691	TCDD_TIME38	Program * Cooling DD * Weekend * Hour = 14 Indicator	24.4%	93.3%	30.1%	84.5%
692	TCDD_TIME39	Program * Cooling DD * Weekend * Hour = 15 Indicator	23.0%	91.7%	29.6%	85.2%
693	TCDD_TIME40	Program * Cooling DD * Weekend * Hour = 16 Indicator	23.6%	84.9%	30.4%	84.7%
694	TCDD_TIME41	Program * Cooling DD * Weekend * Hour = 17 Indicator	23.0%	88.1%	30.1%	83.6%
695	TCDD_TIME42	Program * Cooling DD * Weekend * Hour = 18 Indicator	26.3%	89.6%	33.4%	83.6%
696	TCDD_TIME43	Program * Cooling DD * Weekend * Hour = 19 Indicator	24.7%	82.2%	33.2%	85.1%
697	TCDD_TIME44	Program * Cooling DD * Weekend * Hour = 20 Indicator	26.3%	69.8%	32.6%	82.4%
698	TCDD_TIME45	Program * Cooling DD * Weekend * Hour = 21 Indicator	28.5%	79.8%	37.3%	80.1%
699	TCDD_TIME46	Program * Cooling DD * Weekend * Hour = 22 Indicator	27.9%	69.6%	37.0%	79.3%
700	TCDD_TIME47	Program * Cooling DD * Weekend * Hour = 23 Indicator	21.6%	81.0%	20.0%	69.9%
701	TCDD_TIME48	Program * Cooling DD * Weekend * Hour = 24 Indicator	0.0%	0.0%	0.0%	0.0%

702	TIDD_TIME1	Program * Heat Index DD * Weekday * Hour = 1 Indicator	5.8%	85.7%	12.9%	76.6%
703	TIDD_TIME2	Program * Heat Index DD * Weekday * Hour = 2 Indicator	4.1%	100.0%	8.2%	93.3%
704	TIDD_TIME3	Program * Heat Index DD * Weekday * Hour = 3 Indicator	3.8%	100.0%	9.3%	85.3%
705	TIDD_TIME4	Program * Heat Index DD * Weekday * Hour = 4 Indicator	4.9%	100.0%	7.4%	85.2%
706	TIDD_TIME5	Program * Heat Index DD * Weekday * Hour = 5 Indicator	6.6%	100.0%	10.1%	91.9%
707	TIDD_TIME6	Program * Heat Index DD * Weekday * Hour = 6 Indicator	7.9%	93.1%	12.3%	77.8%
708	TIDD_TIME7	Program * Heat Index DD * Weekday * Hour = 7 Indicator	8.8%	84.4%	10.7%	74.4%
709	TIDD_TIME8	Program * Heat Index DD * Weekday * Hour = 8 Indicator	10.1%	100.0%	11.0%	95.0%
710	TIDD_TIME9	Program * Heat Index DD * Weekday * Hour = 9 Indicator	8.5%	90.3%	14.5%	96.2%
711	TIDD_TIME10	Program * Heat Index DD * Weekday * Hour = 10 Indicator	11.0%	92.5%	17.3%	95.2%
712	TIDD_TIME11	Program * Heat Index DD * Weekday * Hour = 11 Indicator	14.8%	94.4%	20.8%	86.8%
713	TIDD_TIME12	Program * Heat Index DD * Weekday * Hour = 12 Indicator	12.6%	97.8%	21.1%	97.4%
714	TIDD_TIME13	Program * Heat Index DD * Weekday * Hour = 13 Indicator	15.3%	87.5%	26.0%	89.5%
715	TIDD_TIME14	Program * Heat Index DD * Weekday * Hour = 14 Indicator	12.3%	82.2%	30.4%	86.5%
716	TIDD_TIME15	Program * Heat Index DD * Weekday * Hour = 15 Indicator	13.7%	90.0%	25.8%	81.9%
717	TIDD_TIME16	Program * Heat Index DD * Weekday * Hour = 16 Indicator	14.5%	92.5%	22.2%	84.0%
718	TIDD_TIME17	Program * Heat Index DD * Weekday * Hour = 17 Indicator	11.8%	93.0%	21.1%	89.6%
719	TIDD_TIME18	Program * Heat Index DD * Weekday * Hour = 18 Indicator	10.1%	89.2%	15.9%	87.9%
720	TIDD_TIME19	Program * Heat Index DD * Weekday * Hour = 19 Indicator	9.3%	100.0%	19.5%	94.4%
721	TIDD_TIME20	Program * Heat Index DD * Weekday * Hour = 20 Indicator	6.8%	92.0%	17.8%	81.5%
722	TIDD_TIME21	Program * Heat Index DD * Weekday * Hour = 21 Indicator	7.1%	92.3%	17.8%	83.1%
723	TIDD_TIME22	Program * Heat Index DD * Weekday * Hour = 22 Indicator	6.6%	95.8%	16.4%	93.3%
724	TIDD_TIME23	Program * Heat Index DD * Weekday * Hour = 23 Indicator	10.1%	91.9%	16.4%	88.3%
725	TIDD_TIME24	Program * Heat Index DD * Weekday * Hour = 24 Indicator	9.0%	87.9%	14.2%	82.7%
726	TIDD_TIME25	Program * Heat Index DD * Weekend * Hour = 1 Indicator	7.7%	85.7%	6.8%	76.0%
727	TIDD_TIME26	Program * Heat Index DD * Weekend * Hour = 2 Indicator	4.7%	41.2%	7.7%	53.6%
728	TIDD_TIME27	Program * Heat Index DD * Weekend * Hour = 3 Indicator	4.4%	100.0%	6.3%	65.2%
729	TIDD_TIME28	Program * Heat Index DD * Weekend * Hour = 4 Indicator	4.7%	88.2%	4.4%	87.5%
730	TIDD_TIME29	Program * Heat Index DD * Weekend * Hour = 5 Indicator	1.9%	57.1%	8.2%	76.7%
731	TIDD_TIME30	Program * Heat Index DD * Weekend * Hour = 6 Indicator	4.7%	100.0%	5.8%	71.4%
732	TIDD_TIME31	Program * Heat Index DD * Weekend * Hour = 7 Indicator	6.8%	80.0%	12.9%	85.1%
733	TIDD_TIME32	Program * Heat Index DD * Weekend * Hour = 8 Indicator	8.8%	81.3%	12.1%	90.9%
734	TIDD_TIME33	Program * Heat Index DD * Weekend * Hour = 9 Indicator	10.7%	89.7%	13.2%	87.5%
735	TIDD_TIME34	Program * Heat Index DD * Weekend * Hour = 10 Indicator	11.8%	90.7%	15.6%	82.5%
736	TIDD_TIME35	Program * Heat Index DD * Weekend * Hour = 11 Indicator	10.4%	92.1%	17.5%	85.9%
737	TIDD_TIME36	Program * Heat Index DD * Weekend * Hour = 12 Indicator	15.9%	89.7%	18.4%	92.5%

738	TIDD_TIME37	Program * Heat Index DD * Weekend * Hour = 13 Indicator	15.9%	94.8%	19.7%	90.3%
739	TIDD_TIME38	Program * Heat Index DD * Weekend * Hour = 14 Indicator	14.2%	92.3%	21.9%	90.0%
740	TIDD_TIME39	Program * Heat Index DD * Weekend * Hour = 15 Indicator	13.7%	92.0%	19.5%	87.3%
741	TIDD_TIME40	Program * Heat Index DD * Weekend * Hour = 16 Indicator	10.7%	84.6%	20.3%	86.5%
742	TIDD_TIME41	Program * Heat Index DD * Weekend * Hour = 17 Indicator	11.0%	92.5%	17.0%	87.1%
743	TIDD_TIME42	Program * Heat Index DD * Weekend * Hour = 18 Indicator	12.1%	88.6%	17.8%	78.5%
744	TIDD_TIME43	Program * Heat Index DD * Weekend * Hour = 19 Indicator	6.3%	87.0%	16.7%	93.4%
745	TIDD_TIME44	Program * Heat Index DD * Weekend * Hour = 20 Indicator	6.8%	88.0%	14.5%	92.5%
746	TIDD_TIME45	Program * Heat Index DD * Weekend * Hour = 21 Indicator	6.6%	91.7%	15.6%	89.5%
747	TIDD_TIME46	Program * Heat Index DD * Weekend * Hour = 22 Indicator	8.2%	96.7%	14.2%	92.3%
748	TIDD_TIME47	Program * Heat Index DD * Weekend * Hour = 23 Indicator	5.8%	90.5%	5.8%	66.7%
749	TIDD_TIME48	Program * Heat Index DD * Weekend * Hour = 24 Indicator	0.0%	0.0%	0.0%	0.0%

APPENDIX F. STANDARD ERRORS

These tables provide the standard errors for the realization rates presented in the body of this report. All estimates are considered statistically significant, meaning that it is unlikely the results are due to chance.

Table 45: HUP realization rates and standard errors

	kWh		kW		Therm	
PA	**Realization Rate**	Standard Error	**Realization Rate**	Standard Error	**Realization Rate**	Standard Error
BAYREN	-47.70%	0.74%	5.71%	0.99%	63.35%	0.96%
PGE	5.61%	0.45%	1.94%	0.23%	26.83%	0.42%
SCE	23.94%	0.58%	14.30%	1.24%	0.00%	0.00%
SCG	0.00%	0.00%	0.00%	0.00%	253.74%	3.92%
SDGE	-14.67%	0.53%	-2.70%	0.64%	96.98%	1.49%
SOCALREN	20.33%	0.69%	18.17%	0.55%	96.16%	1.45%

Table 46: AHUP realization rates and standard errors

	kWh		kW		Therm	
PA	**Realization Rate**	Standard Error	**Realization Rate**	Standard Error	**Realization Rate**	Standard Error
BAYREN	---	---	---	---	---	---
PGE	25.21%	0.15%	12.11%	0.15%	10.30%	0.07%
SCE	23.52%	0.18%	21.19%	0.21%	0.00%	0.00%
SCG	0.00%	0.00%	0.00%	0.00%	11.47%	0.07%
SDGE	17.71%	0.26%	24.41%	0.42%	21.21%	0.14%
SOCALREN	---	---	---	---	---	---

APPENDIX G. PROGRAM TRACKING DATA EXCERPT

This appendix includes reported measure names from AHUP and HUP. The AHUP names are not descriptive and require the contractor simulation model files to understand what was installed in the home. For HUP the level of information contained in the measure name varies from PA to PA. Specifically, BayREN provides the most informative reporting of all six PA.

Table 47. Measure names from CPUC HUP program tracking data

Path	Measure Names	BayREN	PG&E	SCE	SoCalGas	SDG&E	SoCalREN	Total
HUP	14 Watt Integral Spiral (Dwelling Area) CFL Replacing Incandescent Average Watts = 48.58			494				494
HUP	1fl.AC:r8 Dct Ins;6% Dct Lkg;seer 14 AC		10					10
HUP	55 Watt Plug-In Lamp CFL			25				25
HUP	AC >= 14 SEER/12 EER, Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%	17						17
HUP	AC >= 14 SEER/12 EER, Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%, Duct Insulation	13						13
HUP	AC >= 14 SEER/12 EER, Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%	16						16
HUP	AC >= 14 SEER/12 EER, Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%, Duct Insulation	13						13
HUP	AC >= 14 SEER/12 EER, Seal Existing Ducts <= 10%, Furnace AFUE >= 95%	13						13
HUP	AC >= 14 SEER/12 EER, Seal Existing Ducts <= 10%, Furnace AFUE >= 95%	13						13
HUP	AC >= 15 SEER/12.7 EER, On-Demand >= 0.82, Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%	9						9
HUP	AC >= 15 SEER/12.7 EER, On-Demand >= 0.82, Seal Existing Ducts <= 10%, Furnace AFUE >= 95%	6						6
HUP	AC >= 15 SEER/12.7 EER, Replacement Ducts Seal <= 6%, Furnace AFUE >= 92%	8						8
HUP	AC >= 15 SEER/12.7 EER, Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%	56						56
HUP	AC >= 15 SEER/12.7 EER, Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%, Attic Insulation, Duct Insulation	6						6
HUP	AC >= 15 SEER/12.7 EER, Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%, Duct Insulation	42						42
HUP	AC >= 15 SEER/12.7 EER, Seal Existing Ducts <= 10%, Furnace AFUE >= 92%	7						7
HUP	AC >= 15 SEER/12.7 EER, Seal Existing Ducts <= 10%, Furnace AFUE >= 95%	60						60
HUP	AC >= 15 SEER/12.7 EER, Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%	23						23
HUP	AC >= 15 SEER/12.7 EER, Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%, Duct Insulation	14						14
HUP	AC >= 15 SEER/12.7 EER, Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%	14						14
HUP	AC >= 15 SEER/12.7 EER, Seal Existing Ducts <= 10%, Furnace AFUE >= 95%	16						16
HUP	AC >= 15 SEER/12.7 EER, Seal Existing Ducts <= 10%, Furnace AFUE >= 95%	7						7

Path	Measure Names	BayREN	PG&E	SCE	SoCalGas	SDG&E	SoCalREN	Total
HUP	Air Conditioner; Attic Insulation And Attic Plane Sealing; Duct Insulation; Duct Replacement; Furnace						11	11
HUP	Air Conditioner; Attic Insulation And Attic Plane Sealing; Duct Insulation; Duct Sealing; Furnace						6	6
HUP	Air Conditioner; Duct Insulation; Duct Replacement						15	15
HUP	Air Conditioner; Duct Insulation; Duct Replacement;						20	20
HUP	Air Conditioner; Duct Insulation; Duct Replacement; Furnace						38	38
HUP	Air Conditioner; Duct Insulation; Duct Replacement; Furnace;						35	35
HUP	Air Conditioner; Duct Insulation; Duct Sealing						13	13
HUP	Air Conditioner; Duct Insulation; Duct Sealing;						18	18
HUP	Air Conditioner; Duct Insulation; Duct Sealing; Furnace						25	25
HUP	Air Conditioner; Duct Insulation; Duct Sealing; Furnace;						15	15
HUP	Air Conditioner; Duct Sealing; Furnace;						9	9
HUP	Burbank Home Upgrade				8			8
HUP	Commissioned Variable Speed Drive On Pool Pump Controls Replacing Single Speed Pool Pump			92				92
HUP	Energy Star Room Air Conditioner DX Equipment			7				7
HUP	Faucet Aerator, Bathroom Sink, 1.0 Gpm - SF				16			16
HUP	Hand Held Showerhead				19			19
HUP	Home Office Or Entertainment Center Smart Power Strip			233				233
HUP	Home Upgrade 10%					52		52
HUP	Home Upgrade 15%					84		84
HUP	Home Upgrade 20%					152		152
HUP	Home Upgrade 25%					281		281
HUP	Ladwp Home Upgrade				29			29
HUP	Muni Home Upgrade				15			15
HUP	R8dctins;6%dctlkg;seer15ac In Heated And Cooled, Two Story, Slab On Grade, 1978-1992 Vintage Whole Home Retrofit			7				7
HUP	R8dctins;6%dctlkg;seer15ac In Heated And Cooled, Two Story, Slab On Grade, Pre 1978 Vintage Whole Home Retrofit			6				6
HUP	R8dctins;6%dctlkg;seer15ac;95afuefrn In Heated And Cooled, Two Story, Slab On Grade, Pre 1978 Vintage Whole Home Retrofit			7				7
HUP	Reduce Leakage >= 15%, AC >= 15 SEER/12.7 EER, Furnace AFUE >= 95%	9						9
HUP	Reduce Leakage >= 15%, AC >= 15 SEER/12.7 EER, Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%	11						11
HUP	Reduce Leakage >= 15%, AC >= 15 SEER/12.7 EER, Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%, Duct Insulation	7						7

Path	Measure Names	BayREN	PG&E	SCE	SoCalGas	SDG&E	SoCalREN	Total
HUP	Reduce Leakage >= 15%, AC >= 15 SEER/12.7 EER, Seal Existing Ducts <= 10%, Furnace AFUE >= 95%	9						9
HUP	Reduce Leakage >= 15%, AC >= 15 SEER/12.7 EER, Furnace AFUE >= 95%	7						7
HUP	Reduce Leakage >= 15%, AC >= 15 SEER/12.7 EER, Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%	6						6
HUP	Reduce Leakage >= 15%, AC >= 15 SEER/12.7 EER, Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%, Duct Insulation	8						8
HUP	Reduce Leakage >= 15%, Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%, Duct Insulation	7						7
HUP	Reduce Leakage >= 30%, AC >= 14 SEER/12 EER, Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%, Duct Insulation	7						7
HUP	Reduce Leakage >= 30%, AC >= 15 SEER/12.7 EER, Furnace AFUE >= 95%	7						7
HUP	Reduce Leakage >= 30%, AC >= 15 SEER/12.7 EER, Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%	6						6
HUP	Reduce Leakage >= 30%, AC >= 15 SEER/12.7 EER, Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%, Duct Insulation	8						8
HUP	Reduce Leakage >= 30%, AC >= 15 SEER/12.7 EER, Seal Existing Ducts <= 10%, Furnace AFUE >= 95%	13						13
HUP	Reduce Leakage >= 30%, AC >= 15 SEER/12.7 EER, Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%	12						12
HUP	Reduce Leakage >= 30%, AC >= 15 SEER/12.7 EER, Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%, Duct Insulation	6						6
HUP	Reduce Leakage >= 30%, AC >= 15 SEER/12.7 EER, Seal Existing Ducts <= 10%, Furnace AFUE >= 95%	7						7
HUP	Reduce Leakage >= 30%, Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%, Duct Insulation	16						16
HUP	Reduce Leakage >= 30%, Furnace AFUE >= 95%, Duct Insulation	6						6
HUP	Reduce Leakage >= 30%, Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%, Duct Insulation	18						18
HUP	Reduce Leakage >= 30%, Replacement Ducts Seal <= 6%, Attic Insulation, Duct Insulation	7						7
HUP	Reduce Leakage >= 30%, Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%, Duct Insulation	6						6
HUP	Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%, Attic Insulation	7						7
HUP	Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%, Attic Insulation, Duct Insulation	19						19
HUP	Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%, Duct Insulation	93						93
HUP	Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%, Duct Insulation	49						49
HUP	Replacement Ducts Seal <= 6%, Attic Insulation, Duct Insulation	9						9
HUP	Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%, Duct Insulation	47						47
HUP	Sce Home Upgrade				171			171
HUP	Seal Existing Ducts <= 10%, Furnace AFUE >= 95%, Attic Insulation	6						6
HUP	Seal Existing Ducts <= 10%, Furnace AFUE >= 95%, Duct Insulation	11						11
HUP	Thermostatic Shower Valve				17			17

Path	Measure Names	BayREN	PG&E	SCE	SoCalGas	SDG&E	SoCalREN	Total
HUP	Window EVAP Cooler			210				210

Source: DNV GL 200 Analysis

Table 48. Measure names from CPUC AHUP program tracking data (> 5 projects)

Path	Measure Names	BayREN	PG&E	SCE	SoCalGas	SDG&E	SoCalREN	Total
AHUP	Advanced Home Upgrade 25%					6		6
AHUP	Comprehensive Whole House Retrofit			843				843
AHUP	Euc Advanced Home Upgrade Therm Kicker		1703					1703
AHUP	Euc Advanced Home Upgrade kWh Kicker		1558					1558
AHUP	Ladwp Advanced Home Upgrade				417			417
AHUP	Muni Advanced Home Upgrade				69			69
AHUP	Res Euc Basic Path Interactive Measure Rollup		1522					1522
AHUP	Retrofit-Res-Whole House-Base Load		1250					1250
AHUP	Retrofit-Res-Whole House-Cooling		1097					1097
AHUP	Retrofit-Res-Whole House-Fans		1548					1548
AHUP	Retrofit-Res-Whole House-Heating		1779					1779
AHUP	Retrofit-Res-Whole House-Lighting		1221					1221
AHUP	Retrofit-Res-Whole House-Water Heating		378					378
AHUP	Savings Bonus - Therms					6		6
AHUP	Savings Bonus - kWh					6		6
AHUP	Sce Advanced Home Upgrade				579			579
AHUP	Targeted Dsm Kicker For High Efficiency AC Replacement - No Savings		35					35

Source: DNV GL 200 Analysis

APPENDIX H. SURVEY INSTRUMENT

HUP IMPACT EVALUATION 2016 - SURVEY FLOW

Sample design TBD by IOU, climate zone, and distribution of difference in normalized annual consumption (NAC).

Map of project goals to survey questions

Goal #	Goal description	Method	Questions that support goal
1	Estimate the gross and net energy savings	Billing / Survey	Sections 6 (overall free rider questions) Sections 7 (measure specific free rider questions)
3	Document participant perspectives between HU and AHU upgrades	Survey	Section 3 (project details) Section 4 (questions about contractor) Section 6 (overall free rider questions)
4	Correlations between program activity, energy savings, project costs, demographics and homeowner preferences and choices.	Survey	Section 8 (household changes) Section 9 (project financing) Section 10 (segmentation items) Section 11 (household characteristics)
6	Accuracy of savings estimates relative to differences in program administration	Survey / Billing	Section 4 (questions about contractor)
2	Develop realization rates	Billing	NA
5	Generate recommendations to improve energy savings estimates	Billing	NA
7	Report number of participants with reduced energy use by 20% or more.	Billing	NA
8	Compare results with prior	Billing	NA

	evaluations and forecasts		

Introduction

This survey is being conducted by an independent research organization with households that participated in the Energy Upgrade California Home Upgrade program to install energy efficiency measures.

This study is sponsored by the California Public Utilities Commission.

The California Public Utilities Commission will use this information to help plan programs to benefit homeowners and save energy. Responses to this survey will be kept strictly confidential and reported only in the aggregate.

You may confirm that this is a legitimate study by contacting Peter Franzese, the California Public Utilities Commission study manager, at Peter.Franzese@cpuc.ca.gov

Thank you for taking the time to participate in this survey.

SCREENER

S1. Which year did you complete the project under the **Energy Upgrade California Home Upgrade** program?

To remind you, the Energy Upgrade California® Home Upgrade program evaluates all of the systems in your home by conducting a home audit to determine which upgrades can reduce your energy use and improve the comfort of your home. Following this, the program provides you with recommendations on upgrades that help you realize energy savings and improve comfort.

1. Prior to 2013
2. Between 2013 and 2015
3. After 2015

98. Don't know

[IF S1 IN (1, 3, 98) THEN SCREEN OUT]

Project Details – Warm Up

Energy Audit

A1. **Prior to undertaking this project, did you have an on-site energy assessment/energy audit done of your home by a certified energy professional to identify measures that would save energy and reduce energy costs?**

1. Yes
2. No ➔ **GO TO C1**
98. Don't know ➔ **GO TO C1**

A2. **Which of the following elements did your energy assessment/energy audit include?**
[CHECK ALL THAT APPLY]

1. In-person inspection of your home
2. Blower door test with large fan to measure air leakage
3. Tests to measure leaks in heating and air conditioning ducts, sometimes known as "Duct Blaster"
4. Testing of the combustion efficiency of your furnace or space heater/boiler
5. A report of results from the energy audit
6. In-person discussion of results and energy saving options with contractor
7. A projection of energy savings from possible retrofits

A3. **Did the contractor who performed the Energy Audit also carry out the improvements to your home?**

1. Yes – all of the improvements
2. Yes – some of the improvements
3. No – none of the improvements
98. Don't know

A4. **Did you have to pay out-of-pocket for the Energy Audit?**

1. Yes
2. No
98. Don't know

A5. **Did the energy audit identify opportunities to save energy in your home that you had not been aware of before the audit?**

1. Yes
2. No
98. Don't know

A6. **Did the onsite energy audit help you decide to participate in the program?**

1. Yes
2. No

98. Don’t know

A7. **Which of the following motivated you to participate in the program [CHECK ALL THAT APPLY, RANDOMIZE]**

1. Program incentives/rebates
2. Potential ongoing savings on your monthly bill
3. Environmental concerns
4. Potential to make your home more comfortable
5. To increase the value of your home
6. Possibility of improving the air quality in your home
7. NONE OF THE ABOVE (exclusive)
8. ALL OF THE ABOVE (exclusive)
97. Other (specify)
98. Don’t know

HUP PROJECT CONTRACTOR

C1. **Which of the following did your contractor bring up when discussing plans for your project? [CHECK ALL THAT APPLY]**

1. Energy savings on your monthly bill
2. Rebates on equipment purchases and contractor services
3. Effect of renovation in improving comfort in your home due to elimination of hot or cold spots
4. Effect of renovation in improving air quality in your home
5. Effect of renovation in improving safety of heating and cooling equipment
6. Effect of renovation in controlling mold

C2. **Please indicate your level of agreement with the following:**

1. Strongly agree
2. Somewhat agree
3. Neither agree nor disagree
4. Somewhat disagree
5. Strongly disagree

98. Don't know

1. The project was worth the money it cost
2. The project resulted in reduced energy costs for my household
3. The project increased the comfort of my home
4. I achieved more energy savings by installing multiple measures at the same time than I would have by installing them individually at different times

Measures Installed

M1. **Please indicate which of the following home improvements your contractor/auditor recommended, which of the recommend improvements you installed, and which of the installed improvements were included as part of your project only because they were a program requirement?**
[CHECK ALL THAT APPLY]

Measure	Description	A: Contractor recommended based on the audit	B: Actually implemented	C: Installed this improvement only because it was a program requirement
1	Add insulation to the attic or ceiling			
2	Add insulation to the walls			
3	Add insulation to the floor (crawlspace)			
4	Seal the building envelope (also referred to as Air Sealing)			
5	Installed a new heat pump			
6	Installed a new furnace			
7	Installed a new air conditioner			
8	Air seal HVAC ducts and reduce leakage / duct replacement			
9	Insulate HVAC ducts / duct replacement			
10	Install a new high efficiency water heater			
11	Insulate hot water pipes e.g. Domestic Hot Water Distributions			
12	Replace windows			

[IF ALL MEASURES UNCHECKED in M1B, THEN T&T]

M2. Which of the following describes how you approached this project?
1. You thought of all the measures installed as a PACKAGE for which you made ONE purchasing decision
2. You considered each measure individually

98. Don't know

[IF M2=1 THEN GO TO OVERALL FREE RIDER MODULE (OF1) ELSE,
GO TO first applicable measure section, per responses in M1B]

OVERALL FREE RIDER MODULE

OF1. Without the program, how likely would you have been to undertake this project?

1. Very likely
2. Somewhat likely
3. Somewhat unlikely
4. Very unlikely

98. Don't know

[IF OF1 in (3, 4) GO TO HOUSEHOLD CHANGES (CH1)
***FR note: 3 or 4 get 100% program attribution for this measure*]**

OF2. Without the program, when would you have undertaken this project?

1. at the same time or sooner
2. 1 to 24 months later _____ (record response, slider)
3. Never

98. Don't know

OF3. Without the program, would you have installed insulation and equipment …?

1. That was the same or higher efficiency as what you installed
2. Above minimum standards/ building code but lower efficiency than what you installed
3. Minimum standards/building code

98. Don't know

[IF M2=1, GO TO HOUSEHOLD CHANGES (CH1).
IF M2=2 THEN GO TO FIRST APPLICABLE MEASURE SECTION BASED ON M1B]

Measure specific free rider modules
ATTIC/CEILING INSULATION

AINS1. Without the program, would you say your likelihood of installing attic or ceiling insulation was…?

1. Very likely
2. Somewhat likely
3. Somewhat unlikely
4. Very unlikely

98. Don't know

[IF AINS1 in (3, 4) GO TO next applicable measure section]
FR note: 3 or 4 get 100% program attribution for this measure

AINS2. Without the program, would you have installed attic or ceiling insulation…?

1. at the same time or sooner
2. 1 to 24 months later _____ (record response, slider)
3. Never **[GO TO NEXT APPLICABLE MEASURE]**

98. Don't know

AINS3. Insulation is rated with an "R-Value", where the higher the R-value, the better the insulation's effectiveness. Without the program, would you have installed attic or ceiling insulation with…

1. Same or higher R value
2. Lower R value but above minimum standards/code
3. Minimum standards/code
4. Would **NOT** have installed any insulation **[GO TO NEXT APPLICABLE MEASURE]**

98. Don't know

AINS4. Without the program, would you have …?

1. Covered the same area/square feet (100%)
2. Covered < 100% but more than 0% _____ (record response, slider) [FR note: Scaled by response]
3. Would **NOT** have installed attic or ceiling insulation (0%)

98. Don't know

[GO TO NEXT APPLICABLE MEASURE]

WALL INSULATION

WINS1. Without the program, would you say your likelihood of installing wall insulation was…?

1. Very likely
2. Somewhat likely
3. Somewhat unlikely
4. Very unlikely
98. Don't know

[IF WINS1 in (3, 4) GO TO next applicable measure section]
FR note: 3 or 4 get 100% program attribution for this measure

WINS2. Without the program, would you have installed wall insulation…?

1. at the same time or sooner
2. 1 to 24 months later _____ (record response, slider)
3. Never **[GO TO NEXT APPLICABLE MEASURE]**
98. Don't know

WINS3. Insulation is rated with an "R-Value", where the higher the R-value, the better the insulation's effectiveness. Without the program, would you have installed wall insulation with…

1. Same or higher R value
2. Lower R value but above minimum standards/code
3. Minimum standards/code
4. would not have installed any insulation **[GO TO NEXT APPLICABLE MEASURE]**
98. Don't know

WINS4. Without the program, would you have installed more or less wall insulation?

1. Covered the **same** area/square feet (100%)
2. Covered < 100% but more than 0% _____ (record response, slider)
3. Would **NOT** have installed attic or ceiling insulation (0%)
98. Don't know

[GO TO NEXT APPLICABLE MEASURE]

FLOOR INSULATION

FINS1. Without the program, would you say your likelihood of installing floor insulation was…?

1. Very likely
2. Somewhat likely
3. Somewhat unlikely
4. Very unlikely

98. Don't know

[IF FINS1 in (3, 4) GO TO next applicable measure section]
FR note: 3 or 4 get 100% program attribution for this measure

FINS2. Without the program, would you have installed floor insulation…?

1. at the same time or sooner
2. 1 to 24 months later _____ (record response, slider)
3. Never **[GO TO NEXT APPLICABLE MEASURE]**

98. Don't know

FINS3. Insulation is rated with an "R-Value", where the higher the R-value, the better the insulation's effectiveness. Without the program, would you have installed floor insulation with…

1. Same or higher R value
2. Lower R value but above minimum standards/code
3. Minimum standards/code
4. would not have installed any insulation**[GO TO NEXT APPLICABLE MEASURE]**

98. Don't know

FINS4. Without the program, would you have installed more or less floor insulation?

1. Covered the **same** area/square feet (100%)
2. Covered < 100% but more than 0% _____ (record response, slider)
3. Would **NOT have installed** attic or ceiling insulation (0%)

98. Don't know

[GO TO NEXT APPLICABLE MEASURE]

WHOLE HOUSE LEAKAGE / AIR SEALING

AS1. Without the program, would you say the likelihood of air sealing your home was… ?

1. Very likely
2. Somewhat likely
3. Somewhat unlikely
4. Very unlikely

98. Don't know

[IF AS1 in (3, 4) GO TO next applicable measure section]
FR note: 3 or 4 get 100% program attribution for this measure

AS2. Without the program, would you have air sealed your home…
[READ LIST, SINGLE RESPONSE]?

1. at the same time or sooner
2. 1 to 24 months later _____ (record response, slider)
3. never

98. Don't know

[GO TO NEXT APPLICABLE MEASURE]

HVAC SYSTEM UPGRADE – HEAT PUMP

HP1. Without the program, what was the likelihood of your getting this heat pump installed?

1. Very likely
2. Somewhat likely
3. Somewhat unlikely
4. Very unlikely

98. Don't know

[IF HP1 in (3, 4) GO TO next applicable measure section]
FR note: 3 or 4 get 100% program attribution for this measure

HP2. Without the program, when would you have installed a heat pump?

1. at the same time or sooner
2. 1 to 24 months later _____ (record response, slider)
3. Never **[GO TO NEXT APPLICABLE MEASURE]**

98. Don't know

HP3. Without the program, would you have installed a heat pump at a level of efficiency that was…? *(≥ 14 SEER or 12 EER)*

1. Same or higher
2. Lower but above minimum standards/code
3. Minimum standards/code
4. Would not have installed a/an heat pump

98. Don't know

[GO TO NEXT APPLICABLE MEASURE]

HVAC SYSTEM UPGRADE – FURNACE

FU1. Without the program, what was the likelihood of your getting this furnace installed?

1. Very likely
2. Somewhat likely
3. Somewhat unlikely
4. Very unlikely

98. Don't know

[IF FU1 in (3, 4) GO TO next applicable measure section]
FR note: 3 or 4 get 100% program attribution for this measure

FU2. Without the program, when would you have got this furnace installed?

1. at the same time or sooner
2. 1 to 24 months later _____ (record response, slider)
3. Never **[GO TO NEXT APPLICABLE MEASURE]**

98. Don't know

FU3. Without the program, would you have installed a furnace at a level of efficiency that was…? *(≥ 92% AFUE)*

1. Same or higher
2. Lower but above minimum standards/code
3. Minimum standards/code
4. Would not have installed a/an furnace

98. Don't know

[GO TO NEXT APPLICABLE MEASURE]

HVAC SYSTEM UPGRADE – AIR CONDITIONER

AC1. Without the program, what was the likelihood of your getting this air-conditioner installed?

1. Very likely
2. Somewhat likely
3. Somewhat unlikely
4. Very unlikely
98. Don't know

[IF AC1 in (3, 4) GO TO next applicable measure section]
FR note: 3 or 4 get 100% program attribution for this measure

AC2. Without the program, when would you have got this air-conditioner installed?

1. at the same time or sooner
2. 1 to 24 months later _____ (record response, slider)
3. Never **[GO TO NEXT APPLICABLE MEASURE]**
98. Don't know

AC3. Without the program, would you have installed an air conditioner at a level of efficiency that was…? *(≥ 14 SEER or 12 EER)*

1. Same or higher
2. Lower but above minimum standards/code
3. Minimum standards/code
4. Would not have installed an air-conditioner
98. Don't know

[GO TO NEXT APPLICABLE MEASURE]

HVAC DUCT LEAKAGE REDUCTION/DUCT REPLACEMENT

HDLR1. Without the program, what was the likelihood of your air sealing/replaced your ducts?

1. Very likely
2. Somewhat likely
3. Somewhat unlikely
4. Very unlikely

98. Don’t know

[IF HDLR1 in (3, 4) GO TO next applicable measure section]
FR note: 3 or 4 get 100% program attribution for this measure

HDLR2. Without the program, when would you have air sealed/replaced your ducts?

1. at the same time or sooner
2. 1 to 24 months later _____ (record response, slider)
3. never

98. Don’t know

[GO TO NEXT APPLICABLE MEASURE]

HVAC DUCT INSULATION/HVAC DUCT REPLACEMENT

DINS1. Without the program, would you say the likelihood of your insulating your ducts/replacing your ducts was… [READ LIST, SINGLE RESPONSE]

1. Very likely
2. Somewhat likely
3. Somewhat unlikely
4. Very unlikely

98. Don't know

[IF DINS1 in (3, 4) GO TO next applicable measure section]
FR note: 3 or 4 get 100% program attribution for this measure

DINS2. Without the program, would you have insulated/replaced your ducts… [READ LIST, SINGLE RESPONSE]?

1. at the same time or sooner
2. 1 to 24 months later _____ (record response, slider)
3. never

98. Don't know

[GO TO NEXT APPLICABLE MEASURE]

WATER HEATER

WH1. Without the program, what was the likelihood of your installing this water heater?

1. Very likely
2. Somewhat likely
3. Somewhat unlikely
4. Very unlikely

98. Don't know

[IF WH1 in (3, 4) GO TO next applicable measure section]
FR note: 3 or 4 get 100% program attribution for this measure

WH2. Without the program, when would you have installed the water heater?

1. at the same time or sooner
2. 1 to 24 months later _____ (record response, slider)
3. Never **[GO TO NEXT APPLICABLE MEASURE]**

98. Don't know

WH3. Without the program, please indicate if you would have installed a water heater with an Energy Factor/efficiency that was…? (EF ≥ 0.62 or 0.67 for a storage water heater or EF >= .82 for an on-demand / tankless water heater)

[*Hover text over Energy Factor/efficiency:* THE WATER HEATER'S EFFICIENCY IS MEASURED AS AN ENERGY FACTOR (EF), WHICH IS USUALLY LISTED BESIDE THE ENERGYGUIDE LABEL. THE HIGHER THE NUMBER, THE MORE ENERGY EFFICIENT THE WATER HEATER IS.]

1. Same or higher efficiency
2. Lower but above minimum standards/code
3. Minimum standards/code
4. Would not have installed a water heater

98. Don't know

[GO TO NEXT APPLICABLE MEASURE]

WINDOW REPLACEMENT

WIN1. Without the program, how likely were you to replace your windows?

1. Very likely
2. Somewhat likely
3. Somewhat unlikely
4. Very unlikely

98. Don't know

[IF WIN1 in (3, 4) GO TO next applicable measure section]
FR note: 3 or 4 get 100% program attribution for this measure

WIN2. Without the program, when would you have replaced your windows?

1. at the same time or sooner
2. 1 to 24 months later _____ (record response, slider)
3. Never **[GO TO NEXT APPLICABLE MEASURE]**

98. Don't know

WIN3. Without the program, would you have upgraded more or fewer windows…?

1. Same or more (100%)
2. Upgraded less than 100% but more than 0% _____ (record response, slider)
3. Would NOT have upgraded windows (0%)

98. Don't know

HOUSEHOLD CHANGES

CH1. Which of the following changes, if any, have you made in your home at the same time or after you undertook this upgrade/project? [CHECK ALL THAT APPLY]

Living space	1	Increased living area/square footage of your home (finished basement to add media room or bedroom, for example)	11	Decreased living area/square footage of your home (converted a bedroom to a store room, for example)
Heating	2	Heating **additional areas** in your home	12	Heating **fewer areas** in your home
	3	Using **more heating** in your home	13	Using **less heating** in your home
Cooling	4	Cooling **additional areas** in your home	14	Cooling **fewer areas** in your home
	5	Using **more cooling** in your home	15	Using **less cooling** in your home
Lighting	6	Using more lighting	16	Using less lighting
Refrigerator	7	Using an additional refrigerator	17	Got rid of/recycled/stopped using an additional refrigerator
Pool	8	Added a pool	18	Eliminated/stopped using your pool
Spa	9	Added a spa	19	Eliminated/stopped using your spa
Occupancy	10	Occupied your home for fewer days in the year compared to previous years	20	Occupied your home for more days in the year compared to previous years
21		Installed a learning/smart thermostat (e.g. Nest or Ecobee)		
22		Installed a home automation system or home energy management (e.g. Amazon's Echo/Alexa or Apple's Home Kit)		
23		No changes made		

PROJECT FINANCING

I would like to ask you about financing for this project. Financing is where you borrow money and repay it over time. It could include a credit card, getting financing through a contractor or retailer, refinancing your home, getting a personal loan from a bank, or borrowing from a family member or friend.

F1. Did you use financing for this upgrade/project?

01. Yes
02. No **[SKIP TO NEXT SECTION]**
98. Don't Know **[SKIP TO NEXT SECTION]**

F2. What type of financing did you use? (**If you used multiple financing sources, please check all that apply)**
[1=CHECKED/USED, 2=NOT CHECKED/USED]

1. Credit card
2. Retail financing [for example, taking a store loan from SEARS to buy an appliance]
3. Financing offered by the contractor who completed your project
4. Home Equity Line of Credit (HELOC) or another type of mortgage loan that uses your home as collateral
5. Personal loan from a bank that does not require anything as collateral
6. Home Energy Renovation Opportunity (HERO) or Property Assessed Clean Energy (PACE) Financing
7. Some other financing specifically for energy efficiency projects
8. Loan from a family member or friend
9. Any other type of financing

[IF F2=6 AND/OR F2=8 =1 OR ALL F2 01-08 =2, ask F2a else skip to F3]

F2a. Please describe the type of financing you used.

_____________ **[OPEN END, 96="Nothing to add"]**

F3. What percent of your total project cost was financed?

__________ **[NUMERIC OPEN END 0-100]**

F4. Please complete the following statement to best describe how financing influenced your energy upgrade project. "Without the financing we used for this project, we…

1. would have done the exact same project."
2. would have done a somewhat smaller project."
3. would have done a much smaller project."
4. would not have done the project at all."

F5. Which statement would you say is truer regarding your project? **(CHECK ONE)**

1. Financing helped convince you to do a larger project than you might have done otherwise.
2. Because you already planned to do a large project you needed to get financing.

SEGMENTATION ITEMS

SEG1. Which of the following do you have in your home? CHECK ALL THAT APPLY.

1	Programmable thermostats
2	Motion detectors for your lights
3	Vent in your attic area to keep the attic cooler
4	Ceiling fans

SEG2. Have you heard of a carbon footprint? *A carbon footprint is a measure of the energy you use, either directly or indirectly. This includes but is not limited to the energy consumption from your home, your transportation, your diet, and your purchases.*

1. Yes
2. No
98. Don't know

SEG3. Please indicate your level of agreement with the following statements:

a. I compare prices of at least a few brands
b. I do not feel responsible for conserving energy because my personal contribution is very small (record response, slider)

1. Strongly Disagree
2. Disagree.
3. No opinion.
4. Agree.
5. Strongly Agree
98. Don't know

SEG4. Which of the following is the ONE reason that would motivate you to save energy? CHECK ONE.

1. Saving money
2. Maintaining health
3. Protecting the environment
4. For the benefit of future generations
5. Reducing our dependence on foreign oil

6. Helping California lead the way on saving energy

RESPONDENT AND HOUSEHOLD CHARACTERISTICS

My last questions are used for statistical purposes only. All individual information is kept **completely confidential.**

HH1. What year was your home built?

[SINGLE RESPONSE]

1. Before the 1970s
2. 1970s
3. 1980s
4. 1990-1994
5. 1994-1999
6. 2000s

98. Don't know

HH2. How many bedrooms are there in your home?

[SINGLE RESPONSE]

1. 1
2. 2
3. 3
4. 4 or more

HH3. Roughly, how large is your home (in square feet): ______________

HH4. **Which of the following best describes your education?**

[SINGLE RESPONSE]

1. Some high school or less
2. Graduated high school
3. Trade or technical school
4. Some college
5. College graduate
6. Post graduate work or degree

98. Don't know

HH5. **How many people, including yourself, lived in your household <u>before</u> the upgrade?**

[SINGLE RESPONSE]

1. 1
2. 2
3. 3
4. 4
5. 5
6. 6 or more

98. Don't know

HH6. **How many people, including yourself, lived in your household <u>after</u> the upgrade?**
[SINGLE RESPONSE]
1. 1
2. 2
3. 3
4. 4
5. 5
6. 6 or more
98. Don't know

HH7. **On a typical weekday is someone at home most or all of the day?**
1. Yes
2. No
98. Don't know

HH8. **Which of the following categories best describe your family's total household income in 2015 before taxes?**
[SINGLE RESPONSE]
1. Under $25,000
2. $25,000 to under $50,000
3. $50,000 to under $75,000
4. $75,000 to under $100,000
5. $100,000 to under $150,000
6. $150,000 to under $200,000
7. $200,000 or more
98. Don't know

Wrap-up

T&T (Used when respondent completes the survey)

Thank you very much for completing our survey. You are helping us improve energy conservation programs in California.

SCREEN OUT (Used when respondent does NOT go through the entire survey and is screened out).

Those are all the questions we have for you today. Thank you for your participation in our survey.

APPENDIX I. STANDARDIZED HIGH LEVEL SAVINGS (ATR)

Tables presented in this appendix reflect the All Things Reported (ATR) data format, are generated automatically from tracking data and include the tracking data as reported - before any additional cleaning takes place.

The tables in Appendix AA (I) 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)

PA	Standard Report Group	Ex-Ante Gross	Ex-Post Gross	GRR	% Ex-Ante Gross Pass Through	Eval GRR
PGE	PGE Advanced HUP	49,344	14,659	0.30	0.0%	0.30
PGE	PGE Basic HUP	616	35	0.06	0.0%	0.06
PGE	**Total**	**49,960**	**14,694**	**0.29**	**0.0%**	**0.29**
SCE	SCE Advanced HUP	15,911	4,158	0.26	0.0%	0.26
SCE	SCE Basic HUP	4,354	1,198	0.28	0.0%	0.28
SCE	**Total**	**20,265**	**5,356**	**0.26**	**0.0%**	**0.26**
SCG	SCG Advanced HUP	10,702	0	0.00	0.0%	0.00
SCG	SCG Basic HUP	535	0	0.00	0.0%	0.00
SCG	SCG MF HUP Passthrough	54	54	1.00	100.0%	
SCG	**Total**	**11,290**	**54**	**0.00**	**0.5%**	**0.00**
SDGE	SDGE Advanced HUP	243	48	0.20	0.0%	0.20
SDGE	SDGE Basic HUP	4,902	-719	-0.15	0.0%	-0.15
SDGE	SDGE MF HUP Passthrough	3,554	3,554	1.00	100.0%	
SDGE	**Total**	**8,699**	**2,882**	**0.33**	**40.9%**	**-0.13**
BAY	BAY Basic HUP	5,593	-2,965	-0.53	0.0%	-0.53
BAY	**Total**	**5,593**	**-2,965**	**-0.53**	**0.0%**	**-0.53**
SCR	SCR Basic HUP	2,289	517	0.23	0.0%	0.23
SCR	**Total**	**2,289**	**517**	**0.23**	**0.0%**	**0.23**
	Statewide	***98,098***	***20,538***	***0.21***	***3.7%***	***0.18***

Net Lifecycle Savings (MWh)

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
PGE	PGE Advanced HUP	41,942	9,945	0.24	0.0%	0.85	0.68	0.85	0.68
PGE	PGE Basic HUP	524	29	0.06	100.0%	0.85	0.85		
PGE	**Total**	**42,466**	**9,975**	**0.23**	**1.2%**	**0.85**	**0.68**	**0.85**	**0.68**
SCE	SCE Advanced HUP	8,857	3,916	0.44	0.0%	0.56	0.94	0.56	0.94
SCE	SCE Basic HUP	3,085	1,126	0.36	0.0%	0.71	0.94	0.71	0.94
SCE	**Total**	**11,943**	**5,042**	**0.42**	**0.0%**	**0.59**	**0.94**	**0.59**	**0.94**
SCG	SCG Advanced HUP	9,097	0	0.00	0.0%	0.85		0.85	
SCG	SCG Basic HUP	455	0	0.00	0.0%	0.85		0.85	
SCG	SCG MF HUP Passthrough	46	46	1.00	100.0%	0.85	0.85		
SCG	**Total**	**9,597**	**46**	**0.00**	**0.5%**	**0.85**	**0.85**	**0.85**	
SDGE	SDGE Advanced HUP	206	43	0.21	0.0%	0.85	0.90	0.85	0.90
SDGE	SDGE Basic HUP	4,167	-585	-0.14	0.0%	0.85	0.81	0.85	0.81
SDGE	SDGE MF HUP Passthrough	3,021	3,021	1.00	100.0%	0.85	0.85		
SDGE	**Total**	**7,394**	**2,479**	**0.34**	**40.9%**	**0.85**	**0.86**	**0.85**	**0.81**
BAY	BAY Basic HUP	4,754	-2,350	-0.49	0.0%	0.85	0.79	0.85	0.79
BAY	**Total**	**4,754**	**-2,350**	**-0.49**	**0.0%**	**0.85**	**0.79**	**0.85**	**0.79**
SCR	SCR Basic HUP	1,946	480	0.25	0.0%	0.85	0.93	0.85	0.93
SCR	**Total**	**1,946**	**480**	**0.25**	**0.0%**	**0.85**	**0.93**	**0.85**	**0.93**
	Statewide	***78,101***	***15,672***	***0.20***	***4.6%***	***0.80***	***0.76***	***0.79***	***0.74***

Gross Lifecycle Savings (MW)

PA	Standard Report Group	Ex-Ante Gross	Ex-Post Gross	GRR	% Ex-Ante Gross Pass Through	Eval GRR
PGE	PGE Advanced HUP	75.1	10.5	0.14	0.0%	0.14
PGE	PGE Basic HUP	1.4	0.0	0.02	0.0%	0.02
PGE	**Total**	**76.5**	**10.5**	**0.14**	**0.0%**	**0.14**
SCE	SCE Advanced HUP	20.5	4.8	0.24	0.0%	0.24
SCE	SCE Basic HUP	4.4	0.7	0.15	0.0%	0.15
SCE	**Total**	**24.9**	**5.5**	**0.22**	**0.0%**	**0.22**
SCG	SCG Advanced HUP	5.6	0.0	0.00	0.0%	0.00
SCG	SCG Basic HUP	0.6	0.0	0.00	0.0%	0.00
SCG	SCG MF HUP Passthrough	0.0	0.0			
SCG	**Total**	**6.2**	**0.0**	**0.00**	**0.0%**	**0.00**
SDGE	SDGE Advanced HUP	0.3	0.1	0.27	0.0%	0.27
SDGE	SDGE Basic HUP	8.3	-0.2	-0.03	0.0%	-0.03
SDGE	SDGE MF HUP Passthrough	4.6	4.6	1.00	100.0%	
SDGE	**Total**	**13.2**	**4.4**	**0.33**	**34.6%**	**-0.02**
BAY	BAY Basic HUP	7.9	0.5	0.06	0.0%	0.06
BAY	**Total**	**7.9**	**0.5**	**0.06**	**0.0%**	**0.06**
SCR	SCR Basic HUP	3.7	0.8	0.20	0.0%	0.20
SCR	**Total**	**3.7**	**0.8**	**0.20**	**0.0%**	**0.20**
	Statewide	***132.5***	***21.7***	***0.16***	***3.4%***	***0.13***

Net Lifecycle Savings (MW)

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
PGE	PGE Advanced HUP	63.8	7.1	0.11	0.0%	0.85	0.68	0.85	0.68
PGE	PGE Basic HUP	1.2	0.0	0.02	100.0%	0.85	0.85		
PGE	**Total**	**65.0**	**7.1**	**0.11**	**1.9%**	**0.85**	**0.68**	**0.85**	**0.68**
SCE	SCE Advanced HUP	11.5	4.2	0.37	0.0%	0.56	0.87	0.56	0.87
SCE	SCE Basic HUP	3.4	0.6	0.19	0.0%	0.78	0.99	0.78	0.99
SCE	**Total**	**14.9**	**4.8**	**0.33**	**0.0%**	**0.60**	**0.88**	**0.60**	**0.88**
SCG	SCG Advanced HUP	4.8	0.0	0.00	0.0%	0.85		0.85	
SCG	SCG Basic HUP	0.5	0.0	0.00	0.0%	0.85		0.85	
SCG	SCG MF HUP Passthrough	0.0	0.0						
SCG	**Total**	**5.3**	**0.0**	**0.00**	**0.0%**	**0.85**		**0.85**	
SDGE	SDGE Advanced HUP	0.2	0.1	0.28	0.0%	0.85	0.88	0.85	0.88
SDGE	SDGE Basic HUP	7.1	-0.2	-0.03	0.0%	0.85	0.90	0.85	0.90
SDGE	SDGE MF HUP Passthrough	3.9	3.9	1.00	100.0%	0.85	0.85		
SDGE	**Total**	**11.2**	**3.7**	**0.33**	**34.6%**	**0.85**	**0.85**	**0.85**	**0.91**
BAY	BAY Basic HUP	6.8	0.3	0.05	0.0%	0.85	0.68	0.85	0.68
BAY	**Total**	**6.8**	**0.3**	**0.05**	**0.0%**	**0.85**	**0.68**	**0.85**	**0.68**
SCR	SCR Basic HUP	3.2	0.7	0.23	0.0%	0.85	0.95	0.85	0.95
SCR	**Total**	**3.2**	**0.7**	**0.23**	**0.0%**	**0.85**	**0.95**	**0.85**	**0.95**
	Statewide	***106.3***	***16.7***	***0.16***	***4.8%***	***0.80***	***0.77***	***0.80***	***0.75***

Gross Lifecycle Savings (MTherms)

PA	Standard Report Group	Ex-Ante Gross	Ex-Post Gross	GRR	% Ex-Ante Gross Pass Through	Eval GRR
PGE	PGE Advanced HUP	9,319	1,118	0.12	0.0%	0.12
PGE	PGE Basic HUP	138	37	0.27	0.0%	0.27
PGE	**Total**	**9,458**	**1,155**	**0.12**	**0.0%**	**0.12**
SCE	SCE Advanced HUP	1,888	0	0.00	0.0%	0.00
SCE	SCE Basic HUP	196	0	0.00	0.0%	0.00
SCE	**Total**	**2,084**	**0**	**0.00**	**0.0%**	**0.00**
SCG	SCG Advanced HUP	2,665	340	0.13	0.0%	0.13
SCG	SCG Basic HUP	221	565	2.56	0.0%	2.56
SCG	SCG MF HUP Passthrough	2	2	1.00	100.0%	
SCG	**Total**	**2,889**	**907**	**0.31**	**0.1%**	**0.31**
SDGE	SDGE Advanced HUP	28	7	0.24	0.0%	0.24
SDGE	SDGE Basic HUP	604	586	0.97	0.0%	0.97
SDGE	SDGE MF HUP Passthrough	153	153	1.00	100.0%	
SDGE	**Total**	**785**	**745**	**0.95**	**19.4%**	**0.94**
BAY	BAY Basic HUP	1,998	1,406	0.70	0.0%	0.70
BAY	**Total**	**1,998**	**1,406**	**0.70**	**0.0%**	**0.70**
SCR	SCR Basic HUP	341	364	1.07	0.0%	1.07
SCR	**Total**	**341**	**364**	**1.07**	**0.0%**	**1.07**
	Statewide	***17,554***	***4,577***	***0.26***	***0.9%***	***0.25***

Net Lifecycle Savings (MTherms)

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
PGE	PGE Advanced HUP	7,922	828	0.10	0.0%	0.85	0.74	0.85	0.74
PGE	PGE Basic HUP	117	32	0.27	100.0%	0.85	0.85		
PGE	**Total**	**8,039**	**859**	**0.11**	**1.5%**	**0.85**	**0.74**	**0.85**	**0.74**
SCE	SCE Advanced HUP	1,056	0	0.00	0.0%	0.56		0.56	
SCE	SCE Basic HUP	181	0	0.00	0.0%	0.92		0.92	
SCE	**Total**	**1,236**	**0**	**0.00**	**0.0%**	**0.59**		**0.59**	
SCG	SCG Advanced HUP	2,265	304	0.13	0.0%	0.85	0.90	0.85	0.90
SCG	SCG Basic HUP	187	392	2.09	0.0%	0.85	0.69	0.85	0.69
SCG	SCG MF HUP Passthrough	2	2	1.00	100.0%	0.85	0.85		
SCG	**Total**	**2,455**	**698**	**0.28**	**0.1%**	**0.85**	**0.77**	**0.85**	**0.77**
SDGE	SDGE Advanced HUP	24	6	0.25	0.0%	0.85	0.90	0.85	0.90
SDGE	SDGE Basic HUP	514	316	0.62	0.0%	0.85	0.54	0.85	0.54
SDGE	SDGE MF HUP Passthrough	130	130	1.00	100.0%	0.85	0.85		
SDGE	**Total**	**667**	**452**	**0.68**	**19.4%**	**0.85**	**0.61**	**0.85**	**0.54**
BAY	BAY Basic HUP	1,698	987	0.58	0.0%	0.85	0.70	0.85	0.70
BAY	**Total**	**1,698**	**987**	**0.58**	**0.0%**	**0.85**	**0.70**	**0.85**	**0.70**
SCR	SCR Basic HUP	290	274	0.95	0.0%	0.85	0.75	0.85	0.75
SCR	**Total**	**290**	**274**	**0.95**	**0.0%**	**0.85**	**0.75**	**0.85**	**0.75**
	Statewide	***14,385***	***3,270***	***0.23***	***1.7%***	***0.82***	***0.71***	***0.82***	***0.71***

Gross First Year Savings (MWh)

PA	Standard Report Group	Ex-Ante Gross	Ex-Post Gross	GRR	% Ex-Ante Gross Pass Through	Eval GRR
PGE	PGE Advanced HUP	3,055	912	0.30	0.0%	0.30
PGE	PGE Basic HUP	50	3	0.06	0.0%	0.06
PGE	**Total**	**3,105**	**914**	**0.29**	**0.0%**	**0.29**
SCE	SCE Advanced HUP	1,137	297	0.26	0.0%	0.26
SCE	SCE Basic HUP	471	113	0.24	0.0%	0.24
SCE	**Total**	**1,608**	**410**	**0.25**	**0.0%**	**0.25**
SCG	SCG Advanced HUP	649	0	0.00	0.0%	0.00
SCG	SCG Basic HUP	32	0	0.00	0.0%	0.00
SCG	SCG MF HUP Passthrough	3	3	1.00	100.0%	
SCG	**Total**	**684**	**3**	**0.00**	**0.5%**	**0.00**
SDGE	SDGE Advanced HUP	15	3	0.20	0.0%	0.20
SDGE	SDGE Basic HUP	297	-44	-0.15	0.0%	-0.15
SDGE	SDGE MF HUP Passthrough	215	215	1.00	100.0%	
SDGE	**Total**	**527**	**175**	**0.33**	**40.9%**	**-0.13**
BAY	BAY Basic HUP	604	-320	-0.53	0.0%	-0.53
BAY	**Total**	**604**	**-320**	**-0.53**	**0.0%**	**-0.53**
SCR	SCR Basic HUP	263	60	0.23	0.0%	0.23
SCR	**Total**	**263**	**60**	**0.23**	**0.0%**	**0.23**
	Statewide	***6,792***	***1,241***	***0.18***	***3.2%***	***0.16***

Net First Year Savings (MWh)

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
PGE	PGE Advanced HUP	2,597	618	0.24	0.0%	0.85	0.68	0.85	0.68
PGE	PGE Basic HUP	42	2	0.06	100.0%	0.85	0.85		
PGE	**Total**	**2,639**	**621**	**0.24**	**1.6%**	**0.85**	**0.68**	**0.85**	**0.68**
SCE	SCE Advanced HUP	633	280	0.44	0.0%	0.56	0.94	0.56	0.94
SCE	SCE Basic HUP	324	106	0.33	0.0%	0.69	0.94	0.69	0.94
SCE	**Total**	**957**	**386**	**0.40**	**0.0%**	**0.60**	**0.94**	**0.60**	**0.94**
SCG	SCG Advanced HUP	551	0	0.00	0.0%	0.85		0.85	
SCG	SCG Basic HUP	28	0	0.00	0.0%	0.85		0.85	
SCG	SCG MF HUP Passthrough	3	3	1.00	100.0%	0.85	0.85		
SCG	**Total**	**582**	**3**	**0.00**	**0.5%**	**0.85**	**0.85**	**0.85**	
SDGE	SDGE Advanced HUP	13	3	0.21	0.0%	0.85	0.90	0.85	0.90
SDGE	SDGE Basic HUP	253	-35	-0.14	0.0%	0.85	0.81	0.85	0.81
SDGE	SDGE MF HUP Passthrough	183	183	1.00	100.0%	0.85	0.85		
SDGE	**Total**	**448**	**150**	**0.34**	**40.9%**	**0.85**	**0.86**	**0.85**	**0.81**
BAY	BAY Basic HUP	513	-254	-0.49	0.0%	0.85	0.79	0.85	0.79
BAY	**Total**	**513**	**-254**	**-0.49**	**0.0%**	**0.85**	**0.79**	**0.85**	**0.79**
SCR	SCR Basic HUP	224	55	0.25	0.0%	0.85	0.93	0.85	0.93
SCR	**Total**	**224**	**55**	**0.25**	**0.0%**	**0.85**	**0.93**	**0.85**	**0.93**
	Statewide	***5,363***	***961***	***0.18***	***4.3%***	***0.79***	***0.77***	***0.79***	***0.76***

Gross First Year Savings (MW)

PA	Standard Report Group	Ex-Ante Gross	Ex-Post Gross	GRR	% Ex-Ante Gross Pass Through	Eval GRR
PGE	PGE Advanced HUP	5.1	0.7	0.14	0.0%	0.14
PGE	PGE Basic HUP	0.1	0.0	0.02	0.0%	0.02
PGE	**Total**	**5.3**	**0.7**	**0.14**	**0.0%**	**0.14**
SCE	SCE Advanced HUP	1.5	0.3	0.24	0.0%	0.24
SCE	SCE Basic HUP	0.4	0.1	0.14	0.0%	0.14
SCE	**Total**	**1.9**	**0.4**	**0.22**	**0.0%**	**0.22**
SCG	SCG Advanced HUP	0.3	0.0	0.00	0.0%	0.00
SCG	SCG Basic HUP	0.0	0.0	0.00	0.0%	0.00
SCG	SCG MF HUP Passthrough	0.0	0.0			
SCG	**Total**	**0.4**	**0.0**	**0.00**	**0.0%**	**0.00**
SDGE	SDGE Advanced HUP	0.0	0.0	0.27	0.0%	0.27
SDGE	SDGE Basic HUP	0.5	0.0	-0.03	0.0%	-0.03
SDGE	SDGE MF HUP Passthrough	0.3	0.3	1.00	100.0%	
SDGE	**Total**	**0.8**	**0.3**	**0.33**	**34.6%**	**-0.02**
BAY	BAY Basic HUP	0.8	0.1	0.06	0.0%	0.06
BAY	**Total**	**0.8**	**0.1**	**0.06**	**0.0%**	**0.06**
SCR	SCR Basic HUP	0.4	0.1	0.20	0.0%	0.20
SCR	**Total**	**0.4**	**0.1**	**0.20**	**0.0%**	**0.20**
	Statewide	***9.6***	***1.5***	***0.16***	***2.9%***	***0.13***

Net First Year Savings (MW)

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
PGE	PGE Advanced HUP	4.4	0.5	0.11	0.0%	0.85	0.68	0.85	0.68
PGE	PGE Basic HUP	0.1	0.0	0.02	100.0%	0.85	0.85		
PGE	**Total**	**4.5**	**0.5**	**0.11**	**2.2%**	**0.85**	**0.68**	**0.85**	**0.68**
SCE	SCE Advanced HUP	0.8	0.3	0.37	0.0%	0.56	0.87	0.56	0.87
SCE	SCE Basic HUP	0.3	0.1	0.18	0.0%	0.78	0.99	0.78	0.99
SCE	**Total**	**1.1**	**0.4**	**0.31**	**0.0%**	**0.61**	**0.88**	**0.61**	**0.88**
SCG	SCG Advanced HUP	0.3	0.0	0.00	0.0%	0.85		0.85	
SCG	SCG Basic HUP	0.0	0.0	0.00	0.0%	0.85		0.85	
SCG	SCG MF HUP Passthrough	0.0	0.0						
SCG	**Total**	**0.3**	**0.0**	**0.00**	**0.0%**	**0.85**		**0.85**	
SDGE	SDGE Advanced HUP	0.0	0.0	0.28	0.0%	0.85	0.88	0.85	0.88
SDGE	SDGE Basic HUP	0.4	0.0	-0.03	0.0%	0.85	0.90	0.85	0.90
SDGE	SDGE MF HUP Passthrough	0.2	0.2	1.00	100.0%	0.85	0.85		
SDGE	**Total**	**0.7**	**0.2**	**0.33**	**34.6%**	**0.85**	**0.85**	**0.85**	**0.91**
BAY	BAY Basic HUP	0.7	0.0	0.05	0.0%	0.85	0.68	0.85	0.68
BAY	**Total**	**0.7**	**0.0**	**0.05**	**0.0%**	**0.85**	**0.68**	**0.85**	**0.68**
SCR	SCR Basic HUP	0.4	0.1	0.23	0.0%	0.85	0.95	0.85	0.95
SCR	**Total**	**0.4**	**0.1**	**0.23**	**0.0%**	**0.85**	**0.95**	**0.85**	**0.95**
	Statewide	***7.7***	***1.2***	***0.15***	***4.3%***	***0.80***	***0.78***	***0.80***	***0.76***

Gross First Year Savings (MTherms)

PA	Standard Report Group	Ex-Ante Gross	Ex-Post Gross	GRR	% Ex-Ante Gross Pass Through	Eval GRR
PGE	PGE Advanced HUP	485	59	0.12	0.0%	0.12
PGE	PGE Basic HUP	9	2	0.27	0.0%	0.27
PGE	**Total**	**494**	**61**	**0.12**	**0.0%**	**0.12**
SCE	SCE Advanced HUP	135	0	0.00	0.0%	0.00
SCE	SCE Basic HUP	12	0	0.00	0.0%	0.00
SCE	**Total**	**147**	**0**	**0.00**	**0.0%**	**0.00**
SCG	SCG Advanced HUP	162	21	0.13	0.0%	0.13
SCG	SCG Basic HUP	13	34	2.56	0.0%	2.56
SCG	SCG MF HUP Passthrough	0	0	1.00	100.0%	
SCG	**Total**	**175**	**55**	**0.32**	**0.1%**	**0.31**
SDGE	SDGE Advanced HUP	2	0	0.24	0.0%	0.24
SDGE	SDGE Basic HUP	37	36	0.97	0.0%	0.97
SDGE	SDGE MF HUP Passthrough	9	9	1.00	100.0%	
SDGE	**Total**	**48**	**45**	**0.95**	**19.4%**	**0.94**
BAY	BAY Basic HUP	128	90	0.70	0.0%	0.70
BAY	**Total**	**128**	**90**	**0.70**	**0.0%**	**0.70**
SCR	SCR Basic HUP	24	26	1.07	0.0%	1.07
SCR	**Total**	**24**	**26**	**1.07**	**0.0%**	**1.07**
	Statewide	***1,015***	***277***	***0.27***	***0.9%***	***0.27***

Net First Year Savings (MTherms)

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
PGE	PGE Advanced HUP	412	44	0.11	0.0%	0.85	0.74	0.85	0.74
PGE	PGE Basic HUP	8	2	0.27	100.0%	0.85	0.85		
PGE	**Total**	**420**	**46**	**0.11**	**1.8%**	**0.85**	**0.75**	**0.85**	**0.74**
SCE	SCE Advanced HUP	75	0	0.00	0.0%	0.56		0.56	
SCE	SCE Basic HUP	11	0	0.00	0.0%	0.94		0.94	
SCE	**Total**	**87**	**0**	**0.00**	**0.0%**	**0.59**		**0.59**	
SCG	SCG Advanced HUP	137	18	0.13	0.0%	0.85	0.90	0.85	0.90
SCG	SCG Basic HUP	11	24	2.09	0.0%	0.85	0.69	0.85	0.69
SCG	SCG MF HUP Passthrough	0	0	1.00	100.0%	0.85	0.85		
SCG	**Total**	**149**	**42**	**0.29**	**0.1%**	**0.85**	**0.77**	**0.85**	**0.77**
SDGE	SDGE Advanced HUP	1	0	0.25	0.0%	0.85	0.90	0.85	0.90
SDGE	SDGE Basic HUP	31	19	0.62	0.0%	0.85	0.54	0.85	0.54
SDGE	SDGE MF HUP Passthrough	8	8	1.00	100.0%	0.85	0.85		
SDGE	**Total**	**40**	**27**	**0.68**	**19.4%**	**0.85**	**0.61**	**0.85**	**0.54**
BAY	BAY Basic HUP	108	63	0.58	0.0%	0.85	0.70	0.85	0.70
BAY	**Total**	**108**	**63**	**0.58**	**0.0%**	**0.85**	**0.70**	**0.85**	**0.70**
SCR	SCR Basic HUP	20	19	0.95	0.0%	0.85	0.75	0.85	0.75
SCR	**Total**	**20**	**19**	**0.95**	**0.0%**	**0.85**	**0.75**	**0.85**	**0.75**
	Statewide	***825***	***198***	***0.24***	***1.9%***	***0.81***	***0.71***	***0.81***	***0.71***

APPENDIX J. STANDARDIZED PER UNIT SAVINGS

Per Unit (Quantity) Gross Energy Savings (kWh)

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
PGE	PGE Advanced HUP	0	0.0%	0.0%	16.5	3.5	0.2	0.2
PGE	PGE Basic HUP	0	100.0%	0.0%	18.0	189.1	15.3	10.5
SCE	SCE Advanced HUP	0	0.0%	0.0%	14.0	3.3	0.2	0.2
SCE	SCE Basic HUP	0	8.3%	0.0%	10.6	329.9	31.1	25.9
SCG	SCG Advanced HUP	0	0.0%	0.0%	16.5	0.0	0.0	0.0
SCG	SCG Basic HUP	0	0.0%	0.0%	18.7	0.0	0.0	0.0
SCG	SCG MF HUP Passthrough	1	0.0%		16.5	53,801.5	3,260.7	3,260.7
SDGE	SDGE Advanced HUP	0	0.0%	0.0%	16.5	2,163.4	131.1	131.1
SDGE	SDGE Basic HUP	0	0.0%	0.0%	16.5	-1,219.4	-73.9	-73.9
SDGE	SDGE MF HUP Passthrough	1	0.0%		16.5	122,551.8	7,427.4	7,427.4
BAY	BAY Basic HUP	0	100.0%	0.0%	18.3	-2,116.1	-228.6	-117.2
SCR	SCR Basic HUP	0	100.0%	0.0%	17.4	1,228.4	141.4	71.2

Per Unit (Quantity) Gross Energy Savings (Therms)

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
PGE	PGE Advanced HUP	0	0.0%	0.0%	16.5	0.3	0.0	0.0
PGE	PGE Basic HUP	0	100.0%	0.0%	18.0	202.5	13.1	11.3
SCE	SCE Advanced HUP	0	0.0%	0.0%	14.0	0.0	0.0	0.0
SCE	SCE Basic HUP	0	8.3%	0.0%	10.6	0.0	0.0	0.0
SCG	SCG Advanced HUP	0	0.0%	0.0%	16.5	317.7	19.3	19.3
SCG	SCG Basic HUP	0	0.0%	0.0%	18.7	422.2	25.8	25.8
SCG	SCG MF HUP Passthrough	1	0.0%		16.5	2,411.6	146.2	146.2
SDGE	SDGE Advanced HUP	0	0.0%	0.0%	16.5	304.6	18.5	18.5
SDGE	SDGE Basic HUP	0	0.0%	0.0%	16.5	993.1	60.2	60.2
SDGE	SDGE MF HUP Passthrough	1	0.0%		16.5	5,262.5	318.9	318.9
BAY	BAY Basic HUP	0	100.0%	0.0%	18.3	1,003.6	64.1	54.7
SCR	SCR Basic HUP	0	100.0%	0.0%	17.4	864.7	61.0	49.6

Per Unit (Quantity) Net Energy Savings (kWh)

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
PGE	PGE Advanced HUP	0	0.0%	0.0%	16.5	2.4	0.1	0.1
PGE	PGE Basic HUP	1	100.0%		18.0	160.7	13.0	8.9
SCE	SCE Advanced HUP	0	0.0%	0.0%	14.0	3.1	0.2	0.2
SCE	SCE Basic HUP	0	8.3%	0.0%	10.6	310.0	29.2	24.3
SCG	SCG Advanced HUP	0	0.0%	0.0%	16.5	0.0	0.0	0.0
SCG	SCG Basic HUP	0	0.0%	0.0%	18.7	0.0	0.0	0.0
SCG	SCG MF HUP Passthrough	1	0.0%		16.5	45,731.3	2,771.6	2,771.6
SDGE	SDGE Advanced HUP	0	0.0%	0.0%	16.5	1,954.3	118.4	118.4
SDGE	SDGE Basic HUP	0	0.0%	0.0%	16.5	-990.7	-60.0	-60.0
SDGE	SDGE MF HUP Passthrough	1	0.0%		16.5	104,169.0	6,313.3	6,313.3
BAY	BAY Basic HUP	0	100.0%	0.0%	18.3	-1,677.7	-181.2	-92.9
SCR	SCR Basic HUP	0	100.0%	0.0%	17.4	1,140.7	131.3	66.1

Per Unit (Quantity) Net Energy Savings (Therms)

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
PGE	PGE Advanced HUP	0	0.0%	0.0%	16.5	0.2	0.0	0.0
PGE	PGE Basic HUP	1	100.0%		18.0	172.2	11.2	9.6
SCE	SCE Advanced HUP	0	0.0%	0.0%	14.0	0.0	0.0	0.0
SCE	SCE Basic HUP	0	8.3%	0.0%	10.6	0.0	0.0	0.0
SCG	SCG Advanced HUP	0	0.0%	0.0%	16.5	284.6	17.2	17.2
SCG	SCG Basic HUP	0	0.0%	0.0%	18.7	292.6	17.9	17.9
SCG	SCG MF HUP Passthrough	1	0.0%		16.5	2,049.9	124.2	124.2
SDGE	SDGE Advanced HUP	0	0.0%	0.0%	16.5	275.6	16.7	16.7
SDGE	SDGE Basic HUP	0	0.0%	0.0%	16.5	536.1	32.5	32.5
SDGE	SDGE MF HUP Passthrough	1	0.0%		16.5	4,473.1	271.1	271.1
BAY	BAY Basic HUP	0	100.0%	0.0%	18.3	704.5	45.0	38.4
SCR	SCR Basic HUP	0	100.0%	0.0%	17.4	650.2	45.9	37.3

APPENDIX K. SUMMARY OF FINDINGS AND RECOMMENDATIONS

Study ID	Study Type	Study Title	Study Manager			
TBD	Impact	2015 HOME UPGRADE PROGRAM IMPACT EVALUATION	CPUC			
Recommendation	**Program or Database**	**Summary of Findings**	**Additional Supporting Information**	**Best Practice / Recommendations**	**Recommendation Recipient**	**Affected Workpaper or DEER**
1	HUP	Program / Project Data are missing, or of poor quality	CPUC Program tracking database	Review savings expectations and tracking data for reasonableness. Specifically, • In the program database, filter for outliers, zero values, and negative values • Verify the household account numbers for each fuel type and identify service provider • Collect home vintage. Different building codes and techniques will affect savings differently and may help improve program targeting • Collect home square feet and number of floors before and after the project • Deveop a consistent definition for project duration. The ideal is date	All Program Administrators / CPUC data team / evaluator	NA

				the contractor starts the installation and date they complete installation. Using current data fields, DNV GL recommends project start date as "date of contract signing". For end date we recommend, "project inspection date". These should be verified. Project durations of 1 day or 365 days are most likely incorrect.		
2	HUP	Reported savings may not be calculated correctly or homes are not receiving claimed measures		• Physically verify a sample of installations if not already doing so - particularly in coastal climate zones – to verify all measures are installed and preforming correctly. • Review the electric and gas assumptions and calculations in the EUCA model for reasonableness relaitive to customer bills. Typical savings should be about 5% to 10% of annual usage. If possible, compare savings for a sample of projects in EUCA and EnergyPro or eQuest and check for consistency of savings estimates.	All Program Administrators	
3	AHUP	Program / Project data are missing, or of poor quality		Review savings expectations and tracking data for reasonable savings. Specifically, • In the program database, filter	All IOU Program Administrators / CPUC data team	NA

				for outliers, zero values, and negative values • Verify the household account numbers for each fuel type and identify service provider • Collect home vintage. Different building codes and techniques will affect savings differently • Collect home square feet before and after the project. A household increase actually may be decrease on a per square foot basis • Deveop a consistent definition for project duration. DNV GL recommends project start date as “date of contract signing”. For end date we recommend, “project inspection date”. • Collect and review model inputs and outputs from contractors using simulation software. • Check for square feet and vintage information • Check for number and type of measures installed		
4	HUP / AHUP	Project data are missing, or of poor quality		Evaluators should provide each PA with an extract of the program data to be used to evaluate their program. In addition to the review noted in recommendation 1 and 3, the tracking data should be reviewed for	CPUC evaluators / all PAs	

				accuracy. This includes correct program assignment and correct PA assignment in the case of overlapping PAs. Evaluators and PAs should begin this process as early as possible in the evaluations process. This will ensure the evaluators and PAs are learning from the same datasets, will allow a tighter link with meter data, and, if necessary, will allow time for PAs to correct and refile program data in a timely manner.		
5	HUP / AHUP	Savings may be affected by weather data in certain climate zones		Research savings calculations for climate zones with very low CDD - specifically CZ3, CZ4, and CZ5. Research to include: • Comparison of hourly, daily, and monthly electric meter data for AHUP and HUP projects. • the CZ2010 weather data set • other demographic variables from census or survey data. • various model specifications.	CalTrack team	NA
6	HUP / AHUP	Reported savings may not be calculated correctly or homes are not receiving claimed		• Verify, or continue to verify, a sample of projects for quality and quantity of measure installations - particularly in coastal climate zones • DNV GL recommends additional research on projects in climate	All Program Administrators	NA

		measures		zones 1-5.		
7	HUP / AHUP	Savings Influences		• Consider targeting customers in older homes • For electric savings, focus on climate zones with a wide range for CDD and HDD • For gas savings, focus on climate zones with more CDD	All Program Administrators	NA
8	HUP / AHUP	Level of free riders is low		No recommendations	All Program Administrators	NA

APPENDIX L. RESPONSE TO COMMENTS

#	Source	Subject	Page	Evaluation Text/Reference	Comment/feedback/change requested	Evaluator's Response
1	PG&E, BayREN	Billing Analysis Model	D-12, D-13	The average R-squared value was 0.148 for the HUP models and 0.159 for the AHUP models. The fitted therm model for the HUP program was 0.084.	These R-sq values are extremely low. Could DNV GL please explain why this model was chosen given that 85%-99% of the variation in usage is not explained by the model?	The R-squares were outdated in the draft report. These are updated in the final version.
2	PG&E, BayREN	Billing Analysis Model	E-1	749 explanatory variables	Could DNV GL please provide the reasoning behind the explanatory variables chosen for the analysis? We feel that 749 variables may have been excessive, especially as it assumes a linear relationship to usage for all 749 variables. Could we please see F-test values that compared the model to models with fewer explanatory variables?	The 365 HUP kWh models were fit with an average of 1.5 million data points per model and the 365 AHUP kWh models were fit with an average of 3.7 million data points per model. So the 749 variables is not particularly excessive. F-statistics for models with lessor number of explanatory variables were not computed.

3	PG&E, BayREN	Billing Analysis Model	E-1	Lagged Explanatory Variables	A fixed effects model requires strict exogeneity. Adding lagged variables violates that model assumption where fixed effects no longer yields consistent estimates. Could DNV GL please explain the reasoning in using lagged variables, or otherwise address this assumption violation?	There were no lagged variables used in the models. Some temperature data from the previous few hours and days were included as explanatory variables, but these wouldn't be considered lagged variables. A list of the independent variables used in the model are presented in Appendix E of the report. In Appendix E, the phrase "lag" in the labels was refering to a difference in time (in days specifically). These labels will be changed to avoid further confusion.
4	PG&E, BayREN	Billing Analysis Model	E-1	Appendix B	All PA's HUP counts used in the billing analysis are fewer than 749. Could DNV GL please explain how the model equation was solved when the number of independent variables exceeds the number of equations?	Separate models were not fit to each PA so from a modeling perspective, the number of participants by PA is irrelevant. And the kWh models were fit with hourly data. As noted in comment 2, the models were fit using an average of 1.5 million (HUP) and 3.7 million (AHUP) data points.
5	PG&E, BayREN	Billing Analysis Model	E-1	Percent of Time Variable Was Significant in the HUP/AHUP Models at 0.10 Level.	Could DNV GL please describe whether each explanatory variable was significant overall? The way significance was presented makes it difficult to analyze.	There were 365 models fit for both the HUP and AHUP program. Showing the significance of each of the 749 variables in each of the 730 models is not very useful. Appendix E shows the percent of the 365 HUP and AHUP models that each variable was estimated to be significant at the .10 level.

6	PG&E, BayREN	Billing Analysis Model	D-9	American Community Survey (ACS)	Could DNV GL please clarify the benefits to adding the ACS variables to the savings analyses, given that it only improved the model fit by 0.6%?	The ACS variables were included to be consistent with the 2013/2014 evaluation and because obtaining neighborhood characteristics was one of the few pieces of auxiliary information we could obtain for each participant. We acknowledge including these variables did not improve the fit of the models to any appreciable extent.
7	PG&E, BayREN	Billing Analysis Model	D-2	Equation (1)	Equation (1) does not include a time-invariant individual effect when pg 23 indicates the main billing analysis is a fixed effects model. Could DNV GL please describe what happened to the time-invariant individual effect?	Separate models were fit for each day of the year. And the additional time fixed effects, such as hour of the day and day of the week, are components of the z_ki and x_ki vector in equation (1).
8	PG&E, BayREN	Billing Analysis Model	62	DNV GL included other variables such as neighborhood characteristics, day of the week, and hour of the day along with interactive and lag variables, but overall the statistical models had very poor fit in these climate zones. Diagnostics did not reveal an obvious reason for this poor fit.	Given the findings that the statistical models used had a very poor fit in climate zones 1-4, what is DNV GL's reasoning in including findings for these areas in the evaluation? Would it be appropriate to disregard these findings?	Thank you for pointing this wording out and the text has been amended. All the statistical findings are equally valid. The models were not fit by climate zone. The intent was that overall, the models showed less correlation between weather and energy usage than anticipated. The extra explanatory variables added little insight across all climate zones.

9	PG&E, BayREN	Billing Analysis Model	13	Section 1.5.4.3: Survey Findings	We should be wary of spurious correlations. For example, the fact that savers used finance more frequently could really mean that there are some contractors doing better, delivering more savings, and they also offer their customers finance. In this case, contractor quality would be the key to savings, not finance.	We agree spurious correlations shold be avoided. In the report (page XX) we point out that further research is needed (and with larger samples) to truly understand what is driving savings estimates. The body of the report contains a few correlations deemed of interest by the evaluation team, but not necessarily implying causation in any direction and should not be taken as definative drivers of savings/dissavings.
10	PG&E, BayREN	Billing Analysis Model	14	A related topic is climate zones influence. In this and prior evaluations, negative household savings are associated with climate zones 1-5. DNV GL's evaluation models did have statistically significant variables, but overall the electric models explained a small percentage of the overall change relative to weather in these climate zones. In addition to the underlying increase in usage, other factors that may be contributing to these savings results are	It is stated that the model developed by this evaluation did not have statistically significant variables. Please explain further. If that is the case, how would you characterize the strength of the conclusions presented by this evaluation?	The models did have "statistically significant" estimates based on the report text cited. They did have relatively low explainatory power (e.g. low r-squared/adjusted r-squared). As noted in other responses, the evaluation team does have concerns about data quality for computing realization rates. The one constant is that savings percents seem to be low (< 10%) regardless of model specification used, program year evaluated or overall goodness of model fit.

				inaccurate meter data or inaccurate weather data for these regions.		
11	PG&E, BayREN	Billing Analysis Model	32	Figure 8. HUP hourly kWh savings estimates per household	The hourly electric impacts of night relative to day are surprising. Considering common program measures, we have not been able to arrive at a plausible physical or behavioral explanation. Could DNV GL please check whether this result may actually derive from some bias in the statistical model?	As noted in Appendix E, hour of the day was included in the model as a main effect. And hour was interacted with some of the variables, such as heating degree days by weekday/weekend indicator and cooling degree days by weekday/weekend indicator. None of the hour indicators in the model were omitted or treated differently than others. So there is no bias in the model that would effect some hour-level predictions and not others.
12	PG&E, BayREN	Excluded Data	F-3	"Res Euc Basic Path Interactive Measure Rollup" categorized under PG&E HUP with n=1788	Could DNV GL please explain the decision to keep only 38 of 1788 HUP projects, ie 2%?	The tables in Appendix F were updated. In the final report.

13	PG&E, BayREN	Excluded Data	32, 35	PG&E participation counts as shown in tables 13 and 14	According to PG&E's program data, participation counts for 2015 are: HUP = 1818 (vs. DNV GL's count of 38), AHUP = 1832 (vs. DNV GL's count of 2419). Could DNV GL please explain how data was categorized by program and how this discrepancy may have impacted the results of the analysis?	DNV GL used a HUP/AHUP classification that was provided by PGE in a file we received from PGE in early January, 2017. We have recently learned that this classification was incorrect for a large number of participants. This can potentially significantly affect the results.
14	PG&E, BayREN	Excluded Data	D-5	Data Editing Steps	Could DNV GL please provide more detail on how Account and Premise IDs were linked to Service Agreement IDs and usage data?	The CPUC tracking file provides the accounts numbers and claim ids of all HUP and AHUP claims that were submitted by the PAs. DNV GL requested data from each PA that provided the claim id, account, premise id and service agreement id. In some cases, a PA could only provide account because claim id was not on their internal files. Then DNV GL would link usage data to participants by account, premise id and service agreement id.

15	PG&E, BayREN	Excluded Data	D-6	Since most Home Upgrade projects occurred later in the program cycle most customers were excluded because they did not have sufficient data available in the post-period due to the timing of the consumption data files that were used.	This presents a significant challenge to evaluating the program in this report and any future efforts. As with many energy efficiency programs, there tends to be a spike in participation towards the end of the year. If those participants are excluded from evaluations, it may introduce bias to the analysis. Could DNV GL please note an alternative where late in the year participants are included?	Two alternatives that CPUC and those interested in this program might consider are: (1) Post-poning the evaluation a few months so that more of the the late-in-the-year participants could be included. (2) Consider a continuous billing analysis evaluation of the program. This could be done monthly, or perhaps quarterly and would entail obtaining consumption data from each utility for all participants on a regular basis (monthly or quarter). An independent evaluation team could link up appropriate weather and other auxiliary data for the time period and essentially re-run a billing analysis on a regular basis with the new data appended to all input analytic files. This would also be an effective way of quickly identifying participants that erroneously have no consumption data, e.g. maybe because of a fauly account number or a faulty claim id. Continuously revised predictions of the impact of HUP/AHUP could therefore be made available on a regular basis.
16	PG&E, BayREN	Excluded Data	B-1	Table 35, 36: disposition of household counts for electric and gas from CPUC tracking file	Over 50% of the data was excluded due to "Not Enough Usage Data." Could DNV GL please explain why so many participants were excluded from the evaluation? Were the inclusion criteria appropriate?	Table 35 - Mike need to add more detail to this table.

17	PG&E, BayREN	Excluded Data	18	Evaluation results are shown for 2015 projects. To increase the sample size and provide points of comparison however, this evaluation included projects from 2013, 2014, and 2015.	Would DNV GL please explain what it means to have done the analyses for 2013-2015 but the findings are presented for 2015 only? Were the analyses for 2013-14 thrown out? If not, those findings should be presented.	The ongoing concern with performing a billing analysis for the home upgrade program has been the sample size. To mitigate that, we inlcuded homes from the 2013-2014 program as part of the estimation process. Most were 2014 and overlapped with the 2015 program for billing data. The results were generated for 2013, 2014, and 2015. Since results were applied only to 2015, only the 2015 results were reported. In general, 2015 alone had higher savings than 2013, 2014 or 2013-2015 combined.
18	PG&E, BayREN	Evaluation Findings	15	Review the electric and gas assumptions and calculations in the EUCA model for reasonableness relative to customer bills. Typical savings should be about 5% to 10% of annual usage.	The prototypes used to develop the deemed home upgrade energy impacts were calibrated to the baseline billed electric and gas usage of early program participants. Annual consumption for those prototypes is in the range of 6,000 to 10,000 kWh and 600 to 800 therms (varying with climate, size of home, vintage, presence of AC). A recent cross-PA analysis found average claimed HUP savings of 460 kWh and 60 therms, falling within the expected 5-10% of usage. Could DNV GL explain the difference to their findings?	The DNV GL approach statistically compared usage data before and after the blackout period. We did not use any engineering models and can not speak to the cross-PA analysis. We understand there seems to be a historical disconnect between engineering simulation models and comparisons using meter or billing data and this is one topic that needs further study.
19	PG&E, BayREN	Evaluation Findings	31	Table 12. Average savings per household (before updgrade vs after)	The BayREN therm % shown in the table would seem to suggest that bay area homes' baseline use is around 2,000 therms per year. That seems very high. Could DNV GL please clarify?	
20	PG&E, BayREN	Evaluation Findings	39	Table 17. HUP therm program savings 2015	As with table 12, BayREN therm % savings do not look correct. Could DNV GL please	

					clarify?	
21	PG&E, BayREN	Evaluation Findings	14	HUP savings	The savings analysis utilized 16 prototypes (or 80 if you include home size variations) situated in 6 different climates. Savings by PA will certainly differ due to climate. For more detail, see page 18 of the work paper. We recommend that DNV GL perform a reasonableness test on their findings and check against the work paper prior to publication.	Understood. Many variations based on three prototypes. Report text was modified to not imply only three point estimates
22	PG&E, BayREN	Evaluation Findings	11	1.5.4.1 Treatment measures	The treatment measures and climate zones would be more accurately described as correlating with the results than explaining the results. Further investigation is needed to explain the results. At this point, possible explanations should include errors in data or analysis or physical and behavioral changes to participant homes such as adding/increasing air conditioning (non-rebated) at the time of a home upgrade.	Yes - this report tries to shed light on correlations. For savings estimates, evaluation used the available data and modeled it using conventional methods. We then fielded a survey of particpants and linked those results to useage estimates where possible. Due to data limitations and small survey sample sizes, the results highlight correlations to be considered further rather than definative causal findings.
23	PG&E, BayREN	Evaluation Findings	Append J		The report places more emphasis on electric results than natural gas results and tends to make statements about the full program based on the electric results. This is inappropriate, as the program produces higher gas impacts. For example, calculating the percent impact on whole home energy usage is more appropriate than on electric alone.	Yes, the program tended to perform better on gas savings than electric, but neither fuel savings provides a resounding endorsement of the program. Recommendations have been split between gas and electric

24	PG&E, BayREN	Clarification	8	Table 2 Budgets and Spending	Please note that for PG&E the budget and spending figures include both single and multi-family Energy Upgrade California as they are part of the same subprogram (EEGA 21004).	Thank you for the clarification. This impact evaluation does not calculate cost effectiveness, but a footnote on costs was added to the report.
25	PG&E, BayREN	Clarification	C-1	Net to gross surveys: tables 37-39	Could DNV GL please provide the response rate for each PA? It is odd that PG&E did not have 5 participants who took the survey.	Response rates are provided on the Tables tab and added to the report.
26	PG&E, BayREN	Clarification	21	Table 7. Incentive Levels	The rebate maximum values provided appear to be for the 2017 program year. The correct values for 2015 AHUP are $6,500.	Thank you. Report updated
27	PG&E, BayREN	Clarification	11	A related issue is the high-level and inconsistent reporting of measure data across the PAs that hampered a solid analysis of specific measure combinations that produce the most savings. For example, measure descriptions such as, “Comprehensive Whole House Retrofit” or “AC >= 14 SEER/12 EER, Replacement Ducts Seal <= 6%, Furnace AFUE >= 95%, Duct Insulation” are not complete or consistent enough to develop measure or bundle level	The measure name presented represents a complete description. The combination of measures is easily understood based on the measures detailed in the program work paper. Could DNV GL clarify what other information is necessary to add to the measure description?	The report highlights the fact that each IOU reports the measure differently. See report Appendix F for examples of what the evaluators receive. This makes comparing savings bundles or their componenets impossible. The report language has been modified and the recommendations limited to specific utilities.

				savings.		
28	PG&E, BayREN	Clarification	14	For HUP, the evaluated savings were far below the PA reported savings and the overall average realization rate was -11% for kWh, 8% for kWh and 91% for therms.	HUP savings paragraph lists kWh twice. The second should probably be kW.	Thank you. Text edited.
29	PG&E, BayREN	Clarification	14	Savings influences	The comparison to home energy reports and smart thermostats is irrelevant. The interventions here are completely different.	Yes the interventions are completely different, and the costs to the particpant and for the program are completely different, yet the percent savings are about the same. This is worth noting as part of any EE portfolio design activity.

1	SCE	Data reporting/ quality			Southern California Edison has provided the CPUC Energy Division staff an updated program tracking spreadsheet for SCE's HUP. This sheet contains corrected data. It was discovered that reported project savings were 2,3 or 4 times higher than their workpaper solution code counterpart. Program data being submitted to the reporting team listed quantities that reflected the number of measures installed on a project instead of listing quantities to reflect a single whole home project itself which resulted in an overstatement of savings. For example, if 4 measures were installed in a EUC project the savings were recorded 4 times instead of being counted once (on a single project basis.) Based on internal calculations based on corrected data, reported average kWh claimed savings should be 218 and not 783. Also, reported average kW demand claimed savings should be 0.42 and not 1.32. Additionally, 5 projects were found not to have associated energy/demand savings claims. SCE requests that this corrected data be forwarded to the DNV-GL impact evaluation team for the Home Upgrade Program and adjust the realization rates accordingly.	This updated tracking spreadsheet does help explain the very low realization rate found by the evaluation. Unfortunately, the CPUC program tracking data for 2015 programs was locked down in October 2016. We cannot include SCE's updated numbers, but can add a footnote that program data susequently was updated.

1	SCE	Method			There are a lot of stages and models with a lack of the actual flow of the process. What happened when and how was it done? Additionally, there seems to be a serious lack of understanding of the modeling approaches used here. Please consider scheduling a walkthrough of the approach step by step at a high level for the IOU and CPUC Energy Division staff.	DNV GL is working with ED to develop a presentation to collaborate with CalTrack
2	SCE	Method	D-11		What weights were used in the analysis? (pg D-11) How do we know these are reflective of the actual characteristics of the population of homes?	Weights were computed for those households used in the billing analysis to account for households that were eligible for the evaluation and could not be used in the billing analysis for various reasons, e.g. they did not have sufficient data in pre/post periods. Variables used in the weight adjustment were categorized versions of reported kWh, kW and therm gross as well categorized versions of some of the neighborhood characteristics from the American Community Survey such as percent owner occupied, number of units in the structure, housing distribution by number of bedrooms and year structure built. Separate weights were constructed for the HUP/AHUP samples as well for electric (kWh) and gas (therms).

3	SCE	Method			How can there be day of the week indicators in a model estimated by day? Is this part of the rolling 15-day window in the model?	Yes. The parameters in each day-specific model were estimated using the consumption for that calendar day, as well as the data for the 7 days pior to and the 7 days after the target day. One reason for doing this was to capture a day of the week effect.
4	SCE	Method			How appropriate are site specific fixed effects in what is basically a cross-sectional model? There is 1 dependent variable observation for each home in each model? Or multiple? Unclear. Or is this more of a 15 day rolling CSTS?	There is one site specific fixed effect in the model, which basically serves as an intercept. On average, each site (home) contributes 15*24 data points in both the pre and post periods in each of the day-level kWh models. So each site contributes 720 data points to each day level model.
5	SCE	Method			Why is this a daily cross-sectional model and not a premises longitudinal model?	Separate models are fit for each day, thereby making this a daily cross-sectional model.
6	SCE	Method			Are the R-squared values reported adjusted R-squared or simple R-squared? The fact that not all variables end up being included in every model might be driving the changes in R-squared.	The R-squares in the draft report were reported incorrectly. The adjusted R-squares appear in the final version.
7	SCE	Method			Why is R-squared used and not, at least in addition to, other model fit scores? E.g. Bayesian Akaike Information Criterion. R-squared is designed for a true linear AND continuous relationship. Is usage truly continuous from negative infinity to infinity? Hypothetically, close enough but realistically the data generating process is not like this.	R-squares were chosen because most analysts are familiar with this statistic. Other model fit statistics could have been developed but were not. For furture studies these can be specified during the comment period for the research plan.

8	SCE	Method			For the number of variables being used, and for what is basically a fitting exercise, the R-squared is low.	The R-squares reported in the draft report were updated for the final. R-squares remain low, but were updated in the final report.
9	SCE	Method			The distinguishing feature (well, maybe it's just my opinion) of PRISM (pg. D-7) is NOT using weather as predictors BUT instead the calculation of optimal base values for each premise.	PRISM uses weather data to identify weather-correlated load. This flexible regression specification identifies optimal degree day bases precisely so that the non-weather-correlated load (baseload) is estimated in the most effect manner.
10	SCE	Method			There needs to be a fix for the blackout period. SCE's average is 179 days! Pg D-6 reference source not found.	The blackout period is reported by the IOUs and is contained in the CPUC program tracking data.
11	SCE	Method			Please stop calling analysis of meter data "billing analysis".	"billing analyisis" is a generic and industry accepted term. SCE can recommend a preferred term through the residential PCG for use in future evaluations.
12	SCE	Method			Using participants that enroll after a certain period as control is theoretically sound. But please include detailed analysis of the groups.	There are not really "groups". Just the particpants. DNV GL used a pooled fixed effects model, not a two-stage approach.
13	SCE	Method			It's unclear how exactly the "Control" group was used. This isn't a 2x2 difference-in-difference design in any way I can tell.	Participants that participated later are being used at the "control" group for those that participated earlier.
14	SCE	Method			There need to be more site-specific characteristics included in all this modeling. Relying purely on average usage through fixed effects is hiding potential effects of home characteristics interacting with weather. Right now, we have no useful information from this report that can inform the programs on how various baseline	The current models include a separate intercept term for each site (home). Additional site-specific variables are therefore redundant. A different type of evaluation approach is needed to estimate the effect of household characteristics and specific program measures on consumption.

					conditions interact with home upgrades and weather.	
15	SCE	Method			Why are there no confidence intervals for anything? Dozens of plots and charts, but I don't see any reporting of useful confidence intervals nor much discussion of raw data and estimate distributions.	All savings estimates were statistically significant. These are now reported in report Appendix F
16	SCE	Method			How is this analysis controlling for normal trends over time?	By using participants that participated later as the "control" group.

1	SDG&E, SoCalGas	Overarching	Overarching Comments: Thank you for the comprehensive 2015 HUP and AHUP program impact evaluation study. We have the following overarching comments: (1) The customer segmentation analysis of “Gainers” vs “Savers” indeed provided indicative information about program participants. This new information is insightful but not actionable at this time. We recommend incorporating the survey data (i.e., square footage of the house) to calculate Energy Usage Intensity (EUI) values for these segments. It is possible that EUIs can provide additional insights. The benefit of using EUIs is that the values are something the program team can generate to help improve program targeting. (2) We do not agree with all the conclusions. The climate zones may have a significant impact for program results, but EUIs present a clearer picture. You can have a high usage household in a hot climate zone and still be very energy efficient. (3) Concerning the recommendation to improve software accuracy—this is problematic, since the IOUs invested efforts into CALTest to improve software accuracy already. We recommend that ED/DNV-GL do an analysis of a few cases using the current program results against a robust engineering model such as DOE-2 to see if the software accuracy problem can be validated. (4) We recommend restructuring all future impact evaluations by using a quasi-experimental design with propensity to match analysis. The current participants compared against future participants without any propensity to match is not a good study method, since it does not control important variables that may impact the results of the study.	1) Agree. The information is directional, but not definative. 2) True that we did not have all the data necessary to evaluate projects at the sq ft level - only at the home level. The recommendation in this report can be qualified. EUI can be a feature of the next impact evaluation, or a seperate study. 3) Follow-up with CalTrack is worthwhile if ED or IOUs have fundings for additional research 4) We agree that future impact evaluation can be done differently. The current method looks at overall trends, but does not perform a 2-stage comparison between past and future participants.
2	Same	Page.5	Please make it clear that the authors are referring to “gross realization rate” in this section.	Report text addressed
3	Same	Page.7	Thank you for the pre- and post- billing analysis as well as the Participant vs future participant billing analysis. At this time, it is clear that this program is not generating a lot of energy savings. However, it is still not clear if the software tools (already vetted by CALTest) are contributing to the poor gross realization problem. We recommend that ED/DNV-GL do a small sample analysis (perhaps, pick a few projects with large savings) and use an engineering approach to verify energy savings accuracy as part of this impact evaluation. This is especially important since one of the recommendations is to improve software tool accuracy when the IOUs	DNV GL is willing to work with the CalTrack team to provide data necessary.

			already invested in the CALTest analysis.	
4	Same	Page.23	Since the beginning of the HP impact evaluation, starting with 2010-2012 program cycle, we have been concerned about the approach of using program participants to compare against future program participants, without any fitness analysis. This analytical approach is flawed. We have repeatedly recommended that DNV-GL review this issue but have received no resolution. We recommend ED/DNV-GL restructure all future HP impact evaluations by using a more stable methodology such as quasi-experimental design with propensity to match in order to ensure the comparison group is well matched. We understand your argument concerning the lack of program results using pre- and post- billing analysis as well as using this comparison to match group analysis. It may still be a good idea to match non-program participants using a propensity to match approach to do this billing analysis. At this point in time, we have multiple concerns here about the HUP program: (1) Poor realization rate due to software tool (but, the IOUs have initiated CALTest effort), (2) Lack of training for the program implementers to properly estimate savings, (3) There are more people in the program seeking comfort thus exhibiting energy savings take-back, (4) The climate zone is an overwhelming concern for program results, (5) Concern for impact evaluation design and approach. (6) Need to perform solar account analysis and exclude those data from the analysis. Customers may become net-meter accounts after completing the HUP and AHUP upgrades. These accounts should be removed from the billing analysis. It would be good to do some additional work to remove some of the above variables so we can focus on key issues.	We agree there are several issues confounding deeper understadning of the home upgrade program. These issues can be addressed beyond 2015 through, 1) up-front program and evaluation design that facilitates a matching approach 2) more complete and accurate project data collection and reporting 3) linking customer solar installs to Home Upgrade

<table>
<tr><td>5</td><td>Same</td><td>P.26</td><td>Given the sampling design for the self-reported survey, can you talk about what actions were taken to minimize self-selection bias, especially for a web survey? Did you try multiple attempts to reach these respondents?

Table 10. Home Upgrade survey sample disposition
<table><tr><th colspan="2">Description</th><th>Number</th><th>Percent</th></tr><tr><td>Original sample frame</td><td>all Program participants</td><td>10,148</td><td>100%</td></tr><tr><td>Click-through</td><td>those who responded to the survey (partial and complete responses)</td><td>944</td><td>9.3%</td></tr><tr><td>Completes</td><td>eligible respondents who completed the entire survey</td><td>622</td><td>6.1%</td></tr></table></td><td>The survey was sent to a census of Home Upgrade particpants, but in waves. DNV GL issued an invitation and three reminders. The chance to win a $100 gift card was added to later waves, with odds of winning presented as 1 out of 100.
Interestingly, several respondents asked why they received the survey and claimed no knowledge of an upgrade to their home other than solar panels.</td></tr>
<tr><td>1</td><td>SoCalREN</td><td>14</td><td>Typo identified in HUP savings on page 9: "For HUP, …the overall average realization rate was -11% for kWh, 8% for kWh, and 91% for therms." In Table 4 on Page 9, the average realization rate listed is [+]11% for kWh, and 8% for kW. It is listed later in the report as -11% again.</td><td>Thank you. Report text modified.</td></tr>
<tr><td>2</td><td></td><td></td><td>The current draft report states (on HUP savings): "This calculator…uses simulation savings estimations for three prototype buildings. …using these three protoypes indicating there should be more consistency in reported savings across PAs." The statewide HU calculator has several inputs that affect energy savings: Climate Zones (CZ) (CZs are grouped and used as one CZ to represent several), home vintage (3 groupings), foundation type, number of stories, if a home has central furnace vs wall furnace, central AC or no, water heating by gas or electric. The variety of CZ may be the most important difference, SoCalREN recommends the draft report should emphasize this point when describing HUP savings.</td><td>Yes - we understand there are multiple variable applied to the prototypes. Report text updated to provdie this clarity.</td></tr>
</table>

3	SoCalREN	15	Data quality: "Only one IOU (SDG&E) was able to provide the simulation model detail data DNV GL requested for AHUP projects in a timely manner." SoCalREN recommends that the draft report be ammended to add clarification that this report contains a large deficiency in the collected data.	The data referenced in this paragraph was detailed data on home characteristics (pre/post sq ft, vintage, etc) and AHUP simulation model project files. This did not affect the number of homes in the sample or access to billing data, but it did limit the ability to dig deeper into the causes of the savings estimates. The text has been modified to be more clear on what data was not porvided.
4	SoCalREN	15	Data quality: "Missing or bad account numbers…particulary from single fuel utilities with duel fuel projects that span more than one service territory" -- SoCalREN Question: Does this include utilities that are not contributing to the incentive funds (e.g. municipal electric providers other than LADWP, such as Pasadena Water and Power, or other natural gas providers such as SouthWest Gas)? SoCalREN projects always verify participants SCE and SoCalGas accounts.	This program has a reputation for missing or bad account numbers. One reason is due to savings reported from muni accounts (that are not identified as muni accounts). Other reasons include, added digits at the front or back of the true account number, truncated numbers or blank account fields.

5	SoCalREN	16	Recommendations, Savings influences: "Adding a behavioral component is a new recommendation and will require additional study to effectively be incorporate into energy savings estimates." This recommendation would be problematic due to behaviorial program requirements adopted in D.12-11-015; SoCalREN recommends this recommendation be removed due to current EE approved policies.	Evaluation recommendations are not formal directives. Behavior seems to play a significant role in energy savings for this program and should continue to be factored in to program design in some form. This can be in marketing material, contractor messaging, discounted ex ante savings estimates or other approaches.
6	SoCalREN	16	Recommendations, Savings Influences: "underscoring immediate customer benefits in contractor messaging (comfort, savings, safety)" This is already done in program-produced marketing materials and SoCalREN recommends this should be indicated as such in the report.	Report text modified to be more specific on this point
7	SoCalREN	18	"Evaluation results are shown for 2015 projects. To increase the sample size and provide points of comparison however, this evaluation included projects from 2013, 2014, and 2015." There were changes in the HUP energy savings calculations in this time period. SoCalREN is concerned that utilization of these additional data points could have had a significant effect on findings. The Report should include a caveat note warning reader of this implication.	The evaluated savings are independent of the PA reported savings. However, realization rates are a combination of both. A footnote has been added to include your point on calculation methods for SoCalREN.

8	SoCalREN	19-20	**Correction needed**: While SoCalREN offers many programs throughout the 12 counties listed, it only offers HUP in Los Angeles County to customers with both SCE and SoCalGas. Figure 5 "Home upgrade program service areas" incorrectly identifies SoCalREN HUP service areas as all 12 counties; it should instead show only portions of LA County for SoCalREN HUP service area (see map: http://tenres.com/wp-content/uploads/2015/03/TEN_Coverage-Map_0071116.pdf). "SoCalREN operates in 12 counties in southern California and parts of central California. These counties are Los Angeles, Orange, Ventura, Santa Barbara, Riverside, San Bernardino, Kern, Tulare, Inyo, Mono, and portions of Kings and Fresno. In northern California, there is a clear distinction between an IOU service area and REN service area. In southern California, the boundaries between PAs is less clear. In Figure 5 illustrates the IOU and REN service areas. The multiple patterns illustrate the potential confusion for customers and contractors particularly in southern California. Customers may not know who is offering the program and contractors may not differentiate on what data to collect and report for specific fuel types."	Correction noted: SoCalREN offers HUP in LA County only. Map updated in report
9	SoCalREN	20-21	**Correction needed:** Page 20 footnote 14: "BayREN offers an additional $150-$300 rebate for combustion testing after the upgrade is complete." Page 21: "Incentives are paid through the IOUs using IOU program dollars. BayREN provides up to $300 to pay for home audits and safety inspections for customers in their service counties that choose the AHUP path offered through PG&E." SoCalREN also offered $300 for comprehensive assessments for HUP in both SoCalREN and SCE and SoCalGas programs, as well as for AHUP in SCE and SoCalGas programs at least since July 2015. SoCalREN also offered $150 combustion safety testing bonus for projects submitted 4/1/14-7/21/15.	Correction noted: SoCalREN offers additional rebates for combustion testing

10	SoCalREN	20-21	**Correction needed:** Advanced Home Upgrade: "AHUP upgrade incentives have a tiered structure similar to HUP but can increase to $5,500 ($6,500 for SoCalGas) depending on the level of savings achieved (i.e. 10%, 20% or 30% savings)." HUP in SoCalREN and SCE and SoCalGas did not have tiers in 2015. AHUP did not have incentive maximums in SCE and SoCalGas in 2015 -- the marketing listed "up to $6,500*" for both SCE and SoCalGas programs but the * noted incentives could exceed that amount based on energy savings. Table 7 incorrectly lists AHU incentive maximums for SCE and SoCalGas (it's possible PG&E and SDG&E AHUP may also not have had incentive maximums, either).	Correction noted: The incentive levels for AHUP technically can exceed $6,500
11	SoCalREN	26	"The survey included questions on the following:...Changes to operating conditions in the household – lighting use, heating use, appliance use, occupancy etc." ---these occupant behavior changes may explain some of the difference between reported savings and evaluated savings. SoCalREN recommends a copy of the complete survey be attached to this report as an appendix to assist the reader. Only a few of the survey questions are listed within the report (to calculate free-ridership).	Survey attached. This survey also is available on Bascamp. It was posted for comments early in the project.
12	SoCalREN	30	"The majority of AHUP project in the Los Angeles region are SoCalGas projects." How is the report distinguishing between an SCE project and a SoCalGas project? Most likely majority of the AHUP projects in the LA area are in fact projects in the Joint SCE/SoCalGas program. Is the report counting all projects with SoCalGas (including SCE or Public electric utility) vs. all projects with SCE (almost all of which also have SoCalGas, though a small percentage have Long Beach Gas & Oil, all-electric, propane, or SouthWest Gas)? This statement and the identification of the majority of AHUP projects in the LA area in Figure 7 as SoCalGas projects maybe misleading.	Yes. Many of the LA area project were joint projects between SCE/SCG. They are necessarily reported that way. For example, SCG may report a project that includes electric and gas savings. Similarly, SCE may report a project with electric and gas savings. The challange to to identify the fuel supplier (either by account number or ZIP code), match to avalable billing/meter data and avoid double counting of savings. This is not a trivial exercise.

13	SoCalREN	32	Figure 8 shows negative energy savings from 11 p.m. to 2 p.m. -- what causes the energy savings to be negative during these hours? Is this based on the energy use of an upgraded home compared to its energy use before the upgrade? SoCalREN recommends additional explainatory narrative should be included on Figure 8. (Similar type of chart for AHUP is Figure 10, which lists this possibility for it: "The billing analysis cannot give reasons for this pattern, but possibilities include new thermostat settings and heating systems working correctly.")	additional text added
14	SoCalREN	34	"May through September is the exception showing a predominant increase in usage (negative savings). This pattern is similar for all PAs and may be due partially to the phenomenon known as “snapback”. Once people upgrade their homes, they want to enjoy the added comfort and expect the upgrade investment to offset their utility bill. This concept is addressed in section 4.5 later in this report." **Correction needed:** statement is not addressed in 4.5 in the report.	Report text modified for clarity.
15	SoCalREN		**Typo** in the values: "At the household level, SoCalREN experienced the largest kW savings. This PA had savings of 0.22 kW. BayREN and PG&E experienced similar results with savings of 0.4 kW and 0.6 kW respectively." Table 15 lists these values as 0.04 kW for BayREN and 0.06 kW for PG&E.	Thank you. Report text modified.
16	SoCalREN	41	"PAs reported savings for HUP for approximately 90% of households; with savings ranging between zero (0) kWh and 1,999 kWh. The reported annual savings per household ranged from 12,370 kWh to an increase in usage (negative savings) of 3,452 kWh." These two statements conflict with each other. The report may need to be corrected so that the statement is similar to that of the AHUP: "For AHUP, PAs reported 1,257 kWh average household savings per project. In this path, **approximately 90% of household reported savings were between zero kWh and 3,499 kWh**. Reported annual savings per household ranged from 17,750 kWh to an increase in usage (negative savings) of 15,220 kWh."	Thank you. The report text was edited to be more clear.
17	SoCalREN	41	"The full HUP distribution is illustrated in Figure 15." **Typo** Figure 15 is for AHUP, not HUP.	Thank you. Report text modified.
18	SoCalREN	42	"The program does not operate in insolation." Report statement should say "isolation". This **typo** may cause initial confusion because insolation (sun exposure) does affect the energy savings and is taken into account in the energy models.	Thank you. Report text modified.

19	SoCalREN	46	"For HUP we estimated overall savings in only seven of the sixteen climate zones. These were climate zones, 10, 11, 13, 14, 15 and 16. ...Among these seven climate zones with estimated energy savings,..." Only six climate zones are listed in this paragraph, correction maybe needed to add the omitted CZ.	Thank you. Report text modified.
20	SoCalREN	47	"Despite the AHUP projects being dispersed across all climate zones we estimated overall savings in twelve of these climate zones. These were climate zones 4 and 6 through 16. Most of these tend to be warmer climate zones within the state. Within these eleven zones,..." **Ommission:** Twelve climate zones are mentioned twice, then the report refers later to only eleven. Report may need to be ammended to correct this ommission.	Thank you. Report text modified.
21	SoCalREN	55	HUP net savings: "The difference from reported gross savings to evaluated net savings are due almost entirely to the low realization rates estimated from this evaluation." SoCalREN Question: How much of the low realization rates are due to snapback, changes in occupancy, and increasing electric load from new devices added to the home?	This is a key question and one that we attempted to answer give the data we had. In the survey asked about changes in occupany, changes in square footage, changes in equipment/appliances. It is also possible solar installations played a role. For example, occupants of a home with net metering may be less inclined to try and save energy than a home fully dependent on energy purchases. The analysis looked at changes in energy usag, but did not factor in net solar generation since our data on solar was

				incomplete. These are prime topics for any future study of AHUP/HUP

22	SoCalREN	63	SoCalREN recommends that recommendations should be removed if they are already being comepleted. For instance some of the recommendations provided in the following report are already currently done:· Verify the household account numbers for each fuel type and identify service provider **[SCE, SoCalGas, and SoCalREN currently verify SCE and SoCalGas accounts, and SoCalGas also completes this for LADWP accounts. Projects do not move forward without passing these account verifications. Long Beach Gas & Oil may do their own account verification independent of our program. Other electric and gas service providers (in SCE and SoCalGas programs) do not contribute to paying incentives or any other implementation tasks with the program thus verification of account information would not be needed.]** · Collect home vintage. Different building codes and techniques will affect savings differently and may help improve program targeting. **[Currently being completed by SoCalREN, SCE and SoCalGas]** · Collect home square feet and number of floors before and after the project **[Per the report, very few projects involve an increase in square footage. SoCalREN would like to note that if the project intake tools could create a default to keep the before and after square footage and number of stories the same, and only need input from the contractor in cases where they change, then this would not be a great burden to contractors, though updating the intake tools and databases and program documents would incur some expense]** · Develop a consistent definition for project duration. DNV GL recommends project start date as “date of contract signing”. For end date, we recommend “project inspection date” · Verify a sample of installations - particularly in coastal climate zones **[This is currently done via the inspection process. HVAC and DHW equipment efficiency is not tested during the inspection but the manufacturer's specification information is used. Air sealing and duct sealing and insulation values are verified.]** · [HUP]Review the electric and gas assumptions and calculations in the EUCA model for reasonableness relative to customer bills. Typical savings should be about 5% to 10% of annual usage. If possible, compare a sample of projects in EUCA and EnergyPro or eQuest for consistency of savings estimates. **[This is currently what the statewide HU calculator energy savings are based on]· -[AHUP]: Collect and review model inputs and outputs from contractors using simulation software:** · Check for square feet and vintage information **[This is currently being captured within the program]**	Recommendation modifed to imply "do" or "continue to do".

			· Check for number and type of measures installed **[This is currently being captured within the program]**	

23	SoCalREN	64	Data quality recommendations: Track and report the number and types of measures being installed in homes. This may require more detailed record keeping. For AHUP, this means collecting the contractor building simulation files and performing quality reviews before committing funds to the project.**[This is currently being done by SCE and SoCalGas]** At minimum, reviews should include a check for, · general data entry errors · duplicate records and associated savings · durations between project start and stop dates greater than six months [**SCE and SoCalGas currently track projects with no acitivity after 3 months and place them in a special "Pending Contractor Action" status which will in turn a engage a follow up process]** · extreme values in general · Savings for same measures reported under multiple programs **[previous and simultaneous participation checks are performed for SoCalGas projects, and previous participation checks are performed for LADWP projects]** For AHUP projects in particular, a reasonableness review of savings should be performed by PA program staff on a sample of projects from each contractor to rule out systematic bias caused by misuse of the software, data entry errors, or errors transferring data from model output to program form. **[Every AHUP project in SCE and SoCalGas currently undergoes this review]**	Noted. DNV GL GL commends SCE and SoCalGas for the efforts on data completeness and quality. The recommendations are valid and apply to all PAs for all program years. The fact the SCE and SoCalGas already perform these tasks increases the accuracy and any future impact evaluations or other analysis.
1	NRDC		**Billing analysis resulted in very low R- squared values**: The R-squared values of the statistical billing analysis are extremely low (~ 0.15 for electric savings) despite the large number of explanatory variables applied (more than 700). Although R-squared values are not the only determinant of a successful statistical analysis, such low R-squared values necessitate further investigation and explanation. It is disappointing that these data-fit statistics are not stated in the executive summary or the results section of the report and nor were they shown during the evaluation's public presentation webinar. NRDC's intent is to better understand the study before judging the validity of the evaluation. At a minimum, the report should explain why the evaluation results are valid considering these poor data fit statistics.	The R-squares were reported incorrectly in the draft report and while still considered low for a billing analysis, are revised up in the final report.

2	NRDC			**Application of billing analysis:** Section 1.2, Table 1 shows that that historic program evaluated savings were estimated to be (mostly) fewer than 5% of pre- energy consumption. Section 1.2 further states that: "For billing analysis involving the entire home, one argument made is that changes of five percent or less may reflect only random fluctuations in the meter data and are not definitive changes. This may or may not be true, but it does point out one important characteristic of the home upgrade program – either electric savings are too small to measure accurately or, the program produces very small changes in household electric energy usage" Considering the historical evidence of program savings being possibly too low to determine via billing analysis, an explanation of why a billing analysis only methodology was chosen to evaluate this program is required. A better understanding of the program's impacts may have been gained from limited and targeted primary data collection and measurement based evaluation.	The decision to use billing analysis for the 2015 program was mostly a legacy decision. Prior analysis was done that way and current analysis was to be comparable with past analysis. Low savings results typically are characterized as poorly done studies. Given the current understanding of the program learned from implementation and evaluations, future evaluations should consider a different approach and program design should incorporate data needs for other approaches. For example, SDG&E suggests a "matched" comparison group. The match accurately on characteristics other than energy consumed, more complete customer or project data should be available (e.g. pre/post sq. ft., contractor, solar installs, vintage, orientation, etc.). Other options include master and sub metering for a sub sample.

About DNV GL

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